The Little Gold Mine.

CONKLIN'S HANDY MANUAL OF THE MECHANICAL ARTS AND HOUSE PLANS

CONTENTS.

BUILDING DEPARTMENT.

PLANS.

FACTS ABOUT PRESIDENTS.

INTERESTING HISTORICAL TRUTHS NOW SELDOM THOUGHT OF.

The table below gives at a glance the political history of the Presidents. The letter "o" signifies that the President whose name is opposite filled the specified offices before he was called to guide the ship of State:

NAMES.	Born.	Military Rank.	Legislature.	Congress.	Governor.	U. S. Senate.	Cabinet.	Minister.	Vice Pres.	Minor Offices.
Washington.	1732	Com	o	o	..	..	......	..	..	....
Adams......	1735	......	o	o	..	..	......	o	o	....
Jefferson....	1743	......	o	o	o	..	State .	..	o	....
Madison....	1751	......	o	o	..	..	State .	..	..	....
Monroe......	1758	Capt..	o	o	o	o	State .	o	..	....
J. Q. Adams	1767	......	o	o	..	o	State .	o	..	....
Jackson....	1767	Mj. G.	..	o	o	o	......	..	..	Judge.
Van Buren..	1782	......	o	..	o	o	State .	..	o	....
Harrison ...	1773	Mj. G.	o	o	o	o	......	o	..	Tr. Sec.
Tyler	1790	......	o	o	o	o	......	..	o	....
Polk........	1795	......	o	o	o	..	......	..	..	....
Taylor	1784	Gen ..	..	..	..	..	......	..	..	....
Fillmore....	1800	......	o	o	..	..	......	..	o	Com.....
Pierce......	1804	Bg. G.	o	o	..	o	......	..	..	D. Atty.
Buchanan ..	1791	......	o	o	..	o	State .	o	..	....
Lincoln.....	1809	Capt..	o	o	..	..	......	..	..	Post M.
Johnson....	1808	......	o	o	o	o	......	..	o	Ald.
Grant	1822	Com ..	..	..	..	..	War..	..	..	....
Hayes......	1822	Bg. G.	..	o	o	..	......	..	..	City Sol.
Garfield....	1831	Mj. G.	o	o	..	o	......	..	..	....
Arthur......	1830	Gen...	..	..	..	..	......	..	o	Col Pt.
*Cleveland..	1837	......	..	..	o	..	.....	..	..	Mayor.
Harrison ...	1833	Bg. G.	..	..	..	o	......	..	.	Ct. Rep.

* Clsveland was Sheriff and Assistant District Attorney.

Only three Presidents occupied office after vacating the Presidential chair — Quincy Adams, who afterward spent seventeen years in Congress; Monroe, who became a Justice of the Peace; and Johnson, who was elected United States Senator in 1875.

NUMBER OF WASHERS IN A BOX OR KEG OF 150 POUNDS.

Diameter.	Size of Hole.	Thickness.	Size of Bolt.	No. in 150 lbs.
½	¼	No. 18	3-16	80,000
⅝	5-16	" 16	¼	34,285
¾	5-16	" 16	¼	22,000
⅞	⅜	" 16	5-16	18,500
1	7-16	" 14	⅜	10,550
1¼	½	" 14	7-16	7,500
1⅜	9-16	" 12	½	4,500
1½	⅝	" 12	9-16	3,850
1¾	11-16	" 10	⅝	2,500
2	13-16	" 10	¾	1,600
2¼	15-16	" 9	⅞	1,300
2½	1 1-16	" 9	1	950
2¾	1¼	" 9	1⅛	700
3	1⅜	" 9	1¼	550
3½	1½	" 9	1⅜	450

TEMPERING STEEL PUNCHES.

The following method of tempering steel punches gives excellent results, especially when used for cold punching of machine horseshoes.

Heat your steel to cherry-red, dress out the punch, cut off the point the size of a horseshoe nail, then heat to a cherry-red, immerse it a half inch perpendicularly in the water, then take it out and stand it up perpendicular, clean the end with a piece of grinding stone. When you see the first blue pass over the point, dip it in the water the same depth as before. Clean it again with the stone, and on the appearance of the blue again, cool it off. The second blue is to make the punch tough. The reason for keeping the punch perpendicular is to allow the atmosphere and the water to cool all sides equally, and to have it cool straight and true.

HOW TO MAKE TRACING PAPER.

Take some good thin printing paper, and brush it over on one side with a solution consisting of one part, by measure, of castor oil in two parts of meth. spirit ; blot off and hang up to dry. You can trace by pencil or ink on this. I have tried it and done it.

EXPANSION OF METALS.

The length of the bar at 32° = 1.

	At 212°.	Expan. per deg. Fah.
Brass	1.0019062	.0000106
Copper	1.001745	.0000097
Cast Iron	1.0011112	.0000062
Steel	1.0011899	.0000066
Wrought Iron	1.0012575	.000007
Tin	1.002	.0000111
Zinc	1.002942	.0000163

DECREASE OF STRENGTH OF WROUGHT IRON AT HIGH TEMPERATURES.

Temp.		Decrease per cent. of	Tem.		Decrease per cent. of
Cen.	Fahr.	max. tenacity.	Cen.	Fahr.	max. tenacity.
271°	520°	.0738	500°	932°	.3324
313		.0899	554		.4478
332	630	.1047	599		.5514
350		.1155	624	1154	.6
389	732	.1491	669		.6622
440		.2010	708	1306	.7001

HOW TO MEND BROKEN BELTING.

According to Campe, broken belting can be re-united by the use of chrome glue. With a lap of four or five inches, the re-united part is apparently as firm as any part of the band, though it is well to take the precaution to tack down the ends of the lapped pieces with a few stitches of stout thread. The chrome glue is prepared in this way: Take 100 parts glue, soaked twelve hours in water, then pour off the sulphur water, melt the glue, add 2 per cent. of glycerine and 3 per cent. of red chromate of potash, melting them with the glue. This mixture, thinned by warming, is applied to the lapped ends after having been roughened with a rasp, and then placed between two hardwood strips in a vice and well pressed They should be left twenty-four hours in the vice to become thoroughly dried.

NOTES ON THE WORKING OF STEEL.

1. Good soft heat is safe to use if steel be immediately and thoroughly worked.

It is a fact that good steel will endure more pounding than any iron.

2. If steel be left long in the fire it will lose its steely nature and grain, and partake of the nature of cast iron.

Steel should never be kept hot any longer than is necessary to the work to be done.

3. Steel is entirely mercurial under the action of heat, and a careful study of the tables will show that there must of necessity be an injurious internal strain created, whenever two or more parts of the same piece are subjected to different temperatures.

4. It follows that when steel has been subjected to heat not absolutely uniform over the whole mass, careful annealing should be resorted to.

5. As the change of volume due to a degree of heat increases directly and rapidly with the quantity of carbon present, therefore high steel is more liable to dangerous internal strain than low steel, and great care should be exercised in the use of high steel.

6. Hot steel should always be put in a perfectly dry place of even temperature while cooling. A wet place in the floor might be sufficient to cause serious injury.

7. Never let any one fool you with the statement that his steel possesses a peculiar property which enables it to be "restored" after being "burned;" no more should you waste any money on nostrums for restoring burned steel.

We have shown how to restore "overheated" steel.

For "burned" steel, which is oxidized steel, there is only one way of restoration, and that is through the knobbling fire or the blast furnace.

"Overheating" and "restoring" should only be allowable for purposes of experiment. The process is one of disintegration, and is always injurious.

8. Be careful not to overdo the annealing process; if carried too far it does great harm, and it is one of the commonest modes of destruction which the steelmaker meets in his daily troubles.

It is hard to induce the average worker in steel to believe that very little annealing is necessary, and that a very little is really more efficacious than a great deal.

ALLOYS AND SOLDERS.

ALLOYS.	Tin.	Copper.	Zinc.	Antimony.	Lead.	Bismuth.
Brass engine bearings	13	112	¼			
Tough brass, engine work	15	100	15			
" for heavy bearings	25	160	5			
Yellow brass, for turning		2	1			
Flanges to stand brazing		32	1		1	
Bell metal	5	16				
Babbitt's metal	10	1		1		
Brass locomotive bearings	7	64	1			
" for straps and glands	16	130	1			
Muntz's sheathing		6	4			
Metal to expand in cooling				2	9	1
Pewter	100			17		
Spelter		1	1			
Statuary bronze	2	90	5		2	
Type metal from				1	3	
" to				1	7	
SOLDERS.						
For lead	1				1½	
" tin	1				2	
" pewter	2				1	
" brazing (hardest)		3	1			
" " (hard)		1	1			
" " (soft)	1	4	3			
" " "	2			1		

HOW TO MAKE HARD AND DUCTILE BRASS CASTINGS.

Two per cent. by weight of finely pounded bottle glass, placed at the bottom of the crucible in which red brass is being melted for castings, gives great hardness, and at the same time ductility to the metal. Porous castings are said to be almost an impossibility when this is done, and the product is likely to be of great service in parts of machinery subject to strain. An addition of one per cent. of oxide of manganese facilitates working in the lathe and elsewhere where great hardness might be an objection.

WEIGHT AND NUMBER OF SQUARE NUTS IN A BOX OR KEG OF 200 POUNDS.

Width.	Thickness.	Hole.	Size of Bolt.	No. in 200 lbs.	Weight of Nut.
1/2	1/4	7-32	1/4	14,844	lbs.
5/8	5-16	9-32	5-16	7,880	....
3/4	3/8	11-32	3/8	4,440	....
7/8	7-16	13-32	7-16	2,732	....
7/8	1/2	7-16	1/2	2,450	....
1	1/2	7-16		1,816	....
1 1/8	1/2	1/2	9-16	1,390	....
1 1/8	5/8	9-16	5/8	1,174	.17
1 1/4	5/8	9-16		898	.23
1 3/8	3/4	21-32	3/4	662	.3
1 1/2	3/4	21-32		538	.37
1 5/8	7/8	25-32	7/8	392	.51
1 3/4	7/8	25-32		326	.61
1 3/4	1	7/8	1	304	.66
2	1	7/8		224	.89
2	1 1/8	15-16	1 1/8	214	.93
2 1/4	1 1/8	15-16		152	1.32
2 1/4	1 1/4	1 1-16	1 1/4	143	1.4
2 1/2	1 1/4	1 1-16		108	1.85
2 3/4	1 3/8	1 3-16	1 3/8	83	2.41
3	1 1/2	1 5-16	1 1/2	65	3.1
3 1/4	1 5/8	1 7-16	1 5/8	51	4.
3 1/2	1 3/4	1 9-16	1 3/4	42	4.8
3 3/4	1 7/8	1 11-16	1 7/8	32	6.3
4	2	1 13-16	2	27	7.4
4	2 1/8	1 7/8	2 1/8	....	7 3/4
4 1/4	2 1/4	2	2 1/4	....	8 1/4
4 1/4	2 3/8	2 1/8	2 3/8	....	8 1/4
4 1/2	2 1/2	2 1/4	2 1/2	....	10 3/4
4 3/4	2 3/4	2 7-16	2 3/4	....	13 1/4
5	3	2 11-16	3	....	14

AMOUNT OF HEAT REQUIRED TO MELT WROUGHT IRON.

The temperature necessary to melt wrought iron lies between 4,000° and 5,000° F., and even at that tremendous heat, wrought iron is only rendered fluid by the addition of a small amount of aluminum.

WEIGHT AND NUMBER OF HEXAGON NUTS IN A KEG OR BOX OF 200 POUNDS.

Width.	Thickness.	Hole.	Size of Bolt.	No. in 200 lbs.	Weight of Nut.
½	¼	7-32	¼	17,332	lbs.
⅝	5-16	9-32	5-16	8,964	....
¾	⅜	11-32	⅜	5,016	....
⅞	7-16	13-32	7-16	2,988	....
⅞	½	7-16	½	2,674	....
1	½	7-16		2,160	....
1⅛	9-16	½	9-16	1,445	....
1⅛	⅝	9-16		1,310	.15
1¼	⅝	9-16	⅝	1,028	.2
1¼	¾	9-16		920	.22
1⅜	¾	21-32	¾	752	.27
1½	⅞	21-32		510	.38
1⅝	⅞	25-32	⅞	450	.44
1⅝	1	25-32		428	.47
1¾	1	⅞	1	372	.54
1¾	1⅛	⅞		336	.6
2	1¼	15-16	1⅛	211	.95
2¼	1⅜	1 1-16	1¼	159	1.26
2½	1½	1 3-16	1⅜	119	1.68
2¾	1⅝	1 5-16	1½	88	2.27
3	1¾	1 7-16	1⅝	69	2.9
3¼	1⅞	1 9-16	1¾	56	3.6
3½	2	1 11-16	1⅞	44	4.6
3½	2	1 13-16	2	43	4.7
4	2	1 13-16		29	6.9
3¾	2⅛	1⅞	2⅛	....	5½
3¾	2¼	2	2¼	....	5½
4	2⅜	2⅛	2⅜	....	6¼
4¼	2½	2¼	2½	....	7¼
4½	2¾	2 7-16	2¾	....	9¼
4¾	3	2 11-16	3	....	11½

HOW TO PREVENT GEAR TEETH FROM BREAKING.

Gear teeth generally have one corner broken off first, after which they rapidly go to pieces. This may be avoided and the teeth made much stronger by thinning down the edges with a file, thereby bringing the whole strain along the centre of the tooth. Gear teeth fixed this way will not break unless the strain be sufficient to break off the whole tooth.

DECIMAL EQUIVALENTS
of 8ths, 16ths, 32ds and 64ths of an Inch.

Fractions of an Inch.	Decimals of an Inch.	Fractions of an Inch.	Decimals of an Inch.
1-64 =	.015625	33-64 =	.515625
1-32 =	.03125	17-3 =	.53125
3-64 =	.046875	35-64 =	.546875
1-16 =	.0625	9-16 =	.5625
5-64 =	.078125	37-64 =	.578125
3-32 =	.09375	19-32 =	.59375
7-64 =	.109375	39-64 =	.609375
⅛ =	.125	⅝ =	.625
9-64 =	.140625	41-64 =	.640625
5-32 =	.15625	21-32 =	.65625
11-64 =	.171875	43-64 =	.671875
3-16 =	.1875	11-16 =	.6875
13-64 =	.203125	45-64 =	.703125
7-32 =	.21875	23-32 =	.7185
15-64 =	.234375	47-64 =	.734375
¼ =	.5	¾ =	.75
17-64 =	.265625	49-64 =	.765625
9-32 =	.28125	25-32 =	.78125
19-64 =	.296875	51-64 =	.796875
5-16 =	.3125	13-16 =	.8125
21-64 =	.328125	53-64 =	.828125
11-32 =	.34375	27-32 =	.84375
23-64 =	.359375	55-64 =	.859375
⅜ =	.375	⅞ =	.875
25-64 =	.390625	57-64 =	.89625
13-32 =	.40625	29-32 =	.90625
27-64 =	.421895	59-64 =	.92187[illegible]
7-16 =	.4375	15-16 =	.9375
29-64 =	.453125	61-64 =	.953125
15-32 =	.46875	31-32 =	.96875
31-64 =	.484375	63-64 =	.984375
½ =	.5		

HOW TO ANNEAL SMALL TOOLS.

A very good way to anneal a small piece of tool steel is to heat it up in a forge as slowly as possible, and then take two fireboards and lay the hot steel between them and screw them in a vice. As the steel is hot, it sinks into the pieces of wood, and is firmly imbedded in an almost air-tight charcoal bed, and when taken out cold will be found to be nice and soft. To repeat this will make it as soft as could be wished.

NUMBER OF LIGHTS OF WINDOW GLASS IN A BOX OF 50 FEET.

Size.	No. Lights.	Size.	No. Lights.	Size.	No. Lights.
6x 8	150	28	16	50	5
7x 9	115	30	15	30x38	7
8x10	90	18x22	18	40	6
11	82	24	17	42	6
12	75	26	16	44	6
13	69	28	14	46	5
14	64	30	14	48	5
9x12	67	32	13	50	5
13	62	20x26	14	52	5
14	57	28	13	54	4
15	53	30	12	32x40	6
10x13	56	32	11	42	6
14	52	34	11	32x44	5
15	48	36	10	46	5
16	45	22x28	12	48	5
11x14	47	30	11	50	5
15	44	32	10	52	4
16	41	34	10	54	4
18	39	36	9	56	4
12x15	40	38	9	34x44	5
16	38	24x30	10	46	5
18	34	32	10	48	5
20	30	24x34	9	50	4
13x16	35	36	9	52	4
18	31	38	8	54	4
20	28	40	8	56	4
22	25	26x32	9	58	4
14x18	29	34	8	60	4
20	26	36	8	36x46	4
22	24	38	7	48	4
24	22	40	7	50	4
15x18	27	42	7	52	4
20	24	44	6	54	4
22	22	28x36	7	56	4
24	20	38	7	58	3
26	19	40	7	36x60	3
16x20	23	42	6	62	3
22	21	44	6	64	3
24	19	46	6	38x46	4
26	17	48	5	48	4

NUMBER OF LIGHTS OF WINDOW GLASS IN A BOX OF 50 FEET.—Continued.

Size.	No. Lights.	Size.	No. Lights.	Size.	No. Lights.
50	4	60	3	66	3
52	4	40x62	3	68	3
54	4	64	3	70	2
56	3	66	3	44x54	3
58	3	40x68	3	56	3
60	3	70	3	58	3
62	3	42x50	3	60	3
64	3	52	3	62	3
66	3	54	3	64	3
40x48	4	56	3	66	2
50	4	58	3	68	2
52	3	60	3	70	2
54	3	62	3	72	2
56	3	64	3		

TEMPERING STEEL SPRINGS.

Coiled springs of steel wire are tempered by heating them in a box or piece of gaspipe, in which they are packed with bone dust or animal charcoal, precisely as though they were to be heated for case-hardening. If a piece of gaspipe is used, which is very handy in such work, one end should be closed by a screw-plug or cap, and the open end luted with clay. When the box or pipe is sufficiently heated, say to a deep red, remove the spring or plunge the receptacle and its contents together into a bath of animal oil. Do not attempt water-hardening or the use of crude petroleum. If common whale oil is not handy, melt lard, and use it while it is in liquid. The wire will be sufficiently hard to require "drawing." This should be done by putting the spring into a shallow pan, with tallow or animal oil, over the forge fire, and agitating the pan and its contents until the oil takes fire. Take the springs out, and, when the oil is burned off, cool them in water.

WELDING MALLEABLE CAST IRON.

You can weld malleable cast iron plates by riveting them together and using a flux of powdered borax and Norwegian or crucible steel filings, equal parts. Let the first blows of your hammer be tender ones.

LENGTH PER COIL AND WEIGHT OF ROPE PER HUNDRED FATHOMS.

Manila and Sisal Rope.				Tarred Cordage.	
Diameter in inches.	Cir. in inches	Le'gth in feet.	Lbs. per 100 Fa	Le'gth in feet.	Lbs. per 100 Fa
¼ or 6th.	¾	1,300	12	840	18
5-16 or 9th.	15-16	1,300	17	840	29
⅜ or 12th.	1⅛	1,200	23	840	40
15 thread.	15 thread.	1,200	31	840	47
18 thread.	18 thread.	1,100	45	840	58
21 thread.	21 thread.	1,100	50	840	68
½	1½	990	52	960	64
9-16	1¾	990	70	960	79
⅝	2	990	83	960	94
¾	2¼	990	105	960	130
⅞	2½	990	125	960	140
15-16	2¾	990	155	960	170
1	3	990	175	960	207
1 1-16	3¼	990	205	960	238
1 3-16	3½	990	255	960	272
1¼	3¾	990	280	960	300
1 5-16	4	960	310	960	332
1⅜	4¼	960	355	960	376
1½	4½	960	410	960	440
1⅝	4¾	960	450	960	505
1 11-16	5	960	500	960	573
1¾	5¼	960	550	960	610
1⅞	5½	960	610	960	654
1 15-16	5¾	960	690	960	797
2	6	960	750	960	900
2 3-16	6½	960	845	960	1,057
2⅛	7	960	1,000	960	1,163
2½	7½	960	1,100	960	1,356
2⅝	8	960	1,270	960	1,613
3	9	960	1,595	960	2,013

HOW TO MAKE BRONZE MALLEABLE.

Domier has discovered that bronze is rendered malleable by adding to it from one-half to two per cent. of mercury.

WEIGHT AND SPECIFIC GRAVITY OF LIQUIDS.

	Specific grav.	Wt. pr cu. in.	Wt. pr gal.
		Lbs.	Lbs.
Water, distilled, 60° Fahr	1.	.036	8.33
" sea	1.03	.037	8.55
" Dead Sea	1.24	.045	10.4
Acid, Acetic	1.062	.038	8.78
" Nitric	1.217	.044	10.16
" Sulphuric	1.841	.067	15.48
" Muriatic	1.2	.043	9.93
Alcohol, pure	.792	.029	6.7
" proof	.916	.033	7.62
" of commerce	.833	.030	6.93
Cider	1.018	.036	8.4
Honey	1.45	.052	12.
Milk	1.032	.037	8.55
Molasses	1.426	.05	11.66
Oil, Linseed	.940	.034	7.85
" Olive	.915	.033	7.62
" Turpentine	.870	.031	7.16
" Whale	.923	.033	7.65
Naphtha	.848	.031	7.
Petroleum	.878	.032	7.39
Tar	1.015	.036	8.4
Wines (average)	.998	.036	8.3

THE MOST TERRIBLE EXPLOSIVE KNOWN.

The most terrible explosive known to science is chlorate of nitrogen. Dulong discovered it in 1812, and lost two fingers and an eye by it. Since then no one has been anxious to find out what its composition was, until Dr. Gattermann, a German chemist undertook it. In the course of his experiments, Dr. Gattermann observed that chlorate of nitrogen, which explodes with great violence if brought into contact with organic substances, also explodes in the presence of sun or magnesium light. In the dark, or in scattered daylight, it never explodes spontaneously. Sudden and apparently spontaneous explosions of chlorate of nitrogen which have taken place were doubtless occasioned by the unobserved effect of sunlight. Chlorate of nitrogen appears to be one of those substances the world is better off without.

WEIGHT AND SPECIFIC GRAVITY OF METAL.

Metals.	Wt. pr cubic ft.	Wt. pr cubic ft.	Specific grav.
	Lbs.	Lbs.	
Aluminum	166	.096	2.67
Antimony, cast	419	.242	6.72
Bismuth	613	.353	9.822
Brass, cast	524	.3	8.4
Bronze	534	.308	8.561
Copper, cast	537	.31	8.607
" wire	555	.32	8.9
Gold, 24 carat	1208	.697	19.361
" standard	1106	.638	17.724
Gun-metal	528	.304	8.459
Iron, cast	450	.26	7.21
" wrought	485	.28	7.78
Lead, cast	708	.408	11.36
" rolled	711	.41	11.41
Mercury	849	.489	13.596
Platinum	1344	.775	21.531
" sheet	1436	.828	23.
Silver, pure	654	.377	10.474
" standard	644	.371	10.312
Steel	490	.284	7.85
Tin, cast	455	.262	7.291
Zinc	437	.252	7.

HOW TO MEND PATTERNS.

For mending patterns needing temporary repairs, or for making additions where but one or two molds are to be made, the following material will be found very useful. Melt together 1 pound beeswax, 1 pound rosin and one pound paraffine wax. It is well to note here that the beeswax intended is the wax made by the bees, and not the wax made by the wholesale dealers. The cheap wax sold to the shipping houses contains but a small portion of the article made by the bees, and a large proportion of soft paraffine wax. The result of using this compound wax instead of the genuine article, in any mixture, is to introduce too much paraffine and only a little beeswax. When the genuine article is used, this mixture will be found very useful for making additions to patterns, small temporary patterns, and for a variety of purposes in the pattern shop.

VALUE OF METALS.

Gold by the pound avoirdupois.

Vanadium (cryst. fused)	$4,792.40
Rubidium (wire)	3,261.60
Calcium (electrolyctic)	2,446.20
Tantalum (pure)	2,446.20
Cerium (fused globules)	2,446.20
Eithium (globules)	2,228.79
Lithium (wire)	2,935.44
Lubium (fused)	1,671.57
Didymium (fused)	1,620.08
Strontium (electrolyctic)	1,576.44
Indium (pure)	1,522.08
Ruthenium	1,304.64
Columbium (fused)	1,250.28
Rhodium	1,032.84
Barium (electrolyctic)	924.12
Tallium	738.39
Osmium	652.32
Palladium	498.30
Iridium	466.59
Uranium	434.88
Gold	299.72
Titanium (fused)	239.80
Tellurium "	196.20
Chromium "	196.20
Platinum "	122.31
Manganese "	108.72
Molydenum	54.34
Magnesium (wire and tube)	45.30
Potassium (globules)	22.65
Silver	18.60
Aluminum (bar)	16.30
Cobalt (cubes)	12.68
Nickel	3.80
Cadmium	5.26
Sodium	3.26
Bismuth (crude)	1.95
Mercury	1.00
Antimony	.36
Tin	.25
Copper	.22
Arsenic	.15
Zinc	.10
Lead	.06
Iron	.1¾

MEASURES OF DIFFERENT COUNTRIES.

	SURFACE MEASURE.	DRY MEASURE.	LIQUID MEASURE.
Austria.. (METRIC SYSTEM)	1 are=100 square meters.=119.6 sq. yds. 1 hectare=10,000 sq. meters.=2.47 acres.	1 hectoliter=one-tenth cubic meter=2.8377 bu. or=3.53 cubic ft.	1 liter=1,000 cubic centimeters.=0.264 gallons.
Belgium.			
France..			
Germany			
Greece..			
Holland.			
Italy.....			
Norway.			
Portugal			
Spain...			
Sweden..			
Switzerland			
Turkey..			
Denmark	1 tonne=1.36 acres.	1 scheffel=0.4935 bushels.	1 pott=0.255 gallons.
England.	1 square mile=640 acres.	1 quarter=8 bushels.	1 gallon=4 qts @ 2 pts. @ 4 gills.
Russia..	1 dessätine=2.7 acres.	1 tschetwert=5.9570 bushels.	1 wedro@ 10 kruschka=3¼ gal
United States	1 sq. mile=640 acres; 1 acre=43.560 sq. feet; 1 sq. mile=259 hectares; 1 acre=0.4047 hectare.	1 bushel=4 pecks; 1 peck=8 qts.; 1 qt.=2 pts.; 1 bu.=35.24 liters. 1 cubic foot=1,728 cubic in. 1 cu. foot=0.2832 hectoliter.	1 hogshead=63 gals.: 1 gal.=4 qts.; 1 qt.=2 pts.; 1 pt.=4 gills; 1 brl.=4 firkins; 1 firkin=9 gals.; 1 gallon=3.7855 liters.

THE MONETARY UNITS AND STANDARD COINS OF FOREIGN COUNTRIES.

The first section of the act of March 3, 1873, provides "that the value of foreign coin, as expressed in the money of account of the United States, shall be that of the pure metal of such coin of standard value," and that "the value of the standard coins in circulation of the various nations of the world, shall be estimated annually by the director of the mint, and be proclaimed on the first day of January by the secretary of the treasury.

The estimates of values contained in the following table are those made by the director of the mint, Jan. 1, 1878.

Country.	Monetary Unit.	Standard.	Value. D.	C.	M.
Argen Repub...	Peso fuerte....	Gold	1	0	0
Austria	Florin	Silver.......	0	45	3
Belgium	Franc	Gold & Silver	0	19	3
Bolivia	Dollar........	Gold & Silver	0	96	5
Brazil	Milreis of 1000 reis	Gold........	0	54	5
British Amer ...	Dollar........	Gold........	1	0	0
Bogota	Peso	Gold........	0	96	5
Central Amer...	Dollar........	Silver........	0	91	8
Chili	Peso	Gold........	0	91	2
Cuba	Peso	Gold........	0	92	5
Denmark.......	Crown	Gold.......	0	26	8
Ecuador	Dollar........	Silver.......	0	91	8
Egypt	Pound of 100 piasters	Gold........	4	97	4
France.........	Franc	Gold & Silver	0	19	3
Gt. Britain	Pound sterling	Gold........	4	86	6½
Greece	Drachma	Gold & Silver	0	19	3
German Emp ...	Mark	Gold........	0	23	8
India.........	Rupee, 16 an..	Silver.......	0	43	6
Italy	Lira..........	Gold & Silver	0	19	3
Japan	Yen	Gold........	0	99	7
Liberia	Dollar........	Gold........	1	0	0
Mexico	Dollar........	Silver.......	0	99	8
Neitherlands ...	Florin	Silver.......	0	38	5
Norway	Crown........	Gold........	0	26	8
Paraguay	Peso	Gold........	1	0	0
Peru	Sol..........	Silver.......	0	96	0

THE MONETARY UNITS—Continued.

Country.	Monetary Units.	Standard.	Value.
Porto Rico......	Peso	Gold........	0 92 5
Portugal.......	Mil. 1000 r's ..	Gold........	1 8 0
Russia	Rubles, 100 co	Silver.......	0 73 4
Sandwich Islands	Dollar........	Gold........	1 0 0
Spain..........	Peseta of 100 centimes ...	Gold & Silver	0 19 3
Sweden	Crown	Gold........	0 26 8
Switzerland	Franc	Gold & Silver	0 19 3
Tripoli.........	Mah. 20 pi's ..	Silver.......	0 82 9
Tunis..........	Pi's., 16 car...	Silver.......	0 11 8
Turkey	Piaster	Gold........	0 4 3
Colombia.......	Peso	Silver	0 91 8
Uruguay	Patacon	Gold........	0 94 9

DIMENSIONS OF AMERICAN ENSIGNS.

Numbers.	Head or hoist.	Whole length.	Length of union.
	Feet.	Feet.	Feet.
1	19.00	36.00	14.40
2	16.90	32.00	12.80
3	14.80	28.00	11.20
4	13.20	25.00	10.00
5	11.60	22.00	8.80
6	10.00	19.00	7.60
7	8.45	16.00	6.40
8	7.40	14.00	5.60
9	6.33	12.00	4.80
10	5.28	10.00	4.00
11	4.20	8.00	3.20
12	3.70	7.00	2.80
13	3.20	6.00	2.40
14	2.50	5.00	2.00

TO DETECT IRON FROM STEEL TOOLS.

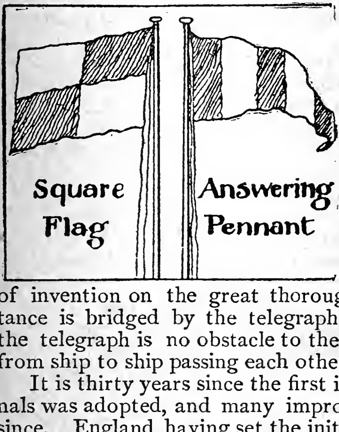
It is diffiult to distinguish between iron and steel tools. They have the same polish and workmanship; use will commonly show the difference. To make the distinction quickly, place the tool upon a stone, and drop upon it some diluted nitric acid, four parts of water to one of acid. If the tool remains clean, it is of iron; if of steel, it will show a black spot where touched with the acid. These spots can be easily rubbed off.

SHIP SIGNALING AT SEA.

HOW CAPTAINS OF VESSELS "SPEAK" EACH OTHER IN MID OCEAN.

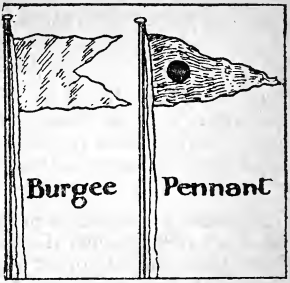
With Eighteen Flags no Fewer than 70,000 Distinct Signals may be Made—Simplicity and Perfection of the Process—The importance of Correct Use of the Flags—Long Distance Signaling in Which Colors do not Count.

Signaling at sea has been brought to a state of perfection that was never dreamed of a quarter of a century ago. What, at first blush, might appear a problem insolvable by human ingenuity has at length, by dint of patient and painstaking investigation, been completely and satisfactorily worked out.



True is it in this, as in all things worth the having, that "Rome was not built in a day." The ordinary observer, eloquen of the extraordinary facilities effected on *terra firma* by the agencies of the electric wire and the modern and magical telephone, is, perhaps, apt to quite overlook the almost equally effective triumphs of invention on the great thoroughfares of the ocean. Distance is bridged by the telegraph, but the non-existence of the telegraph is no obstacle to the transmission of messages from ship to ship passing each other at sea.

It is thirty years since the first international code ot signals was adopted, and many improvements have been made since. England having set the initiative, no less than fifteen nations followed suit, and decided to adopt this most perfect code. Previous to the conception of the international code there existed a multiplicity of codes in a great variety of languages, thus creating a confusion at sea only rivaled by that which obtained on land at the disastrous building of the Tower of Babel. Among all these contending codes the most notable was Marryatt's, and this Marryatt is one and the same individual with the celebrated author of "Peter Simple," "Midshipman Easy," and other stories, which gave such unbounded delight to the men of this generation when they were schoolboys.



Ships are spoken at sea by the aid of variously colored flags. These are eighteen in number (not including the answering pennant), each flag representing a consonant of the alphabet, and by a combination of two, three or four of these flags in a hoist arbitrary signs are made which represent words and sentences. The flags have three distinct shapes, and at the commencement of the code book are printed in colors, with the consonant of the alphabet answering to each flag attached thereto.

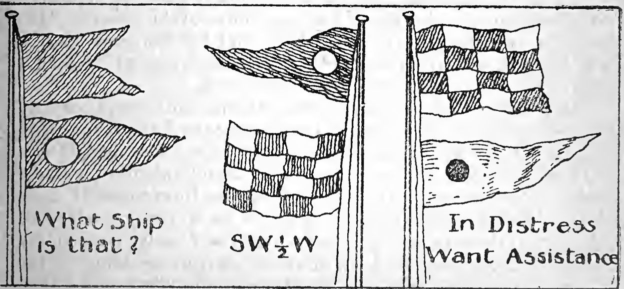
The eighteen flags consist of one burgee, four pennants and thirteen square flags.

By the arrangement of the burgee, pennants and square flags specially distinctive characters are given to the signals, thus: In signals made with *Two Signs*—

The *Burgee uppermost* represents........*Attention* Signals
A *Pennant uppermost* represents........ *Compass* Signals
And a *square Flag uppermost* represents..*Danger* Signals

In signals composed of *Four Signs*—

The *Burgee uppermost* represents........*Geographical*
A *Pennant uppermost* represents........*Vocabulary*
And a *square Flag uppermost* represents.*Ships' Names*

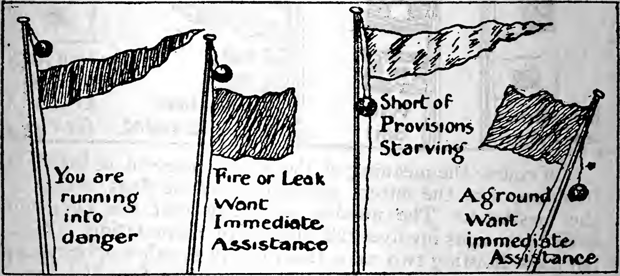


Three-flag signals are universal and express latitude, longitude, time, numeral, and all ordinary signals required for communications.

A captain, by the aid of powerful binocular glasses, sighting another vessel in the distance, and observing, say, four flags flying with a square flag uppermost (N V B Q), would immediately turn to that section of the code devoted to the names of merchant vessels, and as the letters under this and every section are arranged in strictly alphabetical order, he would at once discover the approaching vessel to be

Signal letters.	Name of ship and port of registry.	Rg tonnage.	Horse power.	Official No.
N V B Q	Germanic, Liverpool	3,150	760	70,932

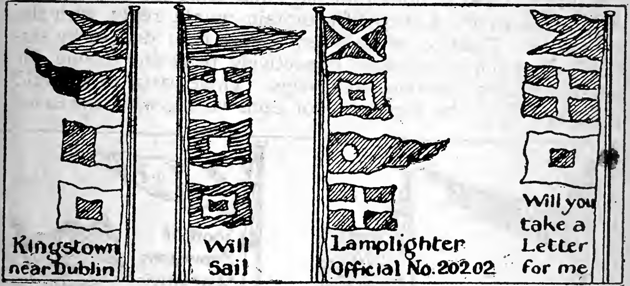
Possessed of this information the captain would "run up" the answering pennant signifying "I see and know you," and in turn proceed to hoist four flags indicating the name of his own ship, to which the other captain would reply with the pennant. The two commanders would then denote by signals what ports they were respectively from and bound for and number of days out on voyage. These particulars would be entered in the log-books of each vessel, with the exact



latitude and longitude of the rencontre, and on arrival at their destinations be duly handed in.

This signaling of ships when "passing" only occupies a brief time to perform, and, as a rule, in ordinary circumstances, this is all the "speaking" that takes place.

That it is absolutely necessary to "speak" correctly on board ship, however the "Queen's English" may be "murdered" with impunity on shore, is proved by the following incident which happened at Cape Town last November: The Clan Gordon (s.), having on board seventy-one tons of dynamite, was compelled to discharge cargo in the bay instead of unloading in the docks in the usual way. While the captain of the R. M. S. Athenian was docking his vessel he suddenly noticed the two flags "N P" run up the masthead of the Clan Gordon. These flags, according to the code, mean "The fire is gaining rapidly; we wish to be taken off immediately." The captain of the Athenian replied by signal, "Get up steam," then proceeded with two tugs to the scene. On arriving on board the Clan Gordon everything appeared in perfect order, and nobody was more surprised than the quartermaster, who had placed the flags upside down—"P N" being the signal for a tug and "N P" that the ship was on fire. The captain of the Athenian immediately returned to the shore and explained to the excited crowd that had gathered at the pierhead, "that a slight mistake in marine signaling had been made."



Of course the meaning of the signals is given in the code book opposite the letters represented by the flags shown at the masthead. The number of signals that can be made with a few signs involves the marvels of permutation. With ten flags, hoisting two at a time, ninety signals can be made; hoisting three at a time, 720 signals; hoisting four at a time, 5,040 signals; hoisting five at a time, 30,240 signals. The code committee, in fixing on eighteen flags, provided for no less than 70,000 distinct signals, with a possible extension to 78,642, each signal consisting of a hoist of not more than four flags; and this provision (as experience has testified) has proved amply sufficient. To counteract the obvious difficulty of colors of signals not being discernible by reason of distance or hazy weather, a code of distant correspondence is inserted in the book, and shapes of signals are substituted.

COMMON NAMES OF CHEMICAL SUBSTANCES.

Aqua Fortis	Nitric Acid.
Aqua Regia	Nitro-Muriatic Acid.
Blue Vitriol	Sulphate of Copper.
Cream of Tartar	Bitartrate of Potassium.
Calomel	Chloride of Mercury.
Chalk	Carbonate of Calcium.
Salt of Tartar	Carbonate of Potassa.
Caustic Potassa	Hydrate of Potassium.
Chloroform	Chloride of Gormyle.
Common Salt	Chloride of Sodium.
Copperas, or Green Vitriol	Sulphate of Iron.
Corrosive Sublimate	Bichloride of Mercury.
Diamond	Pure Carbon.
Dry Alum	Sulphate Aluminum and Potassium.
Epsom Salts	Sulphate of Magnesia.
Ethiops Mineral	Black Sulphide of Mercury.
Fire Damp	Light Carbureted Hydrogen.
Galena	Sulphide of Lead.
Glucose	Grape Sugar.
Goulard Water	Basic Acetate of Lead.
Iron Pyrites	Bisulphide of Iron.
Jeweler's Putty	Oxide of Tin.
King' Yellow	Sulphide of Arsenic.
Laughing Gas	Protoxide of Nitrogen.
Lime	Oxide of Calcium.
Lunar Caustic	Nitrate of Silver.
Mosaic Gold	Bisulphide of Tin.
Muriate of Lime	Chloride of Calcium.
Niter of Saltpeter	Nitrate of Potash.
Oil of Vitriol	Sulphuric Acid.
Potash	Oxide of Potassium.
Red Lead	Oxide of Lead.
Rust of Iron	Oxide of Iron.
Sal Ammoniac	Muriate of Ammonia.
Slacked Lime	Hydrate of Calcium,
Soda	Oxide of Sodium.
Spirits of Hartshorn	Ammonia.
Spirit of Salt	Hydrochloric or Muriatic Acid.
Stucco, or Plaster of Paris	Sulphate of Lime.
Sugar of Lead	Acetate of Lead.
Verdigris	Basic Acetate of Copper.
Vermilion	Sulphide of Mercury.
Vinegar	Acetic Acid (Diluted).
Volatile Alkali	Ammonia.
Water	Oxide of Hydrogen.
White Precipitate	Ammoniated Mercury
White Vitriol	Sulphate of Zinc.

AN IMPROVED METHOD OF MOLDING.

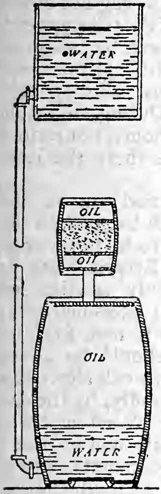
It is claimed that a saving, as well as a better job, can be effected by the substitution of the following for the coal dust and charcoal used with green sand: Take one part common tar and mix with twenty parts of green sand; use the same as ordinary facing. The castings are smoothed and bright, as tar prevents metal from adhering to the sand, prevents formation of blisters, and helps the production of large castings by absorbing the humidity of the sand.

ENGINES OF THE S. S. "CITY OF NEW YORK."

These engines consist of the two largest sets of triple-expansion engines afloat. They are of the usual inverted vertical type. The cylinders are 45 in. + 47 in + 113 in. + 5 ft. stroke. The boiler pressure is 150 lbs. The screws are 22 ft. in diameter, and 28 ft. pitch. They revolve outboard, and there is no opening in the dead wood between them. If they worked without slip, they would make 218 revolutions to the mile, and, at 80 revolutions, which may be taken as the standard speed, the ship would steam at 22 knots. With a slip of about 9 per cent., therefore, the speed of the ship will be 20 knots. The engines stand side by side with a longitudinal bulkhead between them. They are in every respect duplicates. A door is provided in the bulkhead opposite the intermediate cranks, and the starting platforms are opposite the doorway. The reversing gear is Brown's patent hydraulic. The engines are quite easily started, stopped or reversed by one engineer on each platform. The engines are wholly of steel and gun-metal, save the cylinders. The great "A" frames are splendid castings, each weighing 6 tons, that is 12 tons for each cylinder. The valves are all pistons—four being fitted to the low-pressure cylinder, two to the intermediate, and one the high-pressure cylinder. The eccentric hoops are cast-steel, lined with white metal, as are all the bearings throughout. The valves are disposed in the "corners," so to speak, and the valve stems are united in pairs by crossheads. They work so smoothly, and are so perfectly balanced, that the valve gear, which is of the ordinary Stevenson link type, has really very little to do. The surface condensers are horizontal cylinders lying rather high up in the wings. The air pumps are worked by levers in the usual way. There are no feed pumps on the main engine, the boilers being supplied by five vertical Worthington donkey pumps in each engine-room standing against the forward bulkhead. Two of these pumps will feed the boilers, but the others are for reserve, or for the countless pumping jobs wanted in a big ship. The engines actually employed at any time in feeding the boilers are controlled by an automatic arrangement, a float in the hot well rising or falling with the level of the water in the well, and opening or shutting the throttle valve, an arrangement which is, so far as we are aware, quite new in marine work, and found to answer admirably, the donkey remaining steadily at work, instead of tearing away for a few minutes, emptying the hot well, and then having to stand until the well fills again. It would be difficult, if not impossible, to find more admirable examples of the highest type of mechanical engineering than are supplied by the splendid main engines. They have been constructed throughout from the designs of Mr. Parker. Mr. Parker has brought to bear on his task a life-long experience. He was for some years second engineer of the great paddle steamer "Persia," with side-lever engines. Mr. Parker's familiarity with all the difficulties and trials which beset the sea-going engineer, has stood him in good stead; and the engines of the "City of New York" will maintain the fame of Scotch engineers in the New and Old World. Nothing finer can be imagined than the working of these gigantic engines, with a piston speed of 800 ft. per minute — certainly the greatest velocity ever attained by pistons 9 ft. 5 in. in diameter. During the whole run round Ireland, lasting nearly forty-six hours, not a drop of water was needed on a bearing, nor was there the least symptom of heating.

An important experiment is being carried out in the "City of New York." Although she is much larger than the "Umbria" and "Etruria," and is intended to be faster than either, she has less boiler power. The "Etruria" has 72 furnaces. The "City of New York" has only 54 disposed is nine double-ended boilers, and containing 1,250 square feet of grate surface. The apparent deficiency is met, first, by the use of triple-expansion engines, which should be about 20 per cent. more economical than the three-cylinder compound engines of the "Etruria;" and, secondly, by the use of forced draught. The nine boilers are placed in three stoke-holes. The boilers are fired fore and aft, and no direct communication between the boiler compartments exists. Access can be had to each only by ladders and hydraulic hoists. Instead of the usual forest of cowl ventilators, there are erected at each side of the upper deck six large rectangular structures of heavy plate iron fitted with shield lids, which can be raised or lowered by screw gear. When dropped down, a sufficient space exists for the entry of air. In fine weather they are raised to an inclined position, and deflect air down the trunks. These trunks reach down to the fire-rooms, and each is provided at the bottom with a fan about 5 ft. 6 in. in diameter driven by a separate engine at about 500 revolutions per minute. These fans deliver one at each side of the ship into the six stoke-holes, in which they can maintain a plenum of about ¾ in. water pressure. So far the result of the experiment is all that can be desired. During her trial trip the pressure of 150 lbs. was maintained in the boilers. The engines made, one 82 and the other 83, revolutions per minute, and a speed of over 20 knots was attained with about 18,500 horse-power. No precise data as to power or speed have, however, been officially given. There is every reason to believe that, when the engine and fire-room hands have thoroughly settled down to their work, 20,000 horse-power, or a little more, will be obtained.

A SIMPLE OIL FILTER.



A cheap and very serviceable oil filter may be made as follows:

Take a barrel or keg, with both heads in, of sufficient size to hold the oil you wish to cleanse. Run a pipe in at the bottom, and lead it off to an overhead tank that is filled with water, and from which water can be brought down to the barrel. From the top head of the barrel, lead a pipe up to and into the bottom of a smaller cask or tank placed on the barrel. In this tank put two perforated partitions, six or eight inches apart, and fill the space between them with charcoal. In the top of the small tank put the faucet for drawing off the oil. In the bottom head of the barrel, have a hand-hole for cleaning.

The pressure of the water from the upper tank forces the oil up and through the filtering material in the small tank. In this way the oil is filtered upward, and all the heavy matter will fall to the bottom of the barrel, from which it can be readily removed.

HEATING RAILROAD CARS.

Between twenty and thirty railroad companies are introducing specific forms of heating cars, and out of the variety of devices there will certainly be evolved one practicable method. One system uses hot water, which is forced though, pipes, another hot air. One scheme is to use pressure, and another to use an exhaust. The mechanical difficulties in the way cannot be easily overcome. It has been estimated that it will cost $10 a year per car for heat. It has been shown that fifty pounds of exhaust steam, circulated by the suction system, is as effectual as seventy-five pounds of live steam circulated by the pressure system.

SWITCHING FROM THE ENGINE CAB.

A device that will enable the engineer, from his cab, to switch his locomotive at pleasure, while the conductor on the caboose or rear car closes the switch again, would surely be a novelty in railroading, amounting to a revolution. Yet a Cleveland inventor claims to have solved the problem, and to be able to demonstrate its practicability with a working model. Not to go into the details, it may be sufficient to say that the "central throw" switch is shifted by a double-flanged shoe, of any length, dropped from beneath any front or rear truck, while the train is in motion, first overthrowing the crank that draws the lock-plate off the fixed rail, then moving the lug of the angle connected with the fly-rail to the right or left, as indicated by the target on the engine or caboose, after which the lock slides forward and grasps the fixed rail, holding the "fly" in alignment, making a continuous rail. Thus, a switch is carelessly left open, and a passenger train is approaching. The engineer detects the danger; the improvised "shoe" is dropped to the rail; it strikes the lug, the switch is closed, and, a collision avoided. On the other hand, a train may be side-tracked by the same simple operation from the cab. Of course, this would do away with switchmen and frog accidents, and a great many other disadvantages incident to the present method, should the invention come into practical use. This, necessarily is yet to be demonstrated by actual test, under varying conditions, before success can be confidently claimed; but the device is certainly of general interest.

RAILROAD SIGNALS.

The following signals, taken from the "Standard Code," are in use on a majority of American railroads. Explanation: O means short, quick sound; — means long sound.

Apply brakes, stop	O
Release brakes	O O
Back	O O O
Highway crossing signal	— — O, or O O
Approaching stations	— blast lasting five sec.
Call for switchman	O O O O
Cattle on track	— — — — —
Train has parted	— O
For fuel	O O O O O
Bridge or tunnel warning	O O —
Fire alarm	— O O O O
Will take side track	— — —

WHEN COAL WAS FIRST USED ON AMERICAN RAILROADS.

The New York Central initiated this movement in 1858. In that year six locomotives were run between New York and Poughkeepsie, using coal for generating motive power, and two between Poughkeepsie and Albany burned coal. The superintendent at that time, Mr. A. F. Smith, reported that it cost but one-fourth as much to drive the trains by coal as it did to drive them by wood combustion. His investigation showed that, by a train of 21 freight cars, in making a trip from Poughkeepsie to New York and back again, a distance of 144 miles, 6⅝ cords of pine wood, costing $40.15, were consumed, while to make the same trip with a coal-burning locomotive, only 4,193 pounds of coal were consnmed, costing $10.48, and that it required only $9.04 worth of coal to drive an express train from New York to Poughkeepsie and back again. When these facts were verified, the wood-burning engines had to go.

LARGE MILEAGE OF A LOCOMOTIVE.

A passenger locomotive on the Columbus & Cincinnati Midland, No. 4, built by the Schenectady Locomotive Works, was put into service September 9, 1884, and worked continuously until January 20, 1888, when she broke a parallel rod and both back pins. If this accident had not occurred, the engine would have continued in service some time longer, there being nothing absolutely needed in the way of repairs, except turning off the tires. It was probably the "flange on both sides" of the tire that caused her to catch on a curve and twist her pins off. During this time her mileage was 185,483 miles, not including mileage at terminal stations, to and from the depots and round-house. The engine had never been laid up for repairs during that time, had no flues removed, nor been off her wheels at all, had in fact been in constant service with nothing but the simple ordinary repairs necessary at the end of each trip.

PARCHMENT FOR AXLE BEARINGS.

Experiments are being made on Prussian railways with axle boxes fitted with bearings of vegetable parchment in place of brass. The parchment is strongly compressed before being used, and it is thoroughly dried to prevent subsequent shrinkage. Wooden rings are placed on the outside of the bearings, fitting the collars, of the journal. An emulsion of water and oil and all the mineral oils are used as lubricants. The parchment soon becomes impregnated with oil, and is able to go a long time without a renewal of lubrication. It is between the body of the journal and the thin edge of the parchment segments that friction takes place. The claim is made that the compressed paper bearings make a tough material that is superior to metal. Such bearings are also in use in a German saw-mill, with satisfactory operation.

BOATS DRAWN BY A LOCOMOTIVE.

An experiment, which is looked upon as a success, was recently made on the Shropshire Union Canal, at Worleston, by the officials of the London & Northwestern Railway. A set of rails, of 18-inch gauge, was laid down on the bank of the canal for a distance of a mile, and a small locomotive from the Crewe Railway Works drew along easily, at the rate of seven miles an hour, two boats by means of ropes. The size and weight of the boats are not given. How many cars, and how much freight the locomotive could draw on the track, is not stated.

TEST OF LOCOMOTIVE FUEL.

An important test of locomotive fuel was made on the main line of the P. & R., and the result determined the style of thirty new locomotives. The engines selected were what is known as a wagon top boiler and narrow fire box, and the latter a Wootten boiler and fire box. Each engine hauled the same load. The wagon top boiler used 26,600 pounds of steamboat coal, costing $2.45 per ton, in making the round trip, and the Wooten consumed 32,500 pounds of buckwheat coal, costing sixty cents a ton, or a difference in favor of the Wootten of $20.49.

QUANTITY OF ALCOHOL IN WATER.

The quantity of alcohol contained in rain, snow and sea waters may be estimated at from one to several millionths. Cold water and melted snow seem to contain more of it than tepid waters. In the waters of the Seine (France) it is found in appreciable quantities, also in all waters excepting the purest spring water, and in sewage waters the proportion increases very perceptibly. Vegetable mold is quite rich in it; indeed, it is quite likely that alcohol, in its natural state, had its origin in the soil, through the fermentation of the organic matters contained therein.

HOW FAST CAN A LOCOMOTIVE RUN?

Popular opinion concerning the maximum speed at which a locomotive can run, even among engineers, is very vague. The subject is little understood, and rash assertions are sometimes made in consequence. We have ourselves heard it asserted by those who ought to know better that a speed of over 100 miles an hour could easily be reached with a light engine, and recently there was built a French engine intended to run regularly at eighty miles an hour. Now, as a matter of fact, there is no properly recorded instance of an engine attaining a greater velocity than eighty miles an hour, which was reached by one of Mr. Pearson's broad-gauge tank engines with 9 ft. drivers on the Bristol and Exeter Railway. The engine was run light, and driven down an incline of one in eighty-nine, and a speed of seventy-eight miles an hour was attained under precisely similar conditions with one coach attached.

Mr. Marten fully confirms the view we have taken that speeds of more than eighty miles an hour are mythical. At first sight there does not appear to be any adequate reason why this should be the case. Given plenty of steam, a good road and a falling gradient, and an engine which, with a heavy train behind it, will make seventy-two miles an hour, apparently ought, when running without a load, to attain a much higher velocity. In this case, however, conclusions drawn from theory are wrong, and, as we have said, a speed of eighty miles an hour seems to be the utmost that it is possible to attain under any circumstances.

The resistance of the air is very great. It is the same thing whether the engine runs through still air at eighty miles an hour, or, when itself standing, is submitted to the action of a furious hurricane—for that is what a wind blowing at eighty miles an hour is very properly called. Such a current will exert a force of about thirty-two pounds per square foot. If we take the area of the smoke box, funnel, weather board, etc., of a locomotive as equal fifty square feet, we have for the air alone a resistance of $50 \times 32 = 1{,}600$ pounds, which may be taken for an ordinary express engine, with seven foot wheels and eighteen inch cylinders, as equivalent to about sixteen pounds per square inch average effective cylinder pressure alone. But this is only one of the retarding influences with which we have to deal. Another of very much greater proportion is the back pressure in the cylinders. The steam cannot be got out fast enough through any available port. A seven foot wheel makes 240 revolutions per mile, and, when running at eighty miles an hour, 320 per minute. Thus there must be from each cylinder 640 exhausts per minute, or over 10 per second, or for the two cylinders 21 per second. The cylinder full of steam is therefore allowed only the tenth part of a second to get out; and it is not remarkable that the back pressure is something very considerable. At the time of the celebrated brake trials at Trent, the loads were in all cases thirteen coaches, and very different engines were employed to pull them. Each engine had a run of three miles on a level allowed it in which to get up speed, but during the whole time the trials lasted a velocity of sixty miles an hour was never attained. It was found that most of the drivers worked their engines near the middle notch while on the three miles to save steam. The moment they got on the trial ground they put the lever forward a couple of notches, intending to get more speed; but the result was invariably to choke the engine with steam and reduce the speed. Unquestionably the great obstacle in the way of attaining a higher velocity than eighty miles an hour lies in the difficulty of getting rid of the steam; and this is the reason why compound engines do not readily attain very great velocities, because for a given power they have larger piston areas than have non-compound locomotives. There are, however, other retarding forces at work. Much power must, no doubt, be lost in imparting violent motions to masses of metal which can make no return when coming to rest. The swinging of the engine, the excessive vibration of all its parts, and the jar and concussion, all operate to the same end, and tend to keep down speed.

DETECTION OF HOT BEARINGS.

M. Gerboz has devised an apparatus by which an audible and visible signal is given to the engineer if any part of the machinery to which the apparatus is fitted should become unduly heated. In its simplest form, as applied to the crank-pin of a steam engine, the device consists of a small cylinder fastened to and projecting from the crank-pin, and containing a plug of easily fusible alloy, which is pressed against the end of the crank-pin by a perforated piston and spring. The piston-rod, by means of a lever, controls a catch belonging to the mechanism of a bell placed over the apparatus. The gear of the bell, which is actuated by spring power, is previously wound up by hand and locked by the catch. If the crank-pin should become heated, the fusible plug melts, thus allowing the piston to descend, thereby releasing the catch and sounding the bell. In addition to this audible signal, a disc hidden underneath the bell is turned in such a position that a bright color is seen through two holes in the dish of the bell.

POINTS FOR ENGINEERS.

When using a jet condenser, let the engine make three or four revolutions before opening the injection valve, and then open it gradually, letting the engine make several more revolutions before it is opened to the full amount required.

Open the main stop valve before you start the fires under the boilers.

When starting fires, don't forget to close the gauge-cocks and safety-valve as soon as steam begins to form.

An old Turkish towel, cut in two lengthwise, is better than cotton waste for cleaning brass work.

Always connect your steam valves in such a manner that the valve closes against the constant steam pressure.

Turpentine, well mixed with black varnish, makes a good coating for iron smoke pipes.

Ordinary lubricating oils are not suitable for use in preventing rust.

You can make a hole through glass by covering it with a thin coating of wax — by warming the glass and spreading the wax on it, scrape off the wax where you want the hole, and drop a little fluoric acid on the spot with a wire. The acid will cut a hole through the glass, and you can shape the hole with a copper wire covered with oil and rottenstone.

A mixture of one (1) ounce of sulphate of copper, one-quarter (¼) of an ounce of alum, half (½) a teaspoonful of powdered salt, one (1) gill of vinegar and twenty (20) drops of nitric acid will make a hole in steel that is too hard to cut or file easily. Also, if applied to steel and washed off quickly, it will give the metal a beautiful frosted appearance.

It is a fact that thirty-five cubic feet of sea water is equal in weight to thirty-six feet of fresh water, the weight being one ton (2,240 pounds).

Remember that coal loses from ten (10) to forty (40) percentum of its evaporative power if exposed to the influence of sunshine and rain.

Those who have had experience think that for lubricating purposes palm nut oil cannot be surpassed, for the reason that it does not gum or waste; neither does friction remove it readily from the surfaces where it is applied, and its use is exceedingly economical. The best cylinder oils produce no better effect.

If you are obliged to make use of such a barbarism as a rust joint, mix ten (10) parts by weight of iron filings, and three (3) parts of chloride of lime with enough water to make a paste. Put the mixture between the pieces to be joined, and bolt firmly together.

Too much bearing surface in a journal is sometimes worse than too little.

Steel hardened in water loses in strength — but hardening in oil increases its strength, and adds to its toughness.

COST OF RAILROAD TRAVEL.

In Europe the first-class travel is exceedingly small, and the third class constitutes the large portion of the passenger business, while in America almost the whole of the travel is first-class. The following table gives a comparison between the rates per mile in the leading countries of the world:

	First class.	Second class.	Third class.
	Cents.	Cents.	Cents.
United Kingdom.............	4.42	3.20	1.94
France......................	3.86	2.88	2.08
Germany.................. ...	3.10	2.32	1.54
United States................	2.18	....	....

In the State of New York, the first-class fare does not exceed two cents, which is about equal to the third-class fare in Europe, and heat, good ventilation, ice-water, toilet arrangements, and free carriage of a liberal amount of baggage are supplied, while in Europe few of these comforts are furnished. On the elevated railroads of New York a passenger can ride in a first-class car eleven miles for five cents, or about one-half cent a mile, and on surface roads the rates given to suburban passengers are, in some cases, still less.

A HERO OF THE THROTTLE.

In a recent accident at Huntingdon, Engineer Robert Gardner, perceiving that a collision between his own train and another was inevitable, staid at his post, kept his hands on the throttle and brake, and so met his death. While being lifted from the wreck, he asked if any of his "passengers" had been killed, and, when informed that they had all escaped, he said, regardless of his own mortal hurt: "That's good; lay me down. Good-bye, boys."

THE MANUFACTURE OF LOCOMOTIVES.

It is nearly fifty years since locomotive building was inaugurated, and, when fairly beyond the experimental stage, more men were required in the work per locomotive per annum than are now required. The locomotive of that time cost nearly as much as the standard locomotive of the present day, while the latter is, on the average, three or four times as heavy, even more powerful in proportion, and incomparably superior in finish to the former.

In 1832, the "Old Ironsides" was built by Mr. M. W. Baldwin. It was modeled after the English "Planet" type, with a stiff wooden frame and inside connections. Up to 1840 most Baldwin engines were built with inside connections, as were also the earlier Rogers engines; but outside connections afterward became more generally approved, inside-connected engines having now become practically obsolete. Mr. Thos. Rogers was an early advocate of outside connections, and in 1837 filed in the patent office a specification for counterbalancing, which was not in general use until some years later, and even then was considered less essential to the inside than to the outside connected engines. In 1839, in Mr. Baldwin's practice, the outside frame was abandoned, and the machinery, truck and pedestals of the driving-axles were attached directly to the boiler From that time the wood parts of the frame were gradually displaced by iron. About 1839 equalizing beams were used on the Eastwick and Harrison engines, some method being necessary to distribute the weight upon the two pairs of drivers then introduced. In 1841, Mr. Baldwin built some engines for freight traffic with the drivers geared, but in 1842 his six-wheel connected engine met with more favor. In this the four forward wheels had inside journals running in boxes held by wide and deep wrought-iron beams, one on each side and disconnected, the engine frame on each side having a spherical pin bearing in a socket midway between the axles of the frame. The cylindrical boxes used could also turn in the pedestals, and the connecting-rods and ball-and-socket joints, with play enough to allow the engine to pass short curves.

The driving-wheels of "Old Ironsides" had cast-iron hubs, wooden spokes and wrought-iron tires, and the driving-axle was placed in front of the fire-box. The "half-crank" for inside-connected engines was patented by Mr. Baldwin in 1834. The "E. L. Miller" (1834) had driving-wheels of solid bell-metal, which soon wore out, but later, driving-wheels were built with hubs and spokes in single iron casting, and wood felloes, breaking joint in thickness, and bound with wrought-iron tires, secured by bolts. In 1834, Mr. Baldwin built his engines with driving-axle back of the fire-box, and Mr. Norris built engines with drivers in front. The latter plan gave the greater adhesion, and the greater wheel base. To obtain the necessary adhesion, Mr. Baldwin had recourse to the Miller patent for throwing part of the weight of the tender upon the drivers of the engine. It was at this time considered impracticable to cast a chilled car or truck wheel in one solid piece, and the hubs were cast in three pieces and banded together with wrought-iron, the interstices being filled with lead or spelter. The "Brandywine," Baldwin's eighteenth engine (1835), had brass tires to give more adhesion, but they soon wore out. Mr. Rogers began the manufacture of wrought-iron tires in 1834, but in 1838 S. Vail & Co., Morristown, New Jersey, are said to have been the only American manufacturers of tires, which were then made only 1½ inches thick. In 1838 Mr. Baldwin began using chilled wheels for trucks, the truck-wheels having previously been made with tires, and in 1836 Mr. H. R. Campbell patented an eight-wheel engine, with two pairs of driving-axles, one before and one behind the fire-box. This combined the plans of Messrs. Norris and Baldwin, and, with the addition of equalizing springs, was substantially of the same type as the standard American locomotive of to-day. The last half-crank engine was built at the Baldwin works in 1849. Steel axles were tried as an experiment about this time, and chilled tires for drivers began to be used a few years later. The use of steel tires shrunk upon the center was not begun until after 1860. These tires were then imported. In 1863 the Rogers works built their first engine of the "Mogul" type (three pairs of drivers with a pony truck), and the first engine of the "Consolidation" type (four pairs of drivers with pony truck) was built by the Baldwin works in 1866. In these large freight locomotives some of the many drivers are made without flanges, to facilitate the turning of curves. In 1870 the practice of shrinking on steel tires without the use of bolts or rivets, was begun at the Baldwin works in building some locomotives for the Kansas Pacific Railroad.

In 1868 the introduction of narrow-gauge roads began to create a demand for suitable locomotives. Some of these narrow-gauge locomotives have been built of a weight of not less than twenty-five net tons, and, in the past decade, the manufacture of steam and compressed-air street car and motors has been fairly inaugurated.

The use of four-wheeled swiveling-trucks was one of the features which characterized the American, as distinguished from the English locomotives; but one of the most notable improvements of American practice, was the invention of Mr. Baldwin of ground steam joints, instead of joints made of canvas and red lead, then the English practice. With this change the steam pressure was raised from 60 to 120 pounds.

"Old Ironsides" had a loose eccentric for each cylinder. These loose eccentrics were reversed by pin in a stop on the axle working in a half-circular slot. This was changed for a fixed eccentric for each cylinder, with rods extending from the eccentric strap to the arms of a rock-shaft beneath the foot-board of the engine, the reversal being affected by shifting the connection between the rods and the rock-shaft arms. In these early engines fixed eccentrics were commonly used, but Seth Boyden's "Essex" (1838) had valves worked without eccentrics, moving by levers from the cross-heads, each cross-head communicating motion to the opposite cylinder. In 1838 Mr. Baldwin adopted the use of double eccentrics, each terminated by a straight hook, and reversed by a lever, He used, under specification, a form of link motion in 1840, and in 1842 a link motion similar to that used by Stephenson.

(The link motion had been used by Wm. T. James, of New York, in 1832.) In 1845 Mr. Baldwin adopted the half-stroke cut-off, in which there were two slides operated by separate eccentrics, the cut-off eccentrics being set at half stroke. The same year Mr. Rogers began using independent cut-off valves, operated by various combinations of links and V-hooks, and in 1850 he introduced the present form of shifting link. Meanwhile Mr. Baldwin continued experimenting, introducing several forms of variable forms of cut-off, one of which had a wrapping connection and a quadrant and curved link, for varying the position of the block. He then used the "Cuyahoga" cut-off, with lever and shifting link. Finally, in 1857, after putting on a number of them, under specification, he adopted the present form of link motion.

The "Old Ironsides" had a D-shaped smoke-box with side concaved, to make room for cylinders. The boiler was thirty inches in diameter, with seventy-two one and one-half inch copper tubes seven feet long. The "Sandusky" (Rogers, 1837) had a bonnet smoke-stack with deflecting cone, Most of the early engines had high domes over the fire-boxes. In 1835 Mr. Baldwin commenced the practice of driving copper ferrules on the outside of the copper tubes, to make a tight joint with the tube-sheet, instead of, as before, driving the ferrule or thimble inside the tube. At present, with iron tubes and copper ferrules, the end is swaged down, the copper ferrule brazed on, and the iron projecing end turned or riveted over the ferrule and tube-sheet. For copper tubes, wrought-iron thimbles had also been used. These were found liable to leak, but about 1850 this defect was obviated by the use of cast-iron thimbles, a device by Mr. W. S. Hudson. In 1844 iron flues or tubes were first used in the Baldwin engines. Morris, Tasker & Co. had made lap-welded tubes in 1838 — butt-welded prior to that year; and Rass Winans had also made iron tubes by hand for his locomotives. Experiment showed no appreciable advantage to copper over iron tubes. Mr. Rogers first used expansion plates to provide for lengthening the boiler under steam, and about 1850 the wagon-top was substituted for the dome boilers. Prior to this time there had been many experiments, with the view of burning anthracite coal, and in 1854 deflectors in the fire-box began to be used, sheet-iron water leg and fire brick deflectors being tried. In 1856 there was built at the Baldwin works for the Pennsylvania railroad, locomotives with straight boilers having two domes, and in 1859 locomotives having "Dimpfel" water-tube boilers were built for the Philadelphia, Wilmington & Baltimore railroad. Fire-boxes of low steel began to be built in 1861, and had come into general use in 1866; in 1868 all steel boilers (fire-boxes, barrels and tubes) were built by the Pennsylvania railroad. In present practice both straight and wagon-top boilers are built. In 1876 steel boilers, with corrugated sides, were built at the Baldwin works for the Central Railroad of New Jersey.

●The "Old Ironsides" had 9½ by 18 inch cylinders, the "Sandusky" had 11 by 16 inch cylinders. In 1840 the larger Baldwin pattern had 12½ by 16 inch cylinders. The "Gov. Paine," a fast passenger engine (1849), had 17¼ by 20 inch cylinder, and in 1852 a freight locomotive weighing 56,000 pounds, had 18 by 22 inch cylinders. The first "Consolidation" engine (1866) had 20 by 24 inch cylinders, and the "Uncle Dick" (1878) had 20 by 26 inch cylinders. The cylinders of the early engines were generally inclined, but by 1865 horizontal engines had become the rule. Mr. Baldwin was the first American manufacturer to use an outside cylinder, which was made with a circular flange bolted to the boiler.

In 1852, on some engines for the Mine Hill Railroad, these flanges were brought around, nearly meeting, with only a spark-box between them, and later each cylinder and half-saddle was cast in one piece, and the saddles set face to face, and, when horizontal cylinders came into general use, the rights and lefts were made interchangeable.

The early engines had neither cabs nor sand-boxes. Cabs were first used in New England, and the first Baldwin engines provided with sand-boxes were built in 1846,

"Old Ironsides" was estimated to draw thirty tons gross forty miles an hour on the level. In 1838 Mr. Baldwin believed that an engine weighing 26,000 pounds, loaded, and with 12½ by 16 inch cylinders, was as heavy as would ever be called for; but the requirements of heavy freight and passenger service demanded, for economy no less than for convenience, larger and stronger engines, the heaviest ever built at the Baldwin works ("Uncle Dick," 1878) weighing, with water in the tank, 115,000 pounds. In 1849, at the Baldwin works, there were built a number of fast passenger engines of the type of the "Gov. Paine" (Vermont Central Railroad), which could start from rest and run a mile in forty-three seconds; but these engines lacked sufficient adhesion. Within the past few years some attention has been given to the manufacture of fast passenger locomotives, a number having been built which, with light trains, will run sixty miles or more an hour. Of these, a locomotive for the Round Brook line has a single pair of 6½ foot drivers and a patent arrangement for varying the distribution of the weight between the drivers and a pair of trailing-wheels.

At the Brooks Locomotive Works the average weight of locomotives built in 1869 was 28 ton for passenger and 30 ton for freight engines; but the average is now 35 tons for passenger and 42 tons for freight engines, showing the rapid increase in weight, and it is believed by many that 50-ton consolidated engines will soon become the prevailing type and size for American freight service.

Examples of the performance of engines might be given at great length and in great variety. For the Baldwin engine the loads are calculated on the basis of the utilization for adhesion of fully one-fourth of the weight of the driving wheels. A standard "American type" passenger locomotive, with 35,000 pounds on the driving-wheels, will pull one thousand tons gross on a level, and on one, two, and three per cent grades will pull 25½, 12½ and 7½ per cent of that load respectively; a consolidated engine, with 94,000 pounds on the driving wheels, will pull 2,740 tons gross on a level, and on one, two and three per cent grades will pull 26¼, 13½, and 8 per cent of that load respectively. In some heavy freight and switching engines the entire load is upon the driving-wheels, consolidation locomotives having usually 85 to 88 per cent, moguls 80 to 85 per cent, standard American passenger locomotives 60 to 70 per cent, "double-enders" about 50 per cent, and fast passenger locomotives as little as 35 to 40 per cent. of their total weight upon the driving-wheels.

The endurance of an engine in service is very great, but the necessary repairs will average from 1½ to 6 or 7 cents per mile, according to the service. Steel tires last from six to seven years before they wear out. In the transitional stage of locomotive building, engines capable of much longer service were not infrequently broken up, laid aside, or made over on account of the introduction of improvements in design. At present the high quality of material and of workmanship promises a degree of endurance which will require many years to ascertain, and the uniformity of parts cannot fail to lessen the cost of repairs. It must, however, be remembered that the service required of a locomotive is much heavier and more exacting than it was ten years ago, cars often being loaded twice as heavily, and the weight of trains actually drawn averaging nearly twice as heavy for the same size of locomotive.

The present American locomotive may fairly be considered an established criterion of excellence. It is characterized by accuracy and beauty of workmanship and strength, combined with flexibility and adaptability to many difficult conditions of service—an adaptability that has given it the precedence where such conditions have to be met. Although the demands of railroad travel and traffic in this country have absorbed the greater part of the product, American locomotives have been supplied to foreign countries using railroads in such numbers as to make them an important factor in the extension of facilities of travel and communication abroad.

The manufacture of locomotives in locomotive-works is so far based upon the use of costly and partly finished materials, that the additional labor and expense involve less than one half the value of the finished product. The iron and steel plates, steel tires, sheet-brass and iron, copper pipe, smoke and feed pipes, chilled wheels, bolts, rivets, hardware, fittings, boiler tubes, flues, and other materials are in themselves costly products, and some of the forgings and the steel and iron castings are often produced for the work by separate establishments having special facilities. On the whole, the raw material, properly speaking, has its value more than trebled before it is brought into the locomotive works as material for the manufacture. In comparing the manufacture of locomotives with the manufacture of small engines or sewing machines, where the value of material in locomotive manufacture is doubled, in that of small engines it is nearly trebled, and in sewing machines quadrupled; but in locomotives the same increment of added value requires the employment of a considerably greater number of artisans (at similar rates of wages) than are employed in the manufacture of small engines; principally because the prices of locomotives are ruled by the wholesale purchase of large railroad corporations, while the prices of small engines and machinery are ruled to a great degree by small buyers making single purchases. In short, in the manufacture of locomotives, the cost of putting the product upon the market is reduced to a minimum, and of the same added value given in the manufacture and marketings of about 50 per cent. additional goes for the employment of artisans in locomotive building, as compared with the general manufactur of steam engines. The composition by weight of the various crude and finished materials in a locomotive and tender weighing about 45 tons (net) may be stated as follows: About 32 per cent. pig-iron, 18 per cent. bar and hammered iron, 9 per cent. boiler-iron and steel (about one-fifth of which is for the fire-box), 8½ per cent. steel tires, slides, springs and the like; 7 per cent. wheels; 7 per cent. wood for cab, tender and lagging, 5 per cent. axles and connecting rods, 4 per cent. flues, 3½ per cent. tank-iron; 2 per cent. lead, tin, copper, smoke pipe, glass, hardware and fittings; 1½ per cent. bolts and rivets, 1½ per cent. cast and sheet brass, and 1 per cent. sheet-iron.

The market value of a locomotive in 1880 was less than three-fourths as great as it was in 1870, the descent in value being very gradual, with the exception of a very notable rise in 1873, and a slighter appreciation in value after 1879. These fluctuations have mainly followed the general shrinkage of money values, and the fluctuations in the cost of materials, influences great enough to conceal any evidences of improvement in the methods of manufacture such as might here be looked for. Nevertheless, there has been a very general advance in the details of system and machinery, which is confirmed in aggregate results of the capability of a given number of men to perform a given work.

It is the growing practice to make all the parts of locomotives interchangeable. The general growth of the "interchangeable system" in manufacturing has had an influence in the development of manufacturing, agricultural, and other industries which few have heretofore appreciated. It may not be too much to say that, in some respects, this system has been one of the chief influences in the rapid increase of the national wealth. Two of the great industries that constitute the basis of this wealth, agriculture and manufactures, depend now largely on the existence of this remarkable feature of manufacturing, which has reached its highest development in this country. The growth of the system is due to the inventive characteristics of our people, and their peculiar habit of seeking the best and most simple methods of accomplishing results by machinery, untrammeled by traditions or hereditary habits and customs.

PISTON EXPLOSIONS.

The piston of a steam engine is not at first sight a likely part to give way through explosion. But there are cases on record where hollow pistons, on being heated for removal from the rod, have unexpectedly exploded. Such explosions of hollow cast-iron pistons have recently been the subject of special attention in France, the fact appearing that no less than five such explosions have occurred in French workshops during the last twenty years in re-heating these pistons. In examining into the interior of a piston that had been in use for eleven years, there was shown the existence of a brown substance containing fatty matter, oxide of iron and carbon. From this it was supposed that a certain quantity of water had been forced into the cavity in service, either through the iron or through the imperfection in the plugs with which the original core support cavities were filled. This water, in forming oxide of iron, set free its hydrogen, which filled the piston cavity, and, as the recombinations of this hydrogen with the oxygen at a low red heat would have the effect of producing such an explosion, the suggestion is made that this result may be prevented if all such pistons be tapped before re-heating.

EVAPORATION OF LOCOMOTIVE BOILER.

The evaporation of a modern railway locomotive boiler averages about 7 lbs. per pound of coal.

THE THEORY OF THE STEAM ENGINE.

For many years engineers cared nothing about the theory of the steam engine. They went on improving and developing it without any assistance from men of pure science. Indeed it may be said with truth that the greatest improvement ever effected, the introduction of the compound engine, was made in spite of the physicist, who always asserted that nothing in the way of economy of fuel was to be gained by having two cylinders instead of one. In like manner, the mathematical theorist was content to make certain thermo-dynamic assumptions, and, reasoning from them, to construct a theory of the steam engine, without troubling his head to consider whether his theory was or was not consistent with practice. Within the last few years, however, the theorist and the engineer have come a good deal into contact, and the former begins at last to see that the theory of the steam engine is laid down by Rankine, Clausius, and other writers, must be deeply modified, if not entirely re-written, before it can be made to apply in practice. We have recently shown what M. Hirn, who combines in himself practical and theoretical knowledge in an unusual degree, has had to say concerning the received theory of the steam engine, and its utter inutility for practical purposes; and papers recently read before the Institutions of Mechanical and Civil Engineers, and the discussions which followed them, have done something to convince mathematicians that they have a good deal to learn yet about the laws which determine the efficiency of a steam engine. It has always been the custom to class the steam engine with other heat engines. It is now known that nothing can be more erroneous. The steam engine is a heat engine *sui generis*, and to confound it with a hot-air engine, or any motor working with a non-condensible fluid, is a grave mistake. It is not too much to say that many engineers now understand the mathematical theory of the steam engine better than do men making thermo-dynamics a special study. But there remains a large number of engineers who do not as yet quite see their way out of certain things which puzzle them, or which they fail to understand. There are, indeed, phenomena attending the use of steam which are not yet quite comprehended by any one, and we may be excused if we say something about one or two points which require elucidation.

One of these is the mode of operation of the steam jacket. It is a very crude statement that it does good because it keeps the cylinder hot. It might keep the cylinder hot, and yet be a source of loss rather than gain; and, as a matter of fact, it is doubtful now if the application of steam jackets to all the cylinders of a compound engine is advisable. It is well known, too, that circumstances may arise, under which the jacket is powerless for good. Thus, for example, the late Mr. Alfred Barrett, when manager of the Reading Iron Works, carried out a very interesting series of experiments with a horizontal engine, in order to test the value of the jacket. This engine had a single cylinder fitted with a very thin wrought-iron liner, between which and the cylinder was a jacket space. The jacket was very carefully drained, and could be used either with steam or air in it. Experiments were made on the brake with and without steam in the jacket. The result was a practically infinitesimal gain by using steam in the jacket. In one word, the loss by condensation was transferred from the cylinder to the jacket. On the other hand, it is well known that single cylinder condensing engines must be steam jacketed if they are to be fairly economical. Circumstances alter cases, and the circumstances which attend the use of the jackets are more complex than appears at first sight.

In considering the nature of the work to be done, we must repeat a fundamental truth which we have been the first to enunciate. A steam engine can discharge no water from it which it did not receive as water, save the small quantity which results from loss by external radiation and conduction from the cylinder, and from the performance of work. At first sight, the proposition looks as though it were untrue. Its accuracy will, however, become clear when it is carefully considered. After the engine has been fully warmed up, the cycle of events is this: Steam is admitted to the cylinder from the boiler. A portion of this is condensed. It parts with its heat to the metal with which it is in contact. The piston makes its stroke, and the pressure falls. The water mixed with the steam is then too hot for the pressure. It boils and produces steam, raising the toe of the diagram in a way well understood and needing no explanation here. During the return stroke the pressure falls to its lowest point, and the water, being again too hot for the pressure, boils, and is converted into steam, which escapes to the atmosphere or condenser without doing work, and is wasted. The metal of the cylinder, etc., falls to the same temperature as the water. At the next stroke the entering steam finds cool metal to come into contact with, and is condensed, as we have said, and so on. But the quantity condensed during the steam stroke is precisely equal to that evaporated during the exhaust stroke, and consequently no condensed steam can leave the engine as water.

Let us suppose, for the sake of argument, however, that an engine using 20 lbs. of 100 lbs steam per horse per hour, discharges two pounds of water per horse per hour. As each of these brought, in round numbers, 1185 thermal units into the engine, and takes away only 212 units, it is clear that each pound must leave behind it 973 units; consequently the cylinder will be hotter at the end of each revolution than it was at the beginning, and the process would go on until condensation must entirely cease. It will be urged, however, that a steam jacket certainly does discharge water, and that in considerable quantity, which it did not receive; and, as this is apparently indisputable, we are here face to face with one of the puzzles to which we have referred. The fact, however, is in no wise inconsistent with what is advanced. If an engine with an unjacketed cylinder regularly receives water from the boiler, that engine will discharge precisely an equal weight of water. The liquid will pass away in suspension in the exhaust steam. The engine has no power whatever of converting it into steam. The case of a jacketed engine is different. Such an engine will evaporate in the cylinder water received with the steam, but it can only do so at the expense of the steam contained in the jacket. For every 1 lb. of water boiled away in the cylinder 1 lb. of steam is condensed in the jacket; and the corollary is that, if an engine were supplied with perfectly dry steam, there would be no steam condensed in the jacket, save that required to meet the loss due to radiation and the conversion of heat into work. The effect of the jacket will be to boil a portion of the water during the close of the stroke, and so to keep up the toe of the diagram, and so get more work out of the steam. If, however, the steam was delivered wet to the engine, it is very doubtful if the jacket could be productive of much economy. The water would be converted into steam during the exhaust stroke, and no equivalent would be obtained for the steam lost in the jacket.

In a good condensing engine about 3 lbs. of steam per horse per hour are condensed in the jacket. The cylinder will use, say, 15 lbs. of steam, so the total consumption is 18 lbs. per horse per hour. It is none the less a fact, although it is not generally known, that the average Lancashire boiler sends about 8 per cent. of water in the form of insensible priming with the steam. Now, 8 per cent. of 18 lbs. is 1.44 lbs., so that in this way we have nearly one-half the jacket condensation accounted for as just explained.

One horse-power represents 2,562 thermal units expended per hour, or, say, 2.6 lbs. of steam of 100 lbs. pressure condensed to less than atmospheric pressure; and 1.44 — 260 = 4.04 lbs. per horse per hour, as the necessary jacket condensation, if no water is to be found in the working cylinder at the end of each stroke. That this quantity is not condensed only proves that the water received from the boiler, or resulting from the performance of work, is not all re-evaporated.

Something still remains to be written about the true action of the steam jacket, but this we must reserve for the present. We have said enough, we think, to show that, as we have stated, the jacket has more to do than keep the cylinder hot. With jacketed engines, more than any other, it is essential that the steam should be dry. In the case of an unjacketed engine, water supplied from the boiler will pass through the engine as water, and do little harm; but, if the engine is jacketed, then the whole or part of this water will be converted into steam, especially during the period of exhaust, when it can do more good than if it were boiled away in a pot in the engine-room. This is the principal reason why such conflicting opinions are expressed concerning the value of jackets. That depends principally on the merits of the boiler.

TREATMENT OF NEW BOILERS.

No new boiler should have pressure put upon it at once. Instead, it should be heated up slowly for the first day, and whether steam is wanted or not. Long before all the joints are made, or the engine ready for steam, the boiler should be set and in working order. A slight fire should be made and the water warmed up to about blood heat only, and left to stand in that condition and cool off, and absolute pressure should proceed by very slow stages. Persons who set a boiler and then build a roaring fire under it, and get steam as soon as they can, need not be surprised to find a great many leaks developed; even if the boiler does not actually and visibly leak, an enormous strain is needlessly put upon it which cannot fail to injure it. Of all the forces engineers deal with, there are none more tremendous than expansion and contraction.

THE FIRST LOCOMOTIVE IN OHIO.

In 1835, Roger, Ketchum & Grosvenor, of Paterson, N. J., erected some buildings with a view to manufacturing locomotives, and in eighteen months thereafter the first locomotive, the "Sandusky," was completed. On the 16th of October, 1837, a trial trip was made between Paterson and New Brunswick, Timothy Smith acting as engineer. The performance of the engine was entirely satisfactory. The locomotive was built for the New Jersey Railroad, the gauge of the railroad being four feet ten inches. The engine was bought by J. H. James, of Urbana, president of the Mad River & Lake Erie Railroad, and, on the 14th of October, it was shipped to Sandusky via Erie Canal to Buffalo, and, from that port, it was shipped on the schooner Sandusky, in charge of Alexander Borden, of Rockey Ridge. The engine landed in Sandusky on the 30th of November, 1837, and, on the 2d day of December, was unloaded. The father of John Homegardner furnished an ox team and sled, and the locomotive was taken to Knight's blacksmith shop. Here Mr. Knight completed the blacksmith work on the engine. The night of the 2d was the occasion of a big jamboree over the arrival of the first engine in Ohio, and everybody had a high old time.

The engine was in charge of Thomas Hogg, who had worked on it from its commencement. At this time not a foot of the Mad River Railroad track had been laid. The road was built to suit the gauge of the engine, and the Legislature of Ohio passed an act requiring all roads in the State to be four feet ten inches gauge, same as the engine "Sandusky."

The engine was used in the construction of the road until the 11th of April, 1838, when regular trips for the conveyance of passengers commenced between Sandusky and Bellevue.

The engineer, Thomas Hogg, ran the "Sandusky" three years, keeping it in repair. Mr. Hogg subsequently became master mechanic of the Mad River Railroad, and continued in that capacity for about thirty years. He died in Danbury township a few years ago.

The "Sandusky" had eleven-inch diameter cylinders by sixteen inches stroke; one pair of driving wheels of four feet six inches diameter, situated forward of the furnace; the trucks had four thirty-inch wheels, the eccentric rods extending back to the rock-shafts, which were situated under the foot-board; the smoke-pipe was of the bonnet kind, having a deflecting cone curled over the edges in the center, so as to deflect the sparks downward, and thus prevent their passing through the wire bonnet, as well as preventing the bonnet's wearing out too fast.

SPEED OF RAILWAY TRAINS.

What is the fastest railway time ever made? is a question much easier asked than answered, and the answer, if it could be definitely given, aids but little in arriving at the speed practically attainable in regular railway business. Extremely high rates of speed, perhaps equaling, if not surpassing, any that have been attained since, were achieved in the very earliest days of railroading. In 1841, Mr. I. K. Brunel, the constructing engineer of the Great Western Railway of England, and who afterward built the Great Eastern, advertised to run from Bristol to London in two hours, which was at the rate of sixty miles an hour, and Mr. R. Dymond, F. S. A., has stated, in Notes and Queries, that in 1846, he traveled with Brunel over the South Devonshire Railroad at a speed of seventy miles an hour. The first specially fast express train ever run, was in 1846, on the Great Western road, under the management of Brunel, and was known as the "Flying Dutchman," which name it has since retained. It made the distance of 193 miles from London to Exeter, in four and a half hours, with five stops, the full running speed of the train between stations being at the rate of 63.9 miles per hour. The schedule time of the same train, forty years later, is sixteen minutes short of the time then made, but less time is deducted for stops, and the full running speed is only 55.1 miles per hour. The best time ever reported for this train was May 11, 1848, in a run from London to Didcot, 53 miles in 47 minutes, when it is said that a speed of 76 miles per hour was attained for a portion of the distance, the weight of the engine and train being 240,000 pounds, while the weight of the engine and train as now regularly run, with eight cars, is 525,000 pounds. A recently published statement gives the schedule time of a regular train of the Great Northern Railway, of England, for 105½ miles, at 53.6 miles per hour; and for the "Flying Scotchman," a regular train on the East Coast route, from London to Edinburgh, 392½ miles, the speed is 48 miles per hour, there being five stops and the total time being 8 h. 55 m. The fastest regular train on the continent of Europe is said to be that between Bordeaux and Paris, on the Orleans road, the distance of 359 miles being made in 9 h. 6 m., with ten stops, and the full running speed being 43¾ miles per hour.

Probably one of the fastest trains ever run in this country was a special on the West Shore line, from Buffalo to Jersey City, on July 9, 1885, making a distance of 422½ miles in 9 h. 23 m. On a section of 61 miles of this distance, made in 56 minutes, the speed is reported to have reached a rate of 71.6 miles per hour. The weight of the engine and train was 311,000 pounds. On the New York Central, the Sunday train has been run 440 miles from New York to Buffalo at a speed of 45¼ miles per hour, making the total distance in 9 h. 30 m., and running from Syracuse to Rochester, 81 miles, in 85 minutes, or at a rate of 57 miles per hour, and numerous examples can be quoted of speeds about equaling this, it being nothing extraordinary for regular trains to attain a speed of 60 miles an hour and slightly over for short distances. One of the best authenticated tests of locomotive performance was a trial in 1885, over the Bound Brook route from Jersey City, where the weight of the engine and train was 370,000 pounds, and the trial was made in regular service. The tests were made by engineers who published full reports, which were also published in leading English papers, showing consumption of fuel and all details, the engine being built at the Baldwin Locomotive Works, and having coupled drivers only 68 inches in diameter. In this test it was shown that the slip of the driving wheels was practically nothing, and the indicator cards gave a speed as high as a mile in 46 seconds, or equal to 78.26 miles per hour.

The attainment of such exceptionally high speeds, however, for very short distances, has but little of practical value; such apparent feats in railroading are really quite old, and are not to be compared in importance or in difficulty with what is now being accomplished every day by the "limited" trains between New York and Chicago. The distance by the Pennsylvania road is 912 miles, and by the New York Central it is 977 miles, and the time in each case is only twenty-three hours, with heavy trains, making several stoppages. Considering distance, time and quality of work, these trains are undoubtedly entitled to precedence in any proper comparison with the best fast trains operated by railroads anywhere else in the world.

Piston rods on marine steam engines are in many cases larger than a ten year-old child's body. They look as though nothing could break them, but they break very often, in spite of their looks.

SMOKE — HOW FORMED.

When fresh coal is placed on a fire in an open grate, smoke arises immediately; and the cause of this smoke is not far to seek, as it will be easily understood that, before fresh coals were put upon the fire within the grate, the glowing coals radiated their heat and warmed the air above, and thereby enabled the rising gases to at once combine with the warmed air to produce combustion; but, when the fresh coals are placed upon the fire, they absorb the heat, and the air above remains cold.

By gases, is meant the gases arising from coals while on or near the fire, and it may not be known to every one that we do not burn coals, oils, tallow or wood, but only the gases arising from them. This can be made clear by the lighting of a candle, which will afford the information required. By lighting the candle, fire is set to the wick, which, by its warmth, melts a small quantity of tallow directly absorbed by the capillary tubes of the wick, and thereby so very finely and thinly distributed that the burning wick has heat enough to be absorbed by the small quantity of dissolved tallow to form the same into gases, and these gases burning, combined with the oxygen in the atmosphere, give the light of the candle. A similar process is going on in all other materials; but coal contains already about seventeen per cent. of gases, which liberate themselves as soon as they get a little warm. The smaller the coal, the more rapidly will the gases be liberated, so that, in many cases, only part of the gases are consumed.

The fact is, that the volatile gases from the coal cannot combine with cold air for combustion. Still combustion takes place in the following ways. The cold air, in the act of combination, absorbs a part of the warmth of the rising gases, which they cannot spare, and, therefore, must condense, so that small particles are formed, which aggregate and are called smoke, and when collected, produce soot; but as long as these particles and gases are floating, they cannot burn or produce combustion, as they are surrounded by a thin film of carbolic acid. It is only when collected and this acid driven off, that they are consumed.

It has now been shown that cold is the cause of smoke, which may be greatly reduced by care. In the open fire grate the existing fire ought to be drawn to the front of the grate, and the fresh coal placed behind, or in the back of the fire. The fire in the front will then burn more rapidly, warm the air above, and prepare the raising gases for combustion. In this way smoke is diminished, as the gases from the coals at the back rise much more slowly then when placed upon the fire and the air partly warmed.

WHAT IS LATENT HEAT?

Heat has its equivalent in mechanical work, and, when heat disappears, work of some kind will take its place. When a body changes from the liquid to the gaseous form, the molecules have to be separated and placed in different positions with regard to each other. This calls for an expenditure of work. This work is supplied by heat, which disappears at the time. One can hold his hand in steam escaping from a safety valve of a boiler for this reason. The heat of the steam disappears in pushing apart and rearranging the molecules of the steam as it expands when it leaves the safety valve.

The term latent heat, as commonly used, means the amount of heat which disappears when water changes from a liquid into steam. This is considerable, as will be seen by consulting any table of the heat contained in steam, and the water from which it comes.

Water at 212° contains 180 units of heat. Steam at 212° contains 1,146 units of heat. The latent heat is the difference of 966 units. Such a large quantity disappears when liquid water changes to steam, that boiling cannot be raised above 212°, no matter how hard it is boiled. The heat becomes latent, and the mechanical work, or rather molecular work, is sufficient to take up all that is supplied by the fire.

The specific heat of air at constant pressure being 0.2377, the specific heat of water, which is 1, is, therefore, 4.1733 times greater under ordinary circumstances. A pound of water losing 1° of heat, or one thermal unit, will consequently raise the temperature of 4.17 pounds, or, at ordinary temperatures, say 50′ of air, 1°. A pound of steam at atmospheric pressure, having a temperature of 212° F., in condensing to water at 212° F., yields 966 thermal units, which, if utilized, would raise the temperature of $5 \times 966 =$ 4830′ of air 1°, or about 690′ from 5° to 70° F.

INTERESTING FACTS ABOUT AMERICAN LOCOMOTIVES.

Recently an extended trial was had of a modern locomotive on the New Jersey Central R. R., by two graduates of Stevens' Institute, Messrs. H. S. Wynkoop and John Wolff, and the results of it, as shown in the report, for which we are indebted to W. P. Hofecker, M. M. of the New Jersey Central R. R., are a valuable contribution to current engineering data.

The locomotive is of the modern four-driver and truck type, with extended smoke-box; the cylinders are 18″ x 24″; drivers, over all, 68″; weight on same, 68,670 lbs.; total weight of engine and tender, 152,660 lbs. The exhaust nozzles were 3⅝ths in diameter, and the average boiler pressure, 127.40 lbs. Under these circumstances the average evaporation was 7.11 lbs. from and at 212°. The highest power shown was 1,000 i. h. p., but the average was about 750 i. h. p. The water consumption is stated to have been as low as 14.63, and the highest 23 lbs. per h. p. per hour. This seems little short of incredible. The power developed from one square foot of heating surface was 7.51, and the amount of coal per horse-power, per hour, was 40 pounds. It is much easier to weigh the coal exactly and estimate it, than it is the water in the tender and boiler, for more or less waste would seem to be inevitable in the water, through leakages, etc., but, taking the coal consumption as stated, and the power developed as 750 h. p., the anomaly in the amount of water per h. p. is apparent. Fourteen pounds of water per h. p. per hour, is a result seldom, if ever, reached in high powered, high expansion engines, and it is seldom, if ever, reached in the average automatic engine of equivalent expansions. This makes the performance of this locomotive so unusual that we chronicle the fact. The weight of the train was 324,090 lbs., or 162 tons of 2,000 lbs. each.

The gradients were favorable. The line rises 120 ft. from Jersey City to Westfield, and then falls 95 ft. to Bound Brook, the gradients never exceeding 24 ft. per mile. The line then rises almost continuously until it attains a height of 498 ft. above Jersey City, the steepest grade being 41 ft. per mile. The line then falls 287 ft. to Phillipsburg, the steepest grade being 21 feet per mile. The average gradient is about 14 ft. per mile.

The highest speed attained was 78.8 miles per hour, of course on the grade. From Phillipsburg to Jersey City the distance is 73 miles, and it is run in 2 hours 27 minutes, making 21 stops, but any attempt to figure the average speed is nullified by the fact that the time lost in stopping and getting up to speed again is unknown.

It is also interesting to note that the coal consumed per square foot of the grate surface was very much smaller than is generally supposed to be the average on locomotives. The quantity we allude to was only 20 lbs. per square foot of grate surface, and has been burned in ocean steamers thirty years ago with natural draught. Locomotives generally are supposed to burn from 40 to 60 lbs. of coal per square foot of grate surface, and the performance of this engine with 20 lbs. per square foot only, is extraordinary.

NINE THOUSAND LOCOMOTIVES.

The Baldwin Locomotive Works have recently completed their 9,000th engine. Such an enormous output from works is highly creditable to any firm, and is especially remarkable when it is borne in mind that the works were not originally laid out for building modern locomotives, and that they labor under some consequent disadvantages, the individual shops being separated by public streets, and many of them being a considerable distance from the main office. However, a good system of organization and a careful selection of officers and foremen will effect wonders even in the face of physical disadvantages, and this is probably the secret of the success of the Baldwin Locomotive Works, which from small beginnings have built up by far the largest business of the kind in the world. The principle of taking the tried and experienced chiefs of departments into partnership has worked well, and has doubtless contributed greatly to the success of the firm. A manufacturing business, especially when dealing with such complicated pieces of machinery as locomotives, requires great mechanical ability and experience in those at the helm, and this cannot be secured as long as the brains that actuate the whole concern are merely paid a salary, while those who reap the profits have only a pecuniary interest in their work, and cannot understand its technical aspects. This is doubtless one reason why stock companies so often fail in manufacturing enterprises, while private firms, built up gradually by practical men, succeed in spite of limited capital. The members of the successful private firm understand the work produced, and can fully enter into and conceive the improvements by which good workmanship can be produced at a constantly decreasing price, and so meet competition and please their customers.

LOCOMOTIVES OF THE FUTURE.

Thirty years ago fifty and sixty miles per hour was not an uncommon maximum speed. Now sixty and seventy is about as high as we get on any of our lines. The weight of trains has probably grown as much as that of locomotives, and, perhaps, will continue to increase. Supposing, then, that the problem was presented to-day of making a passenger locomotive of double the weight and capacity of the largest now in use. That would mean an engine of somewhat over 200,000 pounds in weight, with a grate surface of fifty-five to sixty square feet, and a boiler with 3,000 square feet of heating surface, and cylinders twenty-seven or twenty-eight inches in diameter. Boilers five feet in diameter are now not uncommon ; seven and a half feet in diameter would give about twice the sectional area. An eight-wheeled American engine, weighing 100,000 pounds, would have about 17,000 pounds on each wheel. Double this weight, or 34,000 pounds per wheel, would be enormous, and would require a very great increase in the weight of rails ; and, even then, would be very doubtful if it could be carried without crushing both the tires and rails. By distributing this load on six or eight wheels, the load per wheel would be 22,666, or 17,000 pounds, which is well within possible limits.

The experience of the last few years has shown that the height of the center of gravity is not a matter of so great importance as was formerly supposed. The first impression is that a high locomotive is as likely to upset as a high load of hay, and it takes a considerable time and some deductive reasoning to realize fully that the vertical inequalities and horizontal deviations from a straight line, which a load of hay is expected to traverse, bear somewhat the same relation to those of a railroad that high mountains do to the gentle undulations of prairie country, and, therefore, that an elevation of the center of gravity which would be disastrous to a load of hay may be quite safe for a locomotive on a railroad. Mr. Wootten had the courage of his convictions, and elevated the centers of the boilers of his locomotives 7 ft. 8 in. above the tops of the rails.

The experience with electric light engines during the past few years has indicated what may be done with high-speed engines, and, in the light of that experience, it may be that wheels of smaller diameter than 5½ ft. might be used, and the requisite speed be obtained by running the pistons at higher velocities than is the present practice with locomotives. This would permit the boilers to be lowered and the size of cylinders to be reduced, and, consequently, the reciprocating parts and wheels would all be smaller and lighter. The reduction in weight could then be put into the boiler, which is the source of all power.

It, therefore, seems quite probable that the size and capacity of locomotives will continue to increase, although it is quite likely that there will be some modifications of the present forms of construction which will permit of the use of larger fire-boxes, and of lowering those parts whose elevation with a changed construction will not be essential.

There are some sanguine people who also predict that the speed of locomotives will also be doubled in the shadowy future, into which none of us can see very far. Past experience has not shown an increase in speed corresponding with that of the weight and capacity of locomotives. The reason is not difficult to find. The capacity of a locomotive — that is, the load it can pull at a given speed — is proportionate to its weight; that is, an engine twice as heavy will pull a train double the weight. There is a physical law which unfortunately prevents the fulfillment of the predictions of the sanguine profits of speed — that is, that the resistance of trains increases as the square of the velocity — probably at even a higher ratio at high velocities; and, what adds to the difficulty is, that, when the amount of work is thus increased, it must be done in less time. Thus at 60 miles an hour the resistance is roughly twice as great as it is at 40 miles, and the work must be done in two-thirds of the time. This law stands in the way of an increase in speed beyond limits which are soon reached in practical service.

RAPID RAILWAY TRANSIT.

As an illustration of the speed at which railway traveling can be effected when the necessity arises, it may be mentioned that last week an American, having missed the train in London, and having to catch an Atlantic steamer at Liverpool, proceeded by the ordinary train to Crewe, where a special engine had been chartered to convey him direct to Liverpool. The distance between Crewe and Liverpool is thirty-six miles, and one of the large Crewe engines completed the journey in thirty-three minutes, the American reaching the landing stage at Liverpool ten minutes before the timed departure of his steamer. The cost for this special service was £11.

RAILWAY GAUGES OF THE WORLD.

Ireland has a standard gauge of 5 ft. 3 in.; Spain and Portugal 5 ft. 6⅛ in.; Sweden and Norway have the 4 ft 8½ in. gauge over the majority of their railroads, but 20 per cent of the Swedish roads have other gauges, varying from 2 feet 7½ in. up to 4 ft.

In Asia, of the British-Indian roads, about 7,450 miles have a gauge of 5 ft. 5⅝ in., the remainder being divided among six gauges from 2 ft. to 4 ft. Of the narrow gauges, the most prevalent, embracing 4,200 miles, is the metre, 3 ft. 3⅜ in.

In Japan, with the exception of an 8-mile piece begun in 1885, with a gauge of 2 ft. 9 in., all the roads have a 3 ft. 6 in. gauge.

In Africa, the Egyptian railroads, amounting to 932 miles, are of the 4 ft. 8½ in. gauge. Algiers and Tunis, with 1,203 miles in 1884, had the 4 ft. 8½ in. standard on all but 155 miles, which had a 3 ft. 7¼ in. gauge. The English Cape Colony had, in 1885, 1,522 miles, all of 3 ft. 6 in. gauge.

In America, practically the whole of the United States and Canadian railroads are of 4 ft. 8½ in. to 4 ft. 9 in. gauge. In Mexico, in 1884, 2,083 miles were 4 ft. 8½ in., and 944 3 ft. gauge. In Brazil, at the end of 1884, there were 869 miles of 5 ft. 3 in. gauge, and 4,164 miles of various gauges between 2 ft. and 7 in., over 3,700 miles being 1 metre, or 3 ft. 3⅜ in., or that this may be considered the standard gauge of Brazil.

In Australia, the different colonies, rather singularly, have different gauges, that of New South Wales being 4 ft. 8½ in., Victoria 5 ft. 3 in., South Australia 4 ft. 3 in. and 3 ft. 6 in., and the other colonies 3 ft. 6 in.

The total mileage in operation in the world at the end of 1885 was 303,048 miles. Of this length, 74 per cent. were of the 4 ft. 8½ in. to 4 ft. 9 in. standard, 12 per cent. had larger gauges, and 14 per cent. smaller.

How many people, outside of practical men, know that steam is an invisible gas until the moisture it bears is condensed by contact with cold air. Such is a fact, nevertheless, as we may readily see by boiling water in a glass vessel. The bubbles that rise to the surface of the water are apparently empty — the white vapor appears after they burst in the air at the surface of the water.

HOW IRON SHIPS ARE PROTECTED.

Now, in dealing with cellular spaces of iron ships, it is all important that the iron or steel should receive a thick coating of the protective material before it commences to oxidize. In the case of steel the black oxide scale which covers the newly rolled material must in all cases be removed before paint or other substance is laid on. This is necessary both inside and outside of the vessel, and, if neglected, the results will sooner or later be expensive and annoying. But, when the scale is off and the surface cleaned, the paint, or whatever else is used, should be put on without any delay. For the interior of the vessel, exposed to bilge water or water ballast, paint is of very little use. Most ship-owners coat the surfaces at these parts with "cement wash," a very fluid preparation of Portland cement laid on with a brush. The same coating has often been laid upon the upper surface of inner bottom plating, with fairly good results. Elsewhere within the vessel iron or steel work should be painted, the thoroughness of the painting and the number of coats applied being of greater importance than the nature of the paint itself, which may be red lead, iron oxide, or white zinc, just as suits the taste of the person paying for it.

Although "cement wash" has proved a fairly satisfactory protection to iron or steel work at the parts already referred to, yet recent experience tends to show that more advantageous results follow the use of Stockholm tar and Portland cement. The surfaces coated must in all cases be free from oxidation, and quite dry. If at all damp the intended protection rapidly falls off. The surfaces are first coated with Stockholm tar, and at once sprinkled with dry cement powder until as much cement is applied as will stick to the tar. The tar and cement speedily amalgamate and slowly set; but when set the protection is quite hard and wholly impermeable to water. The upper surfaces of inner bottoms may advantageously be covered with this protection, more especially when under engines and boilers. Indeed, the wear and tear to inner bottom plating below machinery and boilers has been found to be so great that in all probability the placing of double bottoms at that part of the vessel will, to a large extent, be avoided in the future.

Unless some means can be taken to check the corrosive action which is so destructive at that part of the vessel, it will be necessary to add considerably to the scantlings, in order to provide a sufficient margin for possible and probable deterioration. The Stockholm tar and Portland cement remedy appears so far to meet the necessities of the case, and it is to be hoped that further experience will confirm present expectations regarding it.

Uncovered iron and steel decks continue to waste at a rapid rate, despite all the attempts hitherto made to check corrosive action. Coal tar and black varnish seem only to make matters worse, and the "let-alone" policy appears, so far, to be as good as any. Singularly enough, the more traffic there is on an iron deck, the less the wear and tear is found to be. At the sides of large hatchways, for instance, the corrosion is less than at parts of the deck where men seldom walk. It is not difficult to explain this phenomenon. As is well known, oxidation of iron progresses most rapidly in the presence of existing rust. The rust of copper prevents further corrosion, and only by the constant exfoliation on the surface is the bottom of a copper-sheathed ship kept clean. If that exfoliation is checked, the substance of the copper is preserved from wasting, but at the cost of a foul bottom. With iron, the case is different. Oxidation engenders further oxidation, and hence the necessity for frequently scaling the surface of iron which is permitted to oxidize at all. The wear and tear of traffic near the hatchways wears away the scale of rust as it is formed, and consequently corrosion proceeds more slowly there than elsewhere on the iron deck. The constant falling of salt water on the deck is undoubtedly the cause of its rapid corrosion, and up to the present time no means appear to have been successful in keeping the water from acting on the surface of the iron. Probably the Stockholm tar and Portland cement remedy would be as efficacious as any if it were hard enough to endure, but that is doubtful. Under present circumstances, the best course seems to be to scale the deck frequently, and so imitate at all parts of the surface the action which nominally operates so advantageously at the sides of the hatchways.

HOW BOILER PLATES ARE PROVED.

This is done by placing a piece of Bessemer steel ten inches long in a testing machine. Gradually the surface scales off in the middle, to become smaller in area, and somewhat elongated, till, at last, it breaks with a sharp snap at a breaking strain of about twenty-eight tons to the square inch, the reduction of area being fifty-one per cent., and the elongation twenty-three per cent.

WHY WATER PUTS OUT FIRE.

I have often been puzzled to answer for myself why water extinguishes fire. A great many people say it is because the water and its steam so completely envelop the burning material as to exclude oxygen, and thus the fire must stop. This seems to be an inefficient, if not an entirely erroneous, reason. My reason is this: "We know that nothing will burn (*i. e.*, unite with oxygen with the evolution of heat and light) unless, and until, it has been raised to a given temperature. Thus: Sodium burns at ordinary temperatures—about sixty degrees if dry—the gas of ordinary kerosene at about 170 degrees, or less, and so on. Why do we tie a piece of stick with sulphur and then with phosphorus to make matches? Because, while wood must have a high temperature, phosphorus will burn at a comparatively low temperature—so low that the heat developed by strict friction will ignite it. The phosphorus makes heat enough to ignite the sulphur, but not enough to start the wood. Now, in the large amount of heat which water can take up, and the fact that ordinary inflammables must be raised to a high temperature in order to burn, we have the cause of water putting out a fire. Put a burning match into a very small drop of water and it is extinguished, because of the very large amount of heat taken from the match in reducing the water to steam, which renders the temperature of the match too far below 212 degrees, or, at least, so far, if there is water enough, that the carbon and its compounds, forming wood, will no longer unite with the oxygen of the air. For the same reason, a hot iron thrust into the water is cooled, and water sprinkled on the floor cools the air, the heat of the evaporation in the latter case coming from the air itself, cooling it. If we could find a fluid very plentiful, which requires more heat than water to make it boil, evidently we could put large fires out much more rapidly.

THE NUMBER OF GERMAN LOCOMOTIVES.

According to Herr Leonhardt, a German engineer, the number of locomotives in use on German railroads was 12,450 in the year 1885–86, the average age being 12.49 years. Fifty engines built previous to the year 1850 were still in use at the date referred to, the oldest of which dated from 1845.

ECONOMY IN THE USE OF AN INJECTOR.

The following is an interesting discussion of the economy due to the use of an injector, in comparison with a direct-acting steam-pump, both with and without a feed-water heater, and a geared pump with heater. Although the investigation is theoretical, it seems to be based on reliable data, so that the results, as summarized in the following table, differ little, in all probability, from the figures which would be obtained by actual experiment :

Manner of feeding boiler.	Temperature of feed-water. Fahrenheit.	Relative amount of coal required for feed apparatus, in equal times.	Per cent. of fuel saved over first case.
1. Direct-acting steam-pump, no heater.....	60°	100	0.
2. Injector, no heater	150°	98.5	1.5
3. Injector, with heater........	200°	93.8	6.2
4. Direct-acting steam-pump, with heater...	200°	87.9	12.1
5. Geared-pump, actuated by the main engine, with heater........	200°	86.8	13.8

This does not make the comparison between the economical performance of an injector and pump actuated by the main engine, without heater in each case, or, in other words, he does not consider one of the most general divisions of the problem. Some experiments made on the Illinois Central Railroad may be briefly cited to supplement the discussion. The figures given represent averages of eight trips of 128 miles in each case:

	Feeding with pump.	Feeding with injector.	Per cent. of grain for injector.
Pounds of coal per trip...	9,529	8,736	9.08
Pounds of water per trip.	48,888	46,826	4.04
Pounds of water evaporated per pound of coal	5.14	5.26	4.28

In the experiments with pump, the trains were slightly heavier than when the injector was used, and more time was lost in switching and standing, for which reason the experimenters considered that the economy of coal consumption for the injector should be reduced from 9.08 to 6.21 per cent. Some incidental advantages were observed in the case of the injector, the boiler steamed more freely, and there was less variation of pressure.

A LILLIPUTIAN LOCOMOTIVE.

A very small locomotive has lately left the shops of Kraus & Co., of Munich. This engine, together with a car and one mile of portable track, is intended as a present from the King of Belgium to the Sultan of Morocco. This imperial toy will be laid in the gardens of the palace. The different pieces having necessarily to be carried from the port of landing to the capital by the primitive mode of freight transportation—the pack saddle—lightness of the single piece was the chief consideration with the builders, The gauge is 23⅝ inch. The heaviest parts of the engine. the boiler and the lower frame, weigh about 660 pounds each. The power the engine can develop is 4 H. P., and the speed is nine miles per hour. It is a four-wheeled tender locomotive on the Kraus system, with water tank frame. To save weight without reducing the strength of the single parts, phosphor bronze and steel have been freely used in its construction. The cylinder, piston, cross-head and journals are of phosphor bronze. The firing to be done with wood, a relatively large grate surface (1-14 of the total heating surface) has been given, and the engine has been provided with an American spark arrester. The dimensions are:

Cylinders	3⅛ in. x 6¼ in.
Drivers, diameter	15¼ in.
Wheel base	27½ in.
Heating surface	10.7 sq. ft.
Grate area	.75 sq. ft.
Boiler pressure	180 lbs.
Tank capacity	50 gallons.
Weight, empty	2,420 lbs.
Weight, in working order	3,080 lbs.

This is probably one of the smallest locomotives ever made, though many engines are working regularly on a narrower gauge, 18-inch, in shops, steel works, brick yards, etc.

RULE FOR SAFETY VALVE WEIGHTS.

There seems to be a steady demand for this rule. The following is an easily remembered formula which may be of service to some :

$$\frac{D^2 \times .7854 \times P - D\ W + F}{L} = W.$$

Now, this looks somewhat formidable to those who are not familiar with calculations in any form, but a few words and a little study will make it clear to most persons. The explanation is this :

D^2 means that the diameter of the valve is to be multiplied by the same figure. If the valve is 4″ diameter multiply it by 4. If it is 2″ multiply it by 2; if 3½″ multiply it by 3½. This is called squaring the diameter. Now multiply the sum by .7854 and observe the decimal. This gives the area, as it is called, or number of square inches in the valve exposed to pressure. Of course, the end of the valve exposed to steam has been measured — not the top of it. Now multiply the sum last found by the pressure to be carried on the boiler, say 60, if it is 60 pounds. This gives the force pressing on the bottom of the valve to blow it off its seat. Take half the weight of the lever and whole weight of valve and stem from this last sum, and then multiply by the distance from the center of the valve-stem to the center of the hole in the short end of the lever. Divide the sum so found by the whole length of the lever. Then you have the weight of the ball to go on the end to give 60 lbs. per square inch on the boiler.

This is, in brief, the rule; but it is of no earthly use to those who are not familiar with ordinary arithmetic, for they will be very likely to make serious errors in the result by mistakes in figuring.

The steamboat inspection law demands that candidates for marine licenses shall know this rule; but in many cases it would be just as useful to demand that a man should be able to jump twenty-five feet from a standstill, for those who are incompetent can learn the rule as above given, and pass muster, without being practical working engineers, while those who have mathematical abilities and practical experience also, are only affronted by such appeals to the knowledge they have of their calling.

The qualifications and abilities of engineers for their positions are in nowise determined by such trifling exercises as these.

REMARKABLE TIRE RECORD.

The Cumberland Valley Railroad received, on April 15, 1881, a locomotive built at the Rogers Locomotive and Machine Works, Paterson, N. J., and, on April 20, 1882, received another engine from the same works. These engines were numbered 32 and 35, respectively, and have done duty on passenger runs, making the round trip from Harrisburg to Martinsburg and return, a distance of 94 miles, or 188 miles daily. Engine 32 was brought in the shop to have her tire turned off, after making a run of 169,140 miles. She then made a run of 96,070 miles, and was brought into the shop for other repairs, when her tires were again turned. After this she was again brought in the shop for general overhauling, and has had her tires turned off after a run of 89,487 miles.

No. 35, however, has a remarkable record, her tires never having been turned off since coming on the road until this spring, when, having met with an accident, she had to be brought into the shop, and, in the meantime, had her tires turned off. The turning showed the tires to be less than one-sixteenth out of round in the most worn part. The mileage made by these tires was 328,969 miles. The following table shows the number of miles made each year:

1882	33,954	miles.
1883	57,594	"
1884	57,058	"
1885	57,930	"
1886	54,789	"
1887	55,654	"
1888	11,990	"
	328,969	"

These engines have 63-inch drivers, 16″ — 22″ cylinders, and with a concentrated weight on drivers of 46,550 pounds. The maximum grade they encounter going west is 45 feet per mile, and going east 40 feet per mile. The sharpest curvture is five degrees, but the general curvature does not exceed three degree curve. The average rate of speed on the road, of these engines, is 45 miles per hour.

These tires were made by the Midvale Steel Company, and, apart from the excellent quality of the tires, due credit must be given to the Rogers Locomotive and Machine Works, for the excellent manner in which these engines were put together and counterbalanced. It is also gratifying to note the evident care bestowed on the engines in question by those who had them in charge. The condition of the roadbed, of course, had much to do with the satisfactory working of the engines, and reflects credit on the chief engineer of the road.

SPEED OF TRAINS.

Speed per h'r.	Time required to go.		Speed per h'r.	Time required to go.		Speed per h'r.	Time required to go.	
	½ m	1 m		½ m	1 m		½ m	1 m
ml.	m. s	m. s	ml.	m. s.	m. s	ml.	m. s	m. s
5	6 0	12 0	24	1 15	2 30	43	0 41	1 23
6	5 0	10 0	25	1 12	2 24	44	0 40	1 21
7	4 17	8 34	26	1 9	2 18	45	0 40	1 20
8	3 45	7 30	27	1 6	2 13	46	0 39	1 18
9	3 20	6 40	28	1 4	2 8	47	0 38	1 16
10	3 0	6 0	29	1 2	2 4	48	0 37	1 15
11	2 43	5 27	30	1 0	2 0	49	0 36	1 13
12	2 30	5 0	31	0 58	1 56	50	0 36	1 12
13	2 18	4 37	32	0 56	1 52	51	0 35	1 10
14	2 8	4 17	33	0 54	1 49	52	0 34	1 9
15	2 0	4 0	34	0 53	1 46	53	0 34	1 7
16	1 52	3 45	35	0 51	1 43	54	0 33	1 6
17	1 46	3 31	36	0 50	1 40	55	0 32	1 5
18	1 40	3 20	37	0 48	1 37	56	0 32	1 4
19	1 34	3 9	38	0 47	1 34	57	0 31	1 3
20	1 30	3 0	39	0 46	1 32	58	0 31	1 2
21	1 25	2 51	40	0 45	1 30	59	0 30	1 1
22	1 21	2 43	41	0 43	1 27	60	0 30	1 0
23	1 18	2 36	42	0 42	1 25			

HOW TO MAKE CONICAL SPIRAL SPRINGS.

Wind the springs in usual manner on a straight mandrel and close the ends back, the distance required for the cone, by bending the coils in the jaws of a vise. Commence with the end coil, and squeeze first on one side and then on the other, until it is somewhat reduced in size; then take the next coil, and so on as far as you want to go. Be careful to squeeze the coils in such a manner as to retain their circular form. It is best, in order to get good results, to go over the cone a number of times, instead of reducing each coil to the required size as you go along.

SPEED OF TRAINS IN DIFFERENT COUNTRIES.

The following comparison of the speed of fast trains in different countries is made by taking a journey of about 200 miles from the principal cities of the countries named below:

Country.	Journey.	Distance.	Time.	No. of Stops.	Speed inc'di'g Stops.
U. S.	New York—Boston....	234	6 0	6	39*
"	New York—Washington	226	5 18	3	42 7
England.....	London.....Manchester..	203¼	4 15	2	48*
France......	Paris—Dijon	196	5 33	2	36
Germany....	Berlin—Minden.......	199	5 35	7	36
Austria.....	Vienna—Pilsen.......	217	6 45	11	33
Italy	Rome—Pisa	208	7 0	8	29.5
Spain	Madrid—Saragossa..	211	9 26	9	22
Portugal ...	Lisbon—Oporto.	209	11 0	18	18.5*

Trains marked * carry passengers at the ordinary rate of fare. The time and distance for the Pennsylvania train running to Washington is given from Jersey City. It will be seen that the fastest trains in this country exceed in speed those of any other country, England alone excepted. The average speed of the six Continental expresses referred to is only a trifle above 29 miles an hour, while the average speed of trains carrying passengers at the ordinary rate of fare for the same journeys is about 26 miles an hour, and the average number of stops is 8 for express trains, and 12 for those carrying passengers at ordinary rates.

HOW TO PREVENT INCRUSTATION IN STEAM BOILERS.

To prevent incrustation in steam boilers, triphosphate of soda, mixed with the feed water and allowed to stand for several hours, is being used with success.

COAL PER MILE RUN.

Of all the barren subjects it is possible to bring into a controversy on locomotive construction, none is more barren than the consumption of coal per mile. As a rule, outsiders know accurately little or nothing at all about it. Furthermore, the locomotive superintendent himself can form little more than a good estimate. It is very easy to ascertain how much coal a locomotive burns in running a certain distance, with a given train, but this means nothing in a railway sense. We have met with instances in which the consumption on a trip was under 18 pounds per mile; but the whole class of engines on the same work was debited in the coal sheets with over 30 pounds per mile. Allowances have to be made for lighting up, for standing, for shunting, and so on; and nearly as much coal may be, so to speak, wasted in this way as is actually utilized. An express engine may work for five hours out of the twenty-four, steam being kept up for seventeen hours while the engine is standing. On the other hand, a locomotive may work for nineteen hours out of the twenty-four. Again, the mileage of an engine is, taken alone, no test of its economy. It may mean anything or nothing. We have to consider not only the mileage, but the speed and the load. But perhaps the most important source of error of all is neglect of the quality of the coal. It does not pay, when carriage becomes a serious item, to buy cheap coal. In drawing a comparison, therefore, between the performances of an engine working in the South, and one working in the North, the relative merits of the coal used must not for a moment be lost sight of. Furthermore, individuals do not attach anything like sufficient importance to the influence of speed. They forget that for any given velocity, the consumption of fuel will be augmented in the ratio of the square of the speed. Thus, for example, if an engine runs at sixty miles an hour, it must exert four times the horse-power needed to run at thirty miles an hour with the same load, and the consumption per mile will be doubled from this cause alone. We may add that in practice the fuel bill will be augmented much more than this, for reasons which will be readily understood by engineers.

The stroke of an engine never grows shorter, although it is constantly being cut off.

AN EXPERIMENT WITH A LOCOMOTIVE.

A locomotive engineer who takes an intelligent interest in operating his engine economically, relates the particulars of runs where careful efforts were made to test the difference in the consumption of coal that resulted with the reverse lever hooked back as far as practicable and the throttle full open, and running with a late cut-off, and the steam throttled, or the difference between throttling and cutting off short.

First Case—A train of 19 loaded and 12 empty cars, rated at 25 loads. Run from Mansfield to Lodge, distance, 8.6 miles, nearly level. Forced the train into speed, and then pulled the reverse lever to the center notch, and opened the throttle wide. The engine jarred a good deal, due, doubtless, to the excessive compression, but the speed was maintained. Twenty-two minutes were occupied by the run, a speed of 23 miles per hour, and 17 shovelfuls of coal were consumed in keeping up steam. By weighing, it was found a shovelful averaged 14 pounds, making the coal used per train mile average 27.7 pounds.

Second Case—A train of 25 loads and six empties, rated as 28 loaded cars. Ran, as in the first case, from Mansfield to Lodge. Pulled the train into speed in as nearly as possible the same time as in the previous test, but, when the speed was attained, kept the reverse lever in the nine-inch notch, and throttled the steam to keep down the speed. Although the train was rated two loads heavier than the previous one, it consisted mostly of merchandise, while the other was heavy freight, and handled decidedly easier. Having pulled both trains over 40 miles before arriving at Mansfield, there was full means of judging which was the easier train to handle.

The run was made in 24 minutes, two minutes longer than in the other case, and 32 shovelfuls of coal were used, being at the rate of 52 pounds per train mile. In both instances the fire was as nearly as possible the same depth at the beginning and end of the run.

Our correspondent thus concludes his narrative: "It is interesting to know that on the first occasion 238 pounds of coal were used to do the same work in less time than 448 pounds were required to do under the changed circumstances of the second trip; showing that a gain of 88 per cent. may be effected by running with full throttle and early cut off."

FAST AMERICAN STEAMERS.

The following is a list of twenty-eight fast American steamers of from 2,200 to 4,000 tons, all of which have shown a sea speed of more than fifteen knots for six consecutive hours, and from which would be made the selection of vessels to be held in reserve for cruisers:

Vessels.	Hailing Port.	Tonnage.	Speed.
Newport	New York	2,735	17.9
City of Augusta	Savannah	2,870	16.5
City of Puebla	New York	2,624	16.5
Queen of the Pacific	Portland, Or.	2,728	16.5
Alameda	Philadelphia	3,158	16.5
Mariposa	San Francisco	3,158	16.5
State of California	San Francisco	2,266	16
Alliance	New York	2,985	16
Louisiana	New York	2,840	16
Ohio	Philadelphia	3,126	15.6
Saratoga	New York	2,426	15.4
City of Alexandria	New York	2,480	15.4
Nacoochee	Savannah	2,680	15.4
Chattahoochee	New York	2,676	15.4
Roanoke	New York	2,354	15.4
Excelsior	New York	3,264	15.4
Alamo	New York	2,943	15.4
Lampasas	New York	2,943	15.4
El Paso	New York	3,531	15.4
El Dorado	San Francisco	3,531	15.4
H. F. Dimock	Boston	2,625	15.4
Herman Winter	Boston	2,625	15.4
Seminole	New York	2,557	15.4
El Monte	New York	3,531	15.4
San Pedro	New York	3,119	15.4
San Pablo	New York	4,064	15.4
Cherokee	New York	2,557	15
Santa Rosa	New York	2,417	15

A WARNING TO ENGINEERS.

Never take the cap off a bearing and remove the upper brass to see if things are working well, for you never can replace the brass exactly in its former position, and you will find that the bearing will heat soon afterward, on account of your unnecessary interference. If there is any trouble, you will find it out soon enough.

THE PREVENTION OF ACCIDENTS FROM RUNNING MACHINERY.

A German commission was appointed to investigate accidents in mills and factories, and draw up a series of rules for their prevention. Some of these rules are as follows:

SHAFTING.

All work on transmissions, especially the cleaning and lubricating of shafts, bearings and pulleys, as well as the binding, lacing, shipping and unshipping of belts, must be performed only by men especially instructed in, or charged with, such labors. Females and boys are not permitted to do this work.

The lacing, binding or packing of belts, if they lie upon either shaft or pulleys during the operation, must be strictly prohibited. During the lacing and connecting of belts, strict attention is to be paid to their removal from revolving parts, either by hanging them upon a hook fastened to the ceiling, or in any other practical manner; the same applies to smaller belts, which are occasionally unshipped and run idle.

While the shafts are in motion, they are to be lubricated, or the lubricating devices examined only when observing the following rules: *a.* The person performing this labor must either do it while standing upon the floor, or by the use of *b.* Firmly located stands or steps, especially constructed for the purpose, so as to afford a good and substantial footing to the workman. *c.* Firmly constructed sliding ladders, running on bars. *d.* Sufficiently high and strong ladders, especially constructed for this purpose, which, by appropriate safeguards (hooks above or iron points below), afford security against slipping.

The cleaning and dusting of shafts, as well as of belt or rope pulleys mounted upon them, is to be performed only when they are in motion, either while the workman is standing: *a*, on the floor; or *b*, on a substantially constructed stage or steps; in either case, moreover, only by the use of suitable cleaning implements (duster, brush, etc.), provided with a handle of suitable length. The cleaning of shaft bearings, which can be done either while standing upon the floor or by the use of the safeguards mentioned above, must be done only by the use of long-handled implements. The cleaning of the shafts, while in motion, with cleaning waste or rags held in the hand, is to be strictly prohibited.

All shaft-bearings are to be provided with automatic lubricating apparatus.

Only after the engineer has given the well understood signal, plainly audible in the work-rooms, is the motive engine to be started. A similar signal shall also be given to a certain number of work-rooms, if only their part of the machinery is to be set in motion.

If any work other than the lubricating and cleaning of the shafting is to be performed while the motive engine is standing idle, the engineer is to be notified of it, and in what room or place such work is going on, and he must then allow the engine to remain idle until he has been informed by proper parties that the work is finished.

Plainly visible and easily accessible alarm apparatus shall be located at proper places in the work-rooms, to be used in cases of accident to signal to the engineer to stop the motive engine at once. This alarm apparatus shall always be in working order, and of such a nature that a plainly audible and easily understood alarm can at once be sent to the engineer in charge.

All projecting wedges, keys, set-screws, nuts, grooves, or other parts of machinery, having sharp edges, shall be substantially covered.

All belts and ropes which pass from the shafting of one story to that of another shall be guarded by fencing or casing of wood, sheet-iron or wire netting four feet six inches high.

The belts passing from shafting in the story underneath and actuating machinery in the room overhead, thereby passing through the ceiling, must be inclosed with proper casing or netting corresponding in height from the floor to the construction of the machine. When the construction of the machine does not admit of the introduction of casing, then, at least, the opening in the floor through which the belt or rope passes should be inclosed with a low casing at least four inches high.

Fixed shafts, as well as ordinary shafts, pulleys and fly-wheels, running at a little height above the floor, and being within the locality where work is performed, shall be securely covered.

These rules and regulations, intended as preventions of accidents to workmen, are to be made known by being conspicuously posted in all localities where labor is performed.

ENGINEERS.

The attendant of a motive engine is responsible for the preservation and cleaning of the engine, as well as the floor of the engine-room. The minute inspection and lubrication of the several parts of the engine is to be done before it is set in motion. If any irregularities are observed during the performance of the engine, it is to be stopped at once, and the proper person informed of the reason.

The tightening of wedges, keys, nuts, etc., of revolving or working parts, is to be avoided as much as possible during the motion of the engine.

When large motive engines are required to be turned over the dead point by manual labor, the steam supply valve is to be shut off.

After stoppage, either for rest or other cause, the engine is to be started only after a well-understood and plainly audible signal has been given. The engineer must stop his engine at once upon receipt of an alarm signal.

The engineer has the efficient illumination of the engine-room, and especially the parts moved by the engine, under his charge.

The engineer must strictly forbid the entrance of unauthorized persons into the engine-room.

An attendant of a steam or other power motor, who is charged with the supervision of the engine as his only duty, is permitted to leave his post only after he has turned the care of the engine over to the person relieving him in the discharge of his duties.

The engineer is charged with the proper preservation of his engine, and means therefor. He must at once inform his superior of any defect noticed by him.

The engineer on duty is permitted only to wear closely fitting and buttoned garments. The wearing of aprons or neckties with loose, fluttering ends, is strictly prohibited.

GEARING.

Every work on gearing, such as cleaning and lubricating shafts, bearings, journals, pulleys and belts, as well as the tying, lacing and shipping of the latter, is to be performed only by persons either skilled in such work, or charged with doing it. Females and children are absolutely prohibited from doing such work.

When lacing, binding or repairing the belts, they must either be taken down altogether from the revolving shaft or pulley, or be kept clear of them in an appropriate manner. Belts unshipped for other reasons are to be treated in the same manner.

The lubricating of bearings and the inspection of lubricating apparatus must, when the shafting is in motion, be performed either while standing upon the floor or by the use of steps or ladders, specially adapted for this purpose, or proper staging or sliding ladders. The lubrication of wheel work and the greasing of belts and ropes with solid lubricants is absolutely prohibited during the motion of the parts.

In case of accident, any workman is authorized to sound the alarm signal at once by the use of the apparatus located in the room for this purpose, to the engineer in charge.

The following rules, classified under proper sub-heads, are published by the *Technische Verein*, at Augsburg:

TO PREVENT ACCIDENT BY THE SHAFTING.

While the shafts are in motion, it is strictly prohibited: *a.* To approach them with waste or rags, in order to clean them. *b.* In order to clean them, to raise above the floor by means of a ladder or other convenience.

It is allowable to clean the shafting and pulleys only while in motion.

These parts of the machinery must be cleaned by means of a long-handled brush only, and while standing upon the floor.

The workmen charged with these or other functions about the shafting must wear jackets with tight sleeves, and closely buttoned up; they must wear neither aprons nor neckties with loose ends.

Driving pulleys, couplings and bearings are to be cleaned only when at rest.

This labor should, in general, be performed only after the close of the day's work. If performed during the time of an accidental idleness of the machinery, or during the time of rest, or in the morning before the commencement of work, the engineer in charge is to be informed.

HOW TO FIND THE HORSE-POWER OF AN ENGINE.

Multiply the square of the diameter of the cylinder by 0 7854, and, if the cut-off is not known, multiply the product by four-fifths of the boiler pressure; multiply the last product by the speed of the piston in feet per minute (or twice the stroke in feet and decimals, multiplied by the revolutions per minute). Divide the final product by 33.000. and the horse-power will be the answer.

THE EFFECTS OF TEMPERATURE ON IRON.

It is a well-known principle that heat expands all substances, except clay, which would follow the rule if it were not for the water contained, which, being evaporated, contracts the body of the clay. Heat thus expands all bodies —and so of the reverse. In the absence of heat, or for the want of heat, all substances contract. Every one knows that, when iron is hot, it is pliable and "tough;" that is, its particles hold together with increased tenacity, up to a point of melting, when the particles are so far set apart as to have no more adhesion than other fluids. Every practical man knows that the reverse obtains in proportion to the absence of heat. Not only the woodman knows that his ax is liable to break at a low degree of heat, but the ordinary teamster knows that, under the same circumstances, the tire of his wheel is liable to break if it strikes with extra force some obstruction. So of chains, and other structures of iron. An engineer remarked that, on taking out his engine, one frosty morning, he let the steam on too suddenly; the effect of the jar was to take about four inches in length out of the coupling shaft between the wheels of the locomotive.

Now for the application to the Ashtabula disaster. The bridges of that day, more than now, perhaps, depended upon the strength of the bolts which held the ends of all the various iron bars in place. It will be perceived, that, if these bolts were to give way, the whole structure would unravel, not unlike a stocking, in some degree. The bridge was composed of long bars of iron held together at the ends by these ⅝ or ¾ inch bolts; if for want of heat those bars contracted, the 1-16 or ⅛ of an inch each, they would act as a shear on the bolt, and, being "cold" and short, would be very likely, under the tension, to break; particularly when under the weight of a heavy snow, and the train, drawn by two engines, under quickened motion. The jar of the train would be likely to finish the rupture commenced by the "frost" or absence of heat, and, when once started, would move rapidly on to the fatal downfall and destructive finish.

I believe it is admitted, that cold is not a principle, but the absence of heat.

What is said to be the largest railroad station in the world has recently been opened at Frankfort-on-the-Main. It covers an area of 100,000 square feet, and cost 33,000,000 marks.

HIGH SPEED GEARING.

During the last few years, and particularly since the adoption of double-heliacal teeth, a great increase has been made in speed at which gearing is run, and, in many cases, there are now successfully adopted speeds which in former days would have been regarded as utterly impracticable. The most striking instances of this which we have come across, is in the case of a pair of double-heliacal wheels at the works of Messrs. R. Johnson & Nephew, the well-known wire-drawers of Manchester. These wheels, which were cast by Messrs. Sharples & Co., of Ramsbottom, Lancashire, are 12 in. wide on the face, by 6 ft. 3 in. diameter, and they have now been running for over a year at 220 revolutions per minute, the pitch-line speed being thus 4,319 ft. per minute. Notwithstanding this enormous speed, the wheels run with scarcely any noise, and their working has been most satisfactory. This is the highest speed we have heard of for geared wheels, running iron to iron, and the fact that it has been adopted with success, is a most interesting one.

The large gear on the Corliss engine at the Centennial Exhibition was 30 feet in diameter, outside, and ran at 36 revolutions per minute. It had a 24-in. face, and the speed of the pitch-line is about 3,360 ft. per minute. This speed is exceeded by a similar gear, also made by Mr. Corliss, which is now running in a mill in Massachusetts. It is 30 ft. in outside diameter, and has a 30-in. face. It makes 50 revolutions per minute, and the speed of the pitch-line is not far from 4,670 ft. per minute. This is probably the highest speed at which any gear has yet been run continuously.

The Corliss gears are all accurately shaped by a revolving cutter; but it is probable that Messrs. Sharples & Co.'s gears are not cut, but cast, and then finished up by hand. If that is the case, their performance is much more remarkable than that of the Corliss gears.

THE WORLD'S STEAM ENGINES.

According to the Berlin Bureau of Statistics, there is in the world the equivalent of 46,000,000 horse-power in steam engines, 3,000,000 being in locomotives. In engines other than locomotives, the United States comes first with 7,500,000 horse-power; England next with 7,000,000 horse power; Germany 4,500,000 horse-power; France 3,000,000 horse-power, and Austria 1,500,000. Four-fifths of the steam engines now in operation are said to have been built within the last twenty-five years.

VALUABLE INSTRUCTIONS FOR ENGINEERS.

1. Condition of the Water—The first duty of an engineer, when he enters his boiler-room in the morning, is to ascertain how many gauges of water there are in his boilers. Never unbank or replenish the fires until this is done. Accidents have occurred, and many boilers have been entirely ruined, from neglect of this precaution.

2. Low Water—In case of low water, immediately cover the fire with ashes, or, if no ashes are at hand, use fresh coal. Do not turn on the feed under the circumstances, nor tamper with or open the safety valve. Let the steam outlets as they are.

3. In Case of Foaming—Close the throttle, and keep closed long enough to show true level of water. If that level is sufficiently high, feeding and blowing will usually suffice to correct the evil. In case of violent foaming, caused by dirty water, or change from salt to fresh, or *vice versa*, in addition to the action above stated, check draft, and cover fires with fresh coal.

4. Leaks—When leaks are discovered, they should be repaired as soon as possible.

5. Blowing Off—Blow down under a pressure not exceeding twenty pounds, at least once in two weeks—every Saturday night would be better. In case the feed becomes muddy, blow out six or eight inches every day. Where surface blow-cocks are used, they should be often opened for a few moments at a time.

6. Filling Up the Boiler—After blowing down, allow the boiler to become cool before filling again. Cold water pumped into hot boilers, is very injurious from sudden contraction.

7. Exterior of Boiler—Care should be taken that no water comes in contact with the exterior of the boiler, either from leaky joints or other causes.

8. Removing Deposit and Sediment—In tubular boilers, the hand-holes should be often opened, and all collections removed from over the fire; also, when boilers are fed in front, and blow off through the same pipe, the collection of mud or sediment in the rear end should be often removed.

9. Safety-Valves—Raise the safety-valves cautiously, and frequently, as they are liable to become fast in their seats, and useless for the purpose intended.

10. Safety-Valves and Pressure Gauge—Should the gauge at any time indicate the limit of pressure allowed by

the inspector, see that the safety-valves are blowing off. In case of difference, notify the inspector.

11. Gauge Cocks—Glass Gauges—Keep gauge cocks clear and in constant use. Glass gauges should not be relied on altogether.

12. Blisters—When a blister appears, there must be no delay in having it carefully examined and trimmed, or patched, as the case may require.

13. Clean Sheets—Particular care should be taken to keep sheets and parts of boilers exposed to the fire perfectly clean; also all tubes, flues and connections well swept. This is particularly necessary where wood or soft coal is used as fuel.

14. General care of Boilers and Connections—Under all circumstances keep the gauges, cocks, etc., clean and in good order, and things generally, in and about the engine and boiler-room, in a neat condition.

LOCOMOTIVE FUEL IN INDIA.

One of the greatest problems of Indian railway administration, says London *Engineering*, is that of fuel supply. The railways use wood, coke and coal, and the use of petroleum is now being begun. Of 700,000 tons of coal consumed in 1886, over 240,000 tons were English coal, the cost of which varied from 12s. to 15s. per ton. At the Umaria collieries, which supply the G. I. P. and the Indian Midland Railways, the cost of the coal at the pit's mouth is stated to be about 10s. for large, and 6s. for small coals per ton. This, it need hardly be added, is much higher than the average cost of English coal in like circumstances. On the North-western system, however, trials have been made of a petroleum fuel, with results that are said to be highly satisfactory. The cost of the petroleum fuel per 100 miles worked is stated to have been 36.8 rupees, as compared with 51 to 57 for coal and 16 to 30 for wood. The average evaporative power of petroleum fuel is, however, said to be 9.82 pounds of water, as compared with only 6.91 pounds for fuel, and 7.71 pounds for patent fuel per pound consumed. The average consumption of the petroleum fuel was 28 pounds per train mile, and the cost of adapting locomotive engines for the burning of petroleum is said to vary from 500 to 868 rupees (50*l.* to 86*l.*).

VALUABLE INFORMATION FOR ENGINEERS.

To find the capacity of a cylinder in gallons, multiply the area in inches by the length of stroke in inches, and it will give the total number of cubic inches; divide this by 231, and you will have the capacity in gallons.

The U. S. standard gallon measures 231 cubic inches, and contains 8⅓ pounds of distilled water.

The mean pressure of the atmosphere is usually estimated at 14.7 pounds per square inch.

The average amount of coal used for steam boilers is 12 pounds per hour for each square foot of grate.

The average weight of anthracite coal is 53 pounds to one cubic foot of coal; bituminous, about 48 pounds to the cubic foot.

Locomotives average a consumption of 3,000 gallons of water per 100 miles run.

To determine the circumference of a circle, multiply the diameter by 3.1416.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434, approximately, every foot elevation is equal to ½ pound pressure per square inch, allowing for ordinary friction.

The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. The area of the water piston, multiplied by the pressure of water per square inch gives the resistance. A margin must be made between the power and the resistance to move the pistons at the required speed, from 20 to 40 per cent., according to speed and other conditions.

To determine the diameter of a circle, multiply circumference by .31831.

Steam at atmospheric pressure flows into a vacuum at the rate of about 1550 feet per second, and into the atmosphere at the rate of 650 feet per second.

To determine the area of a circle, multiply the square of diameter by .7854.

A cubic inch of water evaporated under ordinary atmospheric pressure is converted into one cubic foot of steam (approximately).

By doubling the diameter of a pipe, you will increase its capacity four times.

In calculating horse-power of tubular or flue boilers, consider 15 square feet of heating surface equivalent to one nominal horse-power.

THE ENGINEER.

How greatly an engineer resembles his trade!
Both being so "fearfully and wonderfully made.
Brave, frank, open-hearted and manly; no fear,
Be he "high" or "low pressure," of a good engineer.
Like their "engines," 'tis likely they all have their faults;
But what "class" are "perfect" 'neath heaven's blue vaults?
Some work "non condensing" while others "condense;"
Some work by "expansion," all use common sense.

Some "carry high pressure," and as "boilers" oft do,
"Give way" to that "pressure," collapsing a "flue."
No matter what "tests" or "how heavy their load,"
Be it said to their credit, they seldom "explode,"
Though some (though all the fraternity don't)
Will "go on a bust" when their "boilers" just won't;
At abuse he'll "fire up" and "prime," "foam" and "cough;"
Just speak to him rudely and see him "blow off."

He's mostly "in line" and correctly "upright,"
Though "eccentric" full oft, and a "crank" at first sight.
His visage is truth's "indicator," a "gauge"
In his "clear" even "fires" in his furnace that rage;
Energetic and pushing, symmetric in "beam,"
He, like a good "valve," "works" a "full head" of steam.
On his "guides" he "works smooth" with no "knocking around,"
In good men and "engines," slight "friction" less "sound."

Sometimes they've a "cross-head," tee-head" if you will;
But then they must have them "good work to fulfill."
When you meet this same "cross-head," look out for "loud knocks,"
If he's "out of line" badly or has a "hot box."
And, brothers, some of us are "rotary," you know.
Some "run at high speed," while the others "run slow;"
Still, we've a good "check valve," our conscience, you see,
Keep it well "lubricated," not "gummed up" but "free."

Have never a "screw loose," nor charity lacking;
Keep clear of the "hump," save to use it as "packing."
Our "safety-valve" let fidelity be
With "area" large, on its "seat" working free."
Your "boiler" keep "full," but don't get "full" yourself,
For when one gets "full," he'll be "laid on the shelf;"

Keep your life and your "boilers" of "mud" and "scale" clean;
Shun "compounds," "corrosive," rum, whisky and gin.

The "poker" to "draw" "fires," on this lay great stress.
"Draw-poker," however's, a "grate bar" to success.
Be honor your "governor," not alone "automatic,"
Quite "sensitive" be it, not too aristocratic.
Practice "full economy;" keep "everything bright;"
Have a "man-head;" keep sober, but keep your "keys" "tight."
In life's race "run forward;" on each "lap" try to "lead;"
"Run steady," "exhausting" all means for "full speed."

When your "license runs out," to your "doctor" you flee,
And death's "point of cut-off" you plainly can see;
And done with life's "labor," absolved from all cares,
May our tombstones bear record, "laid up for repairs."

—*Henry J. Pate.*

THE PASSENGER BRAKEMAN.

On leaving Gotham, down the aisle,
I saw him come with scornful smile;
Flowed from his lips these words compressed:
"Thiscar'sforallpointsNorthandWest!"

He, later, once more loomed in view —
'Twas understood by one or two —
This jumping jumble, this fanfare:
"Troytwentyminutesbreakfastthere!"

In time again, he through the door
Burst in, and dashed by — as before —
With one of his chain lightning calls
Of "Buff'lochangeforNag'raFalls!"

Next, when we'd crossed Ohio's plain —
And Indiana's — and the train
Jarred, swayed and stopped, he deigned to state
"Ourengine'stelescopedafreight!"

And, when at last my trip was done —
Reached was the land of setting sun,
With Babel sound he gave this shout:
"Chicagopassengersallout!"

HOW FAST CAN A LOCOMOTIVE RUN?

Articles treating of the question as to how fast a locomo-motive can run are appearing again in the railway and mechanical papers, after a considerable sleep. One of the latest of these articles places the limit at 80 miles per hour, and states six reasons for its conclusion that a greater speed cannot be attained, as follows:

a. Because no greater velocity has ever been attained.

b. Because of the resistance of the air.

c. Because of the back pressure in the cylinders.

d. Because of the amount of power which must "no doubt be lost in imparting violent motions to masses of metal which can make no return when coming to rest. The swinging of the engine, the excessive vibration of its parts, and the jar and concussion all operate to the same end, and tend to keep down the speed."

e. Because of "the extraordinary retarding influence of very moderate rising gradients."

f. Because of the coupling rod — "it appears to be beyond question that coupling an engine tends to keep down the speed. On this point, we have, however, *nothing in the way of proof to offer.*"

To this view the *Railway Review* (Chicago) takes exception, saying: "Now the remarkable fact, which appears in all of these articles, is that *no limitations whatever* are placed on the future change in design of the locomotive. This alone removes all force from the argument. * * * In conclusion we feel obliged to state that not one objection has yet been raised to speeds of 100 miles per hour that cannot be readily surmounted. We have now locomotives which will make more steam than can be used with heavy trains at 60 miles per hour. With level roads, improved valve gear, high pressures and independent blast, we cannot believe that the statement 'that speeds of more than 80 miles per hour are mythical' will prove acceptable to careful thinkers."

INGENIOUS WAY OF COOLING A JOURNAL.

An ingenious way of cooling a journal that cannot be stopped is to hang a short endless belt on the shaft next to the box and let the lower part of it run in cold water. The turning of the shaft carries the belt slowly around, bringing fresh cold water continually in contact with the heated shaft, and without spilling or spattering a drop of the water.

THE COST OF A CAR WHEEL.

Advices from Eaton, Pa., state that free-trade orators in that section have asserted that a 500 pound car wheel sold for $12, and that the entire cost of labor was only 85 cents. They state the case in such a manner as to try to mislead the public into believing that the manufacturer pockets enormous profits. In answer to this, the following expert testimony has been given:

Chilled car wheels are made from this kind of pig iron, and a 500 pound wheel sells at $8, not $12. Here is the inaccuracy in the free-trade statement. The company offers to furnish 10,000 of these wheels at $8 if the orators in question will put up the money in advance.

Now as to the labor item. The company states that the average cost of charcoal pig iron used in casting car wheels is $26.50 a ton, from which four wheels can be cast. Old car wheels to the extent of 25 per cent. can be used, which proportion at $19 per ton, the present price, would bring the cost of the metal, unmelted — three-quarters charcoal pig iron, one-quarter old car wheels — to $24.62½ per ton. The item of labor in this amount is 90 per cent. of the whole. The labor, therefore, on the metal for one wheel, unmelted, would be one-quarter of 90 per cent. this cost of $24.62½, or $6.16, and this the wheel manufacturer pays out before the materials come to his mills. Then the items as follows, for one wheel: Cost of melting, core drying, etc., 20 cents; sand, molds and cores, flour and facing, 15 cents; foundry labor and molding and casting, 85 cents; outside work, unloading pig iron, coal, etc., 10 cents; repairs, wear and tear, taxes, insurance, motive power and delivery charges consume 40 cents more, and the cost is $7.86, leaving the company just 14 cents profit on each wheel.

The company adds that "the fact is that all labor required in making car wheels from the raw material or minerals used fully equals 75 per cent. of the cost. The molders who make wheels earn $3.50 a day, as against $1.25 paid in England. Should all the raw materials up to the finished wheel, be reduced to the English standard, the wheels could probably be made at a reasonable profit to the manufacturer."

Locomotives are in use on the Lake Shore Railroad which carry 180 pounds per square inch.

OUR RAILROADS IN 1890.

It is doubtful if there could be selected a better means of studying the wonderful growth of this country within recent years, than by an examination of the statistics presented in "Poor's Manual of Railroads" for 1888. As an example of this, it may be stated that at the end of 1887 there were in the country 149,913 miles of railroad, an increase during a period of seven years of 56,564 miles, the rate of increase being more than sixty per cent. From 1830 to 1840 there were built 2,814 miles; from 1840 to 1850 there were built 6,203 miles; from 1850 to 1860 there were built 22,279 miles; from 1870 to 1880 there were built 40,435 miles, while, as shown above, there have been built, in the last seven years, 56,564 miles; probable mileage in 1890, at same ratio, 175,000.

Viewed in the light of our present knowledge, the statement made by Henry V. Poor, in his "Manual" for 1880, that "the 100,000 miles of to-day will in ten years be 200,-000; the investment of $6,000,000,000 to-day will in ten years equal $10,000,000,000," does not seem to be nearly so extravagant as some people thought it was when it was written.

The total mileage of railroads constructed in 1887 exceeded 13,000 miles — a greater total, by some 1,100 miles, than the mileage constructed in any previous year. Should the construction of the next three years average an equal amount, the total at the end of 1890 will be about 190,000 miles. In any case, it is safe to say the figures will reach 175,000 miles, or only about 12½ per cent. less than the estimate made. With an average increase of 10,000 miles per annum. during the decade ending with 1900, we will have, at the opening of the twentieth century, a total mileage of close on 300,000 miles.

THE ESTRADE HIGH-SPEED LOCOMOTIVE.

The Estrade locomotive, La Parisienne, specially designed for high speeds, and built in the shops of M. J. Boulet, at Paris, is to undergo a series of official trials. It is fitted with driving wheels somewhat over eight feet in diameter, and the speed upon which the designer, M. Estrade, figures for running, is somewhat like 78 miles per hour. Its length is about 32 feet, exclusive of tender, and its weight, when empty, 38 tons. The results of the tests will be awaited with some interest.

QUALIFICATIONS OF AN ENGINEER.

The management and control of a steam engine requires greater intellectual capacity than most of the other trades where manual labor enters into a large portion of the work performed. But engineers and firemen are exposed to no greater dangers, and are liable to no more diseases, if they are prudent, vigilant, regular in their habits and willing to follow the well-known rules by which they should be governed, than other men.

The first thing for them to learn is prudence, and a willingness to observe the precautions recommended by those of longer experience than themselves, whereby they will follow well-established rules, and not make hazardous experiments, or run risks that are more or less rash and foolhardy, wherein success is a stroke of luck that only tends to develop a foolish braggadocio.

Further, the engineer should have a character that is calm, resolute, quick to act and cool; for the man who loses his head the minute there is an accident, is incapacitated for this work. If he is a locomotive engineer, his obedience should be that of a soldier, who receives his order and executes it without a questioning thought. Every sense should be on the alert, even to that of smell, that he may become immediately aware of burning oil or bearings heated by their work.

As for temperance, a man should not forget that he holds in his hands the lives of a large number of persons, and a very little negligence will transform into an instrument of death, a machine which has few dangerous properties when controlled with calm vigilance and presence of mind. As a man's mind depends largely upon his personal comfort, this same temperance should be carried into all of his walks in life ; he should see that his food and clothing are suited to the work to be done, taking especial care to avoid excesses of all kinds, and exercise great caution when it is necessary to pass from one place to another where there are considerable variations of temperature.

Finally, he should avoid that presumption which leads the younger man to think that he is too quickly fitted to take charge of an engine, and the older, that he has learned all that there is to know. Therefore, before entering on this work, it is necessary that he should be thoroughly familiar with the machine and its methods of action. We further advise him not to be content with merely watching an engine in operation, but to make sketches, and then, if he will take the pains to copy them to a scale, he will soon find the work as easy as it is interesting. While studying, he should familiarize himself with the action of the different parts, and the best and simplest means of taking down and erecting parts of the plant, so that repairs and inspection can be performed with the least possible delay. But let him be careful not to touch those parts that can only be handled with tools which he does not possess. The greater portion of every machine, such as stuffing boxes, pistons, packing, cylinder covers, lubricating apparatus, valve motion, the cocks and valves, and all caps and covers that must be removed to clean the interior, can usually be adjusted with the ordinary engine-room appliances. Great care should be taken, however, to replace each piece in the position it originally occupied.

In order that slight repairs may be well and quickly done, it is well if the engineer adds to the practice, which he may obtain in an engine-room, that which can best be acquired in the erecting shop of some good manufactory. The same course will also be of equal value to the firemen, that they may work intelligently under the guidance of the engineer.

For manipulation, the engineer is almost wholly dependent on his experience with each engine. In this he must first have recourse to the instructions of the builder, or the engineer whom he succeeds. It is a good idea to handle the engine before one of these persons, and thus learn the limits of motion, and the action of the moving parts. In this way he will most quickly learn the proper amount of opening to give to the throttle, the injector, the valves for admission, exhaust and the pumps; for, although the principles may be well learned, practice alone can show the best way of using them. It is well, when learning in this way, to go through the motions, for the first time, when the engine is not under steam. In other words, every engineer, however well instructed he may be, will find it advisable to take a few lessons on the particular plant of which he is about to take charge, and this also applies to the assistants and firemen. In large plants, it is frequently insisted upon by the owners.

There are no less than twenty-six lines of passenger steamers, with weekly sailings from this country and ports in Europe, and official returns for 1887 give something approaching 12,000,000 tons of shipping of all kinds, crossing and recrossing.

MANIPULATION OF NEW ENGINES.

After engines have been set up, they must be adjusted to their work. It is not every man that can do this properly, for it requires experience and consideration to determine exactly what is to be done. A new engine is a raw machine, so to speak, and, no matter how carefully the work has been done upon it, it is not in the same condition that it will be in a few weeks, or after the actual work it does has worn its bearings smooth and true. In the best machine-work, there are more or less asperities of surface, and very much more friction than than there will be later on. Bearings and boxes are not fitted under strain; they are fitted as they stand, independently in the shop, and this entails a condition of things which actual work may show to be faulty. For this reason an engineer should not go at a new engine hammer and tongs, and try to suppress at once every slight noise or click that he may hear. Neither should he key up solid, or screw down hard, the working shafts and bearings, for the first few days. It is much better to let the things run easily for a while, at the expense of a little noise, rather than to risk cutting before the details get used to each other. Many good engines have been disabled by too great zeal on the part of those in charge, when a little forbearance would have been much better. Pounding, caused by bad adjustment, or valve setting, and pounding caused by new bearings not in intimate relation with each other, are quite different in character, and a careful engineer will not make haste to decide upon the remedy until he has indicated and investigated the engine, and found out exactly where the trouble is. Not long ago we saw a new engine badly cut in its guides from this very cause; a slight jar was noticed, and the engineer, arguing that the crosshead was the seat of the noise, set out the gibs so much that they seized and plowed some bad scores in the cast-iron guides, which will always remain to remind him of his thoughtlessness. What has been said above of the engine, is also true of the boiler and its appurtenances. No new boiler should have pressure put upon it at once. Instead, it should be heated up slowly for the first day, and whether steam is wanted or not. Long before all the joints are made, or the engine ready for steam, the boiler should be set, and in working order. A slight fire should be made and the water warmed up to about blood heat only, and left to stand in that condition and cool off, and absolute pressure should proceed by very slow stages. Persons who set a boiler and then build a roaring fire under it, and get steam as soon as they can, need not be surprised to find a great many leaks developed ; even if the boiler does not actually and visibly leak, an enormous strain is needlessly put upon it which cannot fail to injure it. Of all the forces engineers deal with, there are none more tremendous than expansion and contraction.

TRIPLE EXPANSIONS.

An interesting example of the value of triple expansion engines, as compared with compound, was exhibited on the Clyde, on the trial of the Orient liner Cuzco, which has recently been thoroughly renovated and furnished with new boilers working to a pressure of 150 pounds to the square inch, and with triple expansion engines of the most approved type The Cuzco is seventeen years old, and has hitherto been regarded as a 12½ knot boat. Recently she was tried on the measured mile for a six-hours run, when she attained a speed of 16 knots, and made upward of 75 revolutions per minute. This increase in speed was, a daily newspaper correspondent says, accompanied with the usual economy in coal consumption, and the incident is remarkable on account of the success with which the power of the new engines has developed a high speed in a vessel, the model of which is comparatively obsolete.

STEAM AS A CLEANSING AGENT.

For cleaning greasy machinery nothing can be found that is more useful than steam. A steam hose attached to the boiler can be made to do better work in a few minutes than any one is able to do in hours of close application. The principal advantages of steam are, that it will penetrate where an instrument will not enter, and where anything else would be ineffectual to accomplish the desired result. Journal boxes with oil cellars will get filthy in time, and are difficult to clean in the ordinary way; but, if they can be removed, or are in a favorable place, so that steam can be used, it is a veritable play work to rid them of any adhering substance. What is especially satisfactory in the use of steam, is that it does not add to the filth. Water and oil spread the foul matter, and thus make an additional amount of work.

COMPARATIVE ECONOMY OF HIGH AND SLOW SPEED ENGINES.

In nearly every case where a flour mill is built, it is intended to be a permanent investment. The very nature of the milling business makes it necessary that the plant shall be built and operated, not for one, two or three years, but for a long term of years. It is the ambition of every mill owner, when he builds a mill, to make it the foundation of a permanent business, and, if he is wise, he will build such a mill and select such machinery as will prove economical, not in first cost, but in the long run. In no part of the milling plant is this more important than in the power outfit of steam mills, and, as most of the mills now being built are steam mills, the comparative economy of different kinds of steam engines becomes an important subject for consideration. No matter whether the mill is large or small, unless it is so advantageously located as regards its supply of fuel that the cost is practically nothing, any wastefulness in the consumption of fuel creates a steady drain on the earning of the mill which will seriously affect the balance of the profit and loss account, and, where fuel is expensive, may result in transferring the balance to the wrong side of the account.

In selecting a power plant, it is a mistake, frequently made, to consider the first cost of the plant as of the highest importance, and any saving in this direction as so much clear gain. Especially is this the case in flouring mills of small capacity, where the builder's capital is limited, and where the idea is to get as much mill for as little money as possible. In such case, any money borrowed from the power plant to put into the balance of the mill, is borrowed at a ruinously high rate of interest, and it is, moreover, borrowed without any chance of repayment, except by throwing out the cheap plant and substituting the higher priced and more economical one at great expense. In no way is the miller more often misled than by the claims of the builders of the high-speed automatic engines, where the name automatic is relied upon to cover a multitude of sins in the direction of low economy. In this connection, some facts from a paper by J. A. Powers are instructive:

After carefully analyzing the problem and considering the requirements of the load to be driven in electric lighting stations, which are more favorable for the high speed engines than is the case in flouring-mill work, Mr. Powers reaches the conclusion as to the different styles of engines in the consumption of steam, as stated by engine builders:

	Steam per H. P. per hour.
High speed engines	28 to 32 lbs.
Corliss engines, non-condensing	24 to 26 lbs.
" " condensing	20 to 21 lbs.
" " compound condensing	15 to 16 lbs.

With an evaporation of eight pounds of water per pound of coal, the coal consumption would be as follows:

	Coal per H. P. per hour.
High speed engine	3.50 to 4 lbs.
Corliss engines, non-condensing	3 to 3.25 lbs,
" " condensing	2.50 to 2.62 lbs.
" " compound condensing	1.87 to 2 lbs.

As the interest on the first cost of the steam plant should properly be charged against its economy, the following statement of comparative first cost is given:

High speed engine	$31 to $36 per H. P.
Corliss engines, non-condensing	42 to 46 "
" " condensing	43 to 48 "
" " compound condensing	52 to 57 "

The comparison of first cost and fuel saving is as follows:

	Cost.	Coal. Consumption.
High speed engine	100 per cent.	100 per cent.
Corliss engine, non-condensing	131 "	62 "
" " condensing	136 "	56 "
" " compound cond'g.	163 "	44 "

If the cost of coal is taken at $3 per ton and interest is figured at six per cent., which figures may be considered a fair average, the results, based on the foregoing figures, for a plant of 400 horse-power, will be as follows:

	Cost of Coal per day.	Saving in Coal over High Speed.
High speed engine	$24.75	$....
Corliss engine, non-condensing	18.90	5.85
" " condensing	15.24	9.51
" " com'd condensing	11.64	13.11
	Interest per day.	**Loss in Interest over High Speed.**
High speed engine	$2.36	$....
Corliss engine, non-condensing	3.08	.72
" " condensing	3.15	.79
" " com'd condensing.	3.75	1.39

And the saving per day over the high speed engine is:

Corliss engine, non-condensing	$ 5.13
" " condensing	8.72
" " compound condensing	11.72

So far as the steam consumption is concerned, results in every-day work show that the comparison is made as favorable as possible for the high speed engine, for, while records of actual tests of Corliss engines show that the figures given are not understated, the average of high speed engines after running a short time is not nearly as low as thirty-two pounds per indicated horse power per hour. So far as the cost of the respective plants are concerned, we should be inclined, especially for small plants, to put the average cost of the high speed plant a little lower than that, of the Corliss a little higher, but this change would not materially affect the result so far as comparative economy is concerned.

To bring the matter in shape to fairly apply to the requirements of the average 100 barrel mill, it may be assumed that the power required will be 50 horse power. In the absence of exact data as to the cost of the high speed plant, and to give it as favorable a showing as possible, the cost of the respective plants may be stated as follows:

High speed	$1,500
Corliss, non-condensing	2,700
" condensing	3,200
" compound condensing	4,300

The economy would then be:

	Water per H. P. per hour.	Coal per H. P. per hour.
High speed	32 lbs.	4 lbs.
Corliss non-condensing	26 lbs.	3.25 lbs.
" condensing	20 lbs.	2.5 lbs.
" compound condensing	16 lbs.	2. lbs.

And with coal and rate of interest assumed as above, based on a continuous run of 280 days, 24 hours per day, the comparison is summarized as follows:

	Cost of Fuel per Year	Interest.	Total.
High speed	$2,016	$ 90	$2,106
Corliss, non-condensing	1,638	162	1,800
" condensing	1,260	192	1,452
" comp'd condensing	1,008	258	1,266

The ratio of saving to difference in cost between the high speed plant and the others, may be stated as follows:

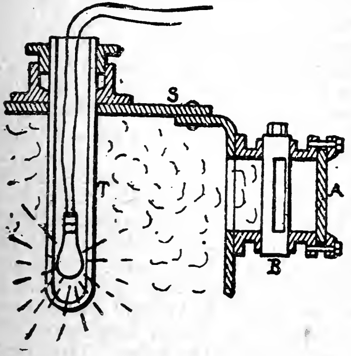
Between high speed and Corliss non-condensing,	25	per cent.
" " " condensing	38½	"
" " " comp. condens'g	30	"

Or, in other words, it would take four years to save the difference in cost using the non-condensing Corliss, a little over two and one-half years if condensing, and three and one-half years if compound condensing. In either case, the saving would be steadily continued, long after the cost of the plant had been wiped out.

THE ELECTRIC LIGHT IN BOILERS.

Experiments have been conducted in Germany for the purpose of watching the action that goes on inside a steam boiler when it is performing its regular work. The details of the apparatus were as follows: A hole was made in the upper part of the shell, *S*, and a stuffing box was attached. Through this stuffing box a thick glass tube, *T*, was passed, and the joint between this tube and the shell was made steam tight by suitable packing. A small incandescent electric lamp was then lowered into the tube as shown in the cut, and by means of this and a galvanic battery the entire interior of the boiler could be lit up.

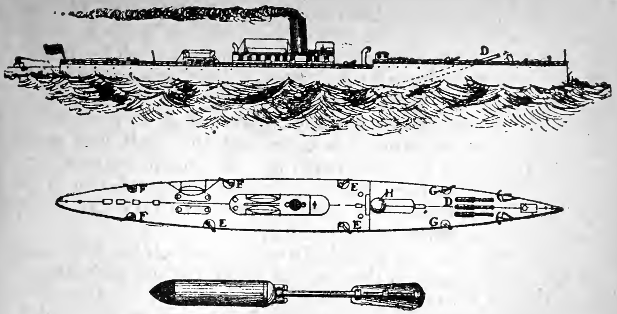
The sight slot was attached to the head of the boiler, as shown on the right of the cut. A small casting with flanges at both ends was first riveted to the head, and to the outer end of this a glass plate, *A*, three-eighths of an inch thick, was secured by means of bolts passing through a slotted face-plate. Gaskets were placed between the glass and the metal, to make the whole steam tight. The slot in the face-plate covering the glass, *A*, was five inches long and half an inch wide, and through this the observations were made.



A cock, *B*, was fitted to the main casting, and a long slot was cut through it, as shown. When this cock was opened by a wrench the apparatus was ready for use; and by closing the cock the glass plate, *A*, could be relieved of the pressure upon it.

We are not aware that any discoveries of practical importance have been made with this apparatus; but the experiments were very interesting. It has been proposed to apply the same device to the cylinders of simple, compound and triple expansion engines, in the hope of procuring direct evidence concerning cylinder condensation; but as the time during which this condensation takes place is so very short, it is probable that the water is in such a fine state of subdivision that it does not make the steam appre-ciably opaque.

THE DYNAMITE CRUISER "VESUVIUS."



A — Dynamite guns. B — Gatling guns. C— One-pounder. D — Three-pounder. E — 37mm rev.

This novel vessel is in many respects similar to the English torpedo cruisers, except that the torpedoes are discharged through the air instead of through the water.

The vessel was built at Cramp's ship-yard, Philadelphia.

Length between perpendiculars, 246 feet 3 inches; length over all, 252 feet 4 inches; breadth, 26 feet 5 inches; depth, 14 feet 1 inch; mean draught, 9 feet; displacement, 725 tons; tons per inch at load line, 10.15; area midship section, 177.5 square feet.

Scantling and general construction — There is an ordinary bar-keel 6 inches deep and 1½ inches thick, with an inner vertical keel of 10-pound plating, lightened between frames by holes about 9 inches in diameter. This plate extends above the floor plates, which are 10 to 15 pounds per square foot, and has along its upper edge double angles 3x2½ inches of 7 pounds per foot. A vertical inner keelson plate is run along on top of the floors, lapping on the vertical keel where it extends above the floors. This keelson pfate is 18 inches deep and 15 pounds per square foot, with double angles along the upper edge 3x2½ inches of 7 pounds per foot.

The frames are spaced 21 inches, frame angles 3x2½ of 7 pounds per foot, reverse angles, 2½x2½ inches of 4 pounds per foot.

The guardboards are 15 pounds per square foot, and remainder of the bottom plating 10 pounds amidships, reduced at the ends, with a double sheer strake of 12½ pounds for about three-fifths the length amidships. The stem and stern posts are of cast steel. The upper deck plating is 7 pounds to the square foot, with planking of 2¾ inches wide white pine, beams 3x2½ inches of 7-pound angles.

The first longitudinal is formed of 10-pound plate, with double angles on the upper edge above the floor and single angle on the lower edge of 3x2½ inches of 7 pounds per foot. The second longitudinal is formed of an angle 10x3 inches, with double angles on the upper edge 3x2½ inches of 7 pounds per foot. The two side stringers on each side are formed of 6x3x3 inches of 14-pound Z-bars, together with 3x2½ inches of 7-pound per foot angles.

There is a captain's saloon, pantry and stateroom aft, just forward of which are the wardroom and four staterooms.

The crew are berthed forward of the fireroom.

Armament—This vessel is armed with three pneumatic dynamite guns of 10½-inch caliber, to throw shells containing 200 pounds of dynamite a distance of a mile, capable of being discharged once in two minutes. Ten dynamite projectiles are carried for each gun. The range can be varied at will from one mile to 200 yards by varying the amount of air entering from the firing reservoir. The guns are not movable in the ship, but are fixed at an incline so that for training the vessel must be turned, but as she has twin screws this is readily accomplished. To insure the safety of the crew while handling the shells and loading and firing the guns a light protective deck is worked over the lower parts of the guns, protecting the loading gear, compressors, etc.

The conning tower, raised above the spar deck and just in rear of the guns, is built of one-inch plates, with a light hood on top. The vessel has a steam steering apparatus.

The guns are placed side by side in the forward part of the vessel. They are made in single sections with flange connections, their length in all being about 54 feet. The shells are fired by fuses igniting by impact or by fuses formed of a composition which ignites on being wet, so that the charge explodes after the shell sinks below the surface of the water.

The shells containing the dynamite are projected by means of compressed air. There is a main reservoir down near the keel, and a firing reservoir near the breech of the guns from which air is let into the guns in the rear of the projectile. The pressure in the main reservoir is about 2,000 pounds. The vessel is capable of placing with accuracy an aerial torpedo charged with a high explosive within the range of two miles. In addition to the three dynamite guns a powerfu' secondary battery is carried, consisting of two 3-pounders, one 1-pounder two 37mm revolving cannon, and two Gatlings.

Machinery — The motive power is furnished by two triple expansion engines developing about 3,200 indicated horsepower. There are four cylinders to each engine. The high-pressure cylinder is 21½ inches in diameter, the intermediate 31, and the two low-pressure cylinders 34 inches. There are four boilers in independent fire-rooms, about 19½ feet long and 9 feet in diameter; grate surface, 200 square feet. The speed is over twenty knots.

THE MODERN TORPEDO UNRELIABLE.

Recent torpedo experiments in England have apparently shown that the charges heretofore used in torpedos are not sufficiently large. The experiments indicated that 100 pounds of explosive cannot be relied upon in an attack on a large vessel, and that 150 or 200 pounds would hardly be sufficient to charge a really formidable torpedo. These experiments also seem to indicate that the locomotive torpedo as controlled from the shore or from a vessel is not by any means as reliable as its advocates claim, and that under many circumstances it would be extremely difficult, if not impossible, to send it where it is wanted. The fact is, that the more extended the practical experience with torpedoes, the more unreliable they seem to be ; and it is evident that the high opinion that has heretofore been entertained of them as weapons for offense and defense must be considerably revised.

HOW TO LIGHT A LAMP WITH A SNOWBALL.

When a small piece of potassium, the size of half a grain of corn, is dropped into a tumblerful of water, some of the oxygen of the water leaves its hydrogen, owing to the intense heat which the chemical action produces, and combines with the metallic potassium, causing a violet, bluish flame. When the piece of potassium is placed on the wick of a coal oil or alcohol lamp the flame produced by touching the potassium with a bit of snow, or ice, or a drop of water, will inflame it Fire under water can be produced by placing a small piece of phosphorus in a conically-shaped glass filled with water, and some crystals of chlorate of potash covering the phosphorus, and then pouring, through a long tunnel or a glass tube, a few drops of sulphuric acid down on the mixture at the bottom of the glass. Tongues of flame can be seen flashing up through the water. The intense chemical action produces sufficient heat to inflame the phosphorus under the water. Where there is sufficient heat and oxygen fire will burn, whether in air or water.

HOW BELLS ARE MADE.

There are only five concerns in the United States engaged in the manufacture of church, school and chime bells.

Contrary to the popular idea, the exact musical tone of a bell depends neither upon the metal nor in any change in it after being cast. If the bell should not be of the exact pitch, there is no alternative but to melt it over and re-cast it until the proper tone is secured. Hence, it is clear that the greatest care must be exercised, and the most thorough skill displayed.

The first operation, and the one upon which success depends, is the forming of the molds. They are made according to plans which are first prepared to demonstrate the weight, thickness and dimensions necessary to produce the required tone. The molding is done entirely by hand, without the use of patterns. For the inside, the shape is made up of loam, which is merely sand, mixed with enough clay to make it cohesive. With nothing but a trowel, a paddle and his hands, the operator molds the loam into the desired shape, working from the bottom toward the apex. The work is necessarily slow, as great care must be exercised, as any variation from the plans would inevitably ruin the effect, and frequent measurements are taken to see that there are no deviations. The surface is now covered with black lead. This is mixed into a thick paint or mortar, and applied with a brush. Each coat must be allowed to dry, and successive coats applied until it reaches a thickness of about three-quarters of an inch, or until the desired shape is accurately secured. The outside half of the mold is built up of loam in the same way, only in this case no coating of plumbago is used. The exterior mold fits over the inside mold, the space between the two determining the thickness of the bell. The molds being finished, they are placed in position in a pit in front of the furnace. At the apex, or at the point where the bell would be hung, an opening is made in the outside mold of about two inches in diameter. A trough then carries the molten metal directly into the mold.

The furnace is very similar to those generally used in melting large quantities of brass. The melting-pot is built between two fire-boxes, so constructed that the heat strikes the sides and bottom with almost equal force, effecting quick results. The metal used is simply ingot copper and tin, in the proportion of four parts of the former to one of the latter. The copper is first melted, and then the tin is put into the molten mass, soon becoming a part of it. The kettle has a capacity of about a ton. For a bell weighing three hundred pounds, the mold is completely filled in seven or eight minutes. For a bell weighing six hundred pounds, it requires about fifteen minutes, and so on.

The bell having cooled sufficiently, the molds are broken, and it is taken out and turned over to the polisher. The inside, having been molded against the smooth surface of black lead, needs no polishing, but the outside requires attention in that respect. The operation is very simple. The bell is hoisted to the center of a double revolving table. The part the bell rests upon revolves one way, the surrounding part in an opposite direction. This latter part is so constructed that it will hold a large quantity of coke. Thus, in revolving, the coke scours the outside of the bell, the result being a smooth, bright surface.

Before polishing, however, the tone of the bell is tested, and it is again tested after polishing, as carefully as the string of a piano or the reed of an organ. If satisfactory, nothing remains to do but the mounting.

An idea of the great accuracy that must be displayed in the plans and preparation of the molds can be seen in that from ten to twenty-five pounds of metal, either too much or too little, in bells weighing from 600 to 2,000 pounds, or a variation of from one-twentieth to one-twelfth of an inch in thickness, will affect the tone. The successful manufacture of chimes and peals, therefore, can only be done by those whose knowledge of the business is as accurate as instinct, and this is possessed only by those who have followed the business for a lifetime.

THE DURATION OF LIGHTNING FLASHES.

It is well known that the lightning flash, or the spark between the terminals of an influence machine, exists for so short an interval of time as to be beyond measurement by any ordinary means. But notwithstanding the acceptance of this knowledge, the peculiarities of some of the flashes photographed have been supposed to be due to the camera, or the sensitive plate, being at the time in a state of vibration. To test this line of thought, Mr. James Wimshurst has made a dark slide for his camera, in which is fitted a train of clock-work carrying a disc, upon which is an arrangement for holding the sensitive plate. When all is complete for photographing a flash the clockwork is wound up; the sensitive plate then rapidly acquires great velocity, which at the maximum reaches 2,500 revolutions per minute, and with the plate rotating at this speed the spark is photographed. The photograph taken under these circumstances in no way indicates movement in the sensitive plate, for the photograph throughout its length is as sharp and as clear as though the plate had been at rest. The experiment is interesting, for it not only shows the infinitely short existence of the spark, but it also shows that chemical change in the sensitive film takes place in an equally minute interval of time.

THE HIGHEST STATIONS FOR METEOROLOGICAL OBSERVATIONS.

The highest stations in Europe for making meteorological observations are about 10,000 and 11,000 feet above sea level. That on Pike's Peak is 14,000 feet; thus exceeding, by more than 3,000 feet, any in Europe. But that is not the highest in America, for on Mount Lincoln, in Colorado, there are mining works at an elevation of 14,297 feet, and at the same point a meteorological station conducted by Harvard College. In Peru there is a station on the Andes 14.300 feet above the sea.

AN IMMENSE FLAG-STONE.

A flag-stone sidewalk is now being laid in front of a private residence in New York city, each stone of which measures twenty by fifteen feet and one foot thick. Their cost, when laid, will be $1,000 apiece.

AN ADJUSTABLE RAILWAY CAR.

A Swedish engineer, says a foreign exchange, has constructed a railway car, which, in a few minutes, may be adapted to five different gauges, the narrowest being 0.890 m. The invention has been pattented in several foreign countries.

A CANAL ACROSS ITALY.

An Italian engineer has completed the survey of a proposed canal across Italy, from near Castro, on the Tyrrhenian Sea, to Fano on the Adriatic. It will be 180 miles long if it is ever built, and will cost $100,000,000.

DIFFERENCES OF TIME FROM NEW YORK.

At any Given Time in New York it is in—

	HRS.	MIN.	SEC.	
Amsterdam (Holland)	5	16		later.
Berne (Switzerland)	5	26		"
Berlin (Prussia)	5	49	35	"
Brussels (Belgium)	5	13	30	"
Buda Pesth (Hungary)	6	12		"
Carlsruhe (Baden)	5	30		"
Christiania (Norway)	5	39		"
Cologne (Germany)	5	24		"
Constantinople (Turkey)	6	52		"
Copenhagen (Denmark)	5	46		"
Dublin (Ireland)	4	30	30	"
Frankfort (Germany)	5	30		"
Geneva (Switzerland)	5	20	30	"
Gothenburg (Sweden)	5	45		"
Greenwich (England)	4	56		"
Hamburg (Germany)	5	36		"
Lisbon (Portugal)	4	19	30	"
London (England)	4	55	56	"
Madrid (Spain)	4	41	15	"
Moscow (Russia)	7	26		"
Munich (Bavaria)	5	42	30	"
Naples (Italy)	5	53		"
Paris (France)	5	05	15	"
Prague (Austria)	5	54		"
Rome (Italy)	5	46		"
St. Petersburg (Russia)	6	57		"
Stuttgart (Würtemberg)	5	33		"
Stockholm (Sweden)	6	08		"
Trieste (Austria)	5	51		"
Venice (Italy)	5	45	30	"
Vienna (Austria.	6	01	33	"
Warsaw (Poland)	6	20		"

The differences are at the rate of one hour for every fifteen degrees of longitude, or four minutes for each degree.

A VALUABLE PRESERVATIVE PAINT.

Soapstone incorporated with oil, after the manner of paint, is said to be superior to any kind of a paint as a preservative. Soapstone is to be had in an exceedingly fine powder, mixes readily with prepared oils for paint, which covers well surfaces of iron, steel, or stone, and is an effectual remedy against rust. It has been known to protect some stone work, such [illegible] in China, for ages past.

TIME AT DIFFERENT PLACES, WHEN IT IS 12 O'CLOCK AT NEW YORK CITY; ALSO, DIFFERENCE IN TIME FROM NEW YORK.

New York City 12 M.					Fast.			Slow.		
Places.	H	M	S		H	M	S	H	M	S
Albany, N. Y.	12	1	1	p.m		1	1			
Annapolis, Md.	11	50	4	a.m.					9	56
Augusta, Me.	12	16	40	p.m		16	40			
Baltimore, Md.	11	49	33	a.m.					10	27
Bangor, Me.	12	20	52	p.m		20	52			
Boston Mass.	12	11	46	"		11	46			
Buffalo, N. Y.	11	40	20	a.m.					19	40
Charleston, S. C.	11	36	18	"					23	42
Chicago, Ill.	11	5	29	"					54	31
Cincinnati, O.	11	18	2	"					41	58
Cleveland, O.	11	28	36	"					31	24
Columbus, O.	11	23	48	"					36	12
Concord, N. H.	12	10	4	p.m		10	4			
Detroit, Mich.	11	23	50	a.m.					36	10
Eastport, Me.	12	28	16	p.m		28	16			
Fall River, Mass.	12	11	32	"		11	32			
Frankfort, Ky.	11	17	20	a.m.					42	40
Halifax, N. S.	12	41	33	p.m		41	33			
Harrisburg, Pa.	11	48	40	a.m.					11	20
Hartford, Conn.	12	5	17	p.m		5	17			
Key West, Fla.	11	28	50	a.m.					31	10
Leavenworth, Kan	10	37	4	a.m.				1	22	56
Lexington, Ky.	11	18	48	"						
Liverpool, Eng.	4	43	56	p.m	4	43	56		41	12
Louisville, Ky.	11	14		a.m.					46	
Lowell, Mass.	12	10	44	p.m		10	44			
Memphis, Tenn.	10	55	28	a.m.				1	4	32
Milwaukee, Wis.	11	4	23	"					55	37
Montpelier, Vt.	12	5	36	p.m		5	36			
Montreal, Que.	12	1	48	"		1	48			
New Bedford, Mass.	12	12	18	"		12	18			
New Haven, Conn.	12	4	18	"		4	18			
New Orleans, La.	10	56		a.m.				1	4	
Niagara Falls, N. Y.	11	39	44	"					20	16
Norfolk, Va.	11	50	46	"					9	14
Omaha, Neb.	10	32	4	"				1	27	56

TIME AT DIFFERENT PLACES.—Continued.

New York City 12 M.					Fast.			Slow.		
Places.	H	M	S		H	M	S	H	M	S
Oswego, N. Y.	11	49	36	"					10	24
Paris, France	5	5	21	p.m	5	5	21			
Philadelphia, Pa.	11	55	20	a.m.					4	40
Pike's Peak, Col.	9	56		"				2	4	
Pittsburg, Pa.	11	35	52	"					24	8
Portland, Me.	12	15	2	p.m		15	2			
Providence, R. I.	12	10	25	"		10	25			
Quebec, Que.	12	11	11	"		11	11			
Raleigh, N. C.	11	40	48	a.m.					19	12
Richmond, Va.	11	46	10	"					13	50
Sacramento, Cal.	8	50	9	"				3	9	51
Salt Lake City, Utah	9	27	36	"				2	32	24
San Francisco, Cal.	8	46	13	"				3	13	47
Savannah, Ga.	11	31	39	"					28	21
Springfield, Mass.	12	5	37	p.m		5	37			
St. Louis, Mo.	10	54	59	a m.				1	5	1
Syracuse, N. Y.	11	51	12	"					8	48
Toronto, Ont.	11	38	27	"					21	33
Trenton, N. J.	11	57	24	"					2	36
Washington, D. C.	11	47	48	"					12	12

LENGTH AND NUMBER OF TACKS TO THE POUND.

Title.	Length.	No. p. lb.	Title.	Length.	No. p. lb.
1 oz.	1/8 in.	16,000	10 oz.	11-16	1,600
1½ "	3-16 "	10,666	12 "	¾	1,333
2 "	¼ "	8,000	14 "	13-16	1,143
2½ "	5-16 "	6,400	16 "	7/8	1,000
3 "	3/8 "	5,333	18 "	15-16	888
4 "	7-16 "	4,000	20 "	1	800
6 "	9-16 "	2,666	22 "	11-16	727
8 "	5/8 "	2,000	24 "	1 1/8	666

Amount of horse power transmitted by single belts to pulleys running 100 revolutions per minute when the diameter of the driving pulley is equal to the diameter of the driven pulley.

Diameter of Pulley.	Width of Belt in Inches.							
	2	2½	3	3½	4	4½	5	6
In.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
	.44	.54	.65	.76	.87	.98	1.09	1.31
6½	.47	.59	.71	.83	.95	1.07	1.19	1.42
7	.51	.64	.76	.89	1.01	1.14	1.27	1.53
7½	.55	.68	.82	.95	1.09	1.23	1.36	1.64
8	.58	.73	.87	1.02	1.16	1.31	1.45	1.75
8½	.62	.77	.93	1.08	1.24	1.39	1.55	1.86
9	.65	.82	.98	1.15	1.31	1.48	1.64	1.97
9½	.69	.86	1.04	1.21	1.39	1.56	1.74	2.08
10	.73	.91	1.09	1.27	1.45	1.63	1.81	2.18
11	.8	1.	1.2	1.4	1.6	1.8	2.	2.4
12	.87	1.09	1.31	1.53	1.75	1.97	2.18	2.62
13	.95	1.18	1.42	1.65	1.89	2.12	2.36	2.83
14	1.02	1.27	1.52	1.77	2.02	2.27	2.53	3.05
[illegible]	1.09	1.36	1.64	1.91	2.19	2.46	2.73	3.29
[illegible]	1.16	1.45	1.74	2.03	2.32	2.61	2.91	3.48
17	1.24	1.55	1.85	2.16	2.47	2.78	3.09	3.70
18	1.31	1.64	1.96	2.29	2.62	2.95	3.27	3.92
19	1.39	1.73	2.07	2.42	2.76	3.11	3.45	4.14
20	1.45	1.82	2.18	2.55	2.91	3.27	3.64	4.36
21	1.52	1.91	2.29	2.67	3.05	3.44	3.82	4.58
22	1.6	2.	2.4	2.8	3.2	3.6	4	4.8
23	1.67	2.09	2.51	2.93	3.35	3.75	4.18	5.02
24	3.5	4.4	5.2	7.	8.7	10.5	12.2	14.
25	3.6	4.5	5.5	7.3	9.1	10.9	12.7	14.5
26	3.8	4.7	5.7	7.6	9.5	11.3	13.2	15.1
27	3.9	4.9	5.9	7.8	9.8	11.8	13.7	15.6
28	4.1	5.1	6.1	8.1	10.2	12.2	14.3	16.3
29	4.2	5.3	6.3	8.4	10.5	12.6	14.8	16.9
30	4.4	5.4	6.6	8.7	10.9	13.1	15.3	17.4
31	4.5	5.6	6.8	9.	11.3	13.5	15.8	18.
32	4.7	5.8	7.	9.3	11.6	14.	16.3	18.6
33	4.8	6.	7.2	9.6	12.	14.4	16.8	19.2
34	4.9	6.2	7.4	9.9	12.4	14.8	17.3	19.8
35	5.1	6.4	7.6	10.2	12.7	15.3	17.9	20.4

Amount of horse power transmitted by single belts to pulleys running 100 revolutions per minute when the diameter of the driving wheel is equal to the diameter of the driven pulley.

Diameter of Pulley.	Width of Belt in Inches.							
	2	2½	3	3½	4	4½	5	6
In.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
36	5.2	6.5	7.8	10.5	13.1	15.7	18.3	20.9
37	5.4	6.7	8.1	10.8	13.5	16.2	18.9	21.5
38	5.5	6.9	8.3	11.	13.8	16.6	19.3	22.1
39	5.7	7.1	8.5	11.3	14.2	17.	19.9	22.7
40	5.8	7.3	8.7	11.6	14.6	17.5	20.4	23.3
42	6.1	7.6	9.2	12.2	15.3	18.2	21.4	24.3
44	6.4	8.	9.6	12.8	16.	19.2	22.4	25.6
46	6.7	8.4	10.	13.4	16.	20.1	23.4	26.8
48	7.	8.8	10.4	14.	17.4	21.	24.4	28.
50	7.2	9.	10.9	14.6	18.2	21.8	25.4	29.
54	7.8	9.8	11.8	15.6	19.6	23.6	26.4	31.2
60	8.8	10.8	13.1	17.4	21.8	26.2	30.6	34.8
66	9.6	12.	14.4	19.2	24.	28.8	33.6	38.4
72	10.4	13.	15.6	21.	26.2	31.4	36.6	41.8
78	11.4	14.2	17.	22.6	28.4	34.	30.8	45.4
84	12.2	15.2	19.4	24.4	30.6	36.4	42.8	48.6
26	3.8	4.7	5.7	7.6	9.5	11.3	13.2	15.1
27	3.9	4.9	5.9	7.8	9.8	11.8	13.7	15.6
28	4.1	5.1	6.1	8.1	10.2	12.2	14.3	16.3
29	4.2	5.3	6.3	8.4	10.5	12.6	14.8	16.9
30	4.4	5.4	6.6	8.7	10.9	13.1	15.3	17.4
31	4.5	5.6	6.8	9.	11.3	13.5	15.8	18.
32	4.7	5.8	7.	9.3	11.6	14.	16.3	18.6
33	4.8	6.	7.2	9.6	12.	14.4	16.8	19.2
34	4.9	6.2	7.4	9.9	12.4	14.8	17.3	19.8
35	5.1	6.4	7.6	10.2	12.7	15.3	17.9	20.4
36	5.2	6.5	7.8	10.5	13.1	15.7	18.3	20.9
37	5.4	6.7	8.1	10.8	13.5	16.2	18.9	21.5
38	5.5	6.9	8.3	11.	13.8	16.6	19.3	22.1
39	5.7	7.1	8.5	11.3	14.2	17.	19.9	22.7
40	5.8	7.3	8.7	11.6	14.6	17.5	20.4	23.3
42	6.1	7.6	9.2	12.2	15.3	18.2	21.4	24.3
44	6.4	8.	9.6	12.8	16.	19.2	22.4	25.6

HOW TO TRUE AN EMERY WHEEL.

An emery wheel may be trued by using a bar of rough iron or copper as a turning tool.

HOW TO FIND THE DIAMETER OF HIGH AND LOW PRESSURE CYLINDERS AT DIFFERENT PRESSURES.

The following is a table from actual practice giving the diameters of the high and low pressure cylinders at different boiler pressures, the piston speed being taken at 420 ft. minute:

Indicated horse-power.	Diam. L. P. cylinder.	Boiler pressure 45 lbs.	Boiler pressure 80 lbs.	Boiler pressure 125 lbs.
		Diam. H.P. cylinder.	Diam. H.P. cylinder.	Diam. H.P. cylinder.
10	7¼ in.	4 in.	3⅜ in.	3¼ in.
20	10	5¾	5	4½
25	11½	6½	5½	5⅛
30	12⅜	7⅛	6¼	5⅝
40	14¼	8¼	7⅛	6⅜
50	16	9¼	8	7¼
100	22½	13	11¼	10⅛
150	27⅝	16	14	12⅜

THE LARGEST STEAM BOILER IN AMERICA.

The largest steam boiler ever constructed in America has been manufactured at Scranton, Pa. The boiler is 35 feet 4 inches in length, 10 feet 6 inches wide, and 11 feet 6 inches high. It is made of steel, weighs 45 tons, and is of 1,000 horse-power. One sheet of steel used weighed two tons. The metal from the "crown sheet" to the "wagon top" is 1⅜ inches in diameter, that near the valve is ¾ of an inch, and the other parts 9-16 of an inch in diameter. There are 198 three-inch tubes in the boiler, a double fire box connecting with the flues, and stay bolts and rivets are used varying in length from six to ten inches.

HOW TO MAKE A STRONG FLANGE JOINT.

To make a flange joint that won't leak or burn out on steam pipes, mix two parts white lead to one part red lead to a stiff putty; spread on the flange evenly, and cut a liner of gauze wire — like mosquito net wire — and lay on the putty, of course cutting out the proper holes; then bring the flanges "fair," put in the bolts and turn the nuts on evenly. For a permanent joint this is A 1.

DENSITY OF WATER.

Temperature F.	Comparative Volume. Water 32°=1.	Comparative Density. Water 32°=1.	Weight of 1 Cubic Foot.
32	1.00000	1.00000	62.418
35	0.99993	1.00007	62.422
40	0.99989	1.00011	62.425
45	0.99993	1.00007	62.422
46	1.00000	1.00000	62.418
50	1.00015	.99985	62.409
55	1.00038	.99961	62.394
60	1.00074	.99926	62.372
65	1.00119	.99881	62.344
70	1.00160	.99832	62.313
75	1.00239	.99771	62.275
80	1.00299	.99702	62.232
85	1.00379	.99622	62.182
90	1.00459	.99543	62.133
95	1.00554	.99449	62.074
100	1.00639	.99365	62.022
105	1.00739	.99260	61.960
110	1.00889	.99119	61.868
115	1.00989	.99021	61.807
120	1.01139	.98874	61.715
125	1.01239	.98808	61.654
130	1.01390	.98630	61.563
135	1.01539	.98484	61.472
140	1.01690	.98339	61.381
145	1.01839	.98194	61.291
150	1.01989	.98050	61.201
155	1.02164	.97882	61.096
160	1.02340	.97715	60.941
165	1.02589	.97477	60.843
170	1.02690	.97380	60 783
175	1.02906	.97193	60.665
180	1.03100	.97006	60.543
185	1.03300	.96828	60.430
190	1.03500	.86632	60.314
195	1.03700	.96440	60.198
200	1.03889	.96256	60.081
205	1.0414	.9602	59.937
210	1.0434	.9584	59.822
212	1.0444	.9575	59.769

CALKING STEAM BOILERS.

No well-made boiler ought to require to be heavily calked, and to provide for light calking it is imperative that the plates of a boiler should be effectually and thoroughly cleaned of all fire scale before being riveted up. Good boiler work should be very nearly tight without calking, but it is difficult to attain this degree of excellence with hand work. Hydraulic riveting, in which the plates are forcibly pressed together before the rivet is closed and made to fit the hole, will, if carefully done, be found to give a tight boiler without calking. It is obvious that tightness can only be secured by insuring metallic contact. If all the rivets fill the holes perfectly, no leakage can percolate past the rivet heads. If any rivet-heads require calking, they should be cut out and a fresh rivet inserted, as a leak is a sure indication that the rivet does not fill the hole, and is possibly imperfectly closed in addition. It is also obvious that to insure a tight boiler the surfaces of the plates must be in metallic contact, and must remain so when the boiler is subjected to the working pressure which, with the alterations of temperature, will produce certain inevitable changes in the form of the boiler. It is obviously necessary that the surfaces of the plates should be smooth in order to insure metallic contact, and that this cannot be attained unless the scale covers the plates completely, or is wholly detached. As a slight pin-hole in the magnetic oxide with which steel plates are coated will cause a leakage, and under certain circumstances, set up a galvanic and corrosive action, it is advisable to wholly detach the scale. This is easily done with iron plates, but steel plates cannot be completely cleaned of magnetic oxide by the usual mechanical methods. An excellent and effective method is that used at the Crewe Works of the London & Northwestern Railway (England). The plates are brushed over with muriatic acid diluted with water, and applied with a brush or pad made with woolen waste. This

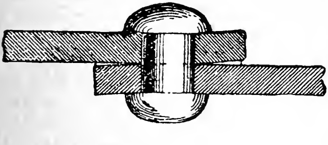


FIG. 1.

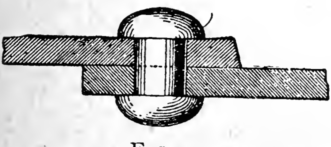


FIG. 2.

loosens and detaches all the scale, and the plates are then cleaned by a solution of lime, which effectually removes any surplus muriatic acid. If the plates are not wanted immediately, they can be protected from rust by a coat of turpentine and oil. If these precautions be not taken, the scale or dirt upon the plates becomes crushed to powder by the squeeze of the riveter, and a close metal to metal joint is rendered impossible, and the consequent leakage must be stopped by calking. With clean plates much calking is not necessary, nor should it be countenanced, for, after all, calking is only an evidence of, and a concession to, more or less inferior, or, at least, imperfect workmanship.

Some boiler-makers firmly believe that calking should be performed both internally and externally, and we may frequently hear this double calking expatiated upon as adding to the value of a boiler. As a matter of fact, however, internal calking should never be resorted to. By internal calking we mean specially to indicate the calking of edges exposed to steam or water, especially the latter, for long experience has shown, with very little room for doubt, that internal calking has frequently been either a cause or an aid in the initiation of corrosive channeling of the plates along the line of the rivet seams. Though channeling is commonly met with along the longitudinal seams, being started, more frequently than by any other cause, by the want of perfect circularity of the boiler, yet it is aggravated by the calking of the edge of the plate which borders the channeling, and the explanation is that an abnormal stress is set up in the plate upon which the calked edge is forced down, and too frequently the calking tool itself is driven so severely upon the plate surface as to cause an injury which develops as channeling when other conditions, such as bad water, etc., are present. These causes have been mainly contributory to the modern practice of outside calking only, and, with proper workmanship, this is all that should be required, but the best practice rejects any calking at all in the strict acceptation of the term, and demands that the edges of the plates shall be planed and "fullered;" fullering being the thickening up of the whole edge of the plate by means of a tool having a face equal to the plate thickness. With such a tool as this, it is impossible to wedge apart the plates forming the joint, and so frequently done in the manner shown (exaggerated) in Fig. 1, when the narrow edge of the calking tool, driven perhaps by a heavy hammer, actually forces the plates apart and insures a tight joint only by the piece of damaged plate corner which remains driven fast into the gap.

In contrast to this, Fig. 2 may be taken to fairly represent the correct action of the more correct fullering tool, the plate edge being simply thickened, and contact between the two plates rendered certain for some distance in from the edge. To thus thicken, or "fuller" a plate, requires considerable power, and yet, even the use of a more than usually heavy hammer will not cause injury, as it certainly would do in careless hands, if used with a narrow calking tool. All modern first-class boiler work in England is inviarably fullered, and, though the practice of inside calking is still followed by firms who "fuller," nevertheless, outside work is gaining the day. A further advantage of the "fulling" tool may be named. If inside calking be still practiced, the tendency to cause grooving will be less marked than with the narrow tool, and where, as at times, it is absolutely necessary to internally calk, as may sometimes happen, the last is a great point in favor of the broad tool.

The foregoing remarks are suggested by a few notes on calking in an engineering work, wherein calking tools are described as having from 1/8 to 3-16 of thickness, and "best work" as being calked both inside and out. In itself, calking properly carried out, and lightly performed on good, close-riveted joints, is not necessarily bad, but too frequently is badly performed by careless workmen and boys, and hence "fullering," which is better practice, and is also a safeguard against carelessness, is to be preferred to the old method.

HOW TO THAW OUT A FROZEN STEAM-PIPE.

A good way to thaw out a frozen-up steam pipe, is to take some old cloth, discarded clothes, waste, old carpet, or anything of that kind, and lay on the pipe to be thawed; then get some good hot water and pour it on. The cloth will hold the heat on the pipe, and thaw it out in five minutes. This holds good in any kind of a freeze, water-wheel, or anything else.

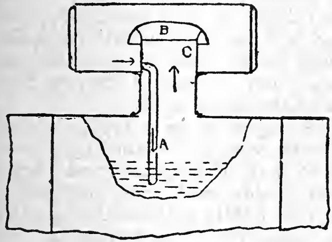
NUMBER OF STEAM BOILERS IN NEW YORK.

The total number of steam boilers in New York City is nearly 7,000. The volume of one pound of steam is about twenty-six cubic feet. A cubic inch of water makes about a cubic foot of dry steam. Only a small fraction of the latent heat of steam can be made available in performing work.

About seven-tenths of the latent heat are lost through the existence of natural conditions over which man can probably never expect to gain control. Two-tenths are lost through imperfections of mechanism, and about one-tenth is all that can be utilized, even in the best engines. So, you see, the daily waste is greater than the actual daily consumption.

TO STOP FOAMING IN BOILERS.

The accompanying sketch shows a method for stopping the foaming in boilers. Where a steam drum is used, a pipe C, the size of steam drum neck, is fastened in neck, extending 6 or 8 inches above bottom of steam drum. Then an umbrella B, or cap, is fastened on top of piece of pipe C, to cause current of steam and water to be thrown down on bottom of steam drum. The water in steam is deposited on bottom of drum, and runs down pipe A to boiler. Pipe A is fastened iuto pipe C on level with bottom of steam drum, and extends below surface of water in boiler. This arrangement has cured four boilers which foamed so badly that the engine would stop after being run five or ten minutes.



The same principle can be used on boilers with steam domes, especially where the hole through shell is smaller than dome.

UTILIZING SAWDUST.

What was formerly a waste material is, in many cases, at the present time a valuable product. To convert a waste material into a salable article, there is frequently needed only a little inventive ingenuity with respect to packing and shipping it or adapting it to the market. This general truth has been exemplified by an effort that has been made in some portions of the State of Maine to take care of the large accumulations of sawdust about the lumber factories. The sawdust is being pressed into convenient sizes and inclosed in burlaps. In this form we learn that the material can be shipped to market for less than one-half of the cost of shipping in bulk. We are informed, further, that the new enterprise has received considerable encouragement, and that in various directions there is a demand for sawdust in this form. It would seem reasonable to suppose that for the future baled sawdust about the stables, in cities particularly, would be in much demand. Every one knows the advantage of keeping hay in bales as compared with the loft room that was necessary for hay in bulk formerly, and the same arguments apply, in part at least, to sawdust. The amount of sawdust that is available for the purpose of baling, taking all the lumber regions of the United States into account, is very large. The percentage of lumber that is turned into sawdust in cutting is the evidence of the large quantity of this material that exists. It would seem that the new industry might extend to large proportions.

VALUE OF WET COAL AS A HEAT GENERATOR.

This burning of water is a curious thing, says a writer. When I went to England many years ago, a perfect novice in matters relating to combustion of fuel, and saw the firemen and engineers pouring bucketfuls of water on their coal heaps just before shoveling the coal on their fires, I at once told them that they were doing a very foolish thing, for it took a lot of heat to drive off the water before the coal would burn. But, when they told me that it was a matter that they had proved that they got much hotter fires when they wet their coal than when they put it on dry, I was completely nonplussed; and, when with my "stoker," I fed the furnaces with tan bark, etc., so wet that the water ran out of the hoppers, I believed the firemen were right.

GRAPHITE IN STEAM-FITTING.

Few steam-fitters or engineers understand the valuable properties of graphite in making up joints; this valuable mineral cannot be overestimated in this connection. Indestructible under all changes of temperature, a perfect lubricant and an anti-incrustator, any joint can be made up perfectly tight with it and can be taken apart years after as easy as put together. Rubber or metal gaskets, when previously smeared with it, will last almost any length of time, and will leave the surface perfectly clean and bright. Few engineers put to sea without a good supply of this valuable mineral, while it seems to be almost overlooked on shore.

TAKE CARE OF YOUR AUTOMATIC SPRINKLERS.

Many business blocks, workshops, stores, etc., have been expensively fitted up with automatic sprinklers as a safeguard against fires, a certain temperature of heat fusing the metal, opening a valve and letting on a flow of water. But an inspection of the perforated pipes in a majority of instances will reveal the fact that the apparatus has been neglected. Cobwebs and dust cover the pipes, the sprinklers have been permitted to corrode and unsolder, and, should a fire chance to occur and the friendly services of the sprinklers ever be required, they would be found almost useless, and for all the work they would perform in the line of throwing cold water on the devouring elements, the premises might as well have remained "unprotected."

HOW TO OVERCOME VIBRATION.

How to put the smith shop in an upper story without having the working on the anvils jar the building, has been a problem that has frequently given manufacturers trouble. A mechanical engineer says it may be safely done by placing a good heavy foundation of sheet lead on the floor, and on that putting a good thickness of rubber belting.

Another person who is interested in the problem has tried the experiment, with some success, of placing the block, not on the floor, but on the joist direct, making a cement floor up to the block, and over the wooden floor, reaching back beyond the reach of sparks. It is sometimes said that blacksmith shops never burn, but they keep right on burning in spite of theory, and cement floors ought to be helpful in guarding against fires.

BOILER EXPLOSIONS IN GERMANY.

In Germany, during 1887, there were thirteen boiler explosions, the Germans making up in destructiveness what they lack in numbers of these accidents.

By the thirteen explosions, seventeen persons were killed; five seriously, and fifty-nine slightly injured. One of these explosions was, so far as known, the most destructive that ever occurred. A battery of twenty-two boilers, at the blast furnaces of Friedenshutte, Silesia, exploded, completely demolishing the boiler-house, setting fire to a number of other houses by throwing red-hot bricks, killing ten persons, and wounding fifty-two.

FUEL GAS VS. NATURAL GAS.

A year or two ago, when natural gas and its wonderful cheapness were attracting such wide attention, causing almost a revolution in some industrial interests, Messrs. Disston & Sons, the great saw manufacturers of Philadelphia, contemplated the removal of their immense plant to the natural gas regions. The undertaking, however, involved such immense interests that they investigated very carefully and thoroughly, and finally determined to abandon the idea after being convinced that by a new process it was possible to make fuel gas at their own works at such a low cost as to offset the advantage of natural gas. Last week the *Manufacturers' Record* gave the facts regarding the remarkable success at the Disston works of this fuel gas made by the Loomis process. It is now demonstrated that this gas can be made so cheaply as to greatly reduce the cost of fuel, and its introduction into the South will counterbalance the only advantage which Pittsburgh and that section has possessed over the South by having natural gas. Already Decatur has taken the lead and contracted for a $200,000 plant to furnish this fuel gas to manufacturers at a cost not to exceed the equal of coal at $1 to $1.50 per ton, as well as to make gas for illuminating purposes. A glass manufacturer in Baltimore, who contemplates using this gas as fuel, has been offered a guarantee, with abundant security, of a saving of 33⅓ per cent. compared with the cost of his coal, provided he would give the guarantor all that was saved over that amount. This gas can be made by individual establishments for their own use, as well as by special plants designed to furnish it to other manufacturers for fuel, and also to make at the same time illuminating gas.

A TRENCH DIGGING MACHINE.

A Minneapolis (Minn.) man has invented a machine for digging trenches, and sewer and gas mains. The apparatus is fifty feel long, but can be made longer. On the front of the machine a four-horse power engine runs two knives, which do the digging. In the rear another engine, which furnishes the power for the apparatus, carries the dirt to that part of the machine, and drops it into the portion of the trench in which the pipe meanwhile has been laid. The trench may be of any reasonable width. Six men attend the monster. It has been claimed that 1,200 yards of pipe can be laid in a day by this machine.

MANILLA ROPE TRANSMISSION.

A four-strand, hard-laid manilla rope, having a core, or "heart-yarn," is probably the best rope for transmission purposes, although three-strand rope is generally recommended, says a writer in the *American Miller*. Of course it is important to have the rope laid in tallow, as that greatly prolongs its life. The matter of splice is also important. Seamen all agree that the long splice is the best, but the experience of rope-transmission men is almost universally in favor of a short splice. The length of a long splice in an inch diameter rope will be five or six feet, while a short one is two and two and a half feet. I think this is what the sailors term "a short splice." I have seen a short splice succeed where long ones have repeatedly failed. I have known of a manilla rope used out of doors being painted with oil, and then varnished. It seems to work well. Tar is certainly unsuitable as a dressing for transmission rope. In the first place, it weakens it; in the second, its sticking to the pulley or sheave would be a detriment rather than an improvement. There is no difficulty about the ropes sticking on the sheave, if properly designed and constructed.

SAFE WORKING PRESSURE FURNACE FLUES.

In a report to his company, the chief engineer of the Engine, Boiler and Employers' Liability Insurance Company, purposes the following rule for the safe-working pressure for cylindrical furnaces in flues: Safe-working pressure

$$=\frac{50t^2 \cdot \quad d}{\sqrt{ld} \quad l}$$

where

t=thickness of plate in thirty-second of an inch.
l=length of flue in feet.
d=diameter in inches.

RIVETLESS STEEL SLEEPERS.

Mr. H. Hipkins has invented a rivetless steel sleeper for railroads. The lips or jaws for holding the rails in place are stamped out of the solid plate, and are stiffened by corrugations or brackets, which are also raised from the solid plate out of the hollow at the back of each jaw. A center strip is provided for the rail to rest upon, dispensing with all rivets and loose parts. These sleepers can be laid rapidly, and they are claimed to be especially adapted to use underground in mines.

WHY MEN CANNOT FLY.

No combination of wings will enable a man to fly until he can work them with as much muscular power to the pound of weight as the bird exerts in flying. If a man had, in proportion to his weight, the muscular energy and leverage of a flea in his legs, he could jump a mile in three leaps; and, if his arms had the driving power of a wild pigeon's wing, he would have no use for balloons or railways. The transportation problem would be solved.

The albatross can keep its wings, thirteen feet from tip to tip, in motion all day, while the strongest man, weighing five or six times as much as the albatross, would exhaust all his strength in keeping even an albatross' wings in motion half an hour. "We have in the bird," says the *Engineer*, "a machine burning concentrated fuel in a large grate at a tremendous rate, and developing a very large power in a small space.

"There is no engine in existence; certainly no steam engine and boiler combined, which, weight for weight, gives out anything like the mechanical power exhibited by the albatross. Consequently, no mechanical machinery yet devised can operate wings with sufficient power to sustain its own weight in the air, and there is none known. Keely's alleged discovery, or some new process of storing and exerting great electric power in an apparatus of light weight, might supply the deficiency, but science has not learned how to develop in inanimate machinery anything like the mighty nervous energy which acts in the bones, sinews and muscles of a living bird's wing."

PROTECTION OF BOILER TUBES.

In order to prevent the rapid burning out of the front end of the boiler tubes, a corrugated shield or inner cover for each tube has been devised by two Americans. This shield, which may also be made with a plain surface, is to be applied in the end of each tube at the point of each connection with the fire-box of the boiler. It is removable. and can be easily replaced when destroyed.

It is estimated that at least fifty per cent. of the gas now used in the Pittsburgh mills and factories is lost through ineffective methods and bad management. But the supply, too, is running short, and already one concern that moved to the gas territory, expecting great things from the new fuel, has announced its intention to return to its old stand.

STEAM POWER IN FRANCE.

According to statistics issued by the French Ministry of Public Works, the number of industrial establishments employing steam power has risen from 29,000 in 1877, to 42,600 in 1887. A large development has taken place in the use of steam in agriculture; the number of engines employed for this purpose has risen, in the same period, from 4,800 to 13,000. The number of locomotives rose from 6,602 to 9,114. The number of steamships has nearly doubled since 1877, there being now over 700 in the French mercantile marine.

TO TEST THE QUALITY OF WHITE LEAD.

Pure white lead, if heated to 212° F., does not lose weight. If 68 grains are mixed with 150 minims of acetic acid diluted with a fluid ounce of water, the white lead will be entirely dissolved. If it is dissolved in nitric acid (C. P.), and treated with sulphate of soda solution, no precipitate should be formed.

METAL SLEEPERS.

Metal sleepers, or a system invented by M. M. Bayenva and Ponsard, are being tried on the French state railways, and it is said that they are giving satisfaction. Denain has recently supplied a number of them to the Western Algerian Railway, and has now in course of execution an order for 25,000 for the Dakar Company, of St. Louis, in Senegal.

HOW TO INCREASE ENGINE SPEED WITHOUT CHANGING GOVERNOR.

If it is desired to increase the engine speed, and still use the governor, the size of the governor pulley required may be found by multiplying the revolutions of engine by diameter of engine shaft pulley, and dividing by the desired revolutions of governor, or *vice versa*.

LONG DISTANCE TELEPHONE.

The attempt made recently to communicate by telephone between Marseilles and Dijon, a distance of nearly 500 miles, was completely successful. The experiments between Marseilles and Troyes, a distance of about 620 miles, were however, not so fortunate; but they are to be repeated after a thorough overhauling of the lines.

A NON-CONDUCTING COATING FOR STEAM PIPES, ETC.

A non-conducting coating for steam pipes, etc., used for the past ten years with perfect satisfaction by a Boulogne engineering firm, is described in a recent issue of the Revue Industrielle as being conveniently applied and cheap; while it can be prepared by any steam user. It consists of a mixture of wood sawdust with common starch, used in a form of thick paste. If the surfaces to be covered are well cleaned from all trace of grease, the adherance is perfect for either cast or wrought iron; and a thickness of twenty-five mm. will produce the same effect as that of the most costly non-conductors. For copper pipes, there should be used a priming coat or two of potter's clay, mixed thin with water and laid on with a brush. The sawdust is sifted to remove too large pieces, and mixed with very thin starch. A mixture of two-thirds of wheat starch with one-third of rye starch is the best for this purpose. It is the common practice to wind string spirally round the pipes to be treated, keeping the spirals one centimetre apart, to secure adhesion for the first coat, which is about five m. thick. When this is set, a second and third coat are successfully applied; and so on until the required thickness is attained. When it is all dry, two or three coats of coal-tar, applied with a brush, protect it from the weather. It is stated that 20 frs. worth of starch will go as far in this way as 1,000 frs. spent in any known commercial non-conductors of heat.

To Tin Cast Iron — Pickle the castings in oil of vitriol. Make a solution of zinc in spirit of salt, and immerse the castings in this solution. Then dip in a bath of melted solder or tin, and the castings will become coated with tin.

USEFUL CEMENTS.

A cement said to resist petroleum, is made by taking 3 parts resin, 1 part caustic soda to 5 of water, boiled together, the resin being melted first, of course. This makes a resin soap, to which must be added half its weight of plaster. It hardens in forty minutes. Useful for uniting lamp tops to glass. Glycerine and litharge, mixed thoroughly, is said to form a cement which hardens rapidly, and will join iron to iron or iron to stone. Not affected by water or acids.

A cement for leaky roofs is made by the following articles in the proportions named: 4 pounds resin, 1 pint linseed oil, 2 ounces red lead; stir in finest white sand until of the proper consistency, and apply hot. It possesses elasticity, and is fireproof.

Starch and chloride of zinc form a cement which hardens quickly, and is durable. Sometimes used for stopping blow-holes in castings.

A cement for uniting metal to glass is made with 2 ounces thick solution of glue, 1 ounce linseed oil varnish. Stir and boil thoroughly. The pieces should be tied together for three days.

A cement of 100 parts each white sand, litharge and limestone, combined with 7 parts of linseed oil, makes the strongest mineral cement known. At first the mass is soft and of little coherence, but in six months' time it will, if pressed, become so hard as to strike fire from steel.

A free application of soft soap to a fresh burn almost instantly removes the fire from the flesh. If the injury is very severe, as soon as the pain ceases apply linseed oil, and then dust over with fine flour. When this covering dries hard, repeat the oil and flour dressing until a good coating is obtained. When the latter dries, allow it to stand until it cracks and falls off, as it will in a day or two, and a new skin will be found to have formed where the skin was burned.

A new form of electrical railway is being erected at St. Paul, Minn. The cars do not touch the ground, but are suspended from girders which form the track and at the same time the mains conveying the current. Speeds of from eight to ten miles per hour are expected.

CELLULOID SHEATHING.

Among the various uses of celluloid, it would appear to be a suitable sheathing for ships, in place of copper. A French company now undertakes to supply the substance for this at nine francs per surface meter, and per millimeter of thickness. In experiments by M. Butaine, plates of celluloid applied to various vessels in January last, were removed five or six months after, and found quite intact and free from marine vegetation, which was abundant on parts uncovered. The color of the substance is indestructible; the thickness may be reduced to 0.0003 meter; and the qualities of elasticity, solidity and impermeability, resistance to chemical action, etc., are all in favor of the use of celluloid.

TRANSMITTING POWER BY A VACUUM.

The idea of producing a vacuum in a receiver or in a system of pipes, and utilizing this vacuum to transmit power, was put forth many years ago. In an article published in 1688 Papin recommends the use of this mode of transmission. He mentions its advantages, particularly its simplicity and convenience; he gives for different cases, the proper diameters of the pipes in which the vacuum is made, and recommends lead as the material from which to make them. The idea is therefore old, but it is only recently that it has been put into practice. There is now a central station running on this principle in Paris, distributing 250 h. p. by means of pipes in which a seventy-five per cent. vacuum is maintained. One year ago the company running this station had fifty customers; now there are 105 leases signed.

The possibility of maintaining a vacuum in an extensive system of pipes has sometimes been questioned. Repeated experiments, however, have shown that in a line of pipes a third of a mile long a pressure of a quarter of an atmosphere can be maintained so that two gauges, one at each end of the pipe, stand at exactly the same point.

In the station at Paris the exhauster is operated by a Corliss engine of special construction, the speed of which is automatically controlled by a regulator operated by the variations in pressure in the main pipe. The branch pipes are of lead, and are of different diameters, according to the number of consumers that each is to supply. Each of these branch pipes is provided with a cock that can be opened or closed by means of a wrench that is kept at the central station. The smaller branches that supply the individual customers are also of lead, and are likewise provided with cocks that can be opened or closed only by the employés of the company, who retain possession of the wrenches that open them.

Two kinds of motors are in use, one, the rotary class, being used for the smaller powers; the other class, which have cylinders and pistons, being used only for larger powers. The small motors have an efficiency of about 40 per cent., while in the largest size the efficiency is said to be as high as 80 per cent.

SPONTANEOUS COMBUSTION.

No one of average intelligence and information now believes in the possibility of human beings or the lower animals undergoing spontaneous combustion; and yet it is barely forty years since Liebig devoted a long chapter of his celebrated "Familiar Letters on Chemistry" to exposing the fallacy of this idea, thus showing that at that date it was prevalent. Every reader of Dickens will remember that in one of his most interesting stories an important episode is made to turn on the popular belief in spontaneous combustion, a belief which Dickens himself would seem to have shared. Of course, as Liebig points out, it requires no explanation to account for the connection which has often been shown to exist between death by burning and the too frequent indulgence of ardent spirits. Spontaneous combustion, though not of living animals, may, however, occur in certain cases, and give rise to fires in buildings, etc., and it may, therefore, be of interest to the reader to examine shortly some of those possible cases and their causes. But first of all, a few words as to "combustion" itself, the true nature of which was explained by the famous French chemist Lavoisier, toward the end of last century.

An act of combustion is an act of chemical combination attended by the evolution of heat and light, and, for such an act, two conditions are necessary, viz.: (1) There must be a gas in which the given substance will burn, *i. e.* with which it will combine chemically, and (2) there must be a certain temperature, the degree of temperature being different for each different substance. Thus, to take only one common example, a piece of coal will remain unaltered, at the ordinary temperature of the air, for practically an unlimited period of time; but, if it be heated to a sufficiently high temperature, it will burn. *i. e.*, the carbon of which it is composed will combine with the oxygen of the air, to form carbonic acid gas; chemical combination goes on in this case so rapidly, comparatively speaking, that the heat and light set free by it are palpable to our senses. Now, the two requisite conditions just mentioned sometimes occur together in nature, giving rise to true cases of spontaneous combustion, of which the following examples may be cited:

1. The *ignis fatuus*, or "will-o'-the-wisp," is the effect of the spontaneous ignition of a volatile compound of phosphorus and hydrogen, which is generated, under certain conditions, from decomposing animal and vegetable matter. This compound has such an intense affinity for the oxygen of the air, that, the moment it comes in contact with the latter, it ignites of itself, giving out the flash of light that has deluded so many a wanderer.

2. Spontaneous combustion also occurs not unfrequently in coal ships, or in the coal bunkers of ordinary vessels. Coal generally contains iron pyrites or "coal brasses" disseminated

through it, and this pyrites, which is a compound of iron and sulphur, has a great tendency to absorb oxygen from the air and to combine with it, forming sulphate of iron, or "green vitriol." This absorption and combination are accompanied by a rise of temperature, and they sometimes go on so rapidly as to raise the temperature of the mass sufficiently high to cause the coal to catch fire.

3. Fires in buildings are often to be traced to the presence of heaps of old cotton waste. Such waste is always more or less impregnated with oil, and, being very loose in texture, it exposes a large surface to the air. The result is that the oil rapidly absorbs and combines chemically with the oxygen of the air, just as the pyrites in coal does, raising the temperature to such a degree that a fire ensues.

4. The "heating of corn which has been stacked before the sheaves have been sufficiently dried, and which sometimes ends in the corn stack catching fire, is the result of chemical changes of the nature of fermentation.

5. Every one must have observed what a large amount of heat is set free when lime is slacked — so much, indeed, that fires have frequently been known to result from it. The reason of this is, that the lime combines with a certain proportion of water, this act of combination causing much heat to be liberated.

The above instances are sufficient to show that spontaneous combustion in no way differs from ordinary combustion, excepting in that the requisite temperature is attained by natural causes, and not artificially, and that the old idea held by the superstitions of last century, that the spontaneous combustion of animals (which we now know to be impossible) was caused by a peculiar kind of fire, differing from ordinary fire, and not extinguishable by water, was the result of ignorance. There is still one other cause of spontaneous combustion, often very dangerous in its effects, and which leads us on to the subject of explosions, which must be mentioned here. One occasionally reads in the newspapers of explosions occurring in flour mills, sometimes from no apparent cause. These explosions are cases of rapid spontaneous combustion, in which a spark from the grindstone sets fire to the fine flour dust with which the air of the mill is impregnated.

But what is an "explosion"? An explosion is nothing more nor less than a combustion which spreads with great rapidity throughout the whole mass of the combustible matter. To our senses it appears to be instantaneous, but it is not really so. An example will make this clear. A mixture of hydrogen and oxygen, or hydrogen and air, is a highly dangerous one, because the instant that a light is introduced into it it explodes; that is to say, the particles of hydrogen and oxygen in the immediate neighborhood of the flame are raised to the requisite temperature at which chemical combination can take place between them. They therefore do combine to form water vapor, and, by doing so, give out heat enough to cause combination between the particles next to them, and so on throughout the whole mass of the gas. This action goes on, as already stated, so rapidly as to be practically instantaneous. The terrible effects of explosions are caused, then, by the sudden production of immense quantities of hot gases. The newspapers constantly tell us of disastrous explosions resulting from the bringing of a light into a room in which an escape of gas is going on. A mixture of coal gas and air behaves in precisely the same manner as the mixture of hydrogen and oxygen, or hydrogen and air, mentioned above, with the exception that the products of the combustion or explosion are different. When an escape of gas is suspected, all lights should be rigorously excluded, the gas turned off at the meter or main, and windows and doors opened, so as to get rid of the already-escaped gas as quickly as possible; and only then, after complete ventilation has taken place, may a light be brought into the room with safety. It is to be hoped that such a technical instruction bill will soon be passed by parliament as will render avoidable accidents of this nature less and less likely to occur. It is likewise a dangerous thing to blow out a paraffine lamp instead of turning the wick down, as, by blowing the flame downward, one is apt to ignite the mixture of oil, gas and air which is in the upper portion of the oil reservoir, and so to produce a serious explosion.

The explosion caused by the ignition of gunpowder or any other ordinary explosive, is explicable in the same way, but can only be touched upon in this article. Gunpowder is a most intimate mixture of charcoal, sulphur and nitre (potassic nitre), the last named substance being a compound containing a very large percentage of oxygen, which can be liberated on heating it. On applying a light to gunpowder, we raise the temperature sufficiently to allow of the carbon and sulphur burning in the oxygen liberated from the nitre; and, since the three substances are so intimately mixed together, this combustion proceeds with explosive rapidity, and produces a relatively enormous quantity of hot gas.

Steel, when hardened, decreases in specific gravity, contracts in length and increases in diameter.

RULES FOR THE FIREMAN.

In the care and management of the steam boiler the first thing required is an unceasing watchfulness — *watch-care* is the very word which describes it. The accidents arising from neglect or incompetency in care of the engine are few and unimportant compared to those which come from negligence in attending to the boiler.

Hence the fireman needs to be a man possessed of some of the highest qualities of manhood. The fact that many of the best steam engineers in the country have begun their careers by handling the shovel is evidence that good men are required and employed in this capacity, and that they are rewarded for their faithfulness by advancement.

An intemperate, reckless or indifferent man should never be given this place of trust. The sooner a man is dismissed who is either of these the better, both for himself and his employers, to say nothing of the innocent and unsuspecting public.

An employer should know something of the character and habits of the man who does the firing. A daily visit, and, at irregular times, with an eye to things in *the boiler-room*, as well as the engine-room, will keep him posted, to his great advantage. This regular inspection is most welcome to faithful and careful men, and is a great inspiration to good service. A steam-user should visit his steam department as regularly as he does his office, although he may not spend as much time there. The failure of scores of otherwise flourishing establishments is due to the waste and recklessness in the use of fuel under the boilers, or the heavy losses incurred by repairs and explosions — by which the whole business is stopped while the expenses continue undiminished.

A feeling of conscientious responsibility should be the uppermost thing upon the mind of a fireman when on duty. He should consider and know how to figure the total tons of pressure upon the plates of his boiler, and have constantly in mind the importance of unceasing vigilance.

To know how to be a good fireman cannot be taught by a book. The knowledge comes by experience and by instruction of engineers who have themselves been good firemen, but the following are some of the hints and rules which may be of advantage to the new beginner.

First — The fireman should be a sober and temperate person. Frivolous or reckless conduct about a steam-boiler is entirely out of place, and should not be permitted. There is too much danger and too much cost — not to call it waste — of fuel to allow any indifference or recklessness in the man upon whom so many depend.

Second — The fireman should be punctual in beginning his work. A loss of five minutes in starting into vigorous activity the men and machines of an establishment is sometimes caused by inattention of the fireman, and the blame which is showered upon him is a stern reminder that he is held accountable for the loss.

Third — A habit of neatness is an almost necessary quality, and which pays better for the cost of investment than any other.

Fourth — The tools should be kept in their places, and in good order.

Fifth — The boiler and all its attachments should be kept in the very tidiest and attractive condition possible.

Sixth — The fireman, notwithstanding its apparent difficulty, should keep himself — as said once — "respectable about his work." Scattered coal and ashes and dripping oil should be constantly cleaned up, and every effort made to make the boiler-room an attractive and cheerful place.

Seventh — The fireman needs to know all the details of his work, and to do with exactness every duty imposed upon him. He needs to be cool and brave in the presence of unexpected conditions, such as sudden leaks, breakages of the glass gauges and sudden stoppages of the engine with a heavy head of steam on.

Eighth — He should have an idea of the importance of his work, and keep in mind to learn to do everything that may fit him in time for an advanced position.

TABLE OF SAVINGS.

One dollar per day saved in cost of fuel amounts, with interest, to the following:

Years.	4 Per Ct.	6 Per Cent	8 Per Cent	10 Per Cent
1............	$ 324 48	$ 330 72	$ 336 96	$ 343 20
5............	1,757 50	1,864 20	1,976 80	2,095 26
10............	3,895 76	4,359 14	4,881 40	5,469 73
15............	6,497 24	7,697 82	9,149 18	10,904 30
20............	9,662 39	12,165 72	15,419 94	19,656 78

These tables are carefully made up. They represent 312 days' work in a year.

HORSE POWER—NOMINAL, INDICATED AND EFFECTIVE, WITH RULES FOR DETERMINING THE HORSE POWER OF AN ENGINE.

Engineers and others who never carefully considered the matter, often use the three terms above as synonymous. While the terms are far from having a like meaning, still we often hear the nominal horse power of a steam engine spoken of when the person using the expression really means the indicated power. To show the distinctive difference between the meanings of the words nominal, indicated and effective, as applied to the term horse power, is our aim.

A horse power is merely an expression for a certain amount of work, and involves three elements—force, space and time. If the force be expressed in pounds and the space passed through in feet, then we have a solution of, and meaning for, the term foot-pound; from which it will be seen that a foot-pound is a resistance equal to one pound moved through a vertical distance of one foot. The work done in lifting thirty pounds through a height of fifty feet is fifteen hundred foot-pounds. Now, if the foot-pounds required to produce a certain amount of work involve a specified amount of time during which the work is performed, and if this number of foot-pounds is divided by the equivalent number representing one horse power (which number will depend upon the time), then the resulting number will be the horse power developed.

For example, suppose the 1,500 foot-pounds just spoken of to have acted in one second. To find the horse power divide by 550, and the result will be the horse power.

A horse power is 33,000 foot-pounds per minute; or, in other words, 33,000 pounds lifted one foot in one minute, or one pound lifted 33,000 feet in one minute, or 550 pounds lifted one foot in one second, etc.

The capacity for work of a steam engine is expressed in the number of horse powers it is capable of developing.

Nominal horse power is an expression which is gradually going out of use, and is merely a conventional mode of describing the dimensions of a steam engine for the convenience of makers and purchasers of engines. The mode of computing the so-called nominal horse power was established by the practice of some of the early English manufacturers, and is as follows:

Assume the velocity of the piston to be 128 feet per minute multiplied by the cube root of length of stroke in feet.

Assume the mean effective pressure to be seven pounds per square inch. From these fictitious data and the area of the piston compute the horse power ; that is, nominal horse power$=7 \times 128 \times \sqrt[3]{\text{stroke in feet}} \times$ area of piston in square inches$\div 33{,}000$.

Indicated horse power is the true measure of the work done within the cylinder of a steam engine, and is based upon no assumptions, but is actually calculated. The data necessary are: The diameter of the cylinder in inches, length in feet, the mean effective pressure and number of revolutions per minute. As we have before stated, or implied, work is force acting through space, and a horse power is the amount of work in a specified time. In a steam engine the force which acts is the product of the area of the piston in square inches multiplied by the mean effective pressure; the space is twice the stroke in feet, or one complete revolution, multiplied by the number of revolutions per minute.

Therefore, indicated horse power equals the area of the piston, multiplied by the mean effective pressure, multiplied by the piston speed in feet per minute divided by 33,000.

Effective horse power is the amount of work which an engine is capable of performing, and is the difference between the indicated horse power and horse power required to drive the engine when it is running unloaded.

Engine rating, guarantees, etc., are usually based upon the indicated horse power, owing to the ease and accuracy with which it can be determined, and as a means of comparison.

Nominal horse power is computed from fictitious data.

Indicated horse power is computed from actual data, which is arrived at by means of what is known as the steam engine indicator.

Effective horse power is computed from actual data, either by means of the indicator, brake or dynamometer.

THE CARE OF MACHINERY.

The money spent in keeping machinery clean and in order is by no means wasted. The better the machinery, the greater the necessity for proper supervision. The first knock in an engine, the smallest leak in a boiler, the slightest variation from truth in a mill spindle, the wearing down of roller bearings, heating of journals, should be rectified immediately. The smooth and even working of machinery has a great deal to do with the cost of driving, while avoidance of the risk of breakage saves a large sum that would otherwise be spent in repairs.

FOAMING IN BOILERS.

The causes are dirty water; trying to evaporate more water than the size and construction of the boiler is intended for; taking the steam too low down; insufficient steam room; imperfect construction of boiler, and too small a steam pipe.

Take a kettle of dirty water and place it on a fire and allow it to boil and watch it foam, and it will be the same in a boiler.

Too little attention is paid to boilers with regard to their evaporating power. Where the boiler is large enough for the water to circulate, and there is surface enough to give oft the steam, foaming never occurs. As the particles of steam have to escape to the surface of the water in the boiler, unless that is in proportion to the amount of steam to be generated, it will be delivered with such violence that the water will be mixed with it and cause what is called foaming.

A high pressure insures tranquillity at the surface, and, the steam itself being more dense, it comes away in a more compact form, and the ebullition at the surface is no greater than at a lower pressure. When a boiler foams, we close the throttle to check the flow, and that keeps up the pressure and lessens the sudden delivery.

Too many flues in a boiler obstruct the passage of the steam from the lower part of the boiler on its way to the surface; this is a fault in construction, but nearly all foaming arises from dirty water, or from trying to evaporate too much water without heating surface or steam room enough. Usually, when first put in, a boiler and engine are large enough, but, as business increases, more machinery is added until the power required is greater than can be furnished by the engine, more pressure has to be carried, and the number of revolutions increased; consequently the evaporating power of the boiler is forced beyond its ability, the steam being drawn off so rapidly that a large portion of water is drawn with it — so much that it would astonish any engineer if he had a testing apparatus attached to the steam pipe.

For the remedy of foul water there are numerous contrivances to prevent it from entering the boiler, which is a far better way than trying to extract the sediment after it is there — though there are many ingenious methods for doing that also. Faulty construction, or lack of capacity, the engineer cannot help, but he soon learns how to run the boiler to get the best possible results from it.

Every intelligent engineer has observed that his engine has an individuality not possessed by any other he ever ran, and nothing but personal acquaintance can get the best work out of it; so it is with the boiler.

The steam pipe may be carried through the flange six inches into the dome, which would prevent the water from entering the pipes by following the sides of the dome as it does.

For violent ebullition a plate hung over the hole where the steam enters the dome from the boiler is a good thing, and prevents a rush of water by breaking it when the throttle is opened suddenly.

Clean water, plenty of surface, plenty of steam room, large steam pipes, boilers large enough to generate steam without forcing the fires, are all that is required to prevent foaming. A surface blow-off is a grand thing, and helps a foaming boiler, and would be a good thing on every boiler, as you can then skim it as you would an open kettle.

HAND-HOLE PLATES.

They should be placed in such a position as to be accessible and at or near all those parts of the boiler where scale or sediment is liable to accumulate. In the locomotive stationary boiler there should be one in each outside corner of the fire box and above the bottom ring, and one in each head under the tubes. In the upright tubular there should be at least two hand-hole plates above the ring, and one over the furnace door, on a line with the lower tube sheet, as in the locomotive boiler. The horizontal boiler should have one in each head under the tubes, and the rule generally observed is, that, whenever sediment is deposited, then there should be a hand-hole to get at it for a regular cleaning out.

These plates should be removed once a month, or oftener if necessary, to keep them clean, and are never considered an article of ornament, but of primary importance.

BOILING.

Let it be remembered, that the boiling spoken of so often is really caused by the formation of the steam particles, and that, without the boiling, there can be but a very slight quantity of steam produced.

While pure water boils at 212°, if it is saturated with common salt, it boils only on attaining 224°, alum boils at 220°, sal ammoniac at 236°, acetate of soda at 256°, pure nitric acid boils at 248°, and pure sulphuric acid at 620°.

INCRUSTATION OF STEAM BOILERS.

One of the greatest difficulties to be contended against in steam engineering is the incrustation on the boiler walls, arising from impure water. This crust is a poor conductor of heat, and causes increased fuel consumption, as well as the oxidizing or "burning" of the plates, owing to their increased temperature. A plate of iron 37½ inches thick conducts heat as well as a "crust" of one inch. A boiler bearing scale only 1-16 inch thick requires 15 per cent. more fuel, with ¼ inch 60 per cent. more, ½ inch 150 per cent. more. If the plates be clean, 90 pounds of steam require a plate temperature of only 325° F.; that is, about 5° above the steam temperature. But if there be a ½ inch scale or crust, the plate must be heated to about 700°, or nearly "low red" heat. Now, about 600° iron soon gets granular and brittle; hence such a scale is dangerous in its results. Crust also retards the circulation of the water. Two very common ingredients in boiler scale are carbonate of lime and sulphate of lime, or gypsum. The moderate use of soda ash (say one part in 5,000 of water) holds this deposit in check, by producing from the principal ingredients a *neutral* carbonate of lime, which will not adhere to the plates, when thus rapidly formed. Soda ash, if used in excess, boils up and passes into the cylinders and pumps, clogging up valves and pistons by combining with the lubricants. If the gauge-glasses become muddy, too much soda water is used. It is much better to supply the boilers with pure water that can deposit no scale, this being done by means of filters and heaters, or by surface-condensers, and being especially advisable with sectional and water tube boilers.

SUPERHEATED STEAM.

Superheated steam is made by drawing steam from the boiler and heating it after it has ceased to be in contact with the water in the boiler. The apparatus by which the extra heat is imparted is called a super-heater. The steam is conducted through the pipes, and hot air and gases of combustion are passed around the outside of them, thus raising the temperature and forming a more perfect gas.

STEAM GAUGES.

Steam gauges indicate the pressure of steam above the atmosphere, the total pressure being measured from a perfect vacuum, which will add 14 7-10 pounds on the average to the pressure shown on the steam gauge.

IMPORTANT TO THOSE OPERATING STEAM BOILERS.

In view of the numerous boiler explosions that have recently occurred, we submit to them the following pertinent questions asked by the *American Machinist*, which should command the careful consideration of every steam user in the land:

How long since you were inside your boiler?

Were any of the braces slack?

Were any of the pins out of the braces?

Did all the braces ring alike?

Did not some of them sound like a fiddle-string?

Did you notice any scale on flues or crown sheet?

If you did, when do you intend to remove it?

Have you noticed any evidence of bulging in the fire-box plates?

Do you know of any leaky socket bolts?

Are any of the flange joints leaking?

Will your safety valve blow off itself, or does it stick a little sometimes?

Are there any globe valves between the safety valve and the boiler? They should be taken out at once, if there are.

Are there any defective plates anywhere about your boiler?

Is the boiler so set that you can inspect every part of it when necessary?

If not, how can you tell in what condition the plates are?

Are not some of the lower courses of tubes or flues in your boiler choked with soot or ashes?

Do you absolutely know, of your own knowledge, that your boiler is in safe and economical working order, or do you merely suppose it is?

HOW TO PREVENT ACCIDENTS TO BOILERS.

1st. Carry regular steam pressure.

2d. Start the engine slowly so as not to make a violent change in the condition of the water and steam, and, when consistent, stop the engine gradually.

3d. Carry sufficient water in the boiler.

4th. Do not exceed the pressure in pounds per square inch allowed to be carried.

5th. See that every appliance of the boiler, feed pipes and safety-valve, fusible plugs, etc., are in complete working order.

PRINCIPLES ON WHICH BOILERS AND THEIR FURNACES SHOULD BE CONSTRUCTED.

Hitherto, those who have made boiler-making a separate branch of manufacture, have given too much attention to mere relative proportions. One class place reliance on enlarged grate surface, another on large absorbing surfaces, while a third demand, as the grand panacea, "boiler-room enough," without, however, explaining what that means. Among modern treatises on boilers, this principle of room enough seems to have absorbed all other considerations, and the requisites, in general terms, are thus summed up :

1. Sufficient amount of internal heating surface.
2. Sufficient roomy surface.
3. Sufficient air-space between the bars.
4. Sufficient area in the tubes or flues ; and
5. Sufficiently large fire-bar surface.

In simpler terms, these amount to the truism — give sufficient size to all the parts, and thus avoid being deficient in any.

With reference to the proportions of the several parts of a furnace, there are two points requiring attention ; first, the superficial area of the grate for retaining the solid fuel or coke ; and, second, the sectional area of the chamber above the fuel for receiving the gaseous portion of the coal.

As to the *area of the grate-bars*, seeing that it is a solid body that is to be laid on them, requiring no more space than it actually covers at a given depth, it is alone important that it be *not too large.* On the other hand, as to the *area of the chamber* above the coal, seeing that it is to be occupied by a gaseous body, requiring room for its rapidly enlarging volume, it is important that it be *not too small.*

As to the best proportion of the grate, this will be the easiest of adjustment, as a little observation will soon enable the engineer to determine the extent to which he may increase or diminish the length of the furnace. In this respect the great desideratum consists in confining that length within such limits that it shall, at all times, be well and uniformly covered. This is the absolute condition and *sine qua non* of economy and efficiency; yet it is the very condition which, in practice, is the most neglected. Indeed, the failure and uncertainty which has attended many anxiously conducted experiments has most frequently arisen from the neglect of this one condition.

If the grate-bars be not equally and well covered, the air will enter in irregular and rapid streams or masses, through the uncovered parts, and at the very time when it should be there most restricted. Such a state of things at once bids defiance to all regulation or control. Now, on the control of the supply of air depends all that human skill can do in effecting perfect combustion and economy; and, until the supply of fuel and the quantity on the bars be regulated, it will be impossible to control the admission of the air.

Having spoken of the grate-bar surface, and what is placed on it, we have next to consider the chamber part of the furnace, and what is formed therein. In marine and cylindrical land boilers, this chamber is invariably made too shallow and too restricted.

The proportions allowed are indeed so limited as to give it rather the character of a large tube, whose only function should be, the allowing the combustible gases to pass through it, rather than that of a chamber, in which a series of consecutive chemical processes were to be conducted. Such furnaces by their diminished areas, have also this injurious tendency, — that they increase the already too great rapidity of the current through them.

The constructing the furnace chamber so shallow and with such inadequate capacity, appears to have arisen from the idea, that the nearer the body to be heated was brought to the source of heat, the greater would be the quantity received. This is no doubt true when we present a body to be heated in front of a fire. When, however, the approach of the colder body will have the direct effect of interfering with the processes of nature (as in gaseous combustion), it must manifestly be injurious. Absolute contact with flame should be avoided where the object is to obtain all the heat which would be produced by the combustion of the entire constituents of the fuel.

So much, however, has the supposed value of near approach, and even impact, prevailed, that we find the space behind the bridge, frequently made but a few inches deep, and bearing the orthodox title of the flame-bed. Sounder views have, however, shown that it should be made capacious, and the impact of the flame avoided.

As a general view, deduced from practice, it may be stated that the depth between the top of the bars and the crown of the furnace should not be less than two feet six inches where the grate is but four feet long; increasing in the same ratio where the length is greater; and secondly, that the depth below the bars should not be less, although depth there is not so essential either practically or chemically.

PROPERTIES OF SATURATED STEAM.

Pressure. By Steam Gauge.	Pressure. Total	Temperature in Fahrenheit Degrees	Volume. Compared with Water.	Volume. Cubic Feet of Steam from 1 lb. of Water.	Latent Heat in Fahrenheit Degrees.	Total heat required to generate 1 lb. of Steam from Water at 32 deg. under constant pressure.
						In Heat Units.
0	15	212.0	1642	26.36	965.2	1146.1
5	20	228.0	1229	19.72	952.8	1150.9
10	25	240.1	996	15.99	945.3	1154.6
15	30	250.4	838	13.46	937.9	1157.8
20	35	259.3	726	11.65	931.6	1160.5
25	40	267.3	640	10.27	926.0	1162.9
30	45	274.4	572	9.18	920.9	1165.1
35	50	281.0	518	8.31	916.3	1167.1
40	55	287.1	474	7.61	912.0	1169.0
45	60	292.7	437	7.01	908.0	1170.7
50	65	298.0	405	6.49	904.2	1172.3
55	70	302.9	378	6.07	900.8	1173.8
60	75	307.5	353	5.68	897.5	1175.2
65	80	312.0	333	5.35	894.3	1176.5
70	85	316.1	31[illegible]	5.05	891.4	1177.9
75	90	320.2	298	4.79	888.5	1179.1
80	95	324.1	283	4.55	885 8	1180.3
85	100	327.9	270	4.33	883.1	1181.4
90	105	331.3	257	4.14	880.7	1182.4
95	110	334.6	247	3.97	878.3	1183.5
100	115	338.0	237	3.80	875.9	1184.5
110	125	344.2	219	3.51	871.5	1186.4
120	135	350.1	203	3.27	867.4	1188.2
130	145	355.6	190	3.06	863.5	1189.9
140	155	361.0	179	2.87	859.7	1191.5
150	165	366.0	169	2.71	856.2	1192.9
160	175	370.8	159	2.56	852.9	1194.4
170	185	375.3	151	2.43	849.6	1195.8
180	195	379.7	144	2.31	846.5	1197.2

This table gives the value of all properties of saturated steam required in calculations connected with steam boilers.

SODA ASH IN BOILERS.

An English boiler inspection company recommends that soda ash be used to prevent scale, instead of soda crystals; and that it be pumped in regularly and continuously in solution, with the feed, instead of spasmodically dumped in solid through the manhole. Tungstate of soda, instead of either soda ash or soda crystal, has been recommended strongly by some high authorities in lieu of the above.

STEAM COAL.

Steam coal, being, as everybody knows, unquestionably the most important and largest expense in the manufacture of steam, is deserving a most careful investigation by engineers and owners, who, unlike chemists and college professors, consider the subject wholly in a practical way, as relating to the coal bills of their establishments.

Useful knowledge of every-day economy of coal is seldom gained by "tests" conducted by experts, for several reasons so plain that they will not require explanation. 1st. The cost of the fuel used in tests, whatever may be stated, is too high, average or "every-day" coal not being used. The experiments are made with picked men and picked fuel, for brief periods, with everything at its best, and the results attained, if looked for in the ordinary run of business, will be disappointment in the results of the wholesale order. 2d. Men, working as firemen, twelve or fourteen hours per day in the hot furnace rooms, cannot be expected, with the ordinary appliances, to watch where every lump of coal falls when feeding the furnaces, nor to clean the grates any oftener than they are compelled to do. 3d. Moreover, too many employers favor the low wages plan, and, for the apparent saving of a few dollars per month, waste many times the amount in their furnace doors, and render their establishments most disagreeable to their neighbors, by a free distribution of unconsumed carbon, or what is commonly called *soot*, and of which most people have no appreciation. 4. Little or no encouragement is given for careful or economical firing, as a rule. The fireman who oftentimes wastes as much as his entire wages, secures the same pay as the man working alongside of him who saves it all. It may be remarked that this is "not business," but many are the concerns who run their steam plants upon this system. Careful handling of coal in firing pays better than any other thing about a steam plant, and it is the wisest economy to secure good and careful men to do it.

As is well understood, the conditions or circumstances attending the combustion of coal for steam purposes, embraces a wide range. A very few establishments work under conditions that admit of a high attainment of economy by having a fixed performance of duty, and their plants well proportioned to the regular work, but by far the largest number having a fluctuating demand for steam, and in that respect are largely at a disadvantage. Many furnaces are badly constructed, others suffer from an insufficiency of draft, and in many cases there seems to be no end of complications detrimental to best results.

These practical difficulties and uncertainties, which are well known to every experienced engineer, render any investigation worthy of the name, slow and laborious. It has taken considerable time and research to arrive at the conclusion, though differing from the preponderance of hearsay or guess-work evidence, that now, at least, "*the highest priced coal is not the cheapest for steam production,*" and that, in fact, the reverse is undoubtedly true, especially in the Western country. Late improvements in the construction of grate bars have undoubtedly added largely to the value of Western soft coals. The great difficulty, in former times, of ridding the furnaces of the incombustible part of these very valuable coals, has now been removed by improvements, and there is no doubt but what a large number of extensive establishments in the West are now, and for some time past have been, obtaining the same duty from the Illinois bituminous coals that they in former years obtained from the high-priced Eastern coals.

BLOWING OFF UNDER PRESSURE.

A boiler can be seriously impaired by blowing it down under a high pressure, and with hot brick work. The heat from the latter will granulate the iron and reduce its tensile strength. A boiler should not be blown right down under a higher pressure than twenty pounds, and not less than four hours after the fire has been drawn.

When a boiler is exposed to cold air, especially in the winter, it is advisable that the damper be closed and the doors thrown open, or *vice-versa.* If both are left open, the strong draught of cold air will cool off the flues faster than the shell; which abuse, if kept up, would reduce the length of the life of the boiler.

THE TOTAL PRESSURE.

A boiler eighteen feet in length by five feet in diameter, with forty-four inch tubes, under a head of eighty pounds of steam, has a pressure of nearly 113 tons on each head, 1,625 tons on the shell and 4,333 tons on the tubes, making a total of 6,184 tons on the whole of the exposed surfaces.

This calculation is made by finding the total square inches under pressure, and multiplying the totals by the pressure, in this case, 80 pounds to the square inch.

Table Showing Safe Working Steam Pressure for Iron Boilers of different sizes, using a Factor of Safety of Six.

Internal Diameter of Shell in inches.	Thickness of Iron.	Longitudinal Seams, Single Riveted. Tensil Strength of Iron.			Longitudinal Seams, Double Riveted. Tensil Strength of Iron.		
		45,000 Lbs. Pressure.	50,000 Lbs. Pressure.	55,000 Lbs. Pressure.	45,000 Lbs. Pressure.	50,000 Lbs. Pressure.	55,000 Lbs. Pressure.
	INCH.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.
36	1/4	104	116	127	125	139	152
	5/16	130	145	159	156	174	191
38	1/4	99	110	121	119	132	145
	5/16	123	137	151	148	164	181
40	1/4	94	104	115	113	125	138
	5/16	117	130	143	140	156	172
42	1/4	89	99	109	107	119	131
	5/16	112	124	136	134	149	163
44	1/4	85	95	104	102	114	125
	5/16	107	118	130	128	142	156
46	1/4	82	91	100	98	109	120
	5/16	102	113	125	122	136	150
48	1/4	78	87	96	94	104	115
	5/16	98	109	120	118	131	144
	3/8	118	131	144	142	157	173
50	1/4	75	83	92	90	100	110
	5/16	94	104	115	113	125	138
	3/8	112	125	138	134	150	166
52	1/4	72	80	88	86	96	106
	5/16	90	100	110	108	120	132
	3/8	108	120	132	130	144	158
54	5/16	87	96	106	101	112	122
	3/8	104	116	127	120	134	148
	7/16	121	135	148	140	156	172
60	5/16	78	87	95	94	104	114
	3/8	94	104	115	113	125	138
	7/16	109	121	134	131	145	160
66	3/8	85	95	104	102	114	125
	7/16	99	111	121	120	133	146
	1/2	112	117	138	137	152	167
72	3/8	78	87	96	94	104	115
	7/16	91	102	112	110	122	134
	1/2	102	117	128	125	140	153

STEAM HEATING.

The advantages of steam heating are set forth by Prof. W. P. Trowbridge, in the *North American Review*, as follows:

1. The almost absolute freedom from risk of fire when the boiler is outside of the walls of the building to be heated, and the comparative immunity under all circumstances.

2. When the mode of heating is the indirect system, with box coils and heaters in the basement, a most thorough ventilation may be secured, and it is in fact concomitant with the heating.

3. Whatever may be the distance of the rooms from the source of heat, a simple steam pipe of small diameter conveys the heat. From the indirect heaters underneath the apartments to be heated, a vertical flue to each apartment places the flow of the low heated currents of the air under the absolute control of the occupants of the apartment. Uniformity of temperature, with certainty of control, may be thus secured.

4. Proper hygrometric conditions of the air are better attained. As the system supplies large volumes of air heated only slightly above the external temperature, there is but little change in the relative degree of moisture of the air as it passes through the apparatus.

5. No injurious gases can pass from the furnace into the air flues.

6. When the method of heat is by direct radiation in the rooms, the advantage of steadiness and control of temperature, sufficient moisture and good ventilation, are not always secured; but this is rather the fault of design, since all these requirements are quite within reach of ordinary contrivances.

7. One of the conspicuous advantages of steam heating is that the most extensive buildings, whole blocks, and even large districts of a city may be heated from one source, the steam at the same time furnishing power where needed for ventilation or other purposes, and being immediately available also for extinguishing fires, either directly or through force pumps.

STOPPING WITH A HEAVY FIRE.

When it becomes necessary to stop an engine with a heavy fire in the furnace, place a layer of fresh coal on the fire, shut the damper and start the injector or pump for the purpose of keeping up the circulation in the boiler.

ANALYSIS OF BOILER INCRUSTATION.

BY DR. WALLACE.

Carbonate of lime	64.98
Sulphate of lime	9.33
Magnesia	6.93
Combined water	3.15
Chloride of sodium	.23
Oxide of iron	1.36
Phosphate of lime of alumina	3.72
Silica	6.60
Organic matter	1.60
Moisture at 212 degrees F	2.10
	100.

CLEANING BOILER TUBES.

The method of cleaning boiler tubes depends upon the kind of fuel used. A steam jet will not answer where wood and soft coal are used, but will do for hard coal, though in any case a scraper is indispensable, where a steam jet is not. Soot and dust will collect in the tubes and burn on so as to require more than a jet of steam to move it. A steam jet or blower should be used only where dry steam is at hand, but by no means with wet steam. Before using the jet, thoroughly blow all the water out of it and heat it up. We have seen some men put the point of the jet in a tube and turn on steam before warming, and then wonder what caused the brick work to crumble away at the back end.

CLEANING BRASS.

The government method prescribed for cleaning brass, and in use at all the United States arsenals, is said to be the best in the world. The plan is, to make a mixture of one part of common nitric, and one-half part sulphuric acid in a stone jar, having also a pail of fresh water and a box of saw-dust. The articles to be treated are first dipped into the acid, then removed into the water, and finally rubbed with the saw-dust. This immediately changes them into a brilliant color. If the brass has become greasy, it is first dipped into a strong solution of potash or soda, in warm water. This dissolves the grease, so that the acid has power to act.

THE THERMAL UNIT

Is the heat necessary to raise one pound of water at 39° F. one degree, or to 40° F.

EXPLOSION OF A FEED WATER HEATER.

Two men were killed and another injured recently by the explosion of a feed water heater which consisted of a plain rectangular tank in which the exhaust from a steam-winch was blown on the surface of the water. This tank measured 9 feet in length by 3 feet 3 inches in width, and 3 feet and 3 inches in depth, and was made throughout of wrought-iron plates three-eighths of an inch thick, while the top and the bottom were secured by angle-iron to the vertical plates.

The cause of the explosion was extremely simple. On the top of the tank there was an open pipe 1¾ inches in diameter for the purpose of carrying away the exhaust heat from the engine. This was attached to the tank by the means of a flange, and the joint was made by the means of a sheet of india rubber one-eighth of an inch thick. The man who made the joint had made the holes for the bolts to pass through, but had neglected to make the opening for the steam to pass through, so that the steam was bottled up in the tank. In consequence of this the pressure went on accumulating as the engine continued working, and, as the feed water tank proved to be weaker than the india-rubber diaphragm, the flat top was blown off with the result recorded.

The following table shows the pressure allowed and thickness required of boiler iron by the laws of the United States, pressure equivalent to the standard, for a boiler ¼ inch thick and 42 inches in diameter:

Thickness in 16ths.	Diameter.						
	34 inches	36 inches	38 inches	40 inches	42 inches	44 inches	46 inches
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5	169.9	160.4	152.	144.4	137.5	131.2	125.5
4½	158.5	149.7	141.8	134.7	128.3	122.5	117.2
4¼	147.2	139.1	131.8	125.1	119.2	113.7	108.8
4	135.9	128.3	121.6	115.5	110	105.	100
3⅔	124.5	117.6	111.4	105.9	100.8	96.2	92.
3⅓	113.2	106.9	101.3	96.2	91.7	87.5	83.
3	101.9	96.2	91.2	82.7	82.5	78.7	75.

DANGER FROM THE MANHOLE COVER.

The Manchester (Eng.) Steam Users' Association lately made a report on the above subject, giving the particulars of nearly twenty distressing accidents arising from carelessness or ignorance in handling that appliance of the steam boiler which had occurred during the past few years in England.

In the first case noted, two men were killed and a third injured. In the depositions made at the coronor's inquest, it appeared that the manhole lid was fastened down with twelve bolts, and that these had been taken out, when the lid was suddenly blown off. The error in judgment consisted in taking out the bolts securing the manhole lid, with the safety valve shut down. Not only should the valves be blocked up so as to be held open, but also it should be seen that all escape of steam from them had absolutely ceased before the nuts were removed.

It should not be overlooked that the adhesion afforded by the red-lead joint is a dangerous trap. Though there may be pressure lingering in the boiler, the joint holds the lid down for a time, but on being lightly disturbed it allows the lid to be suddenly blown off, when a violent rush of steam ensues which in many cases has been attended with fatal results.

The association report several cases where death has been caused by attempting to lighten up the manhole cover bolts under pressure, although nearly all the instances arose from attempting to take off the cover before the pressure of the steam was quite down. A single case was reported when compressed air had caused a fatal accident. The boiler had been laid off for cleaning and pumped nearly full of water in order to cool it. The attendant had taken off the nuts of the cover, and struck it once or twice in order to loosen the joint, when the cover was blown off by the compressed air within the boiler, and, striking him on the head, killed him instantly.

The report showed the cause of death of twenty-four persons and the injury of eight others, and it indicates the importance of propping up safety valves so as to hold them open; and also making sure that all escape of air or steam through them has actually ceased before the nuts of the manhole cover are taken off.

Recent experiments show that water, uncontaminated with carbonic acid, will not corrode lead service pipes.

MISTAKES IN DESIGNING BOILERS.

One of the greatest mistakes that can be made in designing boilers, and the one that is most frequently made of any, consists in putting in a grate too large for the heating surface of the boiler, so that with a proper rate of combustion of the fuel an undue proportion of the heat developed passes off through the chimney, the heating surface of the boiler being insufficient to permit its transmission to the water. This mistake has been so long and so universally made, and boiler owners have so often had to run slow fires under their boilers to save themselves from bankruptcy, that it has given rise to the saying, "Slow combustion is necessary for economy." This saying is considered an axiom, and regarded with great veneration by many, when the fact is, if the truth must be told, it has been brought about by the wastefulness entailed by boiler plants and proportioned badly by ignorant boilermakers and ignorant engineers, who ought to know better, but don't.

Let us consider the matter briefly: Suppose we are running the boiler at a pressure of 80 lbs. per square inch, the temperature of the steam and water inside will be about 325 degrees F.; the temperature of the fire in the furnace will, under ordinary conditions, be about 2,500 degrees F. Now, it should be clear to the dullest comprehension, that we can transmit to the water in the boiler only that heat due to the difference between the temperature in the furnace and that in the boiler. In case of the above figures, about seven-eighths of the total heat of combustion is all that could, by any possibility, be utilized, and this would require that radiation of heat from every source should be absolutely prevented, and that the gases should leave the boiler at the exact temperature of the steam inside, or 325 degrees.

To express the matter plainly, we may say that the utilization of the effect of a *fall* of temperature of 2.175 degrees is all that is possible.

Now, suppose, as one will actually find to be the case in many cases if he investigates carefully, that the gases leave the flues of another steam boiler at a temperature between 500 and 600 degrees. The latter temperature will be found quite common, as it is considered to give "good draft." This is quite true, especially as far as the "draft" on the owner's pocket-book is concerned, for he cannot possibly utilize under these conditions more than 2,500 — 500 = 2,000 degrees of that inevitable difference of temperature to which he is confined, or four-fifths of the total, instead of the seven-eighths, as shown above, where the boiler was running just right, and any attempt to reduce the temperature of the escaping gases by means of slower "combustion," as he would probably be advised to do by nine out of ten men, would simply reduce the temperature of the fire in his furnace, and the economical result would be about the same. His grate is too large to burn coal to the best possible advantage, and his best remedy is to reduce its size and keep his fire as hot as he can.

This is not speculation, as some may be inclined to think. Direct experiments have been made to settle the question. The grate under a certain boiler was tried at different sizes with the following result:

With grate six feet long ratio of grate to heating surface was 1 to 24.4.

With grate four feet long ratio of grate to heating surface was 0 to 36.6.

The use of the smaller grate gave, with different fuels and all the methods of firing, an average economy of nine per cent. above the larger one, and, when compared by burning the same amount of coal per hour on each, twelve per cent. greater rapidity of evaporation and economy were obtained with the smaller grate.

AVERAGE BREAKING AND CRUSHING STRAINS OF IRON AND STEEL.

Breaking strain of wrought iron =23 tons	Per square inch of section.
Crushing strain of wrought iron =17 tons	
Breaking strain of cast iron about 7½ tons	
Crushing strain of cast iron =50 tons....	
Breaking strain of steel bars about 50 tons	
Crushing strain of steel bars up to 116 tons	

PITTING OF MUD DRUMS.

Mud drums have frequently been known to pit through their close connection to the brick work with which they are covered. When the boiler is filled with cold water, the iron will sweat. This moisture mixing with the lime of the brick work will, after a length of time, injure the iron. Mud drums are injured on the inside by a similar chemical action. The sediments of lime, etc., deposit there where their action goes on undisturbed by any circulation. To prevent pitting on the inside from this cause, blow down frequently, and, on the outside, keep the brick off the plates, so that all moisture can pass off.

TABLE OF SPECIFIC GRAVITIES.

	Weight of a Cubic Inch in Lbs.
Copper, cast	.3178
Iron, cast	.263
Iron, wrought	.276
Lead	.4103
Steel	.2827
Sun-metal	.3177

DIVISIONS OF DEGREES OF HEAT.

The thermometer is an instrument for measuring sensible heat. It consists of a glass tube of very fine bore, terminating in a bulb. This bulb is filled with mercury, and the top of the tube is hermetically sealed after all the air has been expelled. The instrument is then put into steam arising from boiling water, and, when the barometer stands at thirty inches, a mark is placed on a scale affixed opposite the place the mercury stands at. It is again put in melting ice, and the scale again marked. The space between these marks is divided into spaces called degrees. In this country and England it is divided into 180 equal parts, calling freezing point 32°, so that the boiling point is 212°; and zero or 0 is 32° below freezing point, and this scale is called Fahrenheit's. On the continent two other scales are in use; the Centigrade, in which the space is divided into 100 equal parts, hence the name; and Reaumur's, in which the space is divided into 80. In both of these scales freezing point is 0, or zero; so that the boiling point of centigrade is 100°, and Reaumur 80°.

THE LAW OF PROPORTION IN STEAM ECONOMY.

The basis of steam engineering science consists in closely adhering to the absolute ratio or proportion of the different parts of the steam-plant, representing the power of the engine and boiler to the amount of the work to be done. To use an extreme illustration, it is not scientific to construct a hundred horse power boiler — say 1,500 square feet of heating surface — to furnish steam for a six-inch cylinder; nor is it in proportion to use a cylinder of the latter size to drive a sewing machine. It may be said truthfully that the law of true proportion between boiler, engine and the desired amount of work is less understood than almost any other in the range of mechanical practice.

PROPORTIONS OF VARIOUS COMPOSITIONS IN COMMON USE.

(In 100 parts.)

Babbitt's metal	Tin, 89; copper 3.7; antimony, 7.3.
Fine yellow brass	Copper, 66; zinc, 34.
Gun metal, valves, etc.	Copper, 90; tin, 10.
White brass	Copper, 10; zinc, 80; tin, 10.
German silver	Copper, 33.3; zinc, 33.4; nickel, 33.3.
Church bells	Copper, 80; zinc, 5.6; tin, 10.1; lead, 4.3.
Gongs	Copper, 81.6; tin, 18.4.
Lathe bushes	Copper, 80; tin, 20.
Machinery bearings	Copper, 87.5; tin, 12.5.
Muntz metal	Copper, 60; zinc, 40.
Sheathing metal	Copper, 56; zinc, 44.

HORSE POWER OF STEAM BOILERS.

It is often remarked that there is no such thing as horse power of steam boilers. This is true, because the same amount of heating surface in a locomotive under full head, or with the exhaust steam creating a powerful draught, is many times greater than in the two-flue boiler with the same heating surface, under ordinary conditions; but for commercial uses and convenience, rules have been agreed upon to designate the horse power of various kinds of boilers.

At the Centennial Exposition, held at Philadelphia, it was agreed by the competitors and the highest scientific authorities, that the evaporation of thirty pounds of water at a temperature of 212° should be considered to be equal to one horse power.

In buying and selling boilers, it is usually considered that fifteen square feet of heating surface in the horizontal tubular boiler is equal to one horse power. The quality of the water, as to its impurities, the form of construction and condition of the boiler, all modify the rule of buying a specified power in a boiler by the amount of heating surface.

A GOOD LUBRICATOR.

It may not be generally known that tallow and plumbago, thoroughly mixed, make the best lubricator for surfaces when one is wood, or when both are wood. Oil is not so good as tallow to mix with plumbago for the lubrication of wooden surfaces, because oil penetrates and saturates the wood to a greater degree than tallow, causing it to swell more.

HOW TO TEST BOILERS.

The safe-working pressure of any boiler is found by multiplying twice the thickness of plate by its tensile strength in pounds, then divide by diameter of boiler, then this result divide by six. This gives safe working pressure.

EXAMPLE.

Twice thickness plate × tensile strength ÷ diameter of boiler in inches ÷ 6 = safe working pressure + one-half more = maximum test pressure.

Diameter of boiler, 60″. Thickness of plate, ½″. Tensile strength of plate, 60,000 lbs. 1″ × 60,000 ÷ 60 = 1,000 ÷ 6 = 166⅔ lbs., which is the safe working pressure + 83⅓ lbs. = 250 lbs., which is the maximum test pressure.

After the safe pressure has been found as above, the usual way is to add one-half more for a test pressure, then apply by hydraulic pressure as high as the test pressure, and, if the boiler goes through this test all right, it is safe to run it at two-thirds of test pressure.

Before putting hydraulic pressure on an old boiler, empty the boiler, go over it carefully with the hammer for broken braces, weak and corroded spots, figure for safe pressure on the thinnest place found in boiler, fill boiler full of cold water, and gradually heat it until the desired pressure is reached. By this mode of testing by hot water pressure, the heated water is expanded, and is more elastic than when cold, and is not so liable to strain the boiler.

Before allowing the pressure to be applied, see that the boiler is properly braced and stayed, and that the rivets are of proper size.

All flat surfaces, such as found in fire-box boilers, should have stays not over 5 or 6 inches apart, for all ordinary pressure and boiler heads not over 7 inches apart.

On account of the loss of strength in the plates by rivet holes, some authorities allow only 70 per cent. of the safe pressure given above, for double-riveted boilers, and 56 per cent. for single-riveted boilers:

EXAMPLE.

166 lbs. safe pressure in first example × 70 per cent. for double-rivets = 116.20 lbs. safe pressure for double-riveted boiler.

166 lbs. safe pressure in first example × 56 per cent. for single-riveted seams = 92.96 lbs. safe pressure for single-riveted boilers.

SCALE IN BOILERS

Mr. T. T. Parker writes as follows to the *American Machinist:*

If there is one thing more than another that the average engineer is careful with, it is the use of boiler compounds. With an open exhaust heater and an overworked boiler, and using water from a drilled well sixty feet deep in limestone, I have had to be rather careful to avoid scale and foaming.

I offer some notes from my experience under the above conditions.

In using compounds containing sal soda, I had to use 40 per cent. more cylinder oil, and this invariably reacted, through the heater and feed water, on the boiler, and produced foaming. I have used six compounds warranted to cure foaming with above results. The compounds were tannic acid and soda.

Changing to the use of crude oil, I found that the volatile parts went over to the engine, and saved 10 per cent. cylinder oil over when using nothing, and 50 per cent. over the use of sal soda. There is a peculiar easy manner of making steam that is very different from the same boiler using sal soda. The results on scale are as follows:

In changing to a different solvent, the results for a few runs were very good, and then it seemed to lose its virtue while losing double quantity; result, foaming. With crude oil used continually, I have had scale from one-eighth inch thick, but never any thicker, as it came off clean, and was very porous. I prefer oil to any acid or alkali solvent. For cleaning a scaled boiler I would recommend alternate use of oil and sal soda, but the remedy is heroic. If the boiler is not clean in two weeks, I miss my guess. I have tried kerosene, and found it too volatile to be of value in a limestone district. In summing up the results, I believe:

First — With an open exhaust heater, use only the best cylinder oil, which should be at least 80 per cent. petroleum.

Second — If the crude oil does not keep the scale all out, alternate one run with sal soda.

Now, I only offer this as my experience, knowing full well that the conditions are never absolutely the same. But I know of a plant (in this city) where the boiler is not worked up to its full capacity, and which is kept entirely free from scale, using hard water, by the alternate use of sal soda and crude oil.

FUTURE OF THE STEAM ENGINE.

The annual meeting of the British Association for the Advancement of Science, lately held at Bath, England, was opened by an address by Sir Frederick Bramwell, the president of the association, in which he repeated a prediction made by him at a former meeting of the association regarding the displacement of the steam engine in the future. He said it was a sad confession to have to make, that the very best steam engines only utilized about one-sixth of the work which resides in the fuel that is consumed, though at the same time it is a satisfaction to know that great economical progress had been made, and that the six pounds or seven pounds of fuel per horse power per hour consumed by the very best engines of Watts' days, when working with the aid of condensation, is now brought down to about one-fourth of this consumption. Continuing, he said: At the York meeting of our association I ventured to predict that, unless some substantial improvement were made in the steam engine (of which improvement, as yet, we have no notion), I believed its days for small powers were numbered, and that those who attended the centenary of the British Association in 1931, would see the present steam engines in museums, treated as things to be respected, and of antiquarian interest, by the engineers of those days, such as the over-topped steam cylinders of Newcomen and of Smeaton to ourselves. I must say I see no reason, after the seven years which have elapsed since the York meeting, to regret having made that prophecy, or to desire to withdraw from it. The working of heat engines, without the intervention of the vapor of water by the combustion of the gases arising from coal, or from coal and from water, is now not merely an established fact, but a recognized and undoubted commercially economical means of obtaining motive power. Such engines, developing from 1 to 40 horse power, and worked by ordinary gas supplied by gas mains, are in most extensive use in printing works, hotels, clubs, theaters, and even in large private houses, for the working of dynamos to supply electric light. Such engines are also in use in factories, being sometimes driven by the gas obtained from "culm" and steam, and are given forth a horse-power for, it is stated, as small a consumption as one pound of fuel per hour. It is hardly necessary to remind you — but let me do it — that, although the saving of half a pound of fuel per horse-power appears to be insignificant when stated in that bald way, one realizes that it is of the highest importance when that half-pound turns out to be 33 per cent. of the whole previous consumption of one of those economical engines to which I have referred. But, looking at the wonderful petroleum industry, and at the multifarious products which are obtained from the crude material, is it too much to say that there is a future for motor engines worked by the vapor of some of the more highly volatile of these products — true vapor — not a gas, but a condensable body capable of being worked over and over again? Numbers of such engines, some of as much as four horse-power, made by Mr. Yarrow, are now running, and are apparently giving good results, certainly excellent results as regards the compactness and lightness of the machinery; for boat purposes they possess the great advantage of being rapidly under way. I have seen one go to work within two minutes of the striking of the match to light the burner. Again, as we know, the vapor of this material has been used as a gas in gas engines, the motive power having been obtained by direct combustion. Having regard to these considerations, was I wrong in predicting that the heat engine of the future will probably be one independent of the vapor of water? And further, in these days of electrical advancement, is it too much to hope for the direct production of electricity from the combustion of fuel?

GAS FOR LOCOMOTIVES.

The problem of obtaining a cheaper fuel than coal for locomotives, which has long bothered railroad men, seems likely to be solved soon by experiments now being made with gas. A very good test of the new fuel has been made at the works of the electric light company in West Chester, which, since the fire that destroyed the old plant several months ago, have been dependent for their motive power upon the Shaw locomotive. This is the engine that made such a good record in some trial trips two or three years ago, but which has never done much road service.

Instead of coal, gas mixed with air has been used in the locomotive with entire success in generating sufficient power to drive the dynamos. With larger machines for producing and mixing the gas, it is believed that power enough can be obtained for driving locomotives with trains, and a special car is now being built at New York to hold a large machine of the kind used in mixing the gas, and the storage receivers.

PROPORTIONS OF STEAM BOILERS.

In a recent communication to the *Societe Scientifique Industrielle* of Marseilles, M. D. Stapfer remarked that, as he had never met with any good practical rules for the proportions of boilers for steam engines, he had taken the trouble to examine a very large number of different types, which were working satisfactorily, and from them had deduced the following rules: The water level in the boilers of torpedo boats was usually placed at two-thirds the diameter of the shell, and in marine, portable and locomotive boilers at three-fourths this diameter. The surface from which evaporation took place should, however, be made greater as the steam pressure was reduced — that was to say, as the size of the bubbles of steam became greater. To produce 100 lbs. of steam per hour, at atmospheric pressure, this surface should not be less than 7.32 square ft., which may be reduced to 1.46 square ft. for steam at 75 lbs. pressure, and 0.73 ft. for steam at a pressure of 150 lbs. It is for this reason that triple-expansion engines can be worked with smaller boilers than were required with engines using steam of lower pressure. The amount of steam space to be permitted depends upon the volume of the cylinder and the number of revolutions made per minute. For ordinary engines it may be made a hundred times as great as the average volume of steam generated per second. The section through the tubes may be one-sixth of the fire-grate area when the draught is due to chimney from 27 ft. to 33 ft. high, which in general corresponds to a fuel consumption of 12.3 pounds of coal per square foot of grate surface per hour. This area may be reduced to one-tenth that of the grate when forced draught is employed.

TESTING BOILER PLATES.

A good every-day shop plan of testing boiler plates is to cut off a strip 1¼ inches wide and of any convenient length. Drill a quarter-inch hole, and enlarge it to three-quarters of an inch by means of a drift-pin and hammer. If the plate shows no signs of fracture, it may be considered of good quality.

Another method is to cut off a narrow strip, heat it to a cherry red and cool suddenly. Grip the piece in a vise, and bend it back and forth at right angles by means of a piece of gas pipe dropped over the end. The number of times the piece can stand this bending is the measure of its quality. A good piece of soft steel boiler-plate should stand twelve or fifteen bendings without showing fracture.

IGNORANCE ABOUT BOILERS.

The facts which might be brought out by a well-directed examination of the persons in charge of steam boilers in some sections of the country would be amusing, were it not for the fact that a steam boiler in charge of a *too* ignorant person is always an element of great danger. Not long since a boiler exploded in one of our cities, and, as such a thing had not occurred in that vicinity for some time, people were somewhat stirred up over the matter, and an examination of the engineers and boilers was of course in order. The following are some of the incidents reported as a result of the examination:

In one place a pile of ashes about four feet high was found banked up against the side of a boiler. The engineer was asked why they were there, and he replied that "the boiler was sweating a little," and that he had put them there to keep the water from coming out of it. The ashes were immediately removed, and four or five holes were found in the boiler through which the water was oozing. The boiler was under a pressure of sixty pounds at the time. Over thirty people were employed in the immediate vicinity of the boiler.

Some ludicrous answers were made by candidates for engineers' licenses. For instance, one candidate when asked the dimensions of the boiler he was running replied, "two and one-half feet high, one foot in diameter, and 120 one and one-half inch tubes in it." It was afterward ascertained that the boiler was 48 inches in diameter and 11 feet long. No license was given in this case.

Another applicant averred that the boiler he was running "was 24 feet high, eight inches in diameter, and had a three-foot square grate under it." This boiler proved to be about ten feet high and forty inches in diameter.

In one place where there was a battery of five boilers, the steam gauges were found indicating all the way from 38 to 100 pounds, when the pressure on the boilers was about 80 pounds. Many other instances of gross ignorance and neglect might be cited, but the above are sufficient to show the alarming state of affairs which prevails in some places.

There is a town in Ohio called Tanktown, where there are nineteen 35,000-barrel tanks, with three more in course of erection, three more to be built soon, making a total tankage capacity of 875,000 barrels.

ANNEALING STEEL BOILERS.

A discovery of great importance to steamship and steamboat owners has recently been made by George V. Sloate, superintendent engineer of the old Dominion steamship line, New York. It is a well-known fact that steel plates forming the furnaces and connections of marine boilers, after a few years' use become crystallized, and crust to such an extent that in many cases they have to be renewed at great expense. By using Sloate's process of annealing about once every three years, the metal is fully restored to its normal condition, viz.: full strength, ductility and proper reduction of area when tested. This treatment will insure the furnaces and connections lasting as long as the boiler. Boilers, with the advantage of surface condensers, should, with proper management and care, give twenty years' actual service, with moderate cost for repairs. The furnaces of the steamships "Roanoke" and "Guyandotte," after five years' service, commenced to crack over the bridge walls to such an extent that the company had to renew two of them on each ship. Upon examination, it was found that the steel in the old furnaces had become crystallized, and was as brittle as cast iron; in fact, it resembled the latter more than the original steel. By heating it to a mild red heat, and afterward allowing it to cool off gradually, the apparently worn-out metal was restored to its original condition and tensile strength.

Thus it was, Mr. Sloate conceived the idea of heating and annealing it. The work of accomplishing this object is very simple. The boiler is emptied of water, all man-hole and hand-hole plates are put on, and the boiler is hermetically sealed. Before closing the furnace doors, a bridge wall is built up within 3 in. of the furnace all round. After this a form is made of boiler iron, 2 ft. less in diameter than the furnace, and about 3 ft. long. The space between is then filled with chemical or tinder dried wood, after which the ash pans are closed, and the fires lighted. When a red heat is reached, the dampers are closed, and all air excluded from furnaces. The fire burns slowly for from twenty-five to thirty hours, and, after all the wood is consumed, the furnace is allowed to cool off gradually. Upon opening the furnace, the steel is found to have become annealed and restored to its normal condition, without any injury to the boiler or loss of time to the ship. The boilers of the steamships "Seneca" and "Guyandotte" have undergone this treatment, thereby saving the owners the expense of repairing the furnaces.

THE FIREMAN AT SEA.

Among firemen there are, as might be expected, many varieties. There is usually a fresh supply every voyage, and their combinations are usually as varied as those of the kaleidoscope. Though selected of one apparent uniform quality, no sooner is the vessel fairly on her voyage than one will develop an unruly disposition, not only making all the others uncomfortable, but sometimes changing the character of the whole group, and making them difficult to manage. Then another falls ill, and it turns out that he was ill when he came, and, being unfit for work on shore, thought that he would make sure of his food and lodgings and medical attendance for a few weeks or months, with some pay at the end, taking his chance of whatever disagreeables might arise, in the knowledge that these could not be worse than if he were starving ashore. As firemen are not always of the most robust appearance, it would puzzle the best medical man to judge, when engaging them, who were or were not unfit for work by illness or laziness. Besides this, the most vigorous are frequently the most unmanageable. Though size and strength in an engineer may keep such men in order, yet ruling by physical strength is a poor way. Such an engineer, though obeyed with more apparent alacrity than another, is really worse served than those who regard the men as human, and not mere machines. There is a well authenticated case of a "second," who, finding complaints made by one of the men that he could not stand the heat of the fires, had the man lashed to the iron companion ladder in front of the opened fire doors. The victim died in consequence, but, a doctor being on board, the case was, it is said, entered in the log book as one of apoplexy, or some other natural cause, and the matter was hushed up. According to latest accounts, that "second" was still in the same employ. Strict discipline can be maintained by far better means than this.

It is often difficult to know what to do with a man who "lays up." In a case of real illness, he will meet sympathy, tempered, perhaps, with an occasional growl from those who are doing his work; but, when a man has purposely come aboard ill, his comforts must be of the scantiest and his medicines of the nastiest, or he will lie in his bunk all the voyage. One fireman, suspected of being a loafer, was summoned aft to receive his medicine, which was concocted entirely with a view to its being of specially atrocious flavor. He drank it calmly to the bottom, looked into the glass, and, seeing a few dregs left, drained these to the bottom; then, expressing his gratitude for the good he knew it was going to do him, walked feebly away, leaving the stewards in consternation at his hardihood. Engineers have to use their judgment in such cases, and sometimes must have a man driven to his work by physical force, or the threat of it; though, in one unfortunate instance, a man so driven died most inconveniently on the deck. Sometimes one of the men, envying the happy lot of the loafer in his bunk, will fall ill also, so that loafer No. 1 has to be driven forth to do the work of No. 2. Where such happens, it will almost certainly come to pass that the illness will go round all the men in rotation, one at a time, as if prearranged; thus, the one who set the ball rolling is forced to do his share of work till his turn comes around for well-earned repose. Soon after the writer went to sea, he mentioned to his chief that he was out of sorts. To his surprise, he heard that the chief was also ill; and, on narrating the coincidence to the "second," he discovered, to his disgust, that he was also similarly affected. The fact is, that at sea a man must work, whether well or ill, unless absolutely unfit for it.

Firemen are usually well in port, for there the drawbacks of a forecastle residence are more felt, and there is also the ever-present fear of being left behind in a foreign hospital. It can thus easily be seen that a fireman's lot is no bed of roses, and that his pay is well-earned. Though his pay exceeds that of a sailor, while his hardships may not be greater than those of his acquaintances who live and work on shore, when work is to be had, and though beneath both him and them are others yet worse off, yet an engineer should remember that the fireman is but weighted down a little lower than himself, by the same competition which is diminishing his own pay as well as the profits of the shipowner, sucking down wages and profits that rents may rise. Many of these firemen, in spite of all disadvantages, give promise of the highest qualities, only awaiting development.

In selecting firemen, those are especially to be avoided who parade their experience when applying for work. These are the sea-lawyers, dreaded of captains; or, rather, they are captain and engineer and steward, all in one. It is amusing to see one such, sitting in the center of a crowd of firemen and sailors, discoursing, with voluble tongue, of how this engineer or that captain acted in certain circumstances, and always to the disparagement of those he is under at the time. He narrates minutely how well they were provisioned in the last ship; for such a one always has found "the last ship" so full of perfection that one wonders why he ever left it.

Sailors and firemen, too, often have good cause to complain of their food, and grumble sometimes to the verge of mutiny by refusing to work with the strength which they have not derived from insufficient and bad food. They know that in many cases, unless they insist on getting "their whack," they will go short. Though there are many worthy and kind-hearted men among ship captains, yet the opposite being the rule, grumbling has also become the rule, and the men cannot always deny themselves the pleasure of complaining, even when well treated—like the man who was never happy unless he was miserable.

In one ship, where, as the story goes, the captain was determined to conquer by kindness, he had a goose cooked, and sent to the men at Christmas. Curiosity caused them to gather about the galley door to discuss the event, the conclusion being that there "must be something wrong with the —— goose, or it would not have been sent" to them. Such discontent throws light on all past and present relations in that and every other ship. On another similar occasion the captain was said to have sent a plum-pudding to his men. After consuming it, a deputation went aft to return thanks, and with the request that the next time a plum-pudding was sent to them, there might be more plums. With complaints of bad food, the engineers cannot directly deal. The men have to fight their own battle, and, as a rule, they are well able to do so. Of course, if they refuse to work in consequence of insufficient food, the question comes prominently to the front; but a captain will do much to avoid this. When a captain is acting fairly to his men, the most effective cure he can apply is to put them strictly on their legal allowance, stopping all extras. The threat of this will usually stop any unreasonable complaints.

With engineers or firemen in opposition to the powers that be, care must be taken to keep out of the log book, except their case is good. Once a formal complaint is laid before the captain, he has to "log" the offender, and this he dare not afterward erase. The log book, after each voyage, is scrutinized by the Board of Trade, and, so strict are they, that in one case, when a large blot had fallen on the page, the captain had to make a formal declaration that nothing was concealed by it. Only when other means fail, should a man be logged. It not only makes him reckless for the rest of the voyage, on the principle of being "as well hanged for a sheep as for a lamb," but the official investigation of the matter at home, leads to much trouble and delay, and its issue is uncertain. Once the voyage is over, many matters which seemed at the time to be of importance, sink into insignificance. Unless in very bad cases, there are many ways of punishing a man at sea without any formal trial ashore. In some cases an effective way is to turn the laugh of his fellows against an offender, such as, telling him that, as his knowledge is of a superior kind, you would be glad if he would take charge of the work himself. Such a request rarely fails to have a disconcerting effect, whether stated jocularly or with contempt.

The Board of Trade is the seafarer's best friend, whether he hail from the sooty or the tarry side of the ship. Argus-eyed, hundred-handed, its agents, the consuls, are in every port to redress wrongs and give assistance and advice of every kind to whoever applies for it, and none dare prevent such application. Though a captain and engineer may complain that it shows an undue partiality for firemen and sailors in order to display its supremacy, yet its influence is for good, and extends far beyond its visible limits, the dread of it preventing even an attempt at such oppression as was once openly practiced, for justice was tardy and uncertain in the days preceding the steamship and telegraph.

PRIESTMAN'S PETROLEUM ENGINE.

This new engine is described as follows: In a tank in the bed of the engine is placed the petroleum, which is forced through a pipe into a compartment where the oil is converted into a fine spray by means of a blast of air. The spray passes into a chamber, is rendered explosive, and, coming in contact with an electric spark — obtained from a small battery in the rear — motive power is at once supplied. In construction it is comparatively simple; it works with admirable regularity, and the piston requires no oiling, the petroleum vapor supplying necessary lubrication.

PROTECTION TO BOILER TUBES.

In order to prevent the rapid burning out of the front end of the boiler tubes, a corrugated shield or inner cover for each tube has been devised by two Americans. This shield, which may also be made with a plain surface, is to be applied in the end of each tube at the point of each connection with the fire-box of the boiler. It is removable, and can be easily replaced when destroyed.

OCEAN TONNAGE OF THE WORLD.

The losses on ocean transportation business have been large from marine disasters of late years, but the new tonnage to take its place has been in excess of that loss. The United Kingdom in 1887 turned out 130,000 tons new ships more than in 1886. The commerce of twelve principal maritime countries, entrances and clearances in tons, were 143,292,000 tons in 1875, against 209,853,000 in 1886, an increase within eleven years of 69,561,000 tons. The registered tonnage, sail and steam, of these twelve countries in 1875 was 13,432,000 tons, and in 1886, 15,793,000 tons, an increase of 2,361,000 tons from 1875 to 1886. The steam tonnage in 1875 was 2,879,000 tons against 5,720,000 tons in 1886, an increase of 2,841,000 tons from 1875 to 1886. This increase is estimated as being equal for work to be done to 8,523,000 tons of sail tonnage. The business done per ton of shipping employed in 1875 was 10 6-10 tons, against 13 3-10 tons in 1886. The rates of freight received in the last three years indicate that the tonnage is too large to make general investments in ships profitable. As between one year and the other, there may be a number of distributing influences coming into play, but as between four yearly periods, this cannot be the case to anything like the same extent. Average tonnage of the merchant navies of the principal maritime countries of Europe, 1878–85:

Countries.	1878–81. tons.	1882–85. tons.	Incr'se. 1882–85.	Decr'se. 1882–85.
United Kingdom.....	6,543,612	7,213,991	670,379	......
Norway..............	1,519,105	1,555,913	36,808	......
Sweden..............	534,917	523,425	....	11,482
Denmark.............	251,510	270,834	19,324	......
Germany.............	1,169,229	1,268,216	98,987	......
Holland.............	334,997	305,915	....	29,082
France..............	935,602	1,005,185	69,583	......
Italy...............	1,005,845	971,939	....	33,906
Totals..............	12,294,817	13,115,428	895,081	74,470

Total net increase 1882–85, 820,611.

The seven countries above named require an average of 420,000 tons of new tonnage to reconstitute removals and vessels wrecked or otherwise destroyed.

TO CLEAN SOLDER FROM OLD FILES.

To clean solder from old files, soak the file in raw muriatic acid for twenty-four hours, and you will have almost a new file.

THE MANAGEMENT OF FUEL.

The Scientific Commission has reported that of 5,000,000 tons of coal annually consumed in London, 3,000,000 are combusted, and 2,000,000 go off in smoke and gas to create fogs and injure health and property. Doubtless, a like inquiry into the waste of fuel in this country would result in substantially the same conclusion, especially where soft coal is used. Our housewives do not realize that of every five cords of wood they burn, one is literally thrown away, and so of coal, but such is the fact.

The process of combustion is continually going on within us and around us. It is simply the union of the oxygen of the air with substances for which it has affinity. In our body the oxygen unites with the waste tissues of the body, and produces heat without visible flame. The rusting of iron is combustion, flameless, and without sensible heat. Though the supply of oxygen is as exhaustless as the air, of which it forms one-fifth part, yet not a surplus atom of oxygen enters into the process of combustion. There are two compounds of oxygen with carbon. One atom of oxygen unites with one atom of carbon, or two atoms of oxygen unite with one atom of carbon. Never an atom and a half of oxygen with an atom and a half of carbon. The union of these two elements is exact, entire and always the same under all circumstances. All this is very elementary, but to those who have not studied chemistry, it may be entirely new, and a knowledge of these underlying facts is essential to an intelligent management of fuel. And it is to be hoped that progress will be made in this most important matter.

MAKING SASH WEIGHTS OUT OF TIN CANS.

The latest use for tin cans, and the chips from the tin shops, is the conversion of the material into sash weights. There is no secret about the process. The only thing is to have a proper sized furnace, and to get up a sufficient heat. The business has developed of late, but the manufacturers say the margin of profit is small. It costs more to melt the scraps than common iron. Chips ready for the furnace cost seven dollars a ton. The sash weights produced are of a superior quality. The business is, like the case of old rubber, an illustration of the use of waste material. The tin can companies, and other manufacturers of tin goods, formerly dumped hundreds of tons into space, but now these scraps are utilized, and the irrepressible small boy works the ash fields to his profit in companionship with the blithesome goat.

STEAM POWER OF THE WORLD.

Four-fifths of the engines now working in the world have been constructed during the last twenty-five years. France owns 49,590 stationary and locomotive boilers, 7,000 locomotives and 1,850 boats' boilers; Germany has 59,000 boilers, 10,000 locomotives and 1,700 ships' boilers; Austria, 12,000 boilers and 2,800 locomotives. The force equivalent to the working steam engines represents: In the United States 7,500,000 horse power, in England 7,000,000 horse power, in Germany 4,500,000, in France 3,000,000, and in Austria 1,500,000. In these figures the motive power of the locomotives is not included, whose number in all the world amounts to 105,000, representing a total of 3,000,000 horse power. Adding this amount to the other powers we obtain the total of 46,000,000 horse power. A steam horse power is equal to three actual horses' power; and a living horse is equal to seven men. The steam engines of the world represent, therefore, approximately the work of 1,000,000,000 men, or more than double the working population of the earth, whose total population amounts to 1,455,923,000 inhabitants. Steam has accordingly trebled man's working power, enabling him to economize his physical strength while attending to his intellectual development.

LOCOMOTIVE BOILER CONSTRUCTION.

Locomotive boiler construction has made some progress, especially in devices for burning inferior coals, such as dust and slack, and further improvements may be expected. It is in the fire-box and boiler that we look for the largest percentage of gain in the future. The average coal-burning boiler used upon American roads is at best not an economical device. The average amount of steam evaporated from a given amount of coal burned is usually, in a locomotive boiler, only one-half of what a perfect utilization of the heating properties of the coal should accomplish. It can be readily seen how large a margin there is for saving in this direction, and a little study of the principles of soft-coal burning should result in improved construction and increased economy. We expect the next twenty-five years to show as great an advance in this part of locomotive practice as the last quarter century has in other directions. The coal bill being one of the largest expenses upon a road, its reduction is a matter of much importance.

STEP BEARINGS FOR VERTICAL SHAFTS.

Probably no bearing around a steam plant demands so much attention from the engineer as the step bearing. They are invariably the source of much annoyance, and in many cases are the direct cause of costly stoppages to cool them off or make repairs. Yet, as important as bearings are, there is no part of millwrighting that has received so little attention from either builders or designers.

We find to-day the same designs as were made years ago; as important and simple as this thing is, coupled with the experience of those who have used them, few have ever written a line upon this subject.

The reason that step bearings give so much trouble, and seem to be almost incurable, is from the fact that they generally have to do about three times the work to the square inch that any other bearing performs, which naturally leaves the margin of safety a very small one for varying conditions. In large mills it is a common thing to find these steps carrying anywhere from six to seven hundred pounds to the square inch on their surfaces, and when we consider that the tendency of the revolving surface of the shaft is to throw the oil off at a tangent, we see very clearly that the slightest defect in the lubrication or any change of temperature, gives a hot box, which, when it does start, generally begins smoking before the mill can be brought to a standstill. In some cases, where the faces begin cutting before the shaft can be stopped, it is generally necessary to jack the whole shaft up and clean off the bottom, which, as every engineer and millwright knows, is a job to be avoided, especially when the mill is waiting to go ahead.

We have ourselves been in places where everything from plumbago down to castor oil was tried without avail.

We were called in to doctor such a case in a white lead works a few months ago, and take pleasure in submitting the remedy to our readers, as it may help some of them out of a bad job. The shaft in question was eight inches in diameter, and about fifty feet high; it was, like its brethren, a constant source of annoyance; everything had been tried, and smoke she would, sometimes firing the oil in the box. The remedy we employed was simple and effective; we had a number of thin plates of steel cut to the diameter of the shaft, nicely beveling the edges, and straightening them up, and placed them in a pile on the bottom of the box, and lowered the shaft down into the box on top of them, filled the box with a good bodied oil, and from that day to this that box has given no trouble, and runs as cool as any bearing in the mill. As will be seen at once, these plates are revolving sometimes with the shaft, and sometimes not, and, if one of them should stick to its neighbor, the next one to it will continue to revolve without extra friction, and so on; ultimately these plates become as smooth as glass, and receive a surface that the end of the shaft never will. Again, their elasticity enables them to conform to any change in position of the box itself.

In the ordinary way, unless the shaft is perfectly vertical with the face of the box, there is trouble from the start until the end of the shaft, or the bottom of the box, are so cut as to bring them face to face. We recommend this plan to our readers; it is a good one, and will seldom fail. Try it.

LOCOMOTIVES IN 1832 AND 1888.

The Baldwin Iron Works, of Philadelphia, in 1832 considered it a great feat that they had constructed an engine which could draw thirty tons on a level, and the papers of the day contained the following announcement:

NOTICE.—The locomotive engine built by M. W. Baldwin, of this city, will depart daily, when the weather is fair, with a train of passenger cars.

☞On rainy days horses will be attached.

Now the same works are constructing ten-wheeled consolidated locomotives for the Dom Pedro Railway, in Brazil, guaranteed to draw 3,600 tons, with no reservation as to "weather."

GOOD-BYE TO BELL ROPES.

An electrical contrivance has been successfully tried on the Boston & Maine Railroad, which dispenses with the old-fashioned bell rope for signaling the engineer. We understand that the Boston & Maine Company has made tests of several electrical devices, and has lately hit upon one which gave satisfaction. Two wires lead from a gong in the locomotive cab the whole length of the train forming a continuous open circuit. By closing this circuit at any point in the train, the engineer's gong is made to ring. Ordinary push buttons in one end of each car serve to close the circuit, enabling signaling to be done from any part of the train. Really, this system seems to be practically the same as the open circuit system of electric bells used in nearly all offices, manufacturing establishments and hotels.

ECONOMY OF HIGH STEAM PRESSURE.

Higher steam pressure being a matter of interest and discussion by railroad men at the present time, a few figures tending, perhaps, to settle doubts as to economy, or to modify extravagant ideas on the subject, may not be out of place. We will compare boilers carrying steam at 175 and 125 pounds above the atmospheric pressure, with five pounds back pressure on the exhaust in each case.

Authorities on the mechanical theory of heat give the efficiency of a perfect engine, $e = \frac{T - T_1}{T}$ where T represents the absolute temperature of the steam before doing its work and T_1 after. Absolute temperature means reckoning from the point where there are absolutely no heat vibrations. Experiments locate this point at 460° below zero, so, to reduce to absolute temperatures, add this figure to the readings of a common thermometer.

The temperature of steam at 175 pounds above the atmosphere is 378°, of 125 pounds 353°, and of 5 pounds 228°. Reducing to absolute temperatures and substituting in the above formula, we have:

For engines using steam at 175 pounds:

$$e = \frac{838 - 688}{838} = 0.1790$$

For engines using steam at 125 pounds:

$$e = \frac{813 - 688}{813} = 0.1537$$

Difference in favor of 175 pounds, .0253, or about 2½ per cent.

Say, engines using steam at 125 pounds burn, on an average, 150 tons of coal per month, or 1,800 tons per year. By using steam at 175 pounds, a saving would have been made of 45.54 tons per year. With coal at $1.90 per ton, this would have amounted to $86.53 per engine.

A railroad having 800 locomotives, on the average, would save $69,224 per year.

The efficiencies given above are for perfect engines, where there is no loss from radiation, imperfect expansion, friction, etc.; but the practicability of using them for ordinary engines is apparent, if the engines are supposed to be equally imperfect.

Actually, the economy will be still greater in favor of high pressure than these figures show, as a smaller cylinder for the same power can be used, and that means less area of condensation, and less friction at the piston head.

RISE AND PROGRESS OF STEAM NAVIGATION.

In fifty years steamships have increased in tonnage from 67,969 tons to 4,318,153 tons, while their proportion to the total registered tonnage of British ships has increased from 1 to 41 to 1 to 2.14. The first Cunarders were only 207 feet long and 34 feet 4 inches beam, while the first steamer which plied regularly between Liverpool and New York, the Royal William, measured only 175 feet in length. The steps by which the marine engine has developed have been, first, the screw propeller, then the introduction of iron and steel in the building of ships, then the increase of steam pressure in the boiler, then the adoption of surface condensation, followed by the use of compound and duplicate expansion cylinders, and a much larger increase in boiler pressure, rendered possible by the use of mild steel in the construction of boilers, have effected in all a reduction of 70 per cent. in the consumption of coal, and an increase of 110 per cent. in speed.

NEW TRANSATLANTIC STEAMER.

At the Glasgow Exhibition there is a model of a new steamer from Fairfield, and bearing a plate, stating that she has been "designed for the Guion Steamship Company, Limited," to sail between "Queenstown and New York in five days. Length, 560 feet; breadth, 63 feet; depth, 52 feet; tonnage, 11,500." She is a twin-screw steamer, has two masts and four funnels, her bridge being aft of the funnels, about 80 feet from the stern, while on the foremast is attached the "lookout's" post. We learn from a reliable source that the vessel has four decks, with accommodations for 1,000 first-class passengers, a few second-class passengers, and a large number of "thirds." She is divided into separate compartments by seventeen bulkheads, four of them for the boilers. These are sixteen in number, and double-ended. Aft of the boiler spaces will be two sets of triple-expansion engines to drive the twin screws. These engines will be of enormous power.

GOVERNMENT METAL TESTS.

The Navy Department has recently made a series of tests at Watertown, Mass., in order to determine the best metal to use for the screw propellers for the new war ships which are now being built. The results of these tests are given below in tabular form:

ALUMINUM BRONZE AND BRASS.

	Pounds Elastic limit.	Per cent. Elongation.	Pounds tensile strength per sq. in.
BRONZE COMPOSITION:			
Copper and 8 per cent. Al. and Si...	19,000	23.7	58,500
Copper and 10 per cent. Al. and Si..	33,000	3.2	68,000
Copper and 8½ per cent. Al. and Si.	18,000	26	61,000
Copper and 7½ per cent. Al. and Si.	19,000	9.3	52,000
Copper and 7 per cent. Al. and Si...	17,000	11.9	46,000
Copper and 8¾ per cent. Al. and Si..	24,000	13.3	66,500
Copper and 9 per cent. Al. and Si....	28,000	4.5	66,000
Copper and 10¼ per cent. Al. and Si.	33,000	3.6	72,500
BRASS COMPOSITION.			
Copper and 3⅓ Al., 33⅓ per cent. Zn.	55,000	1.6	70,000
Copper and 3⅓ Al., 33⅓ per cent. Zn.	65,000	2.5	82,500

GOVERNMENT GUN BRONZE.

	Elastic limit.	Per cent. Elongation.	Pounds tensile strength per sq. in.
Copper 88, tin 10, zinc 2, per cent....	9,000	1.5	18,000
Copper 88, tin 10, zinc 2, per cent....	10,000	2.	18,000
Copper 88, tin 10, zinc 2, per cent....	13,000	3.	20,000
Copper 88, tin 10, zinc 2, per cent....	11,000	5.	22,500
Copper 88, tin 10, zinc 2, per cent....	13,000	1.5	23,000
Copper 88, tin 10, zinc 2, per cent ...	10,000	3.5	19,000

All bars were 22 inches in length by 1⅞ inches in diameter, and 10 inches or 15 inches between elongation marks. The government gun bronze is the material that has been used universally in both the army and navy departments in the construction of all bronze cannon, propeller wheels, gun carriages, etc., for the past fifty years. The Watertown testing machine is the most powerful and accurate machine for testing the physical characteristics of material, such as strength, toughness, malleability, ductility, hardness, etc., and these tests on bronze are the most severe and thorough ever made on brass and bronze anywhere, the bars being of extraordinary size and simple castings. The metal was only worked enough to get it into proper shape for accurate measurement, and had not been forged, rolled or drawn in any manner. These tests were made under the personal direction of Assistant Engineer in Chief Harris, of the bureau of steam engineering and construction of the navy department.

A MAN WHO KNEW JAMES WATT.

Many will be surprised to hear that a man who knew James Watt lived to see the dawn of the present year. This gentleman, Mr. Thomas Lockhart, who recently died in Glasgow, at the age of 97, had literally in a lifetime seen the virtual birth of the steam engine, and had witnessed its marvelous growth and the corresponding advance in all branches of mechanical engineering. The startling nature of this rapid progress is well illustrated by a remark in a letter of James Watt, where he observes that he had just made a piston that fitted the cylinder so truly that a half-crown could hardly be inserted between them at any point of the bore. As this coin is larger than a silver half dollar, the accuracy of workmanship in those days seems to belong to another age. And yet it has been compassed in the lifetime of one old man. It is said that Mr. Lockhart preserved a vivid impression of the great inventor, and was always pleased to recall the circumstances which brought them together.

A NEW STEAM GENERATOR.

A new steam generator in England is arousing a great deal of interest because of its great efficiency. It is run on the pressure instead of the draft principle. This obviates the expensive tall chimneys and costly methods of firing now in use. It is simply done by forcing an increased amount of air into the fuel.

THE WORKING STRENGTH OF BOILERS.

The increase in the working pressure of steam boilers is becoming so general that our boiler-makers will do well to make sure that the old rules for construction are fully applicable to the new constitutions.

Is it not time that there was a reconsideration of the whole subject of boiler pressures? As at present worked, steam boilers are constructed in a wastefully extravagant manner, and practice, as exemplified by the allowances of the boiler insurance companies, makes little or no difference in pressure allowance between a good boiler and a bad one. A steam boiler is either of iron or of steel in their eyes, and is calculated accordingly. Whatever may be the quality of the steel and its tenacity, the boiler made from it is simply a steel boiler, and generally too little attention is given to distinguishing a good from a poor boiler. As a consequence, all boilers are treated as though of poor quality, and their pressure allowed accordingly. A common allowance is

$$P = \frac{13\frac{1}{2} \times 1{,}344 \times t''}{D.''}$$

t and D being in inches and the boiler double riveted. When American practice is considered, this appears a very small allowance indeed. In some instances the United States Government rules allow of a working pressure higher than the hydraulic test pressure customary with us. The higher American limits are decidedly unsafe. Still, American practice may teach us that our own boilers might safely be trusted to carry higher steam. Whatever may be said of the superiority of American iron, there cannot be claimed any superiority for their boiler steel. I think, therefore, that the working allowance should be materially increased and would suggest $P = \frac{20{,}000t}{D}$ as no way excessive for a boiler well made of a 27-ton steel of suitable ductility. This would give 111 lbs. for a standard ½ in. Lancashire boiler 7½ ft. in diameter. For such a boiler the United States rules would allow 134 lbs., whilst for a cargo boat on the Mississippi 140 lbs. would be allowed, and it does not appear, in this latter example, that the seams need be other than *single* riveted! Scores of boilers have been removed of late years in Lancashire to make room for others a fourth stronger, which in America would be deemed amply strong for the enhanced pressure Is not this excessive caution a tax on our manufacturers from which they ought to be exempt? High factors of safety were all very well at one time when so little was really known of the actual strength of metallic structure, but with the proved greater capacity of resisting steady as compared with a variable load, a steam boiler, above all other structures, may be stressed with safety nearly to the elastic resistance of the material of which it is made.

TRANSMISSION OF POWER BY WIRE ROPES.

The size of rope and size and speed of wheels required to obtain any amount of power.

Diam of wh'l in ft	No. of revolutions.	Diam. of rope.	Horse power.	Diam of wh'l in ft	No of revolu'ts	Diam of rope.	Horse power.
4	80	3/8	3.3	10	80	11-16	58.4
	100	3/8	4.1		100	11-16	73.
	120	3/8	5.		120	11-16	87.6
	140	3/8	5.8		140	11-16	102.2
5	80	7-16	6.9	11	80	11-16	75.5
	100	7-16	8.6		100	11-16	94.4
	120	7-16	10.3		120	11-16	113.3
	140	7-16	12.1		140	11-16	132.1
6	80	1/2	10.7	12	80	3/4	99.3
	100	1/2	13.4		100	3/4	124 1
	120	1/2	16.1		120	3/4	148.9
	140	1/2	18.7		140	3/4	173.7
7	80	9-16	16.9	13	80	3/4	122.6
	100	9-16	21.1		100	3/4	153.2
	120	9-16	25.3		120	3/4	183.9
8	80	5/8	22.	14	80	7/8	148.
	100	5/8	27.5		100	7/8	185.
	120	5/8	33.		120	7/8	222
9	80	5/8	41.5	15	80	7/8	217.
	100	5/8	51.9		100	7/8	259.
	120	5/8	62.2		120	7/8	300.

U. S. AND FOREIGN MEASURES OF LENGTH COMPARED.

		U. S. Inches.
U. S. and British	Foot	12.
Amsterdam	"	11.144
Antwerp	Fuss	11.275
Austria	"	12.445
Belgium	Elle	39.371
Brazil	Cubit	25.98
Bremen	Fuss	11.38
Brunswick	" or Schuh	11.23
China	Chick (Commerce)	14.1
Denmark	Fod	12.357
Egypt	Derah	25.49
Florence	Braccio	22.98
Greece	Cubit	18.
India	"	18.
Japan	Fan	12.+
Mexico	Pie	11.28
Norway	Fod	12.353
Persia	Arish	38.27
Portugal	Foot	13.33
Prussia	Fuss	12.357
Rome	Pie (Commer)	11.592
Russia	Foot	13.75
Sardinia	Oucia	1.686
Sicily	Palmo	9.53
Spain	Foot	11.128
Sweden	Fot	33.384
Switzerland (B'e.)	Fuss	11.81
" (Geneva)	"	23.028
Turkey	Pic (Great)	27.9
Venice	Pie	13.68

INTERESTING FACTS ABOUT BOILERS.

When a boiler is made, it is next to impossible for any inspection to detect the quality of the iron. In the sharp competition for business, a great deal of poor iron gets into boilers. It is cheaper, and the boiler can be sold for less money, and, with the improved machinery for flanging, drilling, punching and riveting, the poor quality of the material cannot be detected. But when subjected to the conditions of use, the frequent repairs soon convince the purchaser that his cheap boiler is a very expensive one after all. "Homogeneous steel" is rapidly taking the place of wrought-iron for boiler construction. It is only a few years since this material was thought fit for such use. Its early behavior was quite unsatisfactory, and provoked no little discussion, but, with the improved methods of manufacture, it is becoming recognized as one of, if not the best material for boiler shells. Its ductility and homogeneity are greatly in its favor. These qualities adapt it to the strains caused by the varying conditions of heat, and, being rolled from an ingot, it is almost absolutely free from laminations, and consequently from blisters when subjected to heat. We have occasion to test specimens of steel of the different makers. The results of tests of twelve specimens from one maker recently made show tensile strength ranging from 58,210 to 64,329 lbs., with a reduction of area at point of fracture in the first instance of $58\frac{15}{100}$ per cent., and in the latter of $60\frac{65}{100}$ per cent. In another case where six tests were made, all from the same maker, the highest were 57,900 and 55,020 lbs., with a reduction of area for the former of $55\frac{4}{10}$ per cent., and for the latter of $58\frac{6}{10}$ per cent. Elongation in 8 inches, for the former $25\frac{6}{10}$ per cent., and for the latter $26\frac{1}{10}$ per cent. I regard these as remarkably good steels. We have the records of many other tests, but this will be sufficient to show how a good steel should behave under test. I will say here that the company which I represent has nearly 20,000 boilers under its care, among which are several thousands made of steel, and, as a whole, they are doing excellent service. We have watched them for several years under the conditions of use, which is the best test, and as a result I can confidently recommend *good* steel as an excellent material for boilers. But I will say here that there is a liability to get a cheap steel. Hence we are liable to have the same trouble that was spoken of in regard to iron. The only safe way is to secure pieces of coupons from the plates before the boiler is made, and subject them to test.

There has been considerable discussion in regard to the different methods of riveting boiler plates together, that is, as to which is best — hand-riveting or machine-riveting. I should say both may be very good and both may be very bad. Hand-riveting is so well understood that little need be said about it. In both, the size of rivet-hole and the rivet should be adapted to the thickness of plate. The most perfect joint is that where the strength of the net section of plate (after the holes are punched) is nearly equal to the shearing stress of the rivets. The usual method of laying out rivet holes for double riveted joints is to pitch them, or put them, apart from center to center 2 inches or 2½ inches. If a ¾-inch rivet is used, requiring a 13-16-inch hole, it will be found that so much of the plate has been cut away that the strength of the net section remaining will be only about half that of the shearing stress of the rivets. This is wrong; the rivets should have a wider pitch. To this, many boiler-makers will object, claiming that with wide pitches they cannot make a tight joint. The trouble probably is that the rivet holes are not laid out so as to come fair, hence a "drift-pin" must be used, and the plate becomes buckled and the joint leaks. If the work is well laid out and well done, there will be no trouble. A drift-pin should never be used to bring holes fair that ride one over the other. Suppose we wish to rivet a joint of 3/8-inch plates with 3/4-inch rivets; what should the pitch be? For a double-riveted joint, we would punch or drill the holes 13-16 of an inch in diameter, and pitch them from center to center 3 1/4 inches. We would also pitch the rivet lines 1 5/8 inches apart. This would give a strong joint and a tight joint if the work was well done.

Now about machine riveting. One of the great difficulties is the careless handling of material to be riveted. It is sometimes hung up by a rope or chain running over a pulley, and raised or lowered so as to bring the rivet holes in a line with the axis of the steam piston which drives the rivet. If the center of the hole and the axis of the driving piston do not coincide, the rivet will be imperfectly driven. In the better class of riveting machines, there are two pistons, one within the other. The outer one moves first, and holds the plate in place, and the other follows and drives the rivet. It is the careless way in which the work is done that has brought discredit on machine riveting. Much could be said on this subject, but time will not permit.

A NEW TYPE OF BOILER.

A new type of boiler has been subjected to tests that have given satisfactory results, on the passenger steamers plying on the river Seine, at Paris. The distinguishing feature of the boiler is, that it is composed of a series of inclined tubes, placed in groups of three each. These inclined tubes form a kind of triangular pyramid with a vertical base and a horizontal axis. At the apex, these three tubes are brought into communication with one another by entering a sort of box. At the base, they are inserted into the vertical sides of a chamber that is called the vertical collector, which receives the bases of six or eight of the pyramids, forming a series. Several of these series, put together, form a boiler.

HOW TO USE PETROLEUM FOR FUEL SAFELY.

The hazards attending the use of petroleum as fuel are largely of a controllable nature, and are dependent almost entirely upon the precautions taken in regard to its storage and use.

The tanks should be of iron, placed upon solid foundations, and fitted with tight covers provided with ventilating pipes for the removal of any vapor passing off from the oil.

The tanks should be situated where they will not constitute an exposure to the building in case of fire. It is very desirable that the main tank, at least, if not above ground, should be surrounded by a pike or embankment, inclosing a space sufficiently large to accommodate the whole contents of the tank without overflow.

There should be two tanks; the main tank being placed where it could receive the supply discharged from the tank cars by gravity, whence it may be pumped into the smaller or distributing tank which feeds the oil directly to the burners.

An overflow-pipe in the distributing tank should be placed so as to discharge any excess of oil back into the reservoir tank.

Pipes should be placed underground as far as possible; the various connections should be supplied with valves for cutting off the flow of oil when desired.

If the oil is admitted to the burners before a flame is placed in the furnace, flashes or explosions are almost sure to follow, and it is absolutely necessary for safety that a burning torch or other flame be placed in the furnace before the oil is let on to the burners.

The above requirements may be modified as needed, according to the circumstances pertaining to the use of oil fuel for metal working and other purposes.

COST OF COAL TO RAILROADS.

The coal bills of railroad companies amount to from 9 to 12 per cent. of the total operating expenses. It has been estimated that if this item of cost could be reduced one-half, net earnings could be considerably increased. It has been estimated that the locomotives of this country last year burned 24,000,000 tons of coal, of which only 3 per cent of actual power stored up in coal was utilized. Inventors are at work trying to devise some method by which the coal bills can be reduced one-half.

THE NEW ATLANTIC LINERS.

The greatest interest attaches to the new ships of the Inman Line, "City of New York" and "City of Paris." The first is already launched, and is the largest modern vessel afloat. She is 560 feet long, 63 feet beam, 43 feet deep, and 10,500 tons capacity; proportion of beam to length, 8.89.

The "City of New York" and her companion are to be propelled by twin screws. Twin screws have been adopted for war ships, and in several merchantmen, but none of the first-class Atlantic liners have double propellers. The propellers are supported by massive steel stays, each of which is a casting weighing 26 tons.

The machinery consists of two sets of engines of the three-crank triple-expansion type, having piston valves throughout, each set capable of exerting sufficient power to propel the vessel at four-fifths of her maximum speed, so that, should one set break down, no serious delay will take place, for the vessel will go at a speed of sixteen knots instead of nineteen knots per hour. The dimensions of the engines and boilers must be omitted.

The auxiliary engines of the vessels number thirty-seven, the majority of which are driven by hydraulic power. For hoisting cargo, hydraulic machinery is supplied. The rattle of steam winches will be absent, and those who have tried to sleep on board a steamer the night before departure will appreciate this change. Hoists for many other purposes are fitted in vessels, such as lifting food from the galleys to the pantries, the stores from the store-room to the galleys, the engineers and firemen from the bottom of the vessel to the different levels on which they are to work, and the ashes are also hoisted from the boiler-rooms to the main deck, and put through a tube to the sea without any noise. In all there are ten hydraulic hoists and twelve hydraulic derricks. The steering of the vessels is also effected by hydraulic power, actuated by a powerful ram capable of developing a thrust of eighty tons.

The rudder fitted to these vessels is of a novel description recently patented by Messrs. Thomas & Biles. It has been designed in the first place for use in war ships, where it is a vital consideration to keep the whole of the steering gear below water. The rudder is formed so as to be a continuation of the lines of the vessel. It is a structure built up of steel plates and angle bars, and of sufficient strength to resist the heavy strains that will come upon it on account of its large area of 250 square feet, a surface greater than has yet been adopted even in ships of war. The strains upon the rudder and steering gear will, however, be greatly reduced on account of a part of the surface being on the forward side of the axis of the pintles. The machinery for turning this rudder is on the hydraulic principle, and consists essentially of two hydraulic rams, which are placed one on each side of an ordinary tiller. The plungers of these rams work at right angles to the tiller, and are connected to a block which can slide backward and forward upon the arm of the tiller. Thus, while the rams have a simple reciprocating motion, the tiller has a corresponding angular motion, which is transmitted to the rudder by a massive connecting-rod connected by a simple pin joint to a short tiller on the rudder head. In designing the steering arrangements for these vessels, it has been considered desirable to make them thoroughly efficient for war purposes.

THE MARINE BRAKE.

A marine brake has been invented by M. Pagan, and was recently tested on the Seine. It consists of a cable having attached to it a series of canvas cones which open out by the action of the water, and exert an enormous retarding force on the vessel. Thus the steamer Corsaire, running at a speed of thirteen knots, was stopped by this appliance in seven seconds, thirty-four seconds being required when she stopped by reversing the engines without making use of the brake.

ECONOMICAL LUBRICATORS—1. India rubber, 2 lbs.; dissolved in spirrits turpentine; common soda, 5 lbs.; glue, ½ lb.; water, 5 gals.; oil, 5 gals. Dissolve the soda and glue in the water by heat, add the oil, and then the dissolved rubber.

2. *To Lessen Friction in Machinery*—Grind together black lead with four times its weight of lard or tallow. Camphor is sometimes added, 7 lbs to the hundred weight.

3. *Anti-Friction Grease*—Tallow, 50 lbs.; palm oil, 35 lbs.; boil together; when cooled to 80°, strain through a sieve, and mix with 14 lbs. soda and 3 gals. water.

4. *Booth's Rail-way Axle Grease*—Water, 1 gal.; clean tallow, 3 lbs.; palmoil, 6 lbs; common soda ½ lb.; or tallow 2 lbs.; palm oil, 10 lbs. Heat to about 212°, and stir well until it cools to 70°.

5. *Drill Lubricator*—For wrought iron, use 1 lb. soft soap mixed with one gal. of boiling water.

WEIGHT AND AREAS OF

SQUARE & ROUND BARS OF WROUGHT IRON

And Circumference of Round Bars.

One cubic foot weighing 480 lbs.

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long.	Weight of ○ Bar One Foot long	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar in inches.
0					
1/16	.013	.010	.0039	.0031	.1963
1/8	.052	.041	.0156	.0123	.3927
3/16	.117	.092	.0352	.0276	.5890
1/4	.208	.164	.0625	.0491	.7854
5/16	.326	.256	.0977	.0767	.9817
3/8	.469	.368	.1406	.1104	1.1781
7/16	.638	.501	.1914	.1503	1.3744
1/2	.833	.654	.2500	.1963	1.5708
9/16	1.055	.828	.3164	.2485	1.7671
5/8	1.302	1.023	.3906	.3068	1.9635
11/16	1.576	1.237	.4727	.3712	2 1598
3/4	1.875	1.473	.5625	.4418	2 3562
13/16	2.201	1.728	.6602	.5185	2.5525
7/8	2.552	2.004	.7656	.6013	2.7489
15/16	2.930	2.301	.8789	.6903	2.9452
1	3.333	2.618	1.0000	.7854	3.1416
1/16	3.763	2.955	1.1289	.8866	3.3379
1/8	4.219	3.313	1.2656	.9940	3 5343
3/16	4.701	3.692	1.4102	1 1075	3.7306
1/4	5.208	4.091	1.5625	1.2272	3.9270
5/16	5.742	4.510	1.7227	1.3530	4.1233
3/8	6.302	4.950	1.8906	1.4849	4.3197
7/16	6.888	5.410	2.0664	1.6230	4.5160
1/2	7.500	5.890	2.2500	1 7671	4 7124
9/16	8.138	6.392	2.4414	1.9175	4.9087
5/8	8.802	6.913	2.6406	2.0739	5.1051
11/16	9.492	7.455	2.8477	2.2365	5.3014
3/4	10.21	8.018	3.0625	2.4053	5.4978
13/16	10.95	8.601	3.2852	2.5802	5.6941
7/8	11.72	9.204	3.5156	2.7612	5.8905
15/16	12.51	9.828	3.7539	2.9483	6.0868

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long.	Weight of ○ Bar One Foot long.	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar in inches.
2	13.33	10.47	4.0000	3.1416	6.2832
1/16	14.18	11.14	4.2539	3.3410	6.4795
1/8	15.05	11.82	4.5156	3.5466	6.6759
3/16	15.95	12.53	4.7852	3.7583	6.8722
1/4	16.88	13.25	5.0625	3.9761	7.0686
5/16	17.83	14.00	5.3477	4.2000	7.2649
3/8	18.80	14.77	5.6406	4.4301	7.4613
7/16	19.80	15.55	5.9414	4.6664	7.6576
1/2	20.83	16.36	6.2500	4.9087	7.8540
9/16	21.89	17.19	6.5664	5.1572	8.0503
5/8	22.97	18.04	6.8906	5.4119	8.2467
11/16	24.08	18.91	7.2227	5.6727	8.4430
3/4	25.21	19.80	7.5625	5.9396	8.6394
13/16	26.37	20.71	7.9102	6.2126	8.8357
7/8	27.55	21.64	8.2656	6.4918	9.0321
15/16	28.76	22.59	8.6289	6.7771	9.2284
3	30.00	23.56	9.0000	7.0686	9.4248
1/16	31.26	24.55	9.3789	7.3662	9.6211
1/8	32.55	25.57	9.7656	7.6699	9.8175
3/16	33.87	26.60	10.160	7.9798	10.014
1/4	35.21	27.65	10.563	8.2958	10.210
5/16	36.58	28.73	10.973	8.6179	10.407
3/8	37.97	29.82	11.391	8.9462	10.603
7/16	39.39	30.94	11.816	9.2806	10.799
1/2	40.83	32.07	12.250	9.6211	10.996
9/16	42.30	33.23	12.691	9.9678	11.192
5/8	43.80	34.40	13.141	10.321	11.388
11/16	45.33	35.60	13.598	10.680	11.585
3/4	46.88	36.82	14.063	11.045	11.781
13/16	48.45	38.05	14.535	11.416	11.977
7/8	50.05	39.31	15.016	11.793	12.174
15/16	51.68	40.59	15.504	12.177	12.370

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long.	Weight of ○ Bar One Foot long.	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar in inches.
4	53.33	41.89	16.000	12.566	12.566
1/16	55.01	43.21	16.504	12.962	12.763
1/8	56.72	44.55	17.016	13.364	12.959
3/16	58.45	45.91	17.535	13.772	13.155
1/4	60.21	47.29	18.063	14.186	13.352
5/16	61.99	48.69	18.598	14.607	13.548
3/8	63.80	50.11	19.141	15.033	13.744
7/16	65.64	51.55	19.691	15.466	13.941
1/2	67.50	53.01	20.250	15.904	14.137
9/16	69.39	54.50	20.816	16.349	14.334
5/8	71.30	56.00	21.391	16.800	14.530
11/16	73.24	57.52	21.973	17.257	14.726
3/4	75.21	59.07	22.563	17.721	14.923
13/16	77.20	60.63	23.160	18.190	15.119
7/8	79.22	62.22	23.766	18.665	15.315
15/16	81.26	63.82	24.379	19.147	15.512
5	83.33	65.45	25.000	19.635	15.708
1/16	85.43	67.10	25.629	20.129	15.904
1/8	87.55	68.76	26.266	20.629	16.101
3/16	89.70	70.45	26.910	21.135	16.297
1/4	91.88	72.16	27.563	21.648	16.493
5/16	94.08	73.89	28.223	22.166	16.690
3/8	96.30	75.64	28.891	22.691	16.886
7/16	98.55	77.40	29.566	23.221	17.082
1/2	100.8	79.19	30.250	23.758	17.279
9/16	103.1	81.00	30.941	24.301	17.475
5/8	105.5	82.83	31.641	24.850	17.671
11/16	107.8	84.69	32.348	25.406	17.868
3/4	110.2	86.56	33.063	25.967	18.064
13/16	112.6	88.45	33.785	26.535	18.261
7/8	115.1	90.36	34.516	27.109	18.457
15/16	117.5	92.29	35.254	27.688	18.653

SQUARE AND ROUND BARS.

(CONTINUED)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long.	Weight of ○ Bar One Foot long.	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar. in inches.
6	120.0	94.25	36.000	28.274	18.850
1/16	122.5	96.22	36.754	28.866	19.046
1/8	125.1	98.22	37.516	29.465	19.242
3/16	127.6	100.2	38.285	30.069	19.439
1/4	130.2	102.3	39.063	30.680	19.635
5/16	132.8	104.3	39.848	31.296	19.831
3/8	135.5	106.4	40.641	31.919	20.028
7/16	138.1	108.5	41.441	32.548	20.224
1/2	140.8	110.6	42.250	33.183	20.420
9/16	143.6	112.7	43.066	33.824	20.617
5/8	146.3	114.9	43.891	34.472	20.813
11/16	149.1	117.1	44.723	35.125	21.009
3/4	151.9	119.3	45.563	35.785	21.206
13/16	154.7	121.5	46.410	36.450	21.402
7/8	157.6	123.7	47.266	37.122	21.598
15/16	160.4	126.0	48.129	37.800	21.795
7	163.3	128.3	49.000	38.485	21.991
1/16	166.3	130.6	49.879	39.175	22.187
1/8	169.2	132.9	50.766	39.871	22.384
3/16	172.2	135.2	51.660	40.574	22.580
1/4	175.2	137.6	52.563	41.282	22.777
5/16	178.2	140.0	53.473	41.997	22.973
3/8	181.3	142.4	54.391	42.718	23.169
7/16	184.4	144.8	55.316	43.445	23.366
1/2	187.5	147.3	56.250	44.179	23.562
9/16	190.6	149.7	57.191	44.918	23.758
5/8	193.8	152.2	58.141	45.664	23.955
11/16	197.0	154.7	59.098	46.415	24.151
3/4	200.2	157.2	60.063	47.173	24.347
13/16	203.5	159.8	61.035	47.937	24.544
7/8	206.7	162.4	62.016	48.707	24.740
15/16	210.0	164.9	63.004	49.483	24.936

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long	Weight of ○ Bar One Foot long.	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar. in inches.
8	213.3	167.6	64.000	50.265	25.133
1/16	216.7	170.2	65.004	51.054	25.329
1/8	220.1	172.8	66.016	51.849	25.525
3/16	223.5	175.5	67.035	52.649	25.722
1/4	226.9	178.2	68.063	53.456	25.918
5/16	230.3	180.9	69.098	54.269	26.114
3/8	233.8	183.6	70.141	55.088	26.311
7/16	237.3	186.4	71.191	55.914	26.507
1/2	240.8	189.2	72.250	56.745	26.704
9/16	244.4	191.9	73.316	57.583	26.900
5/8	248.0	194.8	74.391	58.426	27.096
11/16	251.6	197.6	75.473	59.276	27.293
3/4	255.2	200.4	76.563	60.132	27.489
13/16	258.9	203.3	77.660	60.994	27.685
7/8	262.6	206.2	78.766	61.862	27.882
15/16	266.3	209.1	79.879	62.737	28.078
9	270.0	212.1	81.000	63.617	28.274
1/16	273.8	215.0	82.129	64.504	28.471
1/8	277.6	218.0	83.266	65.397	28.667
3/16	281.4	221.0	84.410	66.296	28.863
1/4	285.2	224.0	85.563	67.201	29.060
5/16	289.1	227.0	86.723	68.112	29.256
3/8	293.0	230.1	87.891	69.029	29.452
7/16	296.9	233.2	89.066	69.953	29.649
1/2	300.8	236.3	90.250	70.882	29.845
9/16	304.8	239.4	91.441	71.818	30.041
5/8	308.8	242.5	92.641	72.760	30.238
11/16	312.8	245.7	93.848	73.708	30.434
3/4	316.9	248.9	95.063	74.662	30.631
13/16	321.0	252.1	96.285	75.622	30.827
7/8	325.1	255.3	97.516	76.589	31.023
15/16	329.2	258.5	98.754	77.561	31.220

SQUARE AND ROUND BARS.

(CONUINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot long.	Weight of ○ Bar One Foot long.	Area of □ Bar in sq. inches.	Area of ○ Bar in sq. inches.	Circumference of ○ Bar in inches.
10	333.3	261.8	100.00	78.540	31.416
1/16	337.5	265.1	101.25	79.525	31.612
1/8	341.7	268.4	102.52	80.516	31.809
3/16	346.0	271.7	103.79	81.513	32.005
1/4	350.2	275.1	105.06	82.516	32.201
5/16	354.5	278.4	106.35	83.525	32.398
3/8	358.8	281.8	107.64	84.541	32.594
7/16	363.1	285.2	108.94	85.562	32.790
1/2	367.5	288.6	110.25	86.590	32.987
9/16	371.9	292.1	111.57	87.624	33.183
5/8	376.3	295.5	112.89	88.664	33.379
11/16	380.7	299.0	114.22	89.710	33.576
3/4	385.2	302.5	115.56	90.763	33.772
13/16	389.7	306.1	116.91	91.821	33.968
7/8	394.2	309.6	118.27	92.886	34.165
15/16	398.8	313.2	119.63	93.956	34.361
11	403.3	316.8	121.00	95.033	34.558
1/16	407.9	320.4	122.38	96.116	34.754
1/8	412.6	324.0	123.77	97,205	34.950
3/16	417.2	327.7	125.16	98.301	35.147
1/4	421.9	331.3	126.56	99.402	35.343
5/16	426.6	335.0	127.97	100.51	35.539
3/8	431.3	338.7	129.39	101.62	35.736
7/16	436.1	342.5	130.82	102.74	35.932
1/2	440.8	346.2	132.25	103.87	36.128
9/16	445.6	350.0	133.69	105.00	36.325
5/8	450.5	353.8	135.14	106.14	36.521
11/16	455.3	357.6	136.60	107.28	36.717
3/4	460.2	361.4	138.06	108.43	36.914
13/16	465.1	365.3	139.54	109.59	37.110
7/8	470.1	369.2	141.02	110.75	37.306
15/16	475.0	373.1	142.50	111.92	37,503

Weight of Sheets of Wrought Iron, Steel Copper and Brass. (From Haswell.)

Weight per Square Foot. Thickness by Birmingham Gauge.

No. of Gauge.	Thickness in inches.	Iron.	Steel.	Copper.	Brass.
0000	.454	18.22	18.46	20.57	19.43
000	.425	17.05	17.28	19.25	18.19
00	.38	15.25	15.45	17.21	16.26
0	.34	13.64	13.82	15.40	14.55
1	.3	12.04	12.20	13.59	12.84
2	.284	11.40	11.55	12.87	12.16
3	.259	10.39	10.53	11.73	11.09
4	.238	9.55	9.68	10.78	10.19
5	.22	8.83	8.95	9.97	9.42
6	.203	8.15	8.25	9.20	8.69
7	.18	7.22	7.32	8.15	7.70
8	.165	6.62	6.71	7.47	7.06
9	.148	5.94	6.02	6.70	6.33
10	.134	5.38	5.45	6.07	5.74
11	.12	4.82	4.88	5.44	5.14
12	.109	4.37	4.43	4.94	4.67
13	.095	3.81	3.86	4.30	4.07
14	.083	3.33	3.37	3.76	3.55
15	.072	2.89	2.93	3.26	3.08
16	.065	2.61	2.64	2.94	2.78
17	.058	2.33	2.36	2.63	2.48
18	.049	1.97	1.99	2.22	2.10
19	.042	1.69	1.71	1.90	1.80
20	.035	1.40	1.42	1.59	1.50
21	.032	1.28	1.30	1.45	1.37
22	.028	1.12	1.14	1.27	1.20
23	.025	1.00	1.02	1.13	1.07
24	.022	.883	.895	1.00	.942
25	.02	.803	.813	.906	.856
26	.018	.722	.732	.815	.770
27	.016	.642	.651	.725	.685
28	.014	.562	.569	.634	.599
29	.013	.522	.529	.589	.556
30	.012	.482	.488	.544	.514
31	.01	.401	.407	.453	.428
32	.009	.361	.366	.408	.385
33	.008	.321	.325	.362	.342
34	.007	.281	.285	.317	.300
35	.005	.201	.203	.227	.214
Specific Gravity,		7.704	7.806	8.698	8.218
Weight Cubic Foot,		481.25	487.75	543.6	513.6
" " Inch,		.2787	.2823	.3146	.2972

Weight of Sheets of Wrought Iron, Steel, Copper and Brass. From Haswell.

Weight per Square Foot. Thickness by American (Brown & Sharpe's) Gauge.

No. of Gauge.	Thickness in inches.	Iron.	Steel.	Copper.	Brass.
0000	.46	18.46	18.70	20.84	19.69
000	.4096	16.44	16.66	18.56	17.53
00	.3648	14.64	14.83	16.53	15.61
0	.3249	13.04	13.21	14.72	13.90
1	.2893	11.61	11.76	13.11	12.38
2	.2576	10.34	10.48	11.67	11.03
3	.2294	9.21	9.33	10.39	9.82
4	.2043	8.20	8.31	9.26	8.74
5	.1819	7.30	7.40	8.24	7.79
6	.1620	6.50	6.59	7.34	6.93
7	.1443	5.79	5.87	6.54	6.18
8	.1285	5.16	5.22	5.82	5.50
9	.1144	4.59	4.65	5.18	4.90
10	.1019	4.09	4.14	4.62	4.36
11	.0907	3.64	3.69	4.11	3.88
12	.0808	3.24	3.29	3.66	3.46
13	.0720	2.89	2.93	3.26	3.08
14	.0641	2.57	2.61	2.90	2.74
15	.0571	2.29	2.32	2.59	2.44
16	.0508	2.04	2.07	2.30	2.18
17	.0453	1.82	1.84	2.05	1.94
18	.0403	1.62	1.64	1.83	1.73
19	.0359	1.44	1.46	1.63	1.54
20	.0320	1.28	1.30	1.45	1.37
21	.0285	1.14	1.16	1.29	1.22
22	.0253	1.02	1.03	1.15	1.08
23	.0226	.906	.918	1.02	.966
24	.0201	.807	.817	.911	.860
25	.0179	.718	.728	.811	.766
26	.0159	.640	.648	.722	.682
27	.0142	.570	.577	.643	.608
28	.0126	.507	.514	.573	.541
29	.0113	.452	.458	.510	.482
30	.0100	.402	.408	.454	.429
31	.0089	.358	.363	.404	.382
32	.0080	.319	.323	.360	.340
33	.0071	.284	.288	.321	.303
34	.0063	.253	.256	.286	.270
35	.0056	.225	.228	.254	.240

WEIGHTS OF FLAT ROLLED IRON PER LINEAL FOOT.

For Thicknesses from 1-16 in. to 2 in., and Width from 1 in. to 12¾ in.

Iron weighing 480 lbs. per cubic foot.

Thickness in Inches.	1″	1¼″	1½″	1¾″	2″	2¼″	2½″	2¾″	12″
1/16	.208	.260	.313	.365	.417	.469	.521	.573	2.50
1/8	.417	.521	.625	.729	.833	.938	1.04	1.15	5.00
3/16	.625	.781	.938	1.09	1.25	1.41	1.56	1.72	7.50
1/4	.833	1.04	1.25	1.46	1.67	1.88	2.08	2.29	10.00
5/16	1.04	1.30	1.56	1.82	2.08	2.34	2.60	2.86	12.50
3/8	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.44	15.00
7/16	1.46	1.82	2.19	2.55	2.92	3.28	3.65	4.01	17.50
1/2	1.67	2.08	2.50	2.92	3.33	3.75	4.17	4.58	20.00
9/16	1.88	2.34	2.81	3.28	3.75	4.22	4.69	5.16	22.50
5/8	2.08	2.60	3.13	3.65	4.17	4.69	5.21	5.73	25.00
11/16	2.29	2.86	3.44	4.01	4.58	5.16	5.73	6.30	27.50
3/4	2.50	3.13	3.75	4.38	5.00	5.63	6.25	6.88	30.00
13/16	2.71	3.39	4.06	4.74	5.42	6.09	6.77	7.45	32.50
7/8	2.92	3.65	4.38	5.10	5.83	6.56	7.29	8.02	35.00
15/16	3.13	3.91	4.69	5.47	6.25	7.03	7.81	8.59	37.50
1	3.33	4.17	5.00	5.83	6.67	7.50	8.33	9.17	40.00
1 1/16	3.54	4.43	5.31	6.20	7.08	7.97	8.85	9.74	42.50
1 1/8	3.75	4.69	5.63	6.56	7.50	8.44	9.38	10.31	45.00
1 3/16	3.96	4.95	5.94	6.93	7.92	8.91	9.90	10.89	47.50
1 1/4	4.17	5.21	6.25	7.29	8.33	9.38	10.42	11.46	50.00
1 5/16	4.37	5.47	6.56	7.66	8.75	9.84	10.94	12.03	52.50
1 3/8	4.58	5.73	6.88	8.02	9.17	10.31	11.46	12.60	55.00
1 7/16	4.79	5.99	7.19	8.39	9.58	10.78	11.98	13.18	57.50
1 1/2	5.00	6.25	7.50	8.75	10.00	11.25	12.50	13.75	60.00
1 9/16	5.21	6.51	7.81	9.11	10.42	11.72	13.02	14.32	62.50
1 5/8	5.42	6.77	8.13	9.48	10.83	12.19	13.54	14.90	65.00
1 11/16	5.63	7.03	8.44	9.84	11.25	12.66	14.06	15.47	67.50
1 3/4	5.83	7.29	8.75	10.21	11.67	13.13	14.58	16.04	70.00
1 13/16	6.04	7.55	9.06	10.57	12.08	13.59	15.10	16.61	72.50
1 7/8	6.25	7.81	9.38	10.94	12.50	14.06	15.63	17.19	75.00
1 15/16	6.46	8.07	9.69	11.30	12.92	14.53	16.15	17.76	77.50
2	6.67	8.33	10.00	11.67	13.33	15.00	16.67	18.33	80.00

WEIGHT OF FLAT ROLLED IRON PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	3″	3¼″	3½″	3¾″	4″	4¼″	4½″	4¾″	12″
1/16	.625	.677	.729	.781	.833	.885	.938	.990	2.50
1/8	1.25	1.35	1.46	1.56	1.67	1.77	1.88	1.98	5.00
3/16	1.88	2.03	2.19	2.34	2.50	2.66	2.81	2.97	7.50
1/4	2.50	2.71	2.92	3.13	3.33	3.54	3.75	3.96	10.00
5/16	3.13	3.39	3.65	3.91	4.17	4.43	4.69	4.95	12.50
3/8	3.75	4.06	4.38	4.69	5.00	5.31	5.63	5.94	15.00
7/16	4.38	4.74	5.10	5.47	5.83	6.20	6.56	6.93	17.50
1/2	5.00	5.42	5.83	6.25	6.67	7.08	7.50	7.92	20.00
9/16	5.63	6.09	6.56	7.03	7.50	7.97	8.44	8.91	22.50
5/8	6.25	6.77	7.29	7.81	8.33	8.85	9.38	9.90	25.00
11/16	6.88	7.45	8.02	8.59	9.17	9.74	10.31	10.89	27.50
3/4	7.50	8.13	8.75	9.38	10.00	10.63	11.25	11.88	30.00
13/16	8.13	8.80	9.48	10.16	10.83	11.51	12.19	12.86	32.50
7/8	8.75	9.48	10.21	10.94	11.67	12.40	13.13	13.85	35.00
15/16	9.38	10.16	10.94	11.72	12.50	13.28	14.06	14.84	37.50
1	10.00	10.83	11.67	12.50	13.33	14.17	15.00	15.83	40.00
1 1/16	10.63	11.51	12.40	13.28	14.17	15.05	15.94	16.82	42.50
1 1/8	11.25	12.19	13.13	14.06	15.00	15.94	16.88	17.81	45.00
1 3/16	11.88	12.86	13.85	14.84	15.83	16.82	17.81	18.80	47.50
1 1/4	12.50	13.54	14.58	15.63	16.67	17.71	18.75	19.79	50.00
1 5/16	13.13	14.22	15.31	16.41	17.50	18.59	19.69	20.78	52.50
1 3/8	13.75	14.90	16.04	17.19	18.33	19.48	20.63	21.77	55.00
1 7/16	14.38	15.57	16.77	17.97	19.17	20.36	21.56	22.76	57.50
1 1/2	15.00	16.25	17.50	18.75	20.00	21.25	22.50	23.75	60.00
1 9/16	15.63	16.93	18.23	19.53	20.83	22.14	23.44	24.74	62.50
1 5/8	16.25	17.60	18.96	20.31	21.67	23.02	24.38	25.73	65.00
1 11/16	16.88	18.28	19.69	21.09	22.50	23.91	25.31	26.72	67.50
1 3/4	17.50	18.96	20.42	21.88	23.33	24.79	26.25	27.71	70.00
1 13/16	18.13	19.64	21.15	22.66	24.17	25.68	27.19	28.70	72.50
1 7/8	18.75	20.31	21.88	23.44	25.00	26.56	28.13	29.69	75.00
1 15/16	19.38	20.99	22.60	24.22	25.83	27.45	29.06	30.68	77.50
2	20.00	21.67	23.33	25.00	26.67	28.33	30.00	31.67	80.00

WEIGHTS OF FLAT ROLLED IRON PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	5″	5¼″	5½″	5¾″	6″	6¼″	6½″	6¾″	12″
1/16	1.04	1.09	1.15	1.20	1.25	1.30	1.35	1.41	2.50
1/8	2.08	2.19	2.29	2.40	2.50	2.60	2.71	2.81	5.00
3/16	3.13	3.28	3.44	3.59	3.75	3.91	4.06	4.22	7.50
1/4	4.17	4.38	4.58	4.79	5.00	5.21	5.42	5.63	10.00
5/16	5.21	5.47	5.73	5 99	6.25	6.51	6.77	7.03	12.50
3/8	6.25	6.56	6.88	7.19	7.50	7.81	8.13	8.44	15.00
7/16	7.29	7.66	8.02	8.39	8.75	9.11	9.48	9.84	17.50
1/2	8.33	8.75	9.17	9.58	10.00	10.42	10.83	11.25	20.00
9/16	9.38	9.84	10.31	10 78	11.25	11.72	12.19	12.66	22.50
5/8	10.42	10.94	11.46	11 98	12.50	13.02	13.54	14.06	25.00
11/16	11.46	12.03	12.60	13.18	13.75	14.32	14.90	15.47	27.50
3/4	12.50	13.13	13.75	14.38	15.00	15.63	16.25	16.88	30.00
13/16	13.54	14.22	14 90	15.57	16.25	16.93	17.60	18.28	32.50
7/8	14.58	15.31	16.04	16.77	17.50	18.23	18.96	19.69	35.00
15/16	15.63	16.41	17.19	17.97	18.75	19.53	20.31	21.09	37.50
1	16.67	17.50	18.33	19.17	20.00	20.83	21.67	22.50	40.00
1 1/16	17.71	18.59	19.48	20.36	21.25	22.14	23.02	23.91	42.50
1 1/8	18.75	19.69	20.63	21.56	22.50	23.44	24.38	25.31	45.00
1 3/16	19.79	20.78	21.77	22.76	23.75	24.74	25.73	26.72	47.50
1 1/4	20.83	21.88	22.92	23.96	25.00	26.04	27.08	28.13	50.00
1 5/16	21.88	22.97	24.06	25.16	26.25	27.34	28.44	29.53	52.50
1 3/8	22.92	24.06	25.21	26.35	27.50	28.65	29.79	30.94	55.00
1 7/16	23.96	25.16	26.35	27.55	28.75	29.95	31.15	32.34	57.50
1 1/2	25.00	26.25	27.50	28.75	30.00	31.25	32.50	33.75	60.00
1 9/16	26.04	27.34	28.65	29.95	31.25	32.55	33.85	35.16	62.50
1 5/8	27.08	28.44	29.79	31.15	32.50	33.85	35.21	36.56	65.00
1 11/16	28.13	29.53	30.94	32.34	33.75	35.16	36.56	37.97	67.50
1 3/4	29.17	30.63	32.08	33.54	35.00	36.46	37.92	39.38	70.00
1 13/16	30.21	31.72	33.23	34.74	36.25	37 76	39.27	40.78	72.50
1 7/8	31.25	32.81	34.38	35.94	37.50	39.06	40.63	42.19	75.00
1 15/16	32.29	33.91	35.52	37.14	38 75	40.36	41.98	43.59	77.50
2	33.33	35.00	36.67	38.33	40.00	41.67	43.33	45.00	80.00

WEIGHTS OF FLAT ROLLED IRON PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	7″	7¼″	7½″	7¾″	8″	8¼″	8½″	8¾″	12″
1/16	1.46	1.51	1.56	1.61	1.67	1.72	1.77	1.82	2.50
1/8	2.92	3.02	3.13	3.23	3.33	3.44	3.54	3.65	5.00
3/16	4.38	4.53	4.69	4.84	5.00	5.16	5.31	5.47	7.50
1/4	5.83	6.04	6.25	6.46	6.67	6.88	7.08	7.29	10.00
5/16	7.29	7.55	7.81	8.07	8.33	8.59	8.85	9.11	12.50
3/8	8.75	9.06	9.38	9.69	10.00	10.31	10.63	10.94	15.00
7/16	10.21	10.57	10.94	11.30	11.67	12.03	12.40	12.76	17.50
1/2	11.67	12.08	12.50	12.92	13.33	13.75	14.17	14.58	20.00
9/16	13.13	13.59	14.06	14.53	15.00	15.47	15.94	16.41	22.50
5/8	14.58	15.10	15.63	16.15	16.67	17.19	17.71	18.23	25.00
11/16	16.04	16.61	17.19	17.76	18.33	18.91	19.48	20.05	27.50
3/4	17.50	18.13	18.75	19.38	20.00	20.63	21.25	21.88	30.00
13/16	18.96	19.64	20.31	20.99	21.67	22.34	23.02	23.70	32.50
7/8	20.42	21.15	21.88	22.60	23.33	24.06	24.79	25.52	35.00
15/16	21.88	22.66	23.44	24.22	25.00	25.78	26.56	27.34	37.50
1	23.33	24.17	25.00	25.83	26.67	27.50	28.33	29.17	40.00
1 1/16	24.79	25.68	26.56	27.45	28.33	29.22	30.10	30.99	42.50
1 1/8	26.25	27.19	28.13	29.06	30.00	30.94	31.88	32.81	45.00
1 3/16	27.71	28.70	29.69	30.68	31.67	32.66	33.65	34.64	47.50
1 1/4	29.17	30.21	31.25	32.29	33.33	34.38	35.42	36.46	50.00
1 5/16	30.62	31.72	32.81	33.91	35.00	36.09	37.19	38.28	52.50
1 3/8	32.08	33.23	34.38	35.52	36.67	37.81	38.96	40.10	55.00
1 7/16	33.54	34.74	35.94	37.14	38.33	39.53	40.73	41.93	57.50
1 1/2	35.00	36.25	37.50	38.75	40.00	41.25	42.50	43.75	60.00
1 9/16	36.46	37.76	39.06	40.36	41.67	42.97	44.27	45.57	62.50
1 5/8	37.92	39.27	40.63	41.98	43.33	44.69	46.04	47.40	65.00
1 11/16	39.38	40.78	42.19	43.59	45.00	46.41	47.81	49.22	67.50
1 3/4	40.83	42.29	43.75	45.21	46.67	48.13	49.58	51.04	70.00
1 13/16	42.29	43.80	45.31	46.82	48.33	49.84	51.35	52.86	72.50
1 7/8	43.75	45.31	46.88	48.44	50.00	51.56	53.13	54.69	75.00
1 15/16	45.21	46.82	48.44	50.05	51.67	53.28	54.90	56.51	77.50
2	46.67	48.33	50.00	51.67	53.33	55.00	56.67	58.33	80.00

WEIGHTS OF FLAT ROLLED IRON PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	9″	9¼″	9½″	9¾″	10″	10¼″	10½″	10¾″	12″
1/16	1.88	1.93	1.98	2.03	2.08	2.14	2.19	2.24	2.50
1/8	3.75	3.85	3.96	4.06	4.17	4.27	4.38	4.48	5.00
3/16	5.63	5.78	5.94	6.09	6.25	6.41	6.56	6.72	7.50
1/4	7.50	7.71	7.92	8.13	8.33	8.54	8.75	8.96	10.00
5/16	9.38	9.64	9.90	10.16	10.42	10.68	10.94	11.20	12.50
3/8	11.25	11.56	11.88	12.19	12.50	12.81	13.13	13.44	15.00
7/16	13.13	13.49	13.85	14.22	14.58	14.95	15.31	15.68	17.50
1/2	15.00	15.42	15.83	16.25	16.67	17.08	17.50	17.92	20.00
9/16	16.88	17.34	17.81	18.28	18.75	19.22	19.69	20.16	22.50
5/8	18.75	19.27	19.79	20.31	20.83	21.35	21.88	22.40	25.00
11/16	20.63	21.20	21.77	22.34	22.92	23.49	24.06	24.64	27.50
3/4	22.50	23.13	23.75	24.38	25.00	25.62	26.25	26.88	30.00
13/16	24.38	25.05	25.73	26.41	27.08	27.76	28.44	29.11	32.50
7/8	26.25	26.98	27.71	28.44	29.17	29.90	30.63	31.35	35.00
15/16	28.13	28.91	29.69	30.47	31.25	32.03	32.81	33.59	37.50
1	30.00	30.83	31.67	32.50	33.33	34.17	35.00	35.83	40.00
1 1/16	31.88	32.76	33.65	34.53	35.42	36.30	37.19	38.07	42.50
1 1/8	33.75	34.69	35.63	36.56	37.50	38.44	39.38	40.31	45.00
1 3/16	35.63	36.61	37.60	38.59	39.58	40.57	41.56	42.55	47.50
1 1/4	37.50	38.54	39.58	40.63	41.67	42.71	43.75	44.79	50.00
1 5/16	39.38	40.47	41.56	42.66	43.75	44.84	45.94	47.03	52.50
1 3/8	41.25	42.40	43.54	44.69	45.83	46.98	48.13	49.27	55.00
1 7/16	43.13	44.32	45.52	46.72	47.92	49.11	50.31	51.51	57.50
1 1/2	45.00	46.25	47.50	48.75	50.00	51.25	52.50	53.75	60.00
1 9/16	46.88	48.18	49.48	50.78	52.08	53.39	54.69	55.99	62.50
1 5/8	48.75	50.10	51.46	52.81	54.17	55.52	56.88	58.23	65.00
1 11/16	50.63	52.03	53.44	54.84	56.25	57.66	59.06	60.47	67.50
1 3/4	52.50	53.96	55.42	56.88	58.33	59.79	61.25	62.71	70.00
1 13/16	54.38	55.89	57.40	58.91	60.42	61.93	63.44	64.95	72.50
1 7/8	56.25	57.81	59.38	60.94	62.50	64.06	65.63	67.19	75.00
1 15/16	58.13	59.74	61.35	62.97	64.58	66.20	67.81	69.43	77.50
2	60.00	61.67	63.33	65.00	66.67	68.33	70.00	71.67	80.00

WEIGHTS OF FLAT ROLLED IRON PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	11"	11¼"	11½"	11¾"	12"	12¼"	12½"	12¾"
1/16	2.29	2.34	2.40	2.45	2.50	2.55	2.60	2.66
1/8	4.58	4.69	4.79	4.90	5.00	5.10	5.21	5.31
3/16	6.88	7.03	7.19	7.34	7.50	7.66	7.81	7.97
1/4	9.17	9.38	9.58	9.79	10.00	10.21	10.42	10.63
5/16	11.46	11.72	11.98	12.24	12.50	12.76	13.02	13.28
3/8	13.75	14.06	14.38	14.69	15.00	15.31	15.63	15.94
7/16	16.04	16.41	16.77	17.14	17.50	17.86	18.23	18.59
1/2	18.33	18.75	19.17	19.58	20.00	20.42	20.83	21.25
9/16	20.63	21.09	21.56	22.03	22.50	22.97	23.44	23.91
5/8	22.92	23.44	23.96	24.48	25.00	25.52	26.04	26.56
11/16	25.21	25.78	26.35	26.93	27.50	28.07	28.65	29.22
3/4	27.50	28.13	28.75	29.38	30.00	30.63	31.25	31.88
13/16	29.79	30.47	31.15	31.82	32.50	33.18	33.85	34.53
7/8	32.08	32.81	33.54	34.27	35.00	35.73	36.46	37.19
15/16	34.38	35.16	35.94	36.72	37.50	38.28	39.06	39.84
1	36.67	37.50	38.33	39.17	40.00	40.83	41.67	42.50
1 1/16	38.96	39.84	40.73	41.61	42.50	43.39	44.27	45.16
1 1/8	41.25	42.19	43.13	44.06	45.00	45.94	46.88	47.81
1 3/16	43.54	44.53	45.52	46.51	47.50	48.49	49.48	50.47
1 1/4	45.83	46.88	47.92	48.96	50.00	51.04	52.08	53.13
1 5/16	48.13	49.22	50.31	51.41	52.50	53.59	54.69	55.78
1 3/8	50.42	51.56	52.71	53.85	55.00	56.15	57.29	58.44
1 7/16	52.71	53.91	55.10	56.30	57.50	58.70	59.90	61.09
1 1/2	55.00	56.25	57.50	58.75	60.00	61.25	62.50	63.75
1 9/16	57.29	58.59	59.90	61.20	62.50	63.80	65.10	66.41
1 5/8	59.58	60.94	62.29	63.65	65.00	66.35	67.71	69.06
1 11/16	61.88	63.28	64.69	66.09	67.50	68.91	70.31	71.72
1 3/4	64.17	65.63	67.08	68.54	70.00	71.46	72.92	74.38
1 13/16	66.46	67.97	69.48	70.99	72.50	74.01	75.52	77.03
1 7/8	68.75	70.31	71.88	73.44	75.00	76.56	78.13	79.69
1 15/16	71.04	72.66	74.27	75.89	77.50	79.11	80.73	82.34
2	73.33	75.00	76.67	78.33	80.00	81.67	83.33	85.00

The weights for 12" width are repeated on each page to facilitate making the additions necessary to obtain the weights of plates wider than 12". Thus, to find the weight of 15¼" × ⅞", add the weights to be found in the same line for 3¼ × ⅞ and 12 × ⅞ = 9.48 + 35.00 = 44.48 lbs.

Weight of Rivets, and Round Headed Bolts Without Nuts, Per 100.

Length from under head. One cubic foot weighing 480 lbs.

Length. Inches.	3/8″ Dia.	1/2″ Dia.	5/8″ Dia.	3/4″ Dia.	7/8″ Dia.	1″ Dia.	1 1/8″ Dia.	1 1/4″ Dia.
1 1/4	5.4	12.6	21.5	28.7	43.1	65.3	91.5	123.
1 1/2	6.2	13.9	23.7	31 8	47.3	70.7	98.4	133.
1 3/4	6.9	15.3	25.8	34.9	51.4	76.2	105.	142.
2	7.7	16.6	27.9	37.9	55.6	81.6	112.	150.
2 1/4	8.5	18.0	30.0	41.0	59.8	87.1	119.	159.
2 1/2	9.2	19.4	32.2	44.1	63.0	92.5	126.	167.
2 3/4	10.0	20.7	34.3	47.1	68.1	98.0	133.	176.
3	10.8	22.1	36.4	50 2	72.3	103.	140.	184
3 1/4	11.5	23.5	38.6	53 3	76 5	109.	147.	193.
3 1/2	12.3	24.8	40 7	56 4	80 7	114.	154.	201.
3 3/4	13.1	26.2	42.8	59 4	84.8	120.	161.	210.
4	13.8	27.5	45.0	62.5	89.0	125.	167.	218.
4 1/4	14.6	28.9	47.1	65.6	93.2	131.	174	227.
4 1/2	15.4	30.3	49.2	68.6	97 4	136.	181.	236.
4 3/4	16.2	31.6	51.4	71.7	102.	142.	188.	244.
5	16.9	33.0	53.5	74.8	106.	147.	195.	253.
5 1/4	17.7	34.4	55.6	77.8	110.	153.	202.	261.
5 1/2	18.4	35.7	57.7	80.9	114.	158.	209.	270.
5 3/4	19.2	37.1	59.9	84.0	118.	163.	216.	278.
6	20.0	38.5	62.0	87.0	122.	169.	223.	287.
6 1/2	21.5	41.2	66.3	93.2	131.	180.	236.	304.
7	23.0	43.9	70.5	99 3	139.	191.	250	321.
7 1/2	24.6	46.6	74.8	106.	147.	202.	264.	338.
8	26.1	49.4	79.0	112.	156.	213.	278.	355.
8 1/2	27.6	52.1	83.3	118.	164.	223.	292.	372.
9	29.2	54.8	87.6	124.	173.	234.	306.	389.
9 1/2	30.7	57.6	91.8	130.	181	245.	319.	406.
10	32.2	60.3	96.1	136.	189.	256.	333.	423.
10 1/2	33.8	63.0	101.	142.	198.	267.	347.	440.
11	35.3	65.7	105.	148.	206.	278.	361.	457.
11 1/2	36.8	68.5	109.	155.	214.	289.	375.	474.
12	38.4	71.2	113.	161.	223.	300.	388.	491.
Heads.	1.8	5.7	10.9	13.4	22.2	38.0	57.0	82.0

WEIGHT OF CAST IRON PER LINEAL FOOT.—Example: What is weight of a cast iron plate 2″ x 14″ x one foot long? Ans.—The thickness multiplied by width equals 28″ of sectional area.

In the sixth column, we find that 87½ lbs. is the weight of a piece with a sectional area of 28″ and one foot long.

Area Inches.	Lbs.	Area Inches.	Lbs.	Area Inches.	Lbs.	Area Inches.	Lbs.	Area Inches.	Lbs.
1/16	.20	6	18.75	21½	67.19	43	134.38	69	215.63
⅛	.39	6¼	19.53	22	68.75	43½	135.94	70	218.75
3/16	.59	6½	20.31	22½	70.31	44	137.5	71	221.88
¼	.78	6¾	21.09	23	71.88	44½	139.06	72	225.0
5/16	.98	7	21.88	23½	73.44	45	140.63	73	228.13
⅜	1.17	7¼	22.66	24	75.00	45½	142.19	74	231.25
7/16	1.37	7½	23.44	24½	76.56	46	143.75	75	234.38
½	1.56	7¾	24.22	25	78.13	46½	145.31	76	237.5
9/16	1.76	8	25.00	25½	79.69	47	146.87	77	240.63
⅝	1.95	8¼	25.78	26	81.25	47½	148.44	78	243.75
11/16	2.15	8½	26.56	26½	82.81	48	150.00	79	249.87
¾	2.34	8¾	27.34	27	84.38	48½	151.56	80	250.00
13/16	2.54	9	28.13	27½	85.94	49	153.12	81	253.12
⅞	2.73	9¼	28.91	28	87.5	49½	154.69	82	256.25
15/16	2.93	9½	29.69	28½	89.06	50	156.25	83	259.38
1	3.125	9¾	30.47	29	90.63	50½	157.81	84	262.5
1⅛	3.51	10	31.25	29½	92.19	51	159.38	85	265.63
1¼	3.91	10¼	32.03	30	93.75	51½	160.94	86	268.75
1⅜	4.30	10½	32.81	30½	95.31	52	162.5	87	271.88
1½	4.69	10¾	33.59	31	96.87	52½	164.06	88	275.00
1⅝	5.08	11	34.38	31½	98.44	53	165.63	89	278.13
1¾	5.47	11¼	35.16	32	100.00	53½	167.19	90	281.25
1⅞	5.86	11½	35.94	32½	101.56	54	168.75	91	284.38
2	6.25	11¾	36.72	33	103.12	54½	170.31	92	287.5
2⅛	6.64	12	37.5	33½	104.69	55	171.88	93	290.66
2¼	7.03	12½	39.06	34	106.25	55½	173.44	94	293.75
2⅜	7.42	13	40.63	34½	107.81	56	175.00	95	296.87
2½	7.81	13½	42.19	35	109.38	56½	176.56	96	300.00
2⅝	8.20	14	43.75	35½	110.94	57	178.13	97	303.13
2¾	8.59	14½	45.31	36	112.5	57½	179.69	98	306.25
2⅞	8.98	15	46.87	36½	114.06	58	181.25	99	309.38
3	9.38	15½	48.44	37	115.63	58½	182.81	100	312.5
3¼	10.16	16	50.00	37½	117.19	59	184.38	101	315.63
3½	10.94	16½	51.56	38	118.75	59½	185.94	102	318.75
3¾	11.72	17	53.12	38½	120.31	60	187.5	103	322.88
4	12.5	17½	54.69	39	121.88	61	190.63	104	325.00
4¼	13.28	18	56.25	39½	123.44	62	193.75	105	328.13
4½	14.06	18½	57.81	40	125.00	63	196.87	106	331.25
4¾	14.84	19	59.38	40½	126.56	64	200.00	107	334.38
5	15.63	19½	60.94	41	128.13	65	203.125	108	337.5
5¼	16.41	20	62.5	41½	129.69	66	206.25	109	340.63
5½	17.19	20½	64.06	42	131.25	67	209.38	110	343.75
5¾	17.97	21	65.63	42½	132.81	68	212.5	111	346.87
								112	350.00

LINEAR EXPANSION OF SUBSTANCES BY HEAT.

To find the increase in the length of a bar of any material due to an increase of temperature, multiply the number of degrees of increase of temperature by the coefficient for 100 degrees and by the length of the bar, and divide by 100.

Name of Substance.	Coefficient for 100° Fahrenheit.	Coefficient for 180° Fahrenheit, or 100° Centigrade.
Baywood, (in the direction of the grain, dry,)	.00026 TO .00031	.00046 TO 00057
Brass, (cast,)	.00104	.00188
" (wire,)	.00107	.00193
Brick, (fire,)	.0003	.0005
Cement, (Roman,)	.0008	.0014
Copper,	.0009	.0017
Deal, (in the direction of the grain, dry,)	.00024	.00044
Glass, (English flint,)	.00045	.00081
" (French white lead,)	.00048	.00087
Gold,	.0008	.0015
Granite, (average,)	.00047	.00085
Iron, (cast,)	.0006	.0011
" (soft forged,)	.0007	.0012
" (wire,)	.0008	.0014
Lead,	.0016	.0029
Marble, (Carrara,)	.00036 TO .0006	.00065 TO .0011
Mercury,	.0033	.0060
Platinum,	.0005	.0009
Sandstone,	.0005 TO .0007	.0009 TO .0012
Silver,	.0011	.002
Slate, (Wales,)	.0006	.001
Water, (varies considerably with the temperature,)	.0086	.0155

Weight of Bolts per 100, Including Nuts.

Length.	DIAMETER.								
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
1¼	4.	7.	10.50	15.20	22.50	39.50			
1½	4.35	7.50	11.25	16.30	23.82	41.62			
2	4.75	8.	12.	17.40	25.15	43.75	69.		
2¼	5.15	8.50	12.75	18.50	26.47	45.88	72.		
2½	5.50	9.	13.50	19.60	27.80	48.	75.	116.50	
2¾	5.75	9.50	14.25	20.70	29.12	50.12	78.	121.75	
3	6.25	10.	15.	21.80	30.45	52.25	81.	126.	
3½	7.	11.	16.50	24.	33.10	56.50	87.	134.25	
4	7.75	12.	18.	26.20	35.75	60.75	93.10	142.50	207
4½	8.50	13.	19.50	28.40	38.40	65.	99.05	151.	218
5	9.25	14.	21.	30.60	41.05	69.25	105.20	159.55	229
5½	10.	15.	22.50	32.80	43.70	73.50	111.25	168.	240
6	10.75	16.	24.	35.	46.35	77.75	117.30	176.60	251
6½			25.50	37.20	49.	82.	123.35	185.	262
7			27.	39.40	51.65	86.25	129.40	193.65	273
7½			28.50	41.60	54.30	90.50	135.	202.	284
8			30.	43.80	59.60	94.75	141.50	210.70	295
9				46.	64.90	103.25	153.60	227.75	317
10				48.20	70.20	111.75	165 70	244.80	339
11				50.40	75.50	120.25	177.80	261.85	360
12				52.60	80 80	128.75	189.90	278.90	382
13					86.10	137 25	202	295 95	404
14					91.40	145.75	214.10	313.	426
15					96.70	154 25	226.20	330 05	448
16					102.	162.75	238.30	347.10	470
17					107.30	171.	250.40	364.15	492
18					112.60	179.50	262.60	381 20	514
19					117.90	188.	274.70	398.25	536
20					123.20	196.50	286.80	415.30	558

AMOUNT OF SUGAR IN COAL.

In a ton of coal, there is saccharine equal to that in 230 pounds of sugar. That is to say, there is $16 worth of sweetness in a ton of coal; but how to get it out, is the question.

Electricians are still at work on the problem of obtaining electricity direct from coal.

In four years the commercial efficiency of electrial machinery has been increased from 67 to 90 per cent., and the cost of a given current is not 25 per cent. of what it was a year ago.

Rivets, with countersunk heads, are used for fastening the thin plates of torpedo boats, the rivets being headed inside.

Canada takes nearly 2,000,000 tons of anthracite and bituminous coal each year.

ELECTRO-PLATING WITH NICKEL.

The following solution for electro-plating with nickel is used by several firms in Hainault: 500 grms. of nickel sulphate, 365 grms. of neutral ammonium tartrate, 2-5 grms. of tannin dissolved in ether, and 10 litres of water. 1½ litre of water is first added, and the mixture boiled for fifteen minutes; the remainder of the water is then added, and the whole filtered. The *Electrician* says: "Solution yields an even white deposit, which is not brittle, and the cost of which is hardly more than electro-plating with copper."

ELECTRO–PLATING WITH ALUMINUM.

The electro deposition of aluminum is attended with some practical difficulty. The following solution is said to give excellent results: Alum, 30 parts; water, 300 parts; aluminum chloride, 10 parts. The solution is heated to 200° F., and after cooling, 39 parts of potassium chloride are added.

Most of the industries of Germany are in operation on Sunday. In some factories the workmen, after they become too old to work, receive full pay, and in others half pay, the rest of their lives. In some factories the employés are insured for $500 and $250. Savings banks are also connected with many industries.

IN THE SHOP—TURNING A BALL.

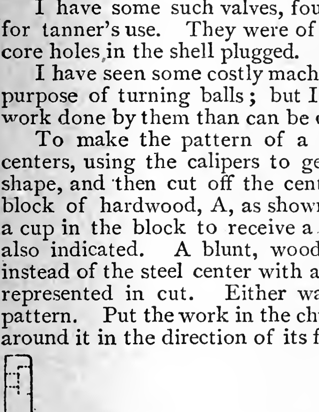
To make a ball as nearly perfect as a billiard ball is made, is not a piece of work that often falls to the lot of the machinist or pattern-maker ; but occasionally arises the necessity for such work.

In pumping where chips, sawdust, or dust is very liable to lodge on the seat under the valve, ball valves are sometimes used, because their rolling motion has a tendency to remove the obstruction, and let the valve seat fairly again. Some of the old-style locomotive pumps had ball valves; and, in tannery work, when small pieces of bark are liable to be in the liquid, ball valves can be used to advantage.

I have some such valves, four or five inches in diameter, for tanner's use. They were of brass, cast hollow, with the core holes in the shell plugged.

I have seen some costly machines which were made for the purpose of turning balls; but I have never seen any better work done by them than can be done in a common lathe.

To make the pattern of a ball, first turn the piece on centers, using the calipers to get it approximately near the shape, and then cut off the centers. Next make a chuck-block of hardwood, A, as shown in the cut, Fig. 1. Make a cup in the block to receive a small section of the ball, as also indicated. A blunt, wood center is sometimes used instead of the steel center with a concave piece of copper, as represented in cut. Either way will do for making the pattern. Put the work in the chuck so as to take the first cut around it in the direction of its former centers, or axis.



Cut lightly, and do not try to make a wide space—let it be only a narrow ribbon or turning—but get it round in the direction of present revolution ; then change the chuck so as to make another ribbon at right angles to the first, the first tool marks being the guide for the depth of the second cutting. Next change the work so as to get a ribbon between the other cuts, and continuing this process of changing and turning over the whole surface, thus making the axis of the pattern of equal length in all directions, and then the pattern will be round—it will be a ball. At first it might seem as if some laying off were needed to get the "ribbons," as I have called them, at right angles to each other, but there is no need of that; by the eye is enough.

When the machinist comes to finish up the casting, he can bolt the chuck-block to his face plate, and use his steel center and a concave piece of copper as represented in the cut. He will have to use a hand tool, or a scraper, after getting under the scale.

If the ball becomes too small for the cup in the block, it is an easy matter to make a new fit by cutting deeper into the chuck-block.

THE ACTION OF SEA-WATER ON CAST-IRON PILES.

Indiana Engineering notes the results of some observations made by the chief engineer of the B. B. and C. I. Railway on the cast-iron piles forming the piers of the South Bassien bridge. The piles were put down in 1862. Two were found almost as fresh in appearance as when sunk, and showed no corrosions in specimens cut from the metal. The deepest corrosion found on any pile was $\frac{3}{32}$ inch; and this corrosion was the greatest near low-water mark. The pile bolts were all in excellent condition. All of these piles have been exposed to the action of sea-water for about twenty-five years, and the examination was made to set aside a current suspicion that they were deteriorating under the action of the water.

JAPANESE WATER PIPES.

The water supply of Tokio, Japan, is by the wooden water pipe system, which has been in existence over two hundred years, furnishing at present a daily supply of from twenty-five to thirty million gallons. There are several types of water pipes in use, the principal class being built up with plank, square, and secured together by frames surrounding them at close intervals. The pipes, less than six inch, consist of bored logs, and somewhat larger ones are made by placing a cap on the top of a log in which a very large groove has been cut. All the connections are made by chamfered joints, and cracks are calked with an inner fibrous bark. Square boxes are used in various places to regulate the uniformity of the flow of the water, which is rather rapid, for the purpose of preventing aquatic growth. The water is not delivered to the houses, but into reservoirs on the sides of the streets, nearly 15,000 in number.

THE HEATING POWER OF FUEL.

The heating power of fuel is ascertained by the following process, which consists in burning one gramme of the coal or fuel in a small platinum crucible, supported on the bowl of a tobacco pipe, and covered by an inverted glass test tube, through which is passed a stream of oxygen, while the whole is placed under water in a glass vessel. The oxygen is fed into the test tube by a movable copper tube, which may be pushed into the test tube so as to come immediately over the crucible. The coals burn away in a few minutes with very intense heat, and the hot gases escape through the water, the bubbles being broken up by passing through sheets of wire gauze which stretch between the test tube and the walls of the vessel containing the water in which it is placed. The temperature of the water is taken before and after the experiment, and, from the figures thus obtained, the heating power of the coal is calculated.

THE DEVELOPMENT OF ELECTRICITY.

There are now about $6,000,000 invested in the manufacture of electric motors in the United States, and this large investment has nearly all been made within the last three or four years. It represents either the independent investment of companies engaged in the exclusive manufacture of motors, or an increase in the capitalization of companies that manufacture electric appliances, and find the construction of electric motors a good auxiliary industry. Some of these companies employ many hundred men, sometimes approaching a thousand, and they turn out motors almost innumerable each year. These motors are of all sizes, from one-half horse power, for driving sewing machines and such other light work, up to several hundred horse power for heavy work. They are becoming a driving force in almost every industry, and can be utilized in localities where the cost of obtaining fuel would almost equal their operating expenses. The chief secret of the rapid advance of this new mechanical agent is found in the flexibility of its resources. Electricity is not the generator of power, but only the agency for its transmission and distribution, as it is an agent for the transmission of the human voice over the telephone wire. Through its resources, power can be distributed to any point, and in quantities to suit the customer. Steam, water, air, caloric, or any known agency for generating power, is either stationary or it demands stationary appliances; but electricity is its messenger boy, its "Puck," who will consent to do its errands invisibly, and never ask a day off or the grant of liberty. Does a lady want an infinitesimal bit of electrical energy to relieve her boot on the treadle of her sewing machine, it can be delivered in her room through an iron box not much bigger than her reticule. Is the restaurant keeper plagued by an invasion of flies that expel all but the most hungry and least profitable customers, they can be gently wafted to the door by a multitude of revolving fans, and turned out either into the bright sunlight or the refreshing shower. Everywhere, anywhere, without a particle of dust, offensive odor or disagreeable noise, the electric motor can be set to work, and, while it will bring the substance of the thing wanted, it will leave behind everything that can give offense. The electric motor has passed its experimental stages, and the day seems to be rapidly approaching when every house will find something for it to do in lifting burdens from floor to floor, and performing every possible labor that can be done by machinery. Manufacturers have not yet begun to construct motors ornamented with gold leaf, mother of pearl, and precious stones, to rock cradles in the nurseries, but these requirements will come in time.

CHEMICAL OR PHYSICAL TESTS FOR STEEL.

Captain Jones, of the Edgar Thomson Steel Works, Pittsburg, was in Edinburgh at the meeting of the Union and Steel Institute, and, when invited to speak, said he could not let what Mr. Clark had said about the practice of punching steel plates in America pass without comment. Punching steel plates was a relic of barbarism, and there was an appropriateness about the president's suggestion, to "punch a man who punched a plate." As to the relative cost of punching and drilling, he had long since made up his mind about that, for many years ago, in constructing a roof, he had drilled all the holes and found it cheaper than punching. With regard to the use of steel in America, they found boiler-makers, bridge-makers and many others using it largely. They had started with physical tests, not chemical analysis, but they had come to the conclusion that physical tests could be met, and yet the metal not be what it should be. The test for boiler plates at the Edgar Thomson Works was higher than that demanded for the boiler plates of the United States cruisers, the limit for phosphorus being .035, and manganese, .350 per cent. He had seen steel made in America, where the heat had been blown for eight minutes, the manganese being put in cold, and he was of opinion that the reaction had not taken place up to the time of speaking. With regard to steel for bridge construction, he considered that not more than .065 per cent. of phosphorus should be present, and the manganese should be kept low, as that was the great oxidizing agent. He would like to see these conditions enforced by law. In conclusion he wished to impress on his hearers the necessity for judging steel by chemical tests first, and letting the physical tests be subsidiary to them.

SUGGESTIONS TO STEEL WORKERS.

Messrs. Miller, Metcalf & Parkin, of Pittsburgh, have issued a pamphlet on this subject. They draw attention to the following points:

Annealing—There is nothing gained by heating a piece of steel hotter than a bright cherry-red heat; on the contrary, a higher heat may render the steel harder on cooling than would be the case with the heat just mentioned. Besides this, the scale formed would be granular, and would spoil the tools to be used in working the metal, and the metal itself would change its structure, and become brittle.

Steel should never be left in a hot furnace over night, as the metal becomes too hot, and is spoilt for after treatment.

Forge Steel—The difficulty experienced in the forge fire is usually due more to uneven heat than to a high temperature. If heated too rapidly, the outside of the bar becomes soft, while the inside is still hard, and at too low a temperature for treatment.

In some cases a high heat is more desirable to save heavy labor; but in every case where a fine steel is to be used for cutting purposes, it must be borne in mind that every heavy forging refines the bars as they slowly cool, and, if the smith heats such refined bars until they are soft, he raises the grain, makes them coarse, and he cannot get them fine again, unless he has a very heavy steam hammer at command, and knows how to use it well.

When the steel is hot through, it should be taken from the fire immediately, and forged as quickly as possible. "Soaking" in the fire causes steel to become "dry" and brittle, and does it very great injury.

Temper—The word "temper," as used by the steelmaker, indicates the amount of carbon in steel; thus, steel of high temper, is steel containing much carbon; steel of low temper, is steel containing little carbon; steel of medium temper is steel containing carbon between these limits. Between the highest and the lowest, there are some twenty divisions, each representing a definite percentage of carbon.

The act of tempering steel is the act of giving to a piece of steel, after it has been shaped, the hardness necessary for the work it has to do. This is done by first hardening the piece—generally a good deal harder than is necessary—and then toughening it by slow heating and gradual softening until it is just right for work.

A piece of steel, properly tempered, should always be finer in grain than the bar from which it is made. If it is necessary, in order to make the piece as hard as is required, to heat it so hot that after being hardened it will be as coarse or coarser in grain than the bar, then the steel itself is of too low a temper for the desired purpose. In a case of this kind, the steelmaker should at once be notified of the fact, and could immediately correct the trouble by furnishing higher steel.

Heating—There are three distinct stages or times of heating:

First, for forging; second, for hardening; third, for tempering.

The first requisite for a good heat for forging is a clean fire, and plenty of fuel, so that jets of hot air will not strike the corners of the piece; next, the fire should be regular, and give a good uniform heat to the whole part to be forged. It should be keen enough to heat the piece as rapidly as possible, and allow it to be thoroughly heated through, without being so fierce as to overheat the corners. Steel should not be left in fire any longer than is necessary to heat it through; and, on the other hand, it is necessary that it should be hot through to prevent surface cracks, which are caused by the reduced cohesion of the overheated parts which overlie the colder central portion of an irregularly heated piece.

By observing these precautions, a piece of steel may always be heated safely up to even a bright yellow heat when there is much forging to be done on it, and at this heat it will weld well. The best and most economical of welding fluxes is clean, crude borax, which should be first throughly melted, and then ground to fine powder. Borax, prepared in this way, will not froth on the steel, and one-half of the usual quantity will do the work as well as the whole quantity unmelted.

After the steel is properly heated, it should be forged to shape as quickly as possible; and, just as the red heat is leaving the parts intended for cutting edges, these parts should be refined by rapid, light blows, continued until the red disappears.

For the second stage of heating, for hardening, great care should be used, first, to protect the cutting edges and working parts from heating more rapidly than the body of the piece; next, that the whole part to be hardened be heated uniformly through without any part becoming visibly hotter than the other. A uniform heat, as low as will give the required hardness, is the best for hardening. For every variation of heat which is great enough to be seen, there will result a variation in grain, which may be seen by breaking the piece; and for every variation in temperature, a crack is likely to be produced. Many a costly tool is ruined by inattention to this point. The effect of too high a heat is to open the grain — to make the steel coarse. The effect of an irregular heat is to cause irregular grain, irregular strains and cracks.

As soon as the piece is properly heated for hardening, it should be promptly and thoroughly quenched in plenty of the cooling medium — water, brine, or oil, as the case may be. An abundance of the cooling bath, to do the work quickly and uniformly all over, is very necessary to good and safe work; and to harden a large piece safely, a running stream should be used. Much uneven hardening is caused by the use of too small baths.

For the third stage of heating, to temper, the first important requisite is again uniformity; the next is time. The more slowly a piece is brought down to its temper, the better and safer is the operation. When expensive tools, such as taps, rose cutters, etc., are to be made, it is a wise precaution, and one easily taken, to try small pieces of the steel at different temperatures, so as to find out how low a heat will give the necessary hardness. The lowest heat is the best for any steel; the test costs nothing, takes very little time, and very often saves considerable loss.

SUCCESSFUL TESTS OF SHEFFIELD STEEL ARMOR PLATES.

The fourth of a series of trials of steel plates took place on board the Nettle, at Portsmouth, England, last week. The plate, which was manufactured by Messrs. Vickers, Sons & Company, Limited, River Don Works, Brightside, Sheffield, was of the dimensions and thickness prescribed for these tests, viz., 8 feet by 6, and 10½ inches thick. It was fired at by a six-inch diameter breech-loading gun, with a charge of 48 lbs. of powder and 100 lbs. shot. The first shot was a Holtzer hardened steel shot, the point of which penetrated as far as the wood backing, and was driven out again by the elasticity of the steel with such force that the shot stuck the bulkhead through which the gun was fired. Only slight cracks were made round the hole made by the projectile. The second shot, also a Holtzer, did not penetrate to the backing, as far as could be seen. It rebounded in the same way as the first one, and caused a slight crack at the top end of the plate. The third and fourth Palliser, 98 lb. cast-iron chilled shot, which went to pieces against the plate, only causing an extension of the crack made by the second shot; and the fifth shot, another Holtzer, was also sent back to the front, after making a slight penetration in the wood backing. These results are considered as very satisfactory by those who witnessed them, the target having resisted all the shots fired at it, and looking quite able to resist still further trial. The shot appeared to be of unusually good steel, as only one seemed seriously distorted by the work.

WATCH AND LEARN.

This is an excellent motto for every young man to adopt, and, by a close observance of it, it will prove of great value, even after he becomes grown up and starts out in business for himself. There is no surer way of gaining knowledge than by a careful and understanding watchfulness of others in the same line of business as yourself. As an apprentice, you cannot expect to know everything, and the best way to gain information from others is to show a willingness to learn; then they will take an interest in teaching. But if, as is too often the case, a young man, after he has been a few months in a place, pretends to know as much, and sometimes more, than those much older and more experienced than himself, he will not get much information from his fellow workmen; neither will he retain their good will for any length of time, and may expect to have all manner of practical jokes played upon him. As a journeyman, if you are intelligent, you will very often have occasion to believe that you do not know it all, and, in fact, the longer you live and the more you learn, the more you will find that there is to be learned. The egotistical and loud man is seldom a perfect man, and is generally very far from being as near perfection as he would have others think him. The person who, on a first acquaintance, is anxious to tell you what he knows, and is very free in giving advice and information without the asking, generally exhausts the supply before very long. He who is willing to listen is generally the one whose source of information is broader and of a more durable, valuable and substantial kind An example may prove the idea to be conveyed more clearly. An employer was in want of a good, practical and experienced man for a certain class of work. A young man applied for the position, who was very certain that he "knew all about the machine," and he was engaged. It was not long before every man in the shop knew all that he did, and one very valuable thing that he did not, and that was that he did not know all that he pretended to. His manner and braggadacio very soon got most of the men down on him. They were not disappointed. The new machine arrived, and was set up ready for operation. The young man was given a job to be worked off, and began operations with that self-conscious air of superiority that is generally apparent in characters of this description. One whole day he worked at the job, and it was not then in a condition to be run. Not only that, but he had shown to the men, who, of course, were secretly watching him, that he knew practically nothing of the machine. Then he began to lay the blame for the trouble upon others, and asked assistance and "points" from some of the other workmen. This of course he did not get, and finally another man was put on the job, and he was discharged amid the taunts and ridicule of the others. If the young man had shown good sense when he first came into the shop; not been quite so free to tell all he knew, and had shown a willingness to learn, there was not a man in the place that would not have gladly assisted him, and he might have remained in a good position. It sometimes pays to be ignorant, at least a little modesty is a good thing to take with you on going to a new place. If you know more than you pretend, it will soon be found out, and you will be the gainer; but, if you fail to make good your pretensions, not only your employer but all your fellow workmen will be "down on you," and things will be correspondingly unpleasant.

DEOXIDIZED COPPER.

The advantages to be obtained by the use of copper as nearly chemically pure as possible, are generally admitted, whether the metal be used as copper, or in the form of brass, bronze, or the many other alloys into which it enters. The Deoxidized Metal Company, of Bridgeport, Conn., claims that the desired result is secured by the process which is used in its works. The castings of brass, bronze, etc., made under this process, are most excellent, while the sheet copper and brass, and the wire made, when submitted to careful tests, show an unusually high degree of strength, copper wire having been tested up to 70,000 lbs. per square inch, tensile strength. The deoxidized metal also possesses the property of great resistance to acids, so that it can be used for many purposes where ordinary metal is soon destroyed by the chemical action. Journal-bearings made from this metal have also been tested with very favorable results, while for bells it is claimed that the tone and quality is much superior to ordinary brass.

HOW THE CHINESE DRILL WELLS.

The French Abbe Huc, lately returned from China, thus describes the system of deep-earth boring practiced in the district in which he has for some time resided. A wooden tube, six feet in length, is first driven down through the surface soil. This tube is held at the surface of the ground by a large flagstone, having a hole in the center to allow the tube to pass through and to project a little above it. A cylindrical mass of iron, weighing about 400 lbs., hollow and pointed at its lower end, and having lateral notches or apertures, is jerked up and down in this tube at the end of a lever, from which it is suspended by a rope. This kind of "monkey" disintegrates the rock, the debris of which, converted into sludge by water poured in, finds its way through the lateral apertures into the interior of the cylinder. By raising the latter at intervals this sludge is removed from the bore-hole. The rate of boring a rock of ordinary hardness is one foot in twelve hours. Only one man is employed at one time to work the lever. By this means wells of 1,800 feet deep are sunk in about two years by the labor of three men, relieving one another every six hours.

COKE AND SOFT COAL MIXED.

If coke and soft coal are mixed in equal proportions, it is said, the great heat of the coke will entirely consume the smoke of the soft coal, all of which passes off when coal is burned by itself. A little dry wood added to the fire occasionally will also effect some saving. Fuel thus used will be much more economical than either used separately.

HOW NON-MAGNETIZABLE WATCHES ARE MADE.

Non-magnetizable watches are made with springs of palladium in place of steel. This is a metal of the platinum group, and is absolutely non-polarizable and rust proof.

HOW TO LACQUER BRASS.

It is strange that not one druggist out of ten knows how to compound and put up a first-class lacquer, but depends entirely on the manufacturer, who, owing to the general lack of knowledge regarding the matter, often imposes upon their customers, sending a vastly inferior article. Again, not one customer in ten knows how to apply lacquer, and the druggist is blamed, when the user's ignorance is the cause of failure. Let both the dealer and the consumer keep the following constantly in mind when selling or using lacquer :

Remove the last vestige of oil or grease from the goods to be lacquered, and do not touch the work with the fingers. A pair of spring tongs or a taper stick in some of the holes is the best way of holding.

Heat the work sufficiently hot to cause the brush to smoke when applied, but do not make hot enough to harm the lacquer.

Fasten a small wire across the lacquer cup from side to side to scrape the brush on ; the latter should have the ends of the hairs trimmed exactly even with a pair of sharp scissors.

Scrape the brush as dry as possible on the wire, making a flat, smooth point at the same time.

Use the very tip of the brush to lacquer with, go very slow, and carry a steady hand.

Put on two coats at least. In order to make a very durable coat, blaze off with a spirit lamp or Bunsen burner, taking special pains not to burn the lacquer.

If the work looks gummy, the lacquer is too thick ; if prismatic colors show themselves, the lacquer is too thin. In the former case, add a little alcohol ; in the latter, place over the lamp, and evaporate to the desired consistency.

If the work is cheap, like lamp-burners, curtain fixtures, etc., the goods may be dipped. For this purpose use a bath of nitric acid, equal parts, plunge the goods in, hung on wire, for a moment, take out and rinse in cold water thoroughly, dip in hot water, the hotter the better, remove and put in alcohol, rinse thoroughly, and dip in lacquer, leaving in but a few minutes; shake vigorously to throw off all surplus lacquer, and lay in a warm place ; a warm metal plate is the best to dry. Do not touch till cool, and the job is done. Lacquered work should not be touched till cold ; it spoils the polish.

Sometimes drops will stand on the work, leaving a spot.

These drops are merely little globules of air, and can b avoided by shaking when taken out.

The best lacquer for brass is bleached shellac and alco hol; simply this, and nothing more.

In the preparation of goods for lacquering, care should b taken to polish gradually, *i. e.*, carefully graduate the fine ness of materials until the last or finest finish. Then, whe the final surface is attained, there will be no deep scratches for, of all things to be avoided in fine work, are deep scratch beneath a high polish.

THE REAL INVENTOR OF THE BESSEMER PRO CESS.

William C. Kelly, inventor of the Bessemer process o making steel, and who died recently in Louisville, Ky., was years ago, the proprietor of the Suanee Iron Works and Union Forge, in Lyon County, Ky. The metal produced at these works was taken from the furnace to the forge, where it was converted into charcoal blooms. These blooms had a great reputation for durability and quality, and were used principally for boiler plates and metal. It was while making the blooms at this place that Mr. Kelly made his great invention of converting iron into Bessemer steel, which Judge Kelly of Pennsylvania, at the Masonic Temple Theater last fall, termed the greatest invention of the age. The old process of making blooms was very expensive, owing to the great amount of charcoal required in its transformation, and Mr. Kelly conceived the idea of converting the metal into charcoal blooms without the use of fuel, by simply forcing powerful blasts of atmosphere up through the molten metal. His idea was that the oxygen of the air would unite with the carbon in the metal and thus produce combustion, refine the metal, and, by eliminating the carbon, wrought-iron or steel would be produced. When he announced his theory to his friends and to skilled iron workers, they scoffed, and were struck with astonishment that a man of Mr. Kelly's learning and practical iron-making knowledge would suggest such an idea as boiling metal without the use of fuel, and by simply blowing air through it.

His friends thought him demented, and discouraged him from wasting his time and money upon any such visionary scheme. Mr. Kelly was confident that his idea was a good one, and began making experiments, which he kept up with varying success for ten years, but the blooms were manufactured without the aid of fuel. It was generally known as

"Kelly's air boiling process," and was in daily use converting iron into blooms at his forge. Mr. Kelly's customers learned finally of the process, and, not understanding it, they advised him that they would not buy blooms made by any but the old and established method. This was the first difficulty placed in Mr. Kelly's way, and he was consequently compelled to carry on his work secretly, which subjected him to many disadvantages. Some English skilled workmen in Mr. Kelly's employ were familiar with his non-fuel process, and went back to England, taking the secret with them. Shortly after their arrival in Liverpool, Henry Bessemer, an English ironmaster, startled the iron world by announcing the discovery of the same process as Mr. Kelly's, and applied for patents in Great Britain and in the United States. Mr. Kelly at once made his application for a patent, and was granted one over Bessemer, the decision being that he was the first inventor and was entitled to the patent by priority.

The history of this remarkable invention is a lengthy one, and it is generally admitted by persons cognizant of the facts in the case that Bessemer's idea was secured from the English ironworkers employed by Mr. Kelly. Certain it is, however, that Mr. Kelly's invention and patents have heaped honors and wealth upon Bessemer, and he has been regarded as the greatest inventor of the nineteenth century, and the proper credit was always accorded him. Mr. Kelly's process was but barely successful until after it was perfected by Robert Musshult, a prominent English iron worker. Concerning the claims of the different persons, a prominent iron and steel manufacturer, the late James Park, of Pittsburg, once said: "The world will some day learn the truth, and in ages to come a wreath of fame will crown William Kelly, the true inventor, and that truth will never be effaced by time."

A NOVEL PLANING MACHINE.

A machine for planing the curved surfaces of propeller blades, so as to render them of uniform thickness and pitch, has been invented in England, and is herewith described. The principal feature is guiding and controlling the tool to travel on the curved surfaces, by a cast-iron former.

The machine is provided with two tables, which can be rotated through a given range by a worm-wheel and worm, so that the inclinations of both tables can be simultaneously varied, and to an equal degree. One of the tables carries a cast-iron copy of the back or front of the blade it is desired to produce, whilst on the other table the actual propeller is secured, one of its blades occupying a similar position on this table to that of the copy on the other.

To insure the rigidity of the work, the table on which the propeller is fixed has its upper surface shaped to correspond with the form of the blade on it, and is finally brought to the exact shape necessary by a coating of Portland cement. A cut 3/8 in. deep can be taken without springing the blade. The propeller is also held by being mounted on a duplicate of the propeller shaft, which is secured to the table. The cutting is done by a tool of the ordinary type, work being commenced at the top of the blade, and a self-acting traverse is used to feed the tool toward the boss.

The tool-holder is connected by a system of levers with a similar holder at the other end of the slide, carrying a follower, which moves over the copy, and thus guides the cutting tool. As the boss is approached, the inclination of the two tables to the horizontal is altered by the worm gear, so as to limit the necessary vertical motion of the tool. In this way all the blades of the propeller may be successfully machined, back and front, and will then be of identical form and thickness, and set at the same angle to the propeller shaft.

One of the propellers lately turned out by this machine was 6 ft. in diameter, with an increasing pitch, the mean of which was 7 ft. 9 in., the thickness in the center of the blades varying from 1/8 in. at the top to 1 in. at the boss. The breadth was 21 in., and the widest part and the cross section showed a regular taper from the center line to a knife-edge.

The importance of accuracy and uniformity in the shape of the blades of propellers for high-speed vessels is now generally acknowledged, and the machine we have described promises to form a very useful addition to the plant of a modern marine engineering establishment.

HOW TO REMOVE RUST FROM IRON.

A method of removing rust from iron consists in immersing the articles in a bath consisting of a nearly saturated solution of chloride of tin. The length of time during which the objects are allowed to remain in the bath depends on the thickness of the coating of rust; but in ordinary cases twelve to twenty-four hours is sufficient. The solution ought not to contain a great excess of acid if the iron itself is not to be attacked. On taking them from the bath, the articles are rinsed in water and afterward in ammonia. The iron, when thus treated, has the appearance of dull silver; but a simple polishing will give it its normal appearance.

HOW TO ANNEAL STEEL.

Owing to the fact that the operations of rolling or hammering steel make it very hard, it is frequently necessary that the steel should be annealed before it can be conveniently cut into the required shapes for tools.

Annealing or softening is accomplished by heating steel to a red heat, and then cooling it very slowly, to prevent it from getting hard again

The higher the degree of heat the more will steel be softened, until the limit of softness is reached, when the steel is melted.

It does not follow that the higher a piece of steel is heated the softer it will be when cooled, no matter how slowly it may be cooled; this is proved by the fact that an ingot is always harder than a rolled or hammered bar made from it.

Therefore, there is nothing gained by heating a piece of steel hotter than a good bright cherry red; on the contrary, a higher heat has several disadvantages: if carried too far, it may leave the steel actually harder than a good red heat would leave it. If a scale is raised on the steel, this scale will be harsh, granular oxide of iron, and will spoil the tools used to cut it. It often occurs that steel is scaled in this way, and then, because it does not cut well, it is customary to heat it again, and hotter still, to overcome the trouble, while the fact is, that the more this operation is repeated, the harder the steel will work, because of the hard scale and the harsh grain underneath. A high scaling heat, continued for a little time, changes the structure of the steel, destroys its crystalline property, makes it brittle, liable to crack in hardening, and impossible to refine.

Again, it is a common practice to put steel into a hot furnace at the close of a day's work, and leave it there all night. This method always gets the steel too hot, always raises a scale on it, and, worse than either, it leaves it soaking in the fire too long, and this is more injurious to steel than any other operation to which it can be subjected.

A good illustration of the destruction of crystalline structure by long-continued heating may be had by operating on chilled cast-iron.

If a chill be heated red hot and removed from the fire as soon as it is hot, it will, when cold, retain its peculiar crystalline structure; if now it be heated red hot, and left at a moderate red for several hours; in short, if it be treated as steel often is, and be left in a furnace over night, it will be found, when cold, to have a perfect amorphous structure, every trace of chill crystals will be gone, and the whole piece be non-crystalline gray cast-iron. If this is the effect upon coarse cast-irons, what better is to be expected from fine cast-steel?

A piece of fine tap steel, after having been in a furnace over night, will act as follows:

It will be harsh in the lathe and spoil the cutting tools.

When hardened, it will almost certainly crack; if it does not crack, it will have been a remarkably good steel to begin with. When the temper is drawn to the proper color and the tap is put into use, the teeth will either crumble off or crush down like so much lead.

Upon breaking the tap, the grain will be coarse and the steel brittle.

To anneal any piece of steel, heat it red hot; heat it uniformly and heat it through, taking care not to let the ends and corners get too hot.

As soon as it is hot, take it out of the fire, the sooner the better, and cool it as slowly as possible. A good rule for heating is to heat it at so low a red that, when the piece is cold, it will still show the blue gloss of the oxide that was put there by the hammer or rolls.

Steel annealed in this way will cut very soft; it will harden very hard, without cracking, and, when tempered, it will be very strong, nicely refined, and will hold a keen, strong edge.

THE BURSTING AND COLLAPSING PRESSURE OF SOLID DRAWN TUBES.

The following table gives the bursting and collapsing pressure of solid drawn tubes:

Diameter.	Bursting Pressure.	Collapsing Pressure.	Difference.
3¼	4800	3300	1500
3⅛	4500	3150	1350
3	4500	3500	1000
2¾	5200	3500	1700
2½	5000	3600	1400
2¼	5900	4500	1400
2	5900	4900	1000
1¾	5600	4000	1600

In this table it will be noticed that the bursting strength exceeds the collapsing strength, and that the difference increases with the diameter, as shown in the last column.

MINERAL WOOL.

Mineral wool is the name of an artificial product now used for a great variety of purposes, chiefly, however, as a non-conductor for covering steam surfaces of whatever character. It is largely used for this, and the underground steam pipes of the New York Steam Company are insulated with it.

Mineral wool is made by converting vitreous substances into a fibrous state. The slag of blast furnaces affords a large supply of material suitable for this purpose. The product thus obtained is known as slag wool. For the reason that slag is seldom free from compounds of sulphur, which are objectionable in the fiber, a cinder is prepared from which is made rock wool. These products comprise the two kinds of mineral wool; they are not to be distinguished from it, but from each other.

The resemblance of the fibers to those of wool and cotton has given the names of mineral wool and silicate cotton to the material, but the similarity in looks is as far as the comparison can be followed. The hollow and joined structure of the organic fiber, which gives it flexibility and capillary properties, is wanting in the mineral fibre. The latter is simply finely-spun glass of irregular thickness, without elasticity or any such appendages as spicules, which would be necessary for weaving purposes. The rough surfaces and markings of the fiber can only be detected under a strong magnifying glass.

Aside from its uses as covering for hot surfaces, it is also largely employed for buildings. A filling of mineral wool in the ground floor, say two inches thick, protects against the dampness of cellar; in the outside walls, from foundation to peak, between the studding, it will prevent the radiation of the warmth of interior, and will destroy the force of winds, which penetrate and cause draughts; in the roof it will retain the heat which rises through stair-wells, bringing about regularity of temperature in cold weather; the upper rooms will not receive the heat of the summer sun, and store it up for the occupants during the night, but remain as cool as those on the floor below; the water fixtures in bath-rooms, closets and pantries will not be exposed to extremes of heat and cold.

Analysis of mineral wool shows it to be a silicate of magnesia, lime, alumina, potash and soda. The slag-wool contains also some sulphur compounds. There is nothing organic in the material to decay or to furnish food and comfort to insects and vermin; on the other hand, the fine fibers of glass are irritating to anything which attempts to burrow in them. New houses lined with mineral wool will not become infested with animal life, and old walls may be ridden of their tenants by the introduction of it.

Mineral wool is largely used for car linings, in which service it reduces the noise of travel greatly. Aside from those mentioned, it can be applied generally in the arts for all purposes where a non-conductor or a shield is required, and the experience of several years show that it is both serviceable and cheap.

NICKEL PLATING SOLUTION.

According to the *Bulletin Internationale de l'Electricite*, the following solution is employed for nickel plating by several firms in Hainault. It is said to give a thick coating of nickel firmly and rapidly deposited. The composition of the bath is as follows:

Sulphate of nickel	1	lb.
Neutral tartrate of ammonia	11.6	oz.
Tannic acid with ether	.08	oz.
Water	16	pints.

The natural tartrate of ammonia is obtained by saturating tartaric acid solution with ammonia. The nickel sulphate to be added must be carefully neutralized. This having been done, the whole is dissolved in rather more than three pints of water, and boiled for about a quarter of an hour. Sufficient water is then added to make about sixteen pints of solution, and the whole is finally filtered. The deposit obtained is said to be white, soft and homogeneous. It has no roughness of surface, and will not scale off, provided the plates have been thoroughly cleaned. By this method good nickel deposits can be obtained on either the rough or prepared casting, and at a net cost which, we are told, barely exceeds that of copper plating.

A NEW ALLOY.

An alloy, the electrical resistance of which diminishes with an increase of temperature, has recently been discovered by Mr. Edward Weston. It is composed of copper, manganese and nickel. Another alloy, due to the same investigator, the resistance of which is practically independent of the temperature, consists of seventy parts of copper, combined with thirty of ferro-manganese.

PROOF OF THE EARTH'S MOTION.

Any one can prove the rotary motion of the earth on its axis by a simple experiment.

Take a good-sized bowl, fill it nearly full of water and place it upon the floor of a room which is not exposed to shaking or jarring from the street.

Sprinkle over the surface of the water a coating of lycopodium powder, a white substance which is sometimes used for the purposes of the toilet, and which can be obtained at almost any apothecary's. Then, upon the surface of this coating of powder, make with powdered charcoal a straight black line, say an inch or two inches in length.

Having made this little black mark with the charcoal powder on the surface of the contents of the bowl, lay down upon the floor, close to the bowl, a stick or some other straight object, so that it shall be exactly parallel with a crack in the floor, or with any stationary object in the room that will serve as well.

Leave the bowl undisturbed for a few hours, and then observe the position of the black mark with reference to the object it was parallel with.

It will be found to have moved about, and to have moved from east to west, that is to say, in that direction opposite to that of the movement of the earth on its axis.

The earth, in simply revolving, has carried the water and everything else in the bowl around with it, but the powder on the surface has been left behind a little. The line will always be found to have moved from east to west, which is perfectly good proof that everything else has moved the other way.

WHY THE COMPASS VARIES.

The compass, upon which the sailor has to depend, is subject to many errors, the chief of which are variation and deviation; that is, the magnetic needle rarely points to the true north, but in a direction to the right or left of north, according to its error at the time and place. The deviation of the compass comprises those errors which are local in their character; that is, due to the effect of immediately surrounding objects, such as the magnetism of the ship itself; this is sometimes very great in an iron ship.

The variation of the compass varies with the position of the ship, as shown by these curves of variation. Thus, from Cape Race to New York the variation of the compass changes from 30° W. to less than 10° W.; and from Cape Race to

New Orleans from 30° W. to more than 5° E., the line of no variation being indicated by the heavier double line stretching from the coast near Charleston down through Puerto Rico and the Windward Islands to the northeastern coast of South America.

To illustrate these variation curves more clearly, a chart has been made upon which variation curves are plotted for each degree. This illustrates very strikingly the positions of the magnetic poles of the earth, which do not by any means coincide with the geographic poles. On the contrary, there are two northern magnetic poles and two southern; up north of Hudson's Bay, at the point where these curves converge, there is one magnetic pole, and another to the northward of Siberia. Similarly, there are two in the southern hemisphere, and these four poles of this great magnet, the earth, are constantly but slowly shifting their positions, and just so constantly and surely does the magnetic needle obey these varying, but ever-present forces, seldom pointing toward the pole which man has marked off on his artificial globe, but always true to the great natural laws to which alone it owes allegiance. The small figures with plus and minus signs at various places on this chart indicate the yearly rate of change of variation, and this rate varies at different positions on the chart. Thus, near the Cape Verde Islands it is plus $\frac{9}{10}$; here the variation increases $\frac{9}{10}$ of a minute a year; farther to the southward, near the South American coast, it is plus $7\frac{4}{10}$, and to the northward, near the Irish Channel, it is minus $7\frac{8}{10}$. Fortunately, however, these changes are small and comparatively regular, and their cumulative effect can be allowed for, when large enough to make it necessary to do so.

COST OF ELECTRIC STREET RAILWAYS.

One of the street railways in New York is about running its cars to Harlem by an electric motor. Experts engaged in perfecting the scheme have made an exhibit, showing that it can be done at a cost of about two-thirds of the amount required to run over the same route with horses or cable. There will be sixteen batteries inclosed in one wagon, which will furnish sufficient power for two round trips. Sixty electric street railways are now in operation in the United States. Of the ultimate success, there can be but little doubt; the one question of any special importance upon which the experts differ is the superiority of any particular system.

KEEPING TOOLS.

Keep your tools handy and in good condition. This applies everywhere and in every place, from the smallest shop to the greatest mechanical establishment in the world. Every tool should have its exact place, and should always be kept there when not in use.

Having a chest or any receptacle with a lot of tools thrown into it promiscuously, is just as bad as putting the notes into an organ without regard to their proper place. If a man wants a wrench, chisel or hammer, it's somewhere in the box or chest, or somewhere else, and the search begins. Sometimes it is found — perhaps sharp, perhaps dull, maybe broken; and by the time it is found he has spent time enough to pay for several tools of the kind wanted.

The habit of throwing every tool down, anyhow, and in any way, or any place, is one of the most detestable habits a man can possibly get into. It is only a matter of habit to correct this. Make an inflexible end of your life to "have a place for everything and everything in its place."

It may take a moment more to lay a tool up carefully after using, but the time is more than equalized when you want to use it again, and so it is time saved. Habits, either good or bad, go a long ways in their influence on men's lives, and it is far better to establish and firmly maintain a good habit, even though that habit has no special bearing on the moral character, yet all habits have their influence.

Keeping tools in good order, and ready to use, is as necessary as keeping them in the proper place. To take up a dull saw, or a dull chisel, and try to do any kind of work with it, is worse than pulling a boat with a broom, and it all comes from just the same source as throwing down tools carelessly — habit, nothing more or less. To say you have no time to sharpen is worse than outright lying, for, if you have time to use a dull tool, you have time to put it in good order.

AN IMPROVED SCREW-DRIVER.

A screw-driver has been made in Philadelphia with the handle in two parts, said parts being capable of rotating one upon the other. A stop-pin and pawl limit the movement of the shank in one direction, while the top of the handle will move backward without turning the shank. The mechanism appears to be very similar to the principle of a stem-winding watch.

THE EFFECT OF MAGNETISM ON WATCHES.

At a meeting of the Western Railway Club, Mr. E. M. Herr, superintendent of telegraph of the Chicago, Burlington & Quincy Railroad, read the following paper:

A magnet is a body, usually of steel, having the property, when delicately poised and free to turn, of pointing toward the north, and of attracting and causing to adhere to its ends or poles, pieces of iron, steel, and some other substances. Materials which are attracted by a magnet are called magnetic, and it is because the rapidly moving parts of a watch are in general, made, in part at least, of magnetic material, that these timepieces are affected by that peculiar force magnetism.

Were magnetic substances only affected while a magnet is near them, there would be little difficulty as far as watches are concerned. Such, unfortunately, is not the case, as certain materials, steel more than any other, are not only attracted by a magnet, but become themselves permanent magnets when brought into contact with or even in the vicinity of a magnetized body. It is to the latter property of steel, namely, becoming permanently magnetized by the approach of a magnet without coming in contact in any way with it, that causes trouble with watches.

Again, a small piece of steel is much more easily magnetized than a large one; consequently, the small and delicate parts of a watch are most likely to be affected. These are found in the balance wheel and staff, hair spring, fork and escape wheel, and are the very ones in which magnetism causes trouble on account of the extreme accuracy and regularity with which they must perform their movements. It is, in fact, upon the uniformity in the motion of the balance wheel, that the timekeeping qualities of the watch depend.

In a magnetized watch this wheel, as well as all other steel parts, become permanent magnets, each tending to place itself in a north and south line, and also to attract and to be attracted by the others; all of which, it is hardly necessary to add, tends to affect its reliability as a timepiece. How small a variation in each vibration of the balance wheel will cause a serious error in the daily rate of a watch, is easily realized when attention is given for a moment to the number of double vibrations this wheel makes in 24 hours.

This varies in different watches from 174,000 to 216,000, and the variation of a single vibration in this number will cause a greater error than is sometimes found in the best watch movements. It is therefore true that the variation in each vibration of the balance wheel of 1-200,000 part of the time of such vibration, or in actual time about the 1-500,000 part of a second, will prevent the watch rating as a strictly first-class time piece.

I wish to state, however, that there are very few watches made of ordinary materials which are absolutely free from magnetism. This may seem like a sweeping statement, but, after taking considerable pains to verify or disprove of it, I am convinced that it is substantially correct.

Why this should be so becomes evident when we consider that a few sharp blows upon a piece of steel held in the direction of a dipping needle suffice to sensibly magnetize it, and then think of the numerous mechanical operations that have to be performed upon each small piece of steel in the moving parts of a watch before it becomes a finished product.

In order to determine, if possible, to what extent magnetism prevails in watches, I have examined and tested for magnetism 28 watches carried by persons other than train or engineer men, with the following result: Three were very seriously magnetized; one to such an extent that it could not be regulated closely; twenty barely perceptibly affected, possibly, but the normal amount due to the process of manufacture, and in but four could no magnetism be detected.

On account of the steel parts of a locomotive being magnetized during the process of construction, and by severe usage in a similar manner to those of a watch, it has been claimed that the watches of engineers are constantly subjected to the action of the magnetic forces, and cannot therefore keep as good time as other watches.

I have examined for magnetism the different parts of a number of locomotives in actual service, and, although they were in general found to be magnetic, they are so slightly charged as to render it almost certain they could have no influence upon the rate of a watch, and would surely produce less effect upon it than the originally slightly magnetized parts of the watch itself. That this amounts to practically nothing, is proven by the large number of finely rated watches now in use in which magnetism is apparent.

As proof of the statement that engine-men's watches are not, as a rule, more highly charged with magnetism than those of men engaged in other occupations, the watches of twenty locomotive engineers were tested. Of these none were found heavily charged with magnetism; but two more than normal; twelve with a barely perceptible charge, and in six none could be detected, showing actually less magnetism in these than in the twenty-eight watches previously examined, none of which were carried on a locomotive, a result probably due to the fact that engineers, as a rule, are very careful of their watches, and are less apt to bring them in dangerous proximity to a dynamo than those not concerned in running trains, and in whom a well-regulated watch is less important. This, I take it, would surely be the case did they all understand that a watch is likely to be entirely disabled by bringing it near a dynamo or motor in operation. It therefore seems important that all to whom accurate time is a necessity, should be carefully instructed as to where the danger lies.

So much has recently been written about the magnetizing of watches that many persons approach any kind of electrical apparatus with caution. Even a battery of ordinary gravity, or LeClanche cells, is regarded with suspicion, while a storage battery is thought almost as dangerous as a dynamo.

Others, on the other hand, do not even know that a dynamo is dangerous to watches. It should be borne in mind that it is not electricity which affects watches, but magnetism, and that magnets are the seats of danger. It is the powerful electro-magnets in dynamos and motors that magnetize watches, and not the strong currents of electricity generated or consumed by them. True, there is a magnetic field about every current of electricity, but it is so very slight that no effect is produced on watches worn in the pocket.

Having spoken of the evils of magnetism in watches, it is, perhaps, proper to add a few words regarding its prevention. The best and most certain way to prevent a watch becoming magnetized is to never allow it to come near a magnet. Unfortunately, in the present age, this is a difficult matter, as no one can say how soon they may find it necessary to be in the vicinity of a dynamo in operation or be seated in a car propelled by an electro-motor.

The only practical protection to watches from magnetism of which I have been able to learn consists essentially of a cup-like casing of very pure soft iron surrounding the works of the watch, which is known as the anti-magnetic shield. That this device is a protection from the effects of magnetism upon watches, there can be no doubt, but that it prevents magnetizing under all circumstances, even its inventor, I believe, does not claim.

It therefore becomes important to know how far our watches are safe when supplied with this protection, and where to draw the danger line for the protected, as well as the unprotected watch. In order to throw some light upon this question, the following tests were made:

First, to discover to what extent magnetic bodies placed within the shield were protected from external magnetic forces; second, in how strong a magnetic field it was necessary to place a watch protected by this device to effect its rate by magnetization.

While no pretense of scientific accuracy or precision was made in these tests, it is believed they are sufficiently accurate for scientific purposes.

The first test was made by filling an inverted shield half full of water, on the surface of which a very light magnetized steel needle was caused to float. In a similarly shaped cup, made of porcelain, another needle, in all respects like the first, was also floated. A horseshoe magnet was then brought near each, and found to affect each needle equally, at the following distances: in shield, 6 in.; in porcelain cup, 13½ in.

Distance below a ¾-in. wooden board, upon which shield and cup were placed, at which needles could be just reversed by magnet — in shield, 3¾ in.; in porcelain cup, 8¼ in. With just enough water to cover the bottom of shield, the following distances for equal effects were observed: first exposure in shield, 8 in.: first exposure in porcelain cup, 20 in.; second exposure in shield, 12 in.: second exposure in porcelain cup, 30 inches.

Since the intensity of a magnetic force varies inversely as the square of the distance, the above results indicate that to produce like effects, at equal distances, magnetic forces from five to six times as strong would be required, with bodies inclosed within the shield, than with those not so protected.

The second test was made with watches of different makes, all furnished with the shield. Space will not permit my going into the details of these tests, which extended over several months. I will only say that they in general consisted in obtaining the rating and performance of the watch before and after it was exposed to magnetic influences. The exposure consisted in placing it nearer and nearer to the pole pieces of a powerful arc light dynamo and observing the rate before and after each exposure. After many tests of this kind, the conclusion was reached that a watch carefully and properly shielded could be safely placed not nearer than 4 in. to the pole pieces of a 20 arc light Ball dynamo. When brought nearer they were without exception magnetized to a greater or less degree, the amount depending largely upon the time of such exposure.

Watches are now being made, however, which it is claimed are entirely non-magnetic and unaffected by the strongest magnetic fields met with in practice. Several such watches were also examined and tested. They were furnished with a balance-wheel, hair-spring, fork and escape wheel made of an alloy of non-magnetic metals in which palladium is the principal component. The first of these watches tested was furnished only with a non-magnetic balance and hair-spring, and had a steel fork and escape wheel. This watch is instantly stopped when brought near a powerful dynamo.

Other movements were then tried, in which all of the rapidly moving parts were of non-magnetic material. These could not be stopped by the field magnets of the most powerful arc light dynamos, although when placed in actual contact with the pole piece the balance-wheel was seen to vibrate less freely, probably due to the attraction of the staff and pivots, which were of steel. The rate of the watch was not, however, altered by this test.

A hair-spring made of this non-magnetic alloy was also delicately suspended in still air and subjected to the action of a powerful horseshoe magnet without developing the slightest observable magnetic effect.

One of our best-known American watch manufacturing firms is now making a non-magnetic watch on a plan similar to that just described; others will probably soon follow, hastening the day when a watch thoroughly protected or inherently insensible to magnetism will be as common, and considered as necessary to the successful keeping of correct time as the adjustment for temperature and position is already.

HOW BARRELS ARE MADE.

Barrels are now being made of hard and soft wood, each alternate stave being of the soft variety, and slightly thicker than the hard-wood stave. The edges of the staves are cut square, and, when placed together to form the barrel, the outsides are even, and there is a V-shaped crack between each stave from top to bottom. In this arrangement the operation of driving the hoops forces the edges of the hard stave into the soft ones, until the cracks are closed, and the extra thickness of the latter causes the inner edges to lap over those of of the hard-wood staves, thus making the joints doubly secure.

FACTS ABOUT IRON CASTINGS.

Some experience of the changes of shape which castings undergo by reason of shrinkage strains is necessary, in order to proportion them correctly. I have seen numerous massive and very strong looking castings fracture during cooling, or a long time afterward while lying in the yard untouched, or while being machined; the reason being that excessive contraction in one portion had put adjacent parts into a condition of great tension. By putting an excess of metal into some vulnerable point of a casting, is introduced an element of weakness, and almost a certainty of its breaking by reason of the internal shrinkage strains. It is not the excess of metal in itself which gives rise to these strains, but the position in which it is placed relatively to other sections. Thus a lump of metal cast in juxtaposition to a thinner portion will not break the latter, so long as it is able to shrink freely upon itself. But if placed between two thinner portions, it may fracture them by its shrinkage. Hence the great aim is to so design castings that all portions thereof thall cool down with approximate uniformity. A founder learns much from the behavior of cast-iron pulleys and light wheels. As they are so light and weak, proportioning must be correctly observed, and when customers ask for a "good, strong boss" or "strong arms," the request is one which, if complied with in the manner described; that is, by unduly increasing the metal, will either fracture the pulley or wheel, or bring it near to breaking limit. In all castings "strong" is a relative term, that form or size being strongest which harmonizes as regards general proportions. In a light pulley, three different conditions may exist: 1. All parts may cool down alike, or nearly so; 2. The rim may cool long before the arms and boss; 3. The arms and boss may cool before the rim. In the first case, the pulley will be strong and safe. In the second, the rim, in cooling, will set rigidly, but the arms and boss will continue shrinking, each arm exerting an inward pull on the rim, and various results may follow. First, the strain may simply cause the arm to straighten; or, in less favorable conditions, and especially if straight arms, or arms but slightly curved, be used, the arms may fracture near the rim, but seldom near the boss. Or, if the rim be weaker than the arm, fracture will take place, or the pulley may be turned, and then break. In the third case, the arms and boss cooling before the rim, they are compressed by the shrinkage of the latter, and the arms may then become fractured, if curved; or, if straight, may prevent the rim from coming inward, and so break it. In most cases, fracture occurs from the mass of metal in the boss. As a single instructtive example out of many, I may quote that of a pair of 2 ft. 6 in. pulleys, fast and loose, which had been running for several years, the fast pulley had a boss 6 in. in diameter, the loose pulley one of 5 in. only, and both were bored to 3 in. By the accidental falling of a bar of iron, both were broken. The rim of the fast pulley was at once pulled in, while the loose pulley remained level at the point of fracture. This illustrates the presence of tension in the rim, due to the larger boss, and this tension had been present since the pulley was made. The pulley with the 5 in. boss was probably much stronger than that with the six in. boss. In fast pulleys, and in wheels keyed on, the necessary strength around the keyway may be obtained by the use of keyway bosses, without increasing the entire diameter Where large bosses are unavoidable, as in some deep, double-armed pulleys, or in spur wheels keyed onto large shafts, shrinkage is assisted by opening out the mold around the bosses, and removing the central core, thereby accelerating the radiation of heat, and further by cooling them with water from a swab brush when at a low red or black heat. Many a casting is saved in this way Another method is to split the boss with plates, and bond or bolt it together afterward. When casting flywheels with wrought-iron arms, the rim is first cast around the arms and allowed to cool nearly down before the boss is poured. If the latter were cast at the same time as the rim, it would set first, and, by preventing the arms from coming inward, would put tension upon the rim.

Where aggregations of metal occur in castings, they may, if the castings be too strong to fracture, cause an evil of a secondary character, known as "drawing;" in other words, the metal is put into a condition of internal stress, and becomes open and spongy in consequence. "Feeding" tends to diminish this evil; but much can often be done by lightening the metal with cores, chambering out, or reducing the metal massed in certain places by other means. There is a difference in the behavior of cast-iron and of gun metal, of which advantage may be taken in small, light castings. Designs which will not stand in cast-iron or steel will stand in gun metal, hence the latter may be useful in cases of difficulty.

Sharp angles very often lead to fracture. When brackets, ribs, slugs, etc., are cast on work, the corners should never be left square or angular, for, if there be much disproportion of metal, fracture will almost certainly commence in the angles.

I have already alluded to the "straining" which large plated and heavy castings undergo, so that the sides and faces increase in dimensions, becoming more or less rounded. The main reason is, I think, that the metal round the central portions does not cool so rapidly as that at the sides. The outsides radiate heat quickly, and shrink to their full extent; but the middle rib or ribs, and the central portions of the plate, retain their heat longer, and hold the sides in a condition of tension, thus forcing them to bulge or become round. When the central portions cool, the outsides are too rigid to yield to the inward pull. This refers to framed hollow work. When plates "gather" or increase in thickness, it is due mainly to the lifting of the cope, from insufficient weighting. When a cubical mass of metal shows no shrinkage, this is due to the pressure of the entire mass compressing the sand on every side.

Briefly stated, then, in deciding the proper contraction allowance for a pattern, I should take into consideration its mass, the manner in which it is molded and cast, the presence or absence of cores, and the nature of the same, its general outline, and the character of the metal. For a heavy solid casting in iron, I should allow considerably less than the normal contraction for iron; for a similar casting in steel, more than the normal contraction for steel; for a heavy casting in gun metal, less than the normal contraction for gun metal. The precise allowance in any case must be regulated by circumstances. For the vertical depth of a shallow casting, very little shrinkage, if any, should be allowed; for a deep casting, the full amount. Then, again, a mold, with dry sand cores of moderate or large size, will not allow the casting to shrink so much as if the cores were of green sand, or were altogether absent. For hard and chilled iron, the shrinkage will be at its maximum; for strong mottled iron, at its maximum; and for common gray metal, at about the average.

FLEXIBLE GLASS.

An article called flexible glass is now made by soaking paper of proper thickness in copal varnish, thus making it transparent, polishing it when dry, and rubbing it with pumice stone. A layer of soluble glass is then applied and rubbed with salt. The surface thus produced is said to be as perfect as ordinary glass.

SOME ELECTRIC LIGHT FIGURES.

Now that modern improvements in the methods of distributing electricity for incandescent lighting have rendered it practicable to establish and maintain central station plants at a profit, even in towns of not more than 4,000 inhabitants, it has become possible to ascertain, with some approach to accuracy, the dimensions of the field which is open to be occupied by this incomparable illuminant.

Experience shows, that, when house-to-house lighting has been thoroughly worked up in any town, the capacity of the central station plant will need to be equal to an average of about one-sixteenth candle-power lamp for each inhabitant.

According to the census of 1880 of the 50,000,000 inhabitants of the United States, 13,000,000, or 26 per cent., resided in 580 towns and cities having a population in excess of 4,000 each.

At the normal rate of increase, we shall have, in five years from the present writing, a population of nearly 70,000,000, of whom some 18,000,000 will be gathered within the limits of towns of 4,000 inhabitants, and upward. Each of these individuals will represent one incandescent lamp, and the necessary power for operating the same. Even after deducting the lamps which have already been installed, there will be required a total output of more than 11,000 lamps, and over 1,000 horse-power each of steam engines, boilers and dynamos, every working day for the next five years, to supply the demand which, from all present appearances, will inevitably arise. This is entirely aside from the additional number of lamps which will be required for renewals—itself an enormous item. The change from gas to electricity, which is now going on in connection with domestic lighting, will be not a little accelerated by the action of the gas companies, who are everywhere evincing an increasing disposition to take up electric lighting themselves; and a very sagacious policy it is too, in view of the present outlook for gas illumination.

TO CLEAN RUSTY STEEL.

Mix ten parts of tin putty, eight parts of prepared buck's horn, and twenty-five parts of spirit of wine to a paste. Cleanse the steel with this preparation, and finally rub off with soft blotting paper.

HINTS ON PATTERN-MAKING.

The pattern shop is one of the most important departments in a plant for the manufacture of machinery. It is here that the plans of the mechanical engineer are first developed, and upon the skillful manner in which the patterns are constructed and those plans faithfully carried out, depends much of the future success in the manufacture of the machine. The skillful pattern-maker, by accurate calculations for shrinkage, finishing and the contingencies of the foundry, may save a great amount of labor and annoyance in the machine shop. It is unreasonable to expect perfect castings from imperfect patterns, and the molder is often blamed for imperfections of the castings when the fault may be traced to an imperfect pattern. Molders as a class have sins enough of their own to answer for without the addition of the sins of the pattern-maker. Patterns are as a rule necessarily expensive, and should be carefully constructed, so that they will retain their shape and proportions for future use, and to this end the selection of materials and the manner of joining the several parts together becomes an important item. For all ordinary purposes, especially for patterns of considerable size, good, clear, well-seasoned white pine is the best, and to obtain the best results it should be seasoned in the open air in the natural way. The sap of all the woods contains a large percentage of water, and to get rid of this is the object in seasoning. Pine wood, besides water, contains a large percentage of turpentine in the sap, and in seasoning it, it is desirable to retain as much of this as possible, as it dries to a hard substance when seasoned in the open air, and helps in a measure to fill up the pores of the wood, and renders it close and more impervious to water, and less liable to be affected by dampness. Kiln-dried lumber, although extensively used at the present time, is not as good for this purpose. The heat and moisture used for this purpose expels, not only the water, but other ingredients, which leaves the grain open and brash, and patterns made from such materials are more liable to absorb dampness and warp than otherwise. In constructing patterns, especially those of considerable size, it is customary to build them up of several pieces glued together; this makes more reliable work, provided good glue is used and proper care manifested in the manner of putting them together. No two pieces should be glued together with grain crossing at right angles, for, no matter how dry the lumber may be, there will always be some shrinkage, and, as lumber shrinks, almost entirely, in its transverse section, it is sure to warp, unless the glue gives way so as to allow each part to shrink in its natural direction. In either case the pattern will be unfit for further use until it is repaired. It is not good practice either, to glue up stuff for patterns with the grain of each piece running parallel with the other, as such patterns are deficient in strength, and are liable to split. The most practical way is to arrange the several pieces so that, when put together, the grain will run diagonally across each piece, at an angle of about twenty-five or thirty degrees. Pattern stuff prepared in this manner will have sufficient strength to prevent splitting by use and handling, and the tendency for warping will, to a great extent, be avoided. In building up circles, the cants should be short, and cut lengthwise of the grain as far as possible, so that the grain of each course as it is laid together to break points, may cross each other diagonally. It is customary with some pattern-makers to use nails or birds in each course as it is laid up, but pegs made of maple or hickory are much better, and, when the stuff is sufficiently thin to admit of it, the common pegs used in shoe shops are very cheap and convenient. The advantage of using pegs instead of brads or nails is, that, being driven in glue, they hold better, and the cants are not as liable to spring apart when exposed to the warm, damp sand in the foundry; besides, they never give the workman any trouble when turning it; and experience has demonstrated that patterns put together in this manner are much more durable than otherwise. Some pattern-makers use but little judgment in the use of glue, and seem to have an idea that the more glue they can get between two surfaces the better; yet, every experienced mechanic knows that exactly the reverse is the case. With a good joint and clear, fresh, thin glue, the least that is retained between the two surfaces the better and stronger will be the joint. In hot weather glue soon sours, turns black and becomes rancid; when in this condition, its strength is impaired and it is unfit for use. Alcohol mixed with it will prevent souring, but, as soon as it is healed up, the alcohol evaporates, and its effects are lost. The most effective preventive is sulphuric acid, but the acid should not be applied clear. For an ordinary glue-pot about fifteen drops of the acid mixed with a couple of spoonfuls of water may be applied; while this in no way impairs the strength of the glue, it will effectually prevent souring, and keep it fresh and clear.

For small gear patterns that are to be in constant use, cut patterns of iron or brass are no doubt the best and cheapest in the end; but, if wood patterns are required, they should be made of some harder wood than pine; mahogany or cherry is considered the best for such work. After the hub is turned to the proper size and width of face, the blanks for the teeth may be glued on and dressed in their places. With large, wide-faced gears, it is not convenient to do so; the blanks for the cogs are usually glued to dovetailed slips, or the dovetailed formed on the under side of the blank so that, when fitted to the rim, or dressed off, and laid out, they may be removed for the convenience of finishing them. The dove-tails should be a perfect fit, and the blank well fitted to the rim; otherwise they will vary the pitch when dressed and replaced again. In constructing patterns for heavy castings, such as lathe and engine beds, the careful and even distribution of metal in each part is an important consideration, and, in order to give some particular part the requisite strength to withstand a heavy strain, it is sometimes necessary to put more metal in some other part where it is not needed in order to prevent the casting from being distorted in shape or cracked by the unequal construction caused by one part cooling faster than another. With the framework for lighter machinery the same allowance for shrinkage must be provided for. But where a frame is composed of several parts, some of which are much lighter than others and yet it is necessary that the whole should be cast together, it is well to make the lighter portions in curves as far as the nature of the work will permit. Sharp edges and square corners should also be avoided as far as possible. A small cove in each corner will add much to the convenience of molding, besides adding to the strength of the casting and insure it against cracks, which are liable to open at these points by shrinkage in cooling.

The pattern-maker should also exercise good judgment in making provision for withdrawing the pattern from the sand; but, as no two patterns are just alike in this respect, no definite rule can be followed. In intricate patterns, which require considerable skill and care on the part of the molder in withdrawing them from the sand, if the nature of the work will admit of it, considerable more draft should be allowed for this reason. But plain patterns may be nearly straight, provided their surface is perfectly smooth. For much draft, especially with gearing, is very objectionable, for it is impossible for such gearing to run together accurately, and bear the whole length of the tooth or cog, unless they are either chipped and filled, or planed straight. If gear patterns are made accurate and true, and the face of the cogs perfectly smooth, there will be no difficulty in molding them if they are nearly or quite straight. All patterns before being used should be well covered with at least two coats of pure shellac varnish. After applying the first coat, and when it is perfectly dry, the surface should be well rubbed down with fine sandpaper, and all imperfections, such as nail holes and sharp corners, not already provided for, should be carefully filled with beeswax and rubbed off smooth before the second coat of varnish is applied. After a pattern has once been used, it is good practice to again rub it off with very fine sandpaper, and apply another coat of varnish. Many well-made patterns are ruined in the foundry by not being provided with the proper facilities for rapping and drawing. The molder must have some means for attaching his appliances for lifting it out, and, if suitable provision is not made for this purpose, he will screw his lifter in any part of the pattern that is most convenient, and the chances are, that it will split the first time it is used, or badly marred up. Iron plates should be let into all patterns with holes threaded to suit his lifters, and well secured either by screws or rivets, and, if a sufficient number are attached, the molder will respect the pattern and use them. Wood patterns should never be allowed to remain in the foundry; as soon as they are used, they should be taken to the pattern-room, brushed off and placed in such a position for future use that they will not become warped or sprung.

ELECTRIC HAND LANTERN.

A German patent has been granted to A. Friedlander for an electric hand lantern. This consists of a box of hard rubber carrying a small three-candle power incandescent light, together with a reflector and glass protector. The elements in the box, carbon and zinc, produce the current necessary to feed the light. The box is divided into five compartments holding the liquid, and the electrodes are placed in such position that no decomposition occurs when the lantern is not in use. The circuit is closed when the electrodes are dipped in the liquid; the current is stronger and the light brighter if the electrodes are dipped deeper in the liquid; this depth and consequently the brightness of the light can be regulated by means of a button on the outside. The liquid is a combined solution of chloride of zinc, bichromate of soda in water and acid, and the lantern can hold a sufficient supply of this solution to last for about three hours.

TABLES OF GEARS FOR CUTTING STANDARD SCREW-THREADS.

INTRODUCTION.

It may, perhaps, be necessary to state that these tables are the fruit of much experience, and a deep-seated conviction that their want is sorely felt by many. Notwithstanding the vast improvements of modern screw-cutting machinery, much time is still wasted by the most experienced workmen in endeavoring to find wheels to but any particular pitch o. screw, or broken number, in consequence of the various changes to be obtained from the usual set of screw-cutting wheels, most of which begin with a 20-teeth, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140 and 150. This may be considered a full set, inasmuch as any screw may be cut with it. Supposing the 20-wheel to be put on the mandrel, for single changes, without the pinion, the first figure up to 95 will give the number of threads to the inch. A 20 and A 25 will cut 2½; 20 and 30, 3 to the inch, and so on in like ratio. When three figures are on the wheels, however, the first two will indicate the number to the inch; as, 20 and 100 will cut 10; 20 and 110 will cut 11; etc. For many common numbers this will save the trouble of looking to the tables, if a ⅝, ¾, or other coarse pitch. If the book be referred to for the decimal of the ratios required, against it will be found the wheels that will cut it. If the number be required to the foot, then multiply by twelve.

These tables are calculated on the assumption that a pinion of twenty teeth is used, and a driving-screw of two threads to the inch.

Wheels, when affixed to the mandrel, are called mandrel-wheels; those on the screw, screw-wheels; and those intervening, intermediate-wheels. When the mandrel and screw-wheels are connected by one or more wheels directly, they are termed simple wheels. When attached by means of a pinion joined to the intermediate wheel, they are calledcompound-wheels.

No. I, is a table of simple wheels. The mandrel-wheels are in the first perpendicular column; and the screw-wheels in the top horizontal column. In the spaces where the perpendicular intersects the horizontal, will be found the pitch of the thread which any two wheels will cut.

The remaining tables are of compound wheels. The mandrel-wheels will be found in the first perpendicular column, the intermediate-wheels in the top horizontal column, and the screw-wheels in the bottom column. The pitch of thread to be cut having been found in the tables, on the left hand the mandrel-wheel will be found, on the top the intermediate wheel, and at the bottom the screw-wheel.

All lathes have not a twenty-teeth pinion, in which case, the following rule will be of use as applying to any other pinion:

Multiply the pitch of thread intended to be cut, by the new pinion, and divide by twenty. Find the wheels in the tables corresponding with the quotient, and use the new pinion instead of the twenty.

In some lathes the mandrel-wheel is a fixture. In these instances, suppose the mandrel-wheel to be the pinion, and attach the mandrel-wheel found in the table to the intermediate-wheel.

To ascertain the ratio of any series of wheels, multiply the whole of the driven wheels together, which will give the total number of teeth in the series. Then divide the result by the driving wheels multiplied into each other. The quotient will be the number of times the first wheel will revolve to the last. Suppose a wheel of twenty teeth to be driving a wheel of 100 teeth, to which is attached a wheel of thirty teeth driving a wheel of 150 teeth, and the ratio be required—

$$\frac{100 \times 150}{20 \times 30} = 25 \text{ revolutions.}$$

To find the number of threads a set of wheels will cut, multiply the ratio of the wheels by the pitch of the driving-screw.

To cut double or more threads, divide the mandrel-wheel in as many parts as you require threads, and, as you cut the screw, shift the mandrel-wheel a division, while the screw-wheel remains stationary. This plan will insure equal division and regularity of cutting. In all lathes where the leading screw is two to the inch, and an equal number of threads being cut, if the saddled clutch be thrown out of gear, it will always fall into the right place. If an odd number of threads are being cut, it will fall right every other one. By attending to this rule, running the lathe backward will be avoided, and a screw cut in about half the time.

A difficulty frequently arises in finding the number of threads to the inch or foot when a particular pitch or fractional number has to be matched. This can easily be ascertained by measuring onward, for, if it do not come right in one inch, notice how many there are between any division of rule. In measuring a screw, you discover there are twenty-eight threads in three inches. Consequently, if twenty-eight be divided by three, it gives 9.333 as the pitch. Against that number in the table will be found the wheels to cut it. Suppose a coarse pitch be required, say one thread in 1⅝ inch, the wheels may be found thus: when there is less than one thread to the inch, see how many there are in twelve inches; as, 1.615 in. pitch into 12 in. is 7.384 to the foot. If divided by twelve, we have the dec. .615, against which in the table will be found the wheels.

SCREW WHEELS.

MANDREL WHEELS.	150	140	130	120	110	100	95	90	85	80	75
20	15.	14.	13.	12.	11.	10.	9.5	9.	8.5	8.	7.5
25	12.	11.2	10.4	9.6	8.8	8.	7.6	7.2	6.8	6.4	6.
30	10.	9.333	8.666	8.	7.333	6.666	6.333	6.	5.666	5.333	5.
35	8.571	8.	7.428	6.856	6.284	5.714	5.428	5.142	4.857	4.571	4.285
40	7.5	7.	6.5	6.	5.5	5.	4.75	4.5	4.25	4.	3.75
45	6.666	6.222	5.777	5.333	4.888	4.444	4.222	4.	3.777	3.555	3.333
50	6.	5.6	5.2	4.8	4.4	4.	3.8	3.6	3.4	3.2	3.
55	5.454	5.09	4.727	4.363	4.	3.636	3.454	3.272	3.091	2.909	2.727
60	5.	4.666	4.333	4.	3.666	3.333	3.166	3.	2.833	2.666	2.5
65	4.615	4.307	4.	3.692	3.384	3.077	2.923	2.769	2.615	2.461	2.307
70	4.285	4.	3.714	3.428	3.142	2.857	2.714	2.571	2.428	2.285	2.142
75	4.	3.733	3.466	3.2	2.933	2.666	2.533	2.4	2.266	2.133	2.
80	3.75	3.5	3.25	3.	2.75	2.5	2.375	2.25	2.125	2.	1.875
85	3.529	3.294	3.058	2.823	2.588	2.353	3.235	2.117	2.	1.882	1.764
90	3.333	3.111	2.888	2.666	2.444	2.222	2.111	2.	1.888	1.777	1.666
95	3.157	2.947	2.736	2.526	2.326	2.105	2	1.894	1.789	1.684	1.579
100	3.	2.8	2.6	2.4	2.2	2.	1.9	1.8	1.7	1.6	1.5
110	2.727	2.545	2.363	2.181	2.	1.818	1.727	1.636	1.545	1.454	1.363
120	2.5	2.333	2.166	2.	1.833	1.666	1.583	1.5	1.416	1.333	1.25
130	2.307	2.153	2.	1.846	1.692	1.538	1.461	1.384	1.307	1.230	1.153
140	2.142	2.	1.857	1.714	1.571	1.428	1.357	1.285	1.214	1.142	1.071
150	2.	1.866	1.733	1.6	1.466	1.333	1.266	1.2	1.133	1.066	1.

SCREW WHEELS.

MANDREL WHEELS.	70	65	60	55	50	45	40	35	30	25
20	7.	6.5	6.	5.5	5.	4.5	4.	3.5	3.	2.5
25	5.6	5.2	4.8	4.4	4.	3.6	3.2	2.8	2.4	2.
30	4.666	4.333	4.	3.666	3.333	3.	2.666	2.333	2.	1.666
35	4.	3.714	3.428	3.142	2.857	2.571	2.284	2.	1.714	1.428
40	3.5	3.25	3.	2.75	2.5	2.25	2.	1.75	1.5	1.25
45	3.111	2.888	2.666	2.444	2.222	2.	1.777	1.555	1.333	1.111
50	2.8	2.6	2.4	2.2	2.	1.8	1.6	1.4	1.2	1.
55	2.545	2.363	2.181	2.	1.818	1.636	1.454	1.272	1.091	.909
60	2.333	2.166	2.	1.833	1.666	1.5	1.333	1.166	1.	.833
65	2.153	2.	1.846	1.692	1.538	1.384	1.230	1.076	.923	.769
70	2.	1.857	1.714	1.571	1.428	1.285	1.142	1.	.857	.714
75	1 866	1.733	1.6	1.466	1.333	1.2	1.066	.933	.8	.666
80	1.75	1.625	1.5	1.375	1.25	1.125	1.	.875	.75	.625
85	1.637	1.529	1.411	1.294	1.176	1.058	.941	.818	.705	.588
90	1.555	1.444	1.333	1.222	1.111	1.	.888	.777	.666	.555
95	1.473	1.368	1.263	1.163	1.052	.947	.842	.736	.631	.526
100	1.4	1.3	1.2	1.1	1.	.9	.8	.7	.6	.5
110	1.272	1.181	1.091	1.	.909	818	.727	.636	.545	.454
120	1.166	1.083	1.	.916	.833	.75	.666	.583	.5	.416
130	1.076	1.	.923	.846	.769	.692	.615	.538	.461	.384
140	1.	.928	.857	.785	.714	.642	.571	.5	.428	.357
150	.933	.866	.8	.733	.666	.6	.533	.466	.4	.333

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	140	130	130	120	120	120	110	110	110	110	100
20	105.	97.5	91.	90.	84.	78	82.5	77.	71.5	66.	75.
25	84.	78.	72.8	72.	67.2	62.4	66.	61.6	57.2	52.8	60.
30	70.	65.	60.666	60.	56.	52.	55.	51.333	47.666	44.	50.
35	60.	55.714	52.	51.428	48.	44.571	47.142	44.	40.857	37.714	42.857
40	52.5	48.75	45.5	45.	42.	39.	41.25	38.5	35.75	33.	37.5
45	46.666	43.333	40.444	40.	37.333	34.666	36.666	34.222	31.777	29.333	33.333
50	42.	39.	36.4	36.	33.6	31.2	33.	30.8	28.6	26.4	30.
55	38.181	35.454	33.091	32.727	30.545	28.303	30.	28.	26.	24.	27.272
60	35.	32.5	30.333	30.	28.	26.	27.5	25.666	23.833	22.	25.
65	32.307	30.	28.	27.692	25.846	24.	25.284	23.692	22.	20.307	23.076
70	30.	27.857	26.	25.714	24.	22 285	23.571	22.	20.428	18.857	21.428
75	28.	26.	24.266	24.	22.4	20.8	22.	20.533	19.066	17.6	20.
80	26.25	24.375	22.75	22.5	21.	19.5	20.625	19.25	17.875	16.5	18.75
85	24.705	22.941	21.41	21.176	19.764	18.352	19 411	18.117	16.823	15.529	17.647
90	23.333	21.666	20.222	20.	18.666	17.333	18.333	17.111	15.888	14.666	16.666
95	22.105	20.526	19.156	18.946	17.684	16.421	17.368	16.21	15.062	13.894	15.789
100	21.	19.5	18.2	18.	16.8	15.6	16.5	15.4	14.3	13.2	15.
110	19.091	17.727	16.545	16.363	15.272	14.181	15.	14.	13.	12.	13.636
120	17.5	16.25	15.166	15.	14.	13.	13.75	12.833	11.916	11.	12.5
130	16.154	15.	14.	13.846	12.933	12.	12.642	11.846	11.	10.153	11.538
140	15.	13.928	13.	12.857	12.	11.142	11.785	11.	10.214	9.428	10.714
SCREW WHEELS.	150	150	140	150	140	130	150	140	130	120	150

PINION 20.

	INTERMEDIATE WHEELS.									
	100	100	100	100	95	95	95	95	95	95
MANDREL WHEELS.										
20	70.	65.	60.	55.	71.25	66.5	61.75	57.	52.25	47.5
25	56.	52.	48.	44.	57.	53.2	49.4	45.6	41.8	38.
30	46.666	43.333	40.	36.666	47.5	44.333	41.166	38.	34.833	31.666
35	40.	37.142	34.285	31.428	40.714	38.	35.284	32.57	29.856	27.142
40	35.	32.5	30.	27.5	35.625	33.25	30.875	28.5	26.125	23 75
45	31.111	28.888	26.666	24.444	31.666	29.555	27.444	25.333	23.222	21.111
50	28.	26.	24.	22.	28.5	26.6	24.7	22.8	20.9	19.
55	25.454	23.636	21.818	20.	25.908	24.181	22.454	20.727	19.	17.272
60	23.333	21.666	20.	18.333	23.75	22.166	20.583	19.	17.416	15.833
65	21.538	20.	18.461	16.923	21.922	20.461	19.	17.538	16.076	14.615
70	20.	18.571	17.142	15.714	20.357	19.	17.642	16.384	14.928	13.570
75	18.633	17.333	16.	14.666	19.	17.733	16.466	15.2	13.932	12.666
80	17.5	16.25	15.	13.75	17.812	16.625	15.437	14.25	13.062	11.875
85	16.470	15.294	14.117	12.941	16.764	15.647	14.528	13.41	12.294	11.176
90	15.555	14.444	13.333	12.222	15.833	14.777	13.722	12 666	11.611	10.555
95	14.736	13.688	12.631	11.578	15.	14.	13.	12.	11.	10.
100	14.	13.	12.	11.	14.25	13.3	12.35	11.4	10.45	9.5
110	12.727	11.818	10.909	10.	12.954	12.091	11.227	10.363	9.5	8.636
120	11.666	10.833	10.	9.166	11.875	11.083	10.291	9.5	8.708	7.916
130	10.769	10.	9.230	8.461	10.961	10.230	9.5	8.769	8.038	7.307
140	10.	9.285	8.571	7.857	10.178	9.5	8.821	8.142	7.464	6.785
	140	130	120	110	150	140	130	120	110	100
	SCREW WHEELS.									

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	90	90	90	90	90	90	90	85	85	85	85
20	67.5	63.	58.5	54.	49.5	45.	42.75	63.75	59.5	55.25	51.
25	54.	50.4	46.8	43.2	39.6	36.	34.2	51.	47.6	44.2	40.8
30	45.	42.	39.	36.	33.	30.	28.5	42.5	39.666	36.833	34.
35	38.571	36.	33.428	30.857	28.282	25.714	24.428	36.428	34.	31.571	29.142
40	33.75	31.5	29.25	27.	24.75	22.5	21.375	31.857	29.75	27.625	25.5
45	30.	28.	26.	24.	22.	20.	19.	28.333	26.444	23.555	22.666
50	27.	25.2	23.4	21.6	19.8	18.	17.1	25.	23.8	22.1	20.4
55	24.545	22.909	21.272	19.636	18.	16.363	15.545	23.181	21.636	20.091	18.545
60	22.5	21.	19.5	18.	16.5	15.	14.25	21.25	19.833	18.416	17.
65	20.769	19.384	18.	16.615	15.238	13.846	13.153	19.615	18.307	17.	15.692
70	19.285	18.	16.714	15.428	14.141	12.847	12.214	18.214	17.	15.785	14.571
75	18.	16.8	15.6	14.4	13.2	12.	11.4	17.	15.866	14.733	13.6
80	16.875	15.75	14.625	13.5	12.375	11.25	10.687	15.937	14.875	13.812	12.75
85	15.882	14.823	13.764	12.705	11.647	10.588	10.058	15.	14.	13.	12.
90	15.	14.	13.	12.	11.	10.	9.5	14.166	13.222	12.277	11.333
95	14.21	13.263	12.315	11.363	10.421	9.468	9.	13.421	12.526	11.631	10.737
100	13.5	12.6	11.7	10.8	9.9	9.	8.55	12.75	11.9	11.05	10.2
110	12.272	11.454	10.636	9.818	9.	8.181	7.772	11.59	10.818	10.045	9.272
120	11.25	10.5	9.75	9.	8.25	7.5	7.125	10.625	9.916	9.208	8.5
130	10.384	9.692	9.	8.307	7.619	6.923	6.576	9.807	9.153	8.5	7.846
140	9.642	9.	8.357	7.714	7.071	6.428	6.107	9.107	8.5	7.892	7.285
SCREW WHEELS.	150	140	130	120	110	100	95	150	140	130	120

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	85	85	85	85	80	80	80	80	80	80
20	46.75	42.5	40.375	38.25	60.	56.	52.	48.	44.	40.
25	37.4	34.	32.3	30.6	48.	44.8	41.6	38.4	35.2	32.
30	31.166	28.333	26.916	25.5	40.	37.333	34.666	32.	29.333	26.666
35	26.714	24.285	23.071	21.857	34.285	32.	29.714	27.428	25.142	22.857
40	23.375	21.25	20.187	19.125	30.	28.	26.	24.	22.	20.
45	20.777	18.8	17.944	17.	26.666	24.888	23.111	21.333	19.555	17.777
50	18.7	17.	16.150	15.3	24.	22.4	20.8	19.2	17.6	16.
55	17.	15.454	14.681	13.909	21.818	20.363	18.981	17.454	16.	14.545
60	15.583	14.166	13.458	12.75	20.	18.666	17.333	16.	14.666	13.333
65	14.384	13.076	12.423	11.769	18.461	17.23	16.	14.769	13.538	12.307
70	13.357	12.142	11.536	10.928	17.142	16.	14.857	13.714	12.571	11.428
75	12.466	11.333	10.766	10.2	16.	14.933	13.866	12.8	11.733	10.666
80	11.687	10.625	10.093	9.562	15.	14.	13.	12.	11.	10.
85	11.	10.	9.5	9.	14.117	13.176	12.235	11.294	10.353	9.411
90	10.388	9.444	8.972	8.5	13.333	12.444	11.555	10.666	9.777	8.888
95	9.842	8.942	8.5	8.053	12.631	11.079	10.942	10.105	9.268	8.421
100	9.35	8.5	8.075	7.65	12.	11.2	10.4	9.6	8.8	8.
110	8.5	7.727	7.342	6.954	10.909	10.181	9.495	8.727	8.	7.272
120	7.791	7.083	6.729	6.375	10.	9.333	8.666	8.	7.333	6.666
130	7.192	6.538	6.211	5.884	9.23	8.615	8.	7.384	6.769	6.153
140	6.678	6.071	5.768	5.464	8.571	8.	7.428	6.857	6.285	5.714
SCREW WHEELS.	110	100	95	90	150	140	130	120	110	100

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	80	80	80	75	75	75	75	75	75	75	75
20	38.	36.	34.	56.25	52.5	48.75	45.	41.25	37.5	35.625	33.75
25	30.4	28.8	27.2	45.	42.	39.	36.	33.	30.	28.5	27.
30	25.333	24.	22.666	37.5	35	32.5	30.	27.5	25.	23.75	22.5
35	21.714	20.571	19.428	32.142	30.	27.856	25.714	23.571	21.428	20.356	19.285
40	19.	18.	17.	28.125	26.25	24.375	22.5	20.625	18.75	17.812	16.875
45	16.8	16.	15.111	25.	23.333	21.666	20.	18.333	16.666	15.833	15.
50	15.2	14.4	13.6	22.5	21.	19.5	18.	16.5	15.	14.25	13.5
55	13.818	13.091	12.363	20.454	19.091	17.727	16.362	15.	13.636	12.955	12.272
60	12.666	12.	11.333	18.75	17.5	16.25	15.	13.75	12.5	11.875	11.25
65	11.692	11.876	10.461	17.307	16.153	15.	13.846	12.692	11.537	10.962	10.384
70	10.857	10.285	9.714	16.071	15.	13.928	12.857	11.785	10.714	10.178	9.642
75	10.133	9.6	9.066	15.	14.	13.	12.	11.	10.	9.5	9.
80	9.5	9.	8.5	14.062	13.125	12.187	11.25	10.312	9.375	8.96	8.437
85	8.941	8.47	8.	13.235	12.352	11.475	10.588	9.758	8.823	8.382	7.941
90	8.4	8.	7.555	12.5	11.666	10.833	10.	9.166	8.333	7.916	7.5
95	8.	7.579	7.157	11.842	11.052	10.263	9.472	8.684	7.894	7.5	7.152
100	7.6	7.2	6.8	11.25	10.5	9.75	9.	8.250	7.5	7.125	6.75
110	6.909	6.545	6.181	10.227	9.545	8.863	8.181	7.5	6.818	6.477	6.136
120	6.333	6.	5.666	9.375	8.75	8.125	7.5	6.875	6.25	5.937	5.625
130	5.846	5.938	5.230	8.653	8.076	7.5	6.923	6.346	5.768	5.481	5.192
SCREW WHEELS.	95	90	85	150	140	130	120	110	100	95	90

PINION 20.

MANDREL WHEELS.	INTERMEDIATE WHEELS.									
	75	75	70	70	70	70	70	70	70	70
20	31.875	30.	52.5	49.	45.5	42.	38.5	35.	33.25	31.5
25	25.5	24.	42.	39.2	36.4	33.6	30.8	28.	26.6	25.2
30	21.25	20.	35.	32.666	30.333	28.	25.666	23.333	22.166	21.
35	18.214	17.142	30.	28.	26.	24.	22.	20.	19.	18.
40	15.937	15.	26.25	24.5	22.75	21.	19.25	17.5	16.625	15.75
45	14.166	13.333	23.333	21.777	20.222	18.666	17.111	15.555	14.776	14.
50	12.75	12.	21.	19.6	18.2	16.8	15.4	14.	13.3	12.6
55	11.59	10.909	19.090	17.816	16.545	15.272	14.	12.727	12.091	11.454
60	10.625	10.	17.5	16.333	15.166	14.	12.833	11.666	11.083	10.5
65	9.807	9.237	16.153	15.076	14.	12.923	11.714	10.769	10.237	9.692
70	9.107	8.571	15.	14.	13.	12.	11.	10.	9.5	9.
75	8.5	8.	14.	13.066	12.133	11.2	10.266	9.32	8.866	8.4
80	7.968	7.5	13.125	12.250	11.375	10.5	9.625	8.75	8.312	7.875
85	7.5	7.058	12.352	11.561	10.758	9.882	9.058	8.235	7.823	7.411
90	7.083	6.666	11.666	10.888	10.111	9.333	8.555	7.777	7.388	7.
95	6.71	6.315	11.052	10.312	9.578	8.842	8.152	7.368	7.	6.603
100	6.375	6.	10.5	9.8	9.1	8.4	7.7	7.	6.650	6.3
110	5.795	5.454	9.545	8.908	8.272	7.636	7.	6.363	6.045	5.727
120	5.312	5.	8.75	8.166	7.583	7.	6.416	5.833	5.541	5.25
130	4.903	4.618	8.076	7.538	7.	6.461	5.857	5.384	5.118	4.846
SCREW WHEELS.	85	80	150	140	130	120	110	100	95	90

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	70	70	70	65	65	65	65	65	65	65	65
20	29.75	28.	26.25	48.75	45.5	42.25	39.	35.75	32.5	30.875	29.25
25	23.8	22.4	21.	39.	36.4	33.8	31.2	28.6	26.	32.7	23.4
30	19.833	18.666	17.5	32.5	30.333	28.166	26.	23.833	21.666	20.580	19.5
35	17.	16.	15.	27.857	26.	24.142	22.285	20.428	18.571	17.642	16.714
40	14.875	14.	13.125	24.375	22.750	21.125	19.5	17.875	16.25	15.437	14.625
45	13.222	12.444	11.666	21.666	20.222	18.777	17.333	15.888	14.444	13.722	13.
50	11.9	11.2	10.5	19.5	18.2	16.9	15.6	14.3	13.	12.35	11.7
55	10.818	10.181	9.545	17.727	16.545	15.363	14.181	13.	11.818	11.227	10.636
60	9.916	9.333	8.75	16.25	15.166	14.083	13.	11.916	10.833	10.291	9.75
65	9.153	8.615	8.076	15.	14.	13.	12.	11.	10.	9.5	9.
70	8.5	8.	7.5	13.928	13.	12.071	11.142	10.214	9.285	8.821	8.357
75	7.933	7.466	7.	13.	12.133	11.266	10.4	9.533	8.666	8.233	7.8
80	7.437	7.	6.562	12.187	11.375	10.562	9.75	8.937	8.125	7.718	7.312
85	7.	6.588	6.176	11.475	10.758	9.941	9.176	8.411	7.647	7.264	6.882
90	6.611	6.222	5.833	10.833	10.111	9.388	8.666	7.944	7.222	6.861	6.5
95	6.263	5.894	5.526	10.263	9.578	8.894	8.215	7.526	6.842	6.5	6.157
100	5.95	5.6	5.25	9.75	9.1	8.45	7.8	7.15	6.5	6.175	5.85
110	5.409	5.090	4.772	8.863	8.272	7.681	7.090	6.5	5.909	5.613	5.318
120	4.958	4.666	4.375	8.125	7.583	7.041	6.5	5.958	5.416	5.145	4.875
130	4.576	4.307	4.038	7.5	7.	6.5	6.	5.5	5.	4.75	4.5
SCREW WHEELS.	85	80	75	150	140	130	120	110	100	95	90

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	65	65	65	65	60	60	60	60	60	60
20	27.624	26.	24.375	22.75	45.	42.	39.	36.	33.	30.
25	22.1	20.8	19.5	18.2	36.	33.6	31.2	28.8	26.4	24.
30	18.416	17.333	16.25	15.166	30.	28.	26.	24.	22.	20.
35	15.785	14.857	13.928	13.	25.714	24.	22.284	20.571	18.857	17.142
40	13.812	13.	12.187	11.375	22.5	21.	19.5	18.	16.5	15.
45	12.277	11.555	10.833	10.111	20.	18.666	17.333	16.	14.666	13.333
50	11.05	10.4	9.75	9.1	18.	16.8	15.6	14.4	13.2	12.
55	10.044	9.454	8.863	8.272	16.363	15.272	14.181	13.091	12.	10.909
60	9.208	8.666	8.125	7.583	15.	14.	13.	12.	11.	10.
65	8.5	8.	7.5	7.	13.846	12.923	12.	11.076	10.153	9.237
70	7.892	7.428	6.964	6.5	12.857	12.	11.142	10.285	9.428	8.571
75	7.306	6.933	6.5	6.066	12.	11.2	10.4	9.6	8.8	8.
80	6.906	6.5	6.093	5.687	11.25	10.5	9.75	9.	8.25	7.5
85	6.5	6.117	5.737	5.352	10.588	9.882	9.176	8.475	7.764	7.058
90	6.138	5.777	5.416	5.055	10.	9.333	8.666	8.	7.333	6.666
95	5.815	5.473	5.131	4.789	9.473	8.842	8.215	7.578	6.947	6.315
100	5.525	5.2	4.875	4.55	9.	8.4	7.8	7.2	6.6	6.
110	5.022	4.727	4.431	4.136	8.181	7.636	7.099	6.545	6.	5.454
120	4.604	4.333	4.062	3.781	7.5	7.	6.5	6.	5.5	5.
130	4.25	4.	3.75	3.5	6.923	6.461	6.	5.538	5.076	4.618
	85	80	75	70	150	140	130	120	110	100

SCREW WHEELS.

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	60	60	60	60	60	60	60	55	55	55	55
20	28.5	27.	25.5	24.	22.5	21.	19.5	41.25	38.5	35.75	33.
25	22.8	21.6	20.4	19.2	18.	16.8	15.6	33.	30.8	28.6	26.4
30	19.	18.	17.	16.	15.	14.	13.	27.5	25.666	23.833	22.
35	16.285	15.428	14.571	13.714	12.857	12.	11.142	23.571	22.	20.428	18.857
40	14.25	13.5	12.75	12.	11.25	10.5	9.75	20.625	19.25	17.875	16.5
45	12.666	12.	11.333	10.666	10.	9.333	8.666	18.333	17.111	15.888	14.666
50	11.4	10.8	10.2	9.6	9.	8.4	7.8	16.5	15.4	14.3	13.2
55	10.363	9.818	9.272	8.727	8.181	7.636	7.091	15.	14.	13.	12.
60	9.5	9.	8.5	8.	7.5	7.	6.5	13.75	12.833	11.916	11.
65	8.769	8.373	7.846	7.384	6.923	6.461	6.	12.692	11.846	11.	10.152
70	8.142	7.714	7.285	6.857	6.428	6.	5.571	11.785	11.	10.214	9.428
75	7.6	7.2	6.8	6.4	6.	5.6	5.2	11.	10.266	9.533	8.8
80	7.125	6.75	6.375	6.	5.625	5.25	4.875	10.312	9.625	8.937	8.25
85	6.758	6.352	6.	5.647	5.294	4.941	4.588	9.758	9.058	8.411	7.764
90	6.333	6.	5.666	5.333	5.	4.666	4.333	9.166	8.555	7.944	7.333
95	6.	5.684	5.368	5.052	4.736	4.421	4.152	8.684	8.152	7.526	6.947
100	5.7	5.4	5.1	4.8	4.5	4.2	3.9	8.25	7.7	7.150	6.6
110	5.181	4.909	4.636	4.363	4.091	3.818	3.545	7.5	7.	6.5	6.
120	4.75	4.5	4.25	4.	3.75	3.5	3.25	6.875	6.416	5.958	5.5
130	4.384	4.186	3.923	3.692	3.461	3.230	3.	6.346	5.923	5.5	5.076
SCREW WHEELS.	95	90	85	80	75	70	65	150	140	130	120

PINION 20.

INTERMEDIATE WHEELS.

Mandrel Wheels	55	55	55	55	55	55	55	55	55	55
20	30.25	27.5	26.125	24.75	23.375	22.	20.625	19.25	17.875	16.5
25	24.2	22.	20.9	19.8	18.7	17.6	16.5	15.4	14.3	13.2
30	20.166	18.333	17.416	16.5	15.583	14.666	13.75	12.833	11.916	11.
35	17.285	15.714	14.928	14.142	13.357	12.571	11.785	11.	10.214	9.428
40	15.125	13.75	13.062	12.375	11.687	11.	10.312	9.625	8.937	8.25
45	13.444	12.222	11.611	11.	10.388	9.777	9.166	8.555	7.944	7.333
50	12.1	11.	10.45	9.9	9.35	8.8	8.25	7.7	7.15	6.6
55	11.	10.	9.5	9.	8.5	8.	7.5	7.	6.5	6.
60	10.083	9.166	8.708	8.25	7.791	7.333	6.875	6.416	5.958	5.5
65	9.376	8.461	8.038	7.615	7.192	6.769	6.346	5.923	5.5	5.075
70	8.642	7.857	7.464	7.071	6.678	6.285	5.892	5.5	5.107	4.714
75	8.066	7.333	6.966	6.6	6.233	5.866	5.5	5.133	4.766	4.4
80	7.562	6.875	6.531	6.185	5.843	5.5	5.156	4.812	4.468	4.125
85	7.117	6.475	6.147	5.823	5.5	5.176	4.876	4.529	4.205	3.882
90	6.722	6.111	5.805	5.5	5.194	4.888	4.583	4.277	3.972	3.666
95	6.368	5.789	5.5	5.215	4.921	4.631	4.342	4.052	3.763	3.473
100	6.05	5.5	5.225	4.95	4.675	4.4	4.125	3.85	3.575	3.3
110	5.5	5.	4.75	4.5	4.25	4.	3.75	3.5	3.25	3.
120	5.041	4.583	4.354	4.125	3.895	3.666	3.437	3.208	2.979	2.75
130	4.688	4.230	4.019	3.807	3.596	3.384	3.173	2.961	2.75	2.537
Screw Wheels	110	100	95	90	85	80	75	70	65	60

SCREW WHEELS.

MANDREL WHEELS.

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	50	50	50	50	50	50	50	50	50	50	50
20	37.5	35.	32.5	30.	27.5	25.	23.75	22.5	21.25	20.	18.75
25	30.	28.	26.	24.	22.	20.	19.	18.	17.	16.	15.
30	25.	23.333	21.666	20.	18.333	16.666	15.833	15.	14.166	13.333	12.5
35	21.428	20.	18.571	17.142	15.714	14.285	13.571	12.857	12.142	11.428	10.714
40	18.75	17.5	16.25	15.	13.75	12.5	11.875	11.25	10.625	10.	9.375
45	16.666	15.555	14.444	13.333	12.222	11.111	10.555	10.	9.444	8.888	8.333
50	15.	14.	13.	12.	11.	10.	9.5	9.	8.5	8.	7.5
55	13.636	12.727	11.818	10.909	10.	9.091	8.636	8.181	7.727	7.272	6.818
60	12.5	11.666	10.833	10.	9.166	8.333	7.916	7.5	7.083	6.666	6.25
65	11.538	10.769	10.	9.237	8.461	7.692	7.376	6.923	6.538	6.153	5.769
70	10.714	10.	9.285	8.571	7.857	7.142	6.785	6.428	6.071	5.714	5.357
75	10.	9.333	8.666	8.	7.333	6.666	6.333	6.	5.658	5.333	5.
80	9.375	8.75	8.125	7.5	6.875	6.25	5.937	5.625	5.312	5.	4.687
85	8.823	8.235	7.647	7.058	6.475	5.882	5.588	5.294	5.	4.758	4.411
90	8.333	7.777	7.222	6.666	6.111	5.555	5.277	5.	4.722	4.444	4.166
95	7.894	7.368	6.842	6.315	5.789	5.263	5.	4.736	4.473	4.215	3.947
100	7.5	7.	6.5	6.	5.5	5.	4.75	4.5	4.25	4.	3.750
110	6.818	6.363	5.909	5.454	5.	4.545	4.318	4.091	3.863	3.636	3.409
120	6.25	5.833	5.417	5.	4.583	4.166	3.958	3.75	3.541	3.333	3.125
130	5.769	5.384	5.	4.618	4.230	3.846	3.688	3.461	3.269	3.076	2.884
SCREW WHEELS.	150	140	130	120	110	100	95	90	85	80	75

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	50	50	50	50	45	45	45	45	45	45
20	17.5	16.25	15.	13.75	33.75	31.5	29.25	27.	24.75	22.5
25	14.	13.	12.	11.	27.	25.2	23.4	21.6	19.8	18.
30	11.666	10.833	10.	9.166	22.5	21.	19.5	18.	16.5	15.
35	10.	9.285	8.571	7.857	19.285	18.	16.714	15.428	14.142	12.857
40	8.75	8.125	7.5	6.875	16.875	15.75	14.625	13.5	12.375	11.25
45	7.777	7.222	6.666	6.111	15.	14.	13.	12.	11.	10.
50	7.	6.5	6.	5.5	13.5	12.6	11.7	10.8	9.9	9.
55	6.363	5.909	5.454	5.	12.272	11.454	10.636	9.818	9.	8.181
60	5.833	5.416	5.	4.583	11.25	10.5	9.75	9.	8.25	7.5
65	5.384	5.	4.615	4.238	10.384	9.692	9.	8.376	7.615	6.92
70	5.	4.642	4.285	3.928	9.642	9.	8.357	7.714	7.071	6.428
75	4.666	4.333	4.	3.666	9.	8.4	7.710	7.2	6.6	6.
80	4.375	4.062	3.75	3.437	8.437	7.875	7.312	6.75	6.187	5.625
85	4.117	3.823	3.529	3.235	7.941	7.411	6.882	6.352	5.823	5.294
90	3.888	3.611	3.333	3.055	7.5	7.	6.5	6.	5.5	5.
95	3.684	3.422	3.263	2.894	7.152	6.031	6.157	5.684	5.215	4.736
100	3.5	3.25	3.	2.75	6.75	6.3	5.85	5.4	4.95	4.5
110	3.181	2.954	2.727	2.5	6.136	5.737	5.318	4.909	4.5	4.091
120	2.916	2.708	2.5	2.291	5.625	5.25	4.875	4.5	4.125	3.75
130	2.692	2.5	2.307	2.119	5.192	4.846	4.5	4.188	3.807	3.46
	70	65	60	55	150	140	130	120	110	100

SCREW WHEELS.

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	45	45	45	45	45	45	45	45	45	45	40
20	21.375	20.25	19.125	18.	16.875	15.75	14.625	13.5	12.375	11.25	30.
25	17.1	16.2	15.3	14.4	13.5	12.6	11.7	10.8	9.9	9.	24.
30	14.25	13.5	12.75	12.	11.25	10.5	9.75	9.	8.25	7.5	20.
35	12.214	11.571	10.928	10.285	9.642	9.	8.357	7.711	7.071	6.428	17.142
40	10.687	10.125	9.562	9.	8.437	7.875	7.312	6.75	6.187	5.625	15.
45	9.5	9.	8.5	8.	7.5	7.	6.5	6.	5.5	5.	13.333
50	8.55	8.1	7.65	7.2	6.75	6.3	5.85	5.4	4.95	4.5	12.
55	7.772	7.363	6.954	6.545	6.136	5.727	5.318	4.909	4.5	4.091	10.909
60	7.125	6.75	6.375	6.	5.625	5.25	4.875	4.5	4.125	3.75	10.
65	6.576	6.237	5.884	5.536	5.192	4.846	4.5	4.153	3.807	3.461	9.237
70	6.107	5.785	5.464	5.142	4.821	4.5	4.178	3.856	3.535	3.214	8.571
75	5.7	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.	8.
80	5.343	5.062	4.781	4.5	4.218	3.937	3.656	3.375	3.093	2.812	7.5
85	5.029	4.764	4.5	4.235	3.97	3.758	3.441	3.176	2.911	2.647	7.058
90	4.75	4.5	4.25	4.	3.75	3.5	3.25	3.	2.75	2.5	6.666
95	4.5	4.263	4.026	3.789	3.576	3.315	3.078	2.842	2.607	2.368	6.315
100	4.275	4.05	3.825	3.6	3.375	3.15	2.925	2.7	2.475	2.25	6.
110	3.886	3.681	3.477	3.272	3.068	2.863	2.659	2.454	2.25	2.045	5.454
120	3.562	3.375	3.187	3.	2.812	2.625	2.437	2.25	2.062	1.875	5.
130	3.288	3.118	2.942	2.768	2.596	2.423	2.25	2.076	1.903	1.730	4.618
SCREW WHEELS.	95	90	85	80	75	70	65	60	55	50	150

PINION 20.

MANDREL WHEELS.	INTERMEDIATE WHEELS.									
	40	40	40	40	40	40	40	40	40	40
20	28.	26.	24.	22.	20.	19.	18.	17.	16.	15.
25	22.4	20.8	19.2	17.6	16.	15.2	14.4	13.6	12.8	11.
30	18.666	17.333	16.	14.666	13.333	12.666	12.	11.333	10.666	10.
35	16.	14.857	13.714	12.571	11.428	10.857	10.285	9.714	9.142	8.571
40	14.	13.	12.	11.	10.	9.5	9.	8.5	8.	7.5
45	12.444	11.555	10.666	9.777	8.888	8.444	8.	7.555	7.111	6.666
50	11.2	10.4	9.6	8.8	8.	7.6	7 2	6.8	6.4	6.
55	10.181	9.454	8.727	8.	7.272	6.909	6.545	6.181	5.818	5.454
60	9.333	8.666	8.	7.333	6.666	6.333	6.	5.666	5.333	5.
65	8.615	8.	7.384	6.769	6.153	5.846	5.538	5.237	4.928	4.615
70	8.	7.428	6.857	6.285	5.714	5.428	5.142	4.857	4.571	4.285
75	7.466	6.933	6.4	5.866	5.333	5.066	4.8	4.533	4.266	4.
80	7.	6.5	6.	5.5	5.	4.75	4.5	4.25	4.	3.75
85	6.588	6.117	5.647	5.176	4.758	4.475	4.235	4.	3.764	3.529
90	6.222	5.777	5.333	4.888	4.444	4.222	4.	3.777	3.555	3.333
95	5.894	5.473	5.055	4.631	4.215	4.	3.789	3.578	3.368	3.157
100	5.6	5.2	4.8	4.4	4.	3.8	3.6	3.4	3.2	3.
110	5.091	4.727	4.363	4.	3.636	3.454	3.272	3.091	2.909	2.727
120	4.666	4.333	4.	3.666	3.333	3.166	3.	2.833	2.666	2.5
130	4.307	4.	3.692	3.384	3.076	2.923	2.769	2.618	2.464	2.307
SCREW WHEELS.	140	130	120	110	100	95	90	85	80	75

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	40	40	40	40	40	40	35	35	35	35	35
20	14.	13.	12.	11.	10.	9.	26.25	24.5	22.75	21.	19.25
25	11.2	10.4	9.6	8.8	8.	7.2	21.	19.6	18.2	16.8	15.4
30	9.333	8.666	8.	7.333	6.666	6.	17.5	16.333	15.166	14.	12.833
35	8.	7.428	6.857	6.285	5.714	5.142	15.	14.	13.	12.	11.
40	7.	6.5	6.	5.5	5.	4.5	13.125	12.25	11.375	10.5	9.625
45	6.222	5.777	5.333	4.888	4.444	4.	11.666	10.888	10.111	9.333	8.555
50	5.6	5.2	4.8	4.4	4.	3.6	10.5	9.8	9.1	8.4	7.7
55	5.091	4.725	4.363	4.	3.636	3.272	9.545	8.909	8.272	7.636	7.
60	4.666	4.333	4.	3.666	3.333	3.	8.75	8.166	7.583	7.	6.416
65	4.307	4.	3.692	3.384	3.076	2.769	8.076	7.538	7.	6.461	5.923
70	4.	3.714	3.428	3.142	2.857	2.571	7.5	7.	6.5	6.	5.5
75	3.733	3.466	3.2	2.933	2.666	2.4	7.	6.533	6.066	5.6	5.133
80	3.5	3.25	3.	2.75	2.5	2.25	6.562	6.125	5.687	5.25	4.812
85	3.294	3.058	2.823	2.588	2.352	2.177	6.176	5 764	5.352	4.941	4.529
90	3.111	2.888	2.666	2.444	2.222	2.	5.833	5.444	5.055	4.666	4.277
95	2.947	2.736	2.526	2.317	2.105	1.894	5.526	5.157	4.789	4.421	4.052
100	2.8	2.6	2.4	2.2	2.	1.8	5.250	4.9	4.550	4.2	3.85
110	2.545	2.363	2.181	2.	1.818	1.636	4.772	4.454	4.136	3.818	3.5
120	2.333	2.166	2.	1.833	1.666	1.5	4.375	4.083	3.769	3.5	3.208
130	2.153	2.	1.846	1.692	1.538	1.384	4.038	3.769	3.5	3.230	2.961
SCREW WHEELS.	70	65	60	55	50	45	150	140	130	120	110

PINION 20.

INTERMDEIATE WHEELS.

MANDREL WHEELS.	35	35	35	35	35	35	35	35	35	35
20	17.5	16.625	15.75	14.875	14.	13.125	12.25	11.375	10.5	9.625
25	14.	13.3	12.6	11.9	11.2	10.5	9.8	9.1	8.4	7.7
30	11.666	11.083	10.5	9.916	9.333	8.75	8.166	7.583	7.	6.416
35	10.	9.5	9.	8.5	8.	7.5	7.	6.5	6.	5.5
40	8.75	8.312	7.875	7.437	7.	6.562	6.125	5.687	5.25	4.812
45	7.777	7.388	7.	6.611	6.222	5.833	5.444	5.055	4.666	4.277
50	7.	6.65	6.3	5.95	5.6	5.25	4.9	4.55	4.2	3.85
55	6.363	6.045	5.727	5.409	5.091	4.772	4.454	4.136	3.818	3.318
60	5.833	5.541	5.25	4.958	4.666	4.375	4.083	3.791	3.5	3.208
65	5.384	5.118	4.846	4.577	4.307	4.038	3.769	3.5	3.231	2.961
70	5.	4.75	4.5	4.25	4.	3.75	3.5	3.25	3.	2.75
75	4.666	4.433	4.2	3.966	3.733	3.5	3.266	3.033	2.8	2.566
80	4.375	4.156	3.937	3.718	3.5	3.281	3.062	2.843	2.625	2.406
85	4.117	3.911	3.758	3.5	3.294	3.088	2.882	2.676	2.47	2.264
90	3.888	3.694	3.5	3.305	3.111	2.916	2.722	2.527	2.333	2.138
95	3.684	3.5	3.315	3.131	2.947	2.763	2 578	2.394	2.21	2.026
100	3.5	3.325	3.15	2.975	2.8	2.625	2.45	2.275	2.1	1.925
110	3.181	3 022	2.863	2.704	2.545	2.386	2.227	2.068	1.909	1.659
120	2.916	2.770	2.625	2.479	2.333	2.187	2.041	1.895	1.75	1.604
130	2.692	2.559	2.423	2.288	2.153	2.019	1.884	1.75	1.5	1.48
	100	95	90	85	80	75	70	65	60	55

SCREW WHEELS.

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	35	35	35	30	30	30	30	30	30	30	30
20	8.75	7.875	7.	22.5	21.	19.5	18.	16.5	15.	14.25	13.5
25	7.	6.3	5.6	18.	16.8	15.6	14.4	13.2	12.	11.4	10.8
30	5.833	5.25	4.666	15.	14.	13.	12.	11.	10.	9.5	9.
35	5.	4.5	4.	12.857	12.	11.142	10.284	9.428	8.571	8.142	7.714
40	4.375	3.937	3.5	11.25	10.5	9.75	9.	8.25	7.5	7.125	6.75
45	3.888	3.5	3.111	10.	9.333	8.666	8.	7.333	6.666	6.333	6.
50	3.5	3 15	2.8	9.	8.4	7.8	7.2	6.6	6.	5.7	5.4
55	3.181	2.863	2.545	8.181	7.636	7.091	6.545	6.	5.454	5.181	4.909
60	2.916	2.625	2.333	7.5	7.	6.5	6.	5.5	5.	4.75	4.5
65	2.692	2.423	2.153	6.923	6.461	6.	5.538	5.077	4.615	4.23	4.154
70	2.5	2.25	2.	6.428	6.	5.571	5.142	4.714	4.285	4 071	3.857
75	2.333	2.1	1.866	6.	5.6	5.2	4.8	4.4	4.	3.8	3.6
80	2.187	1.968	1.75	5.625	5.25	4.875	4 5	4.125	3.75	3.562	3.375
85	2.058	1.879	1.647	5.294	4.941	4.588	4.235	3.882	3.529	3.353	3.176
90	1.944	1.75	1.555	5.	4.666	4.333	4.	3.666	3.333	3.166	3.
95	1.842	1.657	1.473	4.737	4.421	4 105	3.789	3.473	3.157	3.	2.842
100	1.75	1.575	1.4	4.5	4.2	3.9	3.6	3.3	3.	2 85	2.7
110	1.590	1.431	1.272	4.091	3.818	3.545	3.272	3.	2.727	2.590	2.454
120	1.458	1.312	1.166	3.75	3.5	3.25	3.	2.75	2.5	2.375	2.25
130	1.346	1.211	1.076	3.461	3.230	3.	2.769	2.538	2.507	2.115	2.077
	50	45	40	150	140	130	120	110	100	95	90

SCREW WHEELS.

PINION 20.

INTERMEDIATE WHEELS.

MANDREL WHEELS.	30	30	30	30	30	30	30	30	30	30
20	12.75	12.	11.25	10.5	9.75	9.	8.25	7.5	6.75	6.
25	10.2	9.6	9.	8.4	7.8	7.2	6.6	6.	5.4	4.8
30	8.5	8.	7.5	7.	6.5	6.	5.5	5.	4.5	4.
35	7.284	6.857	6.428	6.	5.571	5.142	4.714	4.285	3.857	3.427
40	6.375	6.	5.625	5.25	4.875	4.5	4.125	3.75	3.375	3.
45	5.666	5.333	5.	4.666	4.333	4.	3.666	3.333	3.	2.666
50	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.	2.7	2.4
55	4.636	4.363	4.091	3.818	3.545	3.272	3.	2.727	2.454	2.181
60	4.25	4.	3.75	3.5	3.25	3.	2.75	2.5	2.25	2.
65	3.923	3.692	3.461	3.23	3.	2.769	2.538	2.307	2.077	1.846
70	3.642	3.428	3.214	3.	2.785	2.571	2.357	2.142	1.928	1.714
75	3.4	3.2	3.	2.8	2.6	2.4	2.2	2.	1.8	1.6
80	3.187	3.	2.812	2.625	2.437	2.25	2.062	1.875	1.687	1.5
85	3.	2.823	2.647	2.47	2.294	2.117	1.941	1.764	1.588	1.411
90	2.833	2.666	2.5	2.333	2.166	2.	1.833	1.666	1.5	1.333
95	2.684	2.526	2.368	2.210	2.052	1.894	1.736	1.578	1.421	1.263
100	2.55	2.4	2.25	2.1	1.95	1.8	1.65	1.5	1.35	1.2
110	2.318	2.181	2.045	1.909	1.772	1.636	1.5	1.363	1.227	1.091
120	2.125	2.	1.875	1.75	1.625	1.5	1.375	1.25	1.125	1.
130	1.961	1.846	1.730	1.615	1.5	1.384	1.269	1.153	1.038	.923
	85	80	75	70	65	60	55	50	45	40

SCREW WHEELS.

TABLE FOR MAKING THE UNIVERSAL TAPS, WITH THE MOST SUITABLE PROPORTIONS REQUISITE FOR GOOD WORKING TAPS USED BY HAND.

From 1/4 to 9/16 the head is turned the same size as the screw; the 5/8, and all above, to pass through the holes screwed. As the same table shows the size of tap and bottom of screw, the workman will be enabled to make the tapping holes a size that will insure a full thread. The bottom of screw will give the size for drills, bits, etc.

Diameter of tap.	Bottom of thread, or tapping-hole.	Full length of tap.	Length of screw part.	Head length of square.	Number of threads per inch.	Wheels for cutting the screws.			
						Mandrel.	Intermediate.	Pinion.	Screw.
1/4	3/16	2 1/4	1 1/8	7/16	20	40	80	20	100
5/16	1/4	2 1/2	1 5/16	7/16	18	40	80	20	90
3/8	1/4 and 3/64	2 3/4	1 1/2	9/16	16	45	80	20	90
						Simple wheels.			
7/16	11/32	3 1/8	1 3/4	5/8	14	20	....	....	140
1/2	13/32	3 1/2	2	11/16	12	20	....	....	120
9/16	15/32	3 3/4	2 1/8	11/16	12	20	....	....	120
5/8	1/2 and 1/64	4	2 1/4	3/4	11	20	....	....	110
11/16	9/16 and 1/64	4 1/4	2 3/8	3/4	11	20	....	....	110
3/4	5/8	4 1/2	2 5/8	3/4 and 1/16	10	20	....	....	100
7/8	11/16 and 3/64	5	2 7/8	7/8	9	20	....	....	90
1	3/4 and 3/32	5 1/2	3 1/4	7/8	8	20	....	....	80
1 1/8	15/16	6	3 1/2	1	7	20	..	....	70
1 1/4	1 and 3/64	6 1/2	3 3/4	1 1/8	7	20	....	....	70
1 3/8	1 5/32	7	4 1/4	1 1/4	6	20	....	....	60

TABLE FOR MAKING THE UNIVERSAL TAPS—(Continued.)

Diameter of tap.	Bottom of thread, or tapping-hole.	Full length of tap.	Length of screw part.	Head length of square.	Number of threads per inch.	Wheels for cutting the screws.	
						Mandrel.	Screw.
1 1/2	1 9/32	7 3/4	4 3/4	1 3/8	6	20	60
1 5/8	1 11/32	9	5 1/4	1 3/8	5	20	50
1 3/4	1 7/16 and 3/64	9 1/2	5 3/4	1 3/8	5	20	50
1 7/8	1 19/32	10	6 1/4	1 1/2	4 1/2	40	90
2	1 5/8 and 3/32	11	6 3/4	1 1/2	4 1/2	40	90
2 1/8	1 3/4 and 3/32	11 1/2	7 1/4	1 1/2	4 1/2	40	90
2 1/4	1 7/8 and 1/16	12	7 3/4	1 5/8	4	40	80
2 3/8	2 3/64	12 1/2	8 1/4	1 5/8	4	40	80
2 1/2	2 3/16	13	10 3/4	1 5/8	4	40	80
2 5/8	2 5/16	13	9 1/4	1 3/4	4	40	80
2 3/4	2 3/8	13 1/2	9 3/4	1 3/4	3 1/2	40	70
2 7/8	2 1/2	13 1/2	10	1 3/4	3 1/2	40	70
3	2 5/8	14	10	2	3 1/2	40	70

UNIVERSAL GAS-PIPE THREADS.

DIAMETER.	WHEELS FOR CUTTING, ETC.				Pitch.
	Man-drel.	Interme-diate.	Pinion.	Screw.	
1 1/4, and all above	85	80	20	120	11.294
1	20	....	....	140	14.
3/4	20	....	....	140	14.
5/8	30	65	20	85	18.412
Small brass tube..	30	60	20	120	24.

HOW PUMICE STONE IS MADE.

Pumice stone is now prepared by molding and baking a mixture of white feldspar and fire-clay. This product is said to have superseded the natural stone in Germany and Austria.

MACHINE POETRY.

We notice that some of our trade papers are dropping into "poetry," occasionally, on themes not unconnected with industrial pursuits. If they would thoroughly discourage every man who writes machine poetry, the world would gain something. Verses and rhymes are not poetry; usually they are far from it, and one called "sawdust" is a case in point. Here is a sample verse:

The mill-saw with its teeth of steel
  Bites through the log upon the tram,
And drops the dust like golden meal
  Into the stream below the dam.

Well, what of it? This is a prosaic fact, not at all poetic, and the versifier has not clothed it with a poetic thought; it is merely a rhymed statement of an obvious occurrence. Any one can write this sort of thing with a running pen. Applying it to our own trade, we say:

The steam from out the 'scape pipe floats
  Into the ambient air,
And takes the form of billy goats,
  Which jump, and buck, and "rare."

[N. B.—Rear is the proper word, but it will not rhyme.]

If persons who are determined to write machine poetry would only reflect several times before publishing once, we are sure that they would avoid mortification in the future.

CEMENT TO MEND IRON POTS AND PANS.

Take two parts of sulphur, and one part, by weight, of fine black lead; put the sulphur in an old iron pan, holding it over the fire until it begins to melt, then add the lead; stir it well until all is mixed and melted; then pour it out on an iron plate or smooth stone. When cool break into small pieces. A sufficient quantity of this compound being placed upon the crack of the iron pot to be mended, can be soldered by a hot iron in the same way a tinsmith solders his sheets. If there is a small hole in the pot, drive a copper rivet in it, and then solder over with cement.

BIG BELTS AND FLY-WHEELS.

Here are three interesting queries:

Where is the widest machine belt in the world?

Where is the largest fly-wheel in the world?

Where is the most expensive trip-hammer in the world?

Here's a photograph of the largest leather belt in the universe," said a young man at 29 Ferry street, to whom the first question was repeated, holding up a picture of a big coil of leather. "That belt is 72 inches wide and 100 feet long, and it weighs nearly 2,000 pounds, and is capable of transmitting over 1,200 horse-power. The belt is such a huge affair that it had to be made four ply thick — that is, three layers had to be added to the original single strip of leather in order to keep it down snug on the surface of the driving wheel when in operation. It's a corker, and anybody can get a good look at it by going over to the big carpet factory in President street, Brooklyn. The 60-inch belt that runs the machinery of the electric light station in Elizabeth street in this city, was the biggest leather belt in the world before the 72-inch giant was brought out. The 60-inch mammoth was one of the wonders at the Centennial Exposition in 1876. We have since made a 69-inch belt for the rope factory at 139 Front street, and a 50-inch belt for a big warehouse company on the Brooklyn water-front. When you are told that ordinary single belts cost ten cents an inch, and the price doubles as you double the leather, you can get an idea of the neat sum of money it takes to own one of these mighty curios in the leather line."

"Yes," said President John D. Cheever, of the Rockaway Steeplechase Association, "there are some tremendous leather belts in this world, but rubber belts are not far behind in the point of size either. Some months ago a New York belting and packing manufacturing company used up 88,000 pounds of rubber and cotton duck in a single order for three giant belts. One was a driving-belt 52 inches wide, 8-ply thick, and 298 feet long. It weighed 4,000 pounds, and was the biggest thing in rubber ever produced. The other two were carrying-belts, each three feet wide and nearly a half mile long, and each weighed 11,000 pounds. To make them of leather would have required 1,000 selected hides. All the belts were shipped to West Superior, Wis. This same company made what is known as "the champion" carrying-belt of the world. It is now in operation at the Pennsylvania Railroad Company's grain elevator in Jersey City. It is 2,700 feet long, weighs 16,000 pounds, and runs on small rollers. It is used to carry grain from one end of the elevator to the other, for delivery into the chute at the end of the dock.

"Quite as remarkable as the great size of these rubber belts, is the process of their manufacture. Great tensile strength is imparted to the belts by a webbing of cotton duck, through the meshes of which the rubber is driven by powerful machinery. This duck possesses usually more than double the strength of the duck used for ships' sails. The rubber itself is prepared by an elaborate process. The sulphur used to vulcanize it is all tested and weighed with the greatest care. It is mixed with metallic oxides, and makes a semi-metallic compound that gives to the rubber a very considerable degree of firmness, and enables it to resist high degrees of heat, and at the same time does not reduce its elasticity too much. The different thicknesses of rubber used to make the monster belts are laid over each other so that, by folding over the outside strip at the edges, a perfectly even and rounded edge is secured. In this form the thicknesses are passed between powerful heated rollers, and afterward are finished in a giant steam press. Steam is let into the bed and platen of the press in a way that enables the engineers to control the temperature perfectly, and the pressure and heat are applied simultaneously to the rubber while it is under the heaviest strain that it is designed to subject it to when working machinery. The fibers are thus pressed together as compactly as if they were steel instead of rubber and duck."

The second query about fly-wheels was found to be one of those that Lord Dundreary used to complain that no fellow could find out. There are giant fly-wheels all over the country, and it would be like finding a needle in a hay-stack to pick out the boss of the lot. An expert said that fly-wheels thirty feet in diameter were often met with. The largest he had ever seen was a thirty-four foot mammoth in a shirt factory at new Bedford, Mass. Grass grew everywhere in the town excepting just around this wheel. There were several giant wheels over thirty feet in factories at Fall River and in iron works in Trenton. As a rule, driving wheels are rarely made larger than thirty feet. The thirty-four-foot monster at New Bedford is a gear wheel. A thirty-foot monster, that weighed six tons, burst on December 23, in a knitting mill at Amsterdam, N. Y. It was almost as destructive as an explosion of gunpowder.

The greatest and most costly trip-hammer in the world is the tremendous structure in the Krupp gun works in Germany, and the next largest is in England. America has a giant of her own in the Washington Navy Yard.

What is as great a marvel about these immense hammers as their size is the ease with which they are operated, and the manner in which their ponderous movements can be controlled. In any one of the three historic machines, the descent of the hammer to the bed plate can be checked instantly at will, by touching a small steel lever at the side of the hammer. The Emperor of Germany was amazed when he saw the thing done at Krupp's works, on the occasion of one of the royal visits to that famous establishment. It is related that the Emperor took from his pocket an expensive gold watch, and laid it on the bed plate of the great hammer. The engineer told the Emperor that he would bring the hammer down with all its power, and stop it just in time to save the watch from injury. The machinery was started, and the hammer descended with a swoop. If it struck the watch, it would certainly crush it as completely as if the whole factory had tumbled on it. The engineer kept a watchful eye on it, though, and, just as the Emperor thought his watch was going to be smashed, the engineer pushed the lever, and the huge iron hammer stopped instantly within a fraction of an inch of the surface of the timepiece. The Emperor was awed by the engineer's dextrous skill.

"You may keep the watch," he said. "That is the most amazing thing I ever saw."

Uncle Sam's employé in the Washington Navy Yard tries a more thrilling experiment than the engineer in Krupp's works did. When Americans go to Washington to see the sights, and he wants to show how perfect his control of the enormous hammer is, he puts his finger on the plate, and holds it there without wincing until the great hammer falls. Then he stops the fall dramatically just in time to save the digit. Everybody who sees the experiment, and recovers from the start it gives, declares that it is a tremendous piece of nerve, as well as skill, on the part of the engineer.

"WASTE" NO LONGER A WORD IN MECHANICS.

The complete erasure in the word "waste" from the dictionaries, at all events in so far as it has any relation to industrial products, is, if not quite an accomplished fact, undoubtedly becoming more and more imminent; and we may thank the chemists of this generation for teaching us how to recover and utilize innumerable substances which, in their ignorance, our grandfathers threw away. Thirty years ago the manufacturers of iron, gas and chemicals neglected all but the prime objects of their industries, whereas to-day, on the system of taking care of the pennies, and allowing the pounds to take care of themselves, competition has induced us to regard our legionary by-products as so many integral parts or branches of each enterprise If the intelligent men who have "gone before," and who were looked upon by their contemporaries as wise in their generation, could by any chance reappear among us, we might conduct them to our gas works, and with a certain pride, explain the origin of our sulphate of ammonia, our aniline dyes and our hundred other extracts from coal tar. From the contemplation of gas we could turn with them to some of our smelters and furnaces, and point to the mineral wool, the cement, the glassware, the pottery, the fire-bricks, and the fertilizer, all derived from our furnace slag, and, finally, entering a great chemical works, we should show them how the once devastating gases, so fatal to life and vegetation, are no longer sent free into the air, but are condensed and transformed into staple articles of trade, and how, by an ingenious and, to them, undreamed of process, we extract the precious metals from our exhausted sulphur ores. To their wondering question, "How can these things be?" we might reply that all these marvels result from a modern and enlightened policy, which, in many countries, has fostered every species of research in every branch of science, encouraged great minds to ponder over and gradually unravel the mysteries of nature, and stimulated a general thirsting for that knowledge, which, properly applied, must ever ameliorate our condition in this "vale of tears."

COMBUSTIBILITY OF IRON PROVED.

Combustion is not generally considered one of the properties of iron, yet that metal will, under proper conditions, burn readily. The late Professor Magnus, of Berlin, Germany, devised the following method of showing the combustibility of iron: A mass of iron filings is approached by a magnet of considerable power, and a quantity thereof is permitted to adhere to it. This loose, spongy tuft of iron powder contains a large quantity of air imprisoned between its particles, and is, therefore, and because of its extremely comminuted condition, well adapted to manifest its combustibility. The flame of an ordinary spirit lamp or Bunsen burner readily sets fire to the finely divided iron, which continues to burn brilliantly and freely. By waving the magnet to and fro, the showers of sparks sent off produce a striking and brilliant effect.

The assertion that iron is more combustible than gunpowder, has its origin in the following experiment, which is also a very striking one: A little alcohol is poured into a saucer and ignited. A mixture of gunpowder and iron filings is allowed to fall in small quantities at a time into the flame of the burning alcohol, when it will be observed that the iron will take fire in its passage through the flame, while the gunpowder will fall through it and collect beneath the liquid alcohol below unconsumed. This, however, is a scientific trick, and the experiment hardly justifies the sweeping assertion that iron is more combustible than gunpowder. The ignition of the iron under the foregoing circumstances is due to the fact that the metal particles, being admirable conductors of heat, are able to absorb sufficient heat in their passage through the flame — brief as this is — and they are consequently raised to the ignition point. The particles of the gunpowder, however, are very poor conductors of heat, comparatively speaking, and, during the exceedingly brief time consumed in their passage through the flame, they do not become heated appreciably, or certainly not to their point of ignition. Under ordinary circumstances, gunpowder is vastly more inflammable than iron.

Another method of exhibiting the combustibility of iron, which would appear to justify the assertion that it is really more combustible than gunpowder, is the following: Place in a refractory tube of Bohemian glass a quantity of dry, freshly-precipitated ferric exide. Heat this oxide to bright redness, and pass a current of hydrogen through the tube. The hydrogen will deprive the oxide of its oxygen, and reduce the mass to the metallic state. If, when the reduction appears to be finished, the tube is removed from the flame, and its contents permitted to fall out into the air, it will take fire spontaneously and burn to oxide again. This experiment indicates that pure iron, in a state of the extremest subdivision, is one of the most combustible substances known — more so, even, than gunpowder and other explosive substances which require the application of considerable heat, or a spark, to ignite them.

HOW IRON BREAKS.

Hundreds of existing railway bridges which carry twenty trains a day with perfect safety would break down quickly with under twenty trains an hour, writes a British civil engineer. This fact was forced on my attention nearly twenty years ago, by the fracture of a number of iron girders of ordinary strength under a five-minute train service. Similarly, when in New York last year, I noticed, in the case of some hundreds of girders on the elevated railway, that the alternate thrust and pull on the central diagonals from trains passing every two or three minutes had developed a weakness which necessitated the bars being replaced by stronger ones, after a very short service. Somewhat the same thing had to be done recently with a bridge over the river Trent, but, the train service being small, the life of the bars was measured by years instead of months. If ships were always among great waves the number going to the bottom would be largely increased. It appears natural enough to every one that a piece, even of the toughest wire, should be quickly broken if bent back and forward to a sharp angle; but, perhaps, only to locomotive and marine engineers does this appear equally natural that the same results would follow in time if the bending were so small as to be quite imperceptible to the eye. A locomotive crank axle bends but one eighty-fourth of an inch, a straight driving-axle a still smaller amount, under the heaviest bending stresses to which they are subject, and yet their life is limited. During the year 1883 one iron axle broke in running, and one in fifteen was renewed in consequence of defects. Taking iron and steel axles together, the number then in use on the railways of the United Kingdom was 14,847, and of these 911 required renewal during the year. Similarly, during the past three years, no less than 228 ocean steamers were disabled by broken shafts, the average safe life of which is said to be about three or four years. Experience has proved that a very moderate stress, alternating from tension to compression, if repeated about 100,000,000 times. will cause a fracture as surely as bending to an angle only ten times.

VALUE OF EMERY WHEELS.

The increased quantity and quality of work that goes out of the modern machine shop is due to the skillful use of solid emery wheels. A grain of sand from the common grindstone, magnified, would look like a cobble stone, a fracture of which shows an obtuse angle, whereas a grain of corundum or emery would look like a rhomboid, always breaking with a square or concave fracture. No matter how much it is worn down in use, it does not lose its sharpness; hence it is evident that the grindstone rubs or grinds and heats the work brought in contact with it, while the corundum, or emery wheel, with its sharp, angular grit, cuts like a file or angular saw.

There are two general classes of emery wheels in the market—one class of wheels has the grains of emery joined and consolidated by a pitchy material, as rubber, linseed oil, shellac, etc. These must run at a high speed to burn out the cementing material by friction, loosening the worn-out grains, and thus revealing new cutting angles. These are non-porous wheels. Truing up this class of wheels is done with a diamond tool.

The other class consists of two kinds, one made by mixing the emery with a mineral cement and water into a paste, which will harden and bind the grains together; the other kind, by mixing the emery with a mineral flux or clay, molding into shape, and burning in a muffle at a high temperature. These are porous wheels, in which the grains of emery are held together by matter having affinity therefor. This class of wheels, unlike the grindstone, has sharp grains of emery bedded together among matter which, in some cases, is as hard and sharp as the emery itself. Such wheels cut very greedily, and do not need to be run at any particular speed.

The dresser, made of hardened steel picks, is the proper tool for truing up this class of wheels.

Manufacturers in metal goods aiming at reducing the cost of production, would do well to look into the adaptability of the solid emery wheels or rotary file, and other labor-saving machinery, before deciding on reducing labor wages.

THE SECRET OF CAST STEEL.

The history of cast steel, remarks a contemporary, presents a curious instance of a manufacturing secret stealthily obtained under the cloak of an appeal to philanthropy. The main distinction between iron and steel, as most people know, is that the latter contains carbon. The one is converted into the other by being heated for a considerable time in contact with powdered charcoal in an iron box. Now, steel thus made is unequal. The middle of a bar is more carbonized than the ends, and the surface more than the center. It is, therefore, unreliable. Nevertheless, before the invention of cast steel, there was nothing better. In 1760 there lived at Attercliffe, near Sheffield, a watchmaker named Huntsman. He became dissatisfied with the watch-spring in use, and set himself to the task of making them homogeneous. "If," thought he, "I can melt a piece of steel and cast it into an ingot, its composition should be the same throughout." He succeeded. His steel soon became famous. Huntsman's ingots for fine work were in universal demand. He did not call them cast steel. That was his secret. About 1780 a large manufactory of this peculiar steel was established at Attercliffe. The process was wrapped in secrecy by every means within reach. One midwinter night, as the tall chimneys of the Attercliffe steel works belched forth their smoke a traveler knocked at the gate. It was bitterly cold, and the snow fell fast, and the wind howled across the moat. The stranger, apparently a plowman or agricultural laborer seeking shelter from the storm, awakened no suspicion. Scanning the wayfarer closely, and moved by motives of humanity, the foreman granted his request, and let him in. Feigning to be worn out with cold and fatigue, the old fellow sank upon the floor, and soon appeared to sleep. That, however, was far from his intention. He closed his eyes apparently only. He saw workmen cut bars of steel into bits, place them in crucibles, and thrust the crucibles into a furnace. The fire was urged to its extreme power until the steel was melted. Clothed in wet rags to protect themselves from the heat, the workmen drew out the glowing crucibles and poured their contents into a mold. Mr. Huntsman's factory had nothing more to disclose. The secret of making cast steel had been discovered.

IRON AND STEEL MAKING IN INDIA.

Indian Engineering, in a recent issue, gives a most interesting account of the manufacture of iron and steel in India, which we reproduce below:

Notwithstanding the simplicity of their processes, the iron turned out by the natives is of superior quality, and is selling very cheaply; so, for instance, a mound of horseshoes sells at Rs. seven, and of clamp iron Rs. six-eighths. These low prices are accounted for by cheap fuel, the rich ores, the miserably cheap labor, and the absence of managing expenses.

There are reasons to believe that "Wootz" (Indian cast steel) has been exported to Asia Minor more than 2,000 years ago; how long, however, its manufacture has been commenced, cannot be traced.

The following is a description of the method for making "Wootz" employed by the natives at Hyderabad.

The minute grains or scales of iron are diffused in a sandstone-like gneiss or mica schist, passing into a hornblende slate. These rocks are excavated with crowbars, and then crushed between stones; if hard, this is done after preliminary roasting.

The ore is then separated from the powdered rock by washing. This was at a village called Dundurti, but the process of manufacture was the same as that at Kona Samundrum, twelve miles south of the Godavari, and twenty-five from Nirmal, which has been described by Dr. Voysey. The furnace was made of a refractory clay, derived from decomposed granite, and the crucibles are made of the same, ground to a powder together with fragments of old furnace and broken crucibles kneaded up with rice, chaff and oil. He states that no charcoal was put into the crucible, but some fragments of old glass slag were. A perforation was made in the luted cover. Two kinds of iron, one from Mirtapalli and the other from Kondapore, were used in the manufacture of the steel. The former was made from magnetic sand, and the latter from an ore found in the iron clay (? laterite) twenty miles distant; the proportions used of each were 3 to 2.

This mixture being put into the crucible in small pieces, the fire was kept up at a very high heat for twenty-four hours by means of four bellows, and was then allowed to cool down. Cakes of steel of great hardness, and weighing on the average 1½ lbs., were taken from each crucible. They were then covered with clay and annealed in the furnace for twelve to sixteen hours; then cooled, and, if necessary, the annealing was repeated till the requisite degree of malleability had been obtained. The Telinga name for this steel was "Wootz," and "Kurs" or cake of it, weighing 110 rupees, was sold on the spot for eight annas. The daily produce of a furnace was 50 seers, or in value Rs. 37.

Also Mysore is a country where the manufacture of iron and steel by the natives was of great importance owing to the excellent quality of its produce.

The iron was made from black sand, which the torrents, formed in the rainy season, brought down from the rocks. The furnaces in the Chin-Narayan Durga taluk were on a small scale, the charge of ore being 42½ pounds, from which about 47 per cent. of the metal was obtained. Work was carried on for only four months, the smelters taking to cultivation during the remainder of the year. The stone ore was smelted in the same way as the iron sand, but the latter, it is said, was alone fit for manufacturing into steel. There were in this vicinity five steel forges, four in the above taluk, and one at Devaraya, Durga.

The furnace, of which a figure is given by Buchanan, consisted of a horizontal ash-pit and a vertical fire-place, both sunk below the level of the ground. The ash-pit was about three-fourths of a cubit in width and height, and was connected with a refuse pit into which the ashes could be drawn. The fire-place was a circular pit, a cubit in width, which was connected with the ash-pit, being from the surface of the ground to the bottom two cubits in depth. A screen or mud-wall five feet high, protected the bellows-man from heat and sparks. The bellows were of the ordinary form, a conical leather sack with a ring at the top, through which the operator passed his arm.

The crucibles, made of unbaked clay, were conical in form, and of about one pint capacity. Into each a wedge of iron and three rupees' weight of the stem of the *Cassia Auriculata* and two green leaves of a species of convolvulus or *Ipomaia* were put. The mouths of the crucibles were then covered with round caps of unbaked clay, and the junctures well luted.

They were then dried near the fire, and were ready for the furnace. A row of them was first laid round the sloping mouth of the furnace; within these another row was placed, and the center of the dome, so formed, was occupied by a single crucible, making fifteen in all.

The crucible opposite the bellows was then withdrawn, and its place occupied by an empty one, which could be withdrawn in order to supply fuel below. The furnace, being filled with charcoal, and the crucibles covered with the same, the bellows were plied for four hours, after which the operation was completed. When the crucibles were opened, the steel was found melted into a button with a sort of crystalline structure on its surface, which showed that complete fusion had taken place. These buttons weighed about twenty-four rupees. There were thirteen men to each furnace, a head man to make and fill the crucibles, and four relays of three men each, one to attend the furnace, and two for the bellows.

Each furnace manufactured forty-five pagodas' worth of 1,800 wedges of iron into steel. The net profit was stated to be 1,253 fanams, but into the further details as to cost it is not, perhaps, necessary to enter. The total production of steel in this vicinity was estimated to be 152 cwt., or about £300 per annum.

The principal sources of the ores were the magnetic sand found in rivers, and the richer portion of the laterite.

THE SWISS PATENT LAW.

The Republic of Switzerland has passed a law for the protection of inventions, thus following in the wake of other nations. The final disposition of the question, however, as to whether the law shall be operative or not, will first require the petitions of 30,000 voters asking its submission to the people. That point gained, the law must then be submitted to a vote and be approved by a majority It is not stated whether the

Swiss Government has a patent on this method of giving a law force. It will take three months to carry out this rigmarole. Material objects, and not processes, are protected. It is said that "this feature is due to the efforts of the manufacturers of aniline colors and chemicals, whose interests would be injuriously effected by a law as comprehensive as that of the United States, which protects 'useful arts' and 'compositions of matter,' as well as tools and machines."

HOW BREAKS IN SUBMARINE CABLES ARE DETECTED AND REPAIRED.

The following is an account of how submarine cables are found and repaired at an immense depth:

The break, which the "Minia" was sent to repair, occurred early last summer. The officers of the company first located the distance of the break from the stations on shore, on each side of the ocean. The details of the instrument by which this is done are not easily described, though easily understood in principle. The machine consists of a series of coils of wire, which offer a known resistance to the electric current. Enough of the coils are connected to make a resistance equal to the resistance offered by the entire cable when it is in working order, and thus, when the machine and the cable are connected, a balance is effected. But, if the cable should break, the balance is destroyed, because that portion of the cable between the shore station and the break, wherever it may be, will offer less resistance to the electric current than the entire cable would do. Enough coils of wire are therefore disconnected from the machine to restore the balance. The resistance of the part of the cable that remains intact is thus accurately determined by the number of coils remaining connected with the machine. Having, when the cable was intact, learned the resistance which a mile of the cable offers, by dividing the entire resistance by the number of miles of cable, it is easy to find how many miles of cable are still in good order, by dividing the entire resistance of the piece by the known resistance of one mile

Having determined how many miles from the shore station the break is, orders are sent to go to the place, pick up the ends, and splice them to new piece. Having received such an order and acted on it, Captain Trott found himself and his ship, on July 25th last, in latitude 42° 30′ north, and longitude 46° 30′ west, or just to the eastward of the Grand Banks of Newfoundland, with one of the hardest jobs before him that he had had in some time, for sounding showed that the water was about 13,000 feet, or a good deal more than two miles deep. He knew he was somewhere near the break in the cable, but he did not know absolutely within about three or four miles, because, while he had been able to determine his own position by repeated observations of the sun and stars, he could not tell how accurate the observations of the officers of the ship laying the cable had been.

The first work done was to get a series of soundings over a patch of the sea aggregating twenty-five or thirty square miles. The sounding apparatus consisted of an oblong shot of iron, weighing about thirty-two pounds, attached to a pianoforte wire in such a way that, when lowered to the bottom, the shot would jab a small steel tube into the mud down there, and would then release itself from the wire, and allow the sailors to draw up the tube with the mud in it. The moment the weight was released, the men on deck stopped paying out the wire, and thus, knowing how much wire had been run out, they were able to tell the depth. It is a fact that it took twenty-four minutes and ten seconds for the weight of the sounding apparatus to reach bottom in 2,097 fathoms of water.

The ship was now ready to begin the search proper for the cable. She was run off at right angles to the line of the cable for a distance of five miles, and a buoy got down to mark the limits of the territory to be grappled over in that direction. Buoys were afterward set elsewhere to mark the other limits of the territory. The grappling iron was lowered over the bows, the rope attached to it passing over one of the three big grooved wheels that revolve where the bowsprit of an ordinary vessel stands.

The grappling iron used is the invention of Captain Trott. It looks something like a four-pronged anchor. It has a shaft four feet long, and four arms about a foot long, that are set at right angles to each other at the bottom of the shaft. Right in each crotch formed by the arms is a little button that has a spring behind it that may be regulated in strength. The button projects a third of an inch into the crotch. The angle of the arms with the shaft is so small that a rock could not get down in so far as to reach the button; but, when the cable is caught by the hooks, it presses down against the button, and thus closes an electrical circuit through a copper wire running through the grapnel's rope and the grapnel itself, and a bell is set ringing upon deck. But the experienced men in charge of the grappling are generally able to tell what the hook has hold of without the aid of the bell.

They judge by the strain on the rope, which is indicated by a dynamometer on deck. The ordinary strain on the dynamometer is from 3 to 3¼ tons when the grapnel is dragging freely over a smooth bottom as the vessel forges slowly ahead. Sometimes a rock catches on the hooks. This frequently breaks off an arm, but sometimes it fetches clear, the strain indicated by the dynamometer informing the old sailor man in charge whether an accident has happened or not.

It took two hours and twenty minutes to get the grappling iron from the bow of the ship down to the bottom of the sea, 13,000 feet below. The cable used to drag it with is the patent wire and hemp invention of the captain. The dragging began on July 25th, the day of arrival, but they swept backward and forward over the territory for ten days without finding the broken telegraph cable. A good part of the time they were steaming back and forth day and night, and the only time when they were not doing so was when the weather was too bad. On such occasions they went to the buoy at the supposed end of the broken cable, and hove to till the gale was ended.

Finally, on August 5th, the bell rang, indicating that the grapnel had caught the cable. The grapnel drag rope was thereupon fastened to a buoy and thrown overboard. Then the steamer went off two miles toward the end of the broken cable and got out a cutting grapnel. This is like the other one, except that there are knives in the crotches. When these crotches catch the cable and strain comes on them, they cut the cable off clean.

"Why did you cut off the cable there?" was asked.

"Because, if we had tried to get up the bight of the cable where we first found it, the cable might have broken under the strain. That cable was laid in 1869, and is getting pretty well along in years. It would have been as apt to break on the shore side as the other, but, when we had only an end of two miles to deal with, we were sure of being able to get up without damage. We grappled European end first."

Having cut off the cable, the vessel returned to the buoy on the grappling rope, and, getting the rope inboard again, led it to a drum six feet in diameter located on the upper deck and operated by a steam engine. Then they began to wind in the grapnel rope and hoist the old cable to the bows. They started the drum at 1:20 in the afternoon of August 5, and at 7:51 had the bight of it at the bow of the ship. Then the two miles and odd of end that was hanging down from the bow was fished up and stretched in lengths along the deck until the end was reached. This was connected with a very complete cable telegraph office located amidships, and a second later the operators who had been on watch for days in the British station awaiting this event saw the flashes on a mirror in their office that told them all about it.

Sometimes it happens that, when an end of the cable is picked up in this way, and an attempt is made to communicate with the shore, it is found that there is another break, and that they have only the end of an odd section lying loose. Then they have to drop that over, after testing it to see how long it is, and go on toward the shore and begin over again. In this case, however, they found that they had hold of a sound wire to Great Britain. Without any delay, the end of a new cable was spliced to the old end brought from the bottom. Two experts, one who is trained in splicing cores, and one who is trained in splicing the outside or sheathing, are employed in this work.

When the splice was completed and tested, and found perfect, the cable was started, running out around drums and grooved wheels controlled by brakes, and over the stern, the old end having been led fair through these sheaves before the splicing was done. Then the ship headed for shoal water, and ran away at from three to four knots an hour until over a part of the banks where work could be done more easily than where the water was more than two miles deep. Of course this involved the abandonment of a good many miles of old cable, but the old cable wasn't of very much importance anyhow.

Arriving in shoal water, the end of the new piece was attached to a buoy and put overboard. Then the old cable was grappled and cut as before, and a new piece spliced to it. Then the ends of the two new pieces were spliced together and the job was complete. It had taken nearly two months to do it, although in the meantime two easier jobs were attended to, and a trip to Halifax for provisions was made, not to mention the encountering of the storm that damaged the rudder.

The "Minia" has a crew of ninety, all told, including the captain, three deck officers, a navigator, three expert electricians, four engineers, a purser and a surgeon. A blacksmith and a boiler maker, with their tools, are carried. There are three big, round tanks to hold the 600 miles of cable carried, which includes sizes to fit all the old cables under the charge of this ship. There is a cell-room where the electricity for telegraphing is generated, and two dynamos with their engines, one to furnish electricity for a system of arc lights used when at work at night, and the other for the incandescent system that lights the ship below decks. The main saloon is large, and is comfortably and handsomely fitted. The captain has a cabin under the turtle-back aft, as fine as any captain could wish for, and the other officers have rooms below that are as well fitted as those usually occupied by naval officers. The crew are all expert men, and get pay that averages a good deal better than the pay in the packet service between New York and Liverpool. The entire crew is kept under pay the year round, the ship making her head-quarters at Halifax when not engaged in repairing cables. They are as comfortable a lot of sailor men as one could find anywhere.

THE LONGEST ELECTRIC RAILROAD IN THE COUNTRY.

The longest electric railroad in this country is one under contract at Topeka, Kansas. The length of the road is to be fourteen miles and will require fifty cars. The Thomson-Houston system has been applied.

The breaking strain on various metals is shown in the following table, the size of the rod tested being in each case one inch square, and the number of pounds the actual breaking strain:

	Pounds.
Hard steel	150,000
Soft steel	120,000
Best Swedish iron	84,000
Ordinary bar iron	70,000
Silver	41,000
Copper	35,000
Gold	22,000
Tin	5,500
Zinc	2,600
Lead	860

To make varnish adhere to metal, add five-hundredths per cent. of boracic acid to the varnish.

Machinery will do almost anything, and what machinery can't do a woman can with a hairpin.

To find the weight of a cast-iron ball, Haswell says—Multiply the cube of the diameter in inches by 1365, and the product is the weight in pounds.

NUMBER OF REVOLUTIONS OF WATCH WHEELS.

Very few who carry a watch ever think of the unceasing labor it performs under what would be considered shabby treatment for any other machinery. There are many who think a watch ought to run for years without cleaning, or a drop of oil. Read this and judge for yourself: The main wheel in an ordinary American watch makes 4 revolutions a day of 24 hours, or 1,460 in a year. Next, the center wheel, 24 revolutions in a day, or 8,760 in a year. The third wheel 192 in a day, or 59,080 in a year. The fourth wheel, 2,440 in a day, or 545,600 in a year. The fifth, or 'scape wheel, 12,960 in a day, or 4, 728,200 in a year. The ticks or beats are 388,800 in a day, or 141,882,000 in a year.

A VALUABLE POINT FOR MOLDERS.

It is claimed that a saving, as well as a better job, can be effected by the substitution of the following for the coal dust and charcoal used with green sand: Take one part common tar, and mix with 20 parts of green sand; use the same as ordinary facing. The castings are smooth and bright, as tar prevents metal from adhering to the sand, prevents formation of blisters, and helps the production of large castings by absorbing the humidity of the sand.

METRICAL AND CENTIGRADE EQUIVALENTS.

As much of the scientific literature of the steam engine, the metrical system of weights and measures and the centigrade thermometrical scale are used, we publish the following equivalents, which may be of use to our readers in readily reducing them to British units:

1 kilogrammetre	7,233 foot pounds.
1 foot pound	.188 kilogrammetre.
1 French horse power (chevelvapeur) 75 kilogrammetres per second	.9863 horse power.
1 British horse power	1.0139 chevaux.
1 kilogramme per cheval	2,239 pounds H. P.
1 pound per horse power	.447 kilo. per cheval.
1 caloric, or French heat unit	3.968 British units.
1 British thermal unit	.252 caloric.
French mechanical equivalent, 423.55 (usually called 424) kilogrammetres	3063. 5 ft. pounds.
English mechanical equivalent, 772 foot pounds	10.76 kilogrammetres.

A NEW ALLOY.

An alloy, the electrical resistance of which diminishes with increase of temperature, has recently been discovered. It is composed of copper, manganese and nickel. Another alloy, due to the same investigator, the resistance of which is practically independent of the temperature, consists of 70 parts of copper combined with 30 of ferro-manganese

USE OF NATURAL GAS IN CUPOLAS.

At Pittsburgh, Pa., natural gas has been utilized in cupolas for ordinary castings. The apparatus consists of a series of pipes, covered with fire-clay tiles, and, at the same time, ventilating the pipes with a current of air. A combustion chamber is necessarily connected with the furnace, to insure the required heat and prevent the chilling of the furnace.

A NEW CEMENT.

A cement called magnesium oxychloride, or white cement, has been discovered, and is now manufactured in California, as we learn from an exchange. It is composed of one-half (½) magnesium oxide, which is obtained from the magnesite deposits in the Coast Range, and one-half (½) magnesium chloride, obtained from various sea-salt manufactories throughout the State. It may be used for sidewalks, and for interior decorating, and in appearance resembles pure white marble. It has a natural polish, and, above all, is much cheaper than any of the other substances now in use.

HOW TO CAST A FACE.

The person whose face is to be "taken" is placed flat upon his back, his hair smoothed back by pomatum to prevent it covering any part of the face, and a conical piece of paper or a straw, or a quill put in each nostril to breathe through. The eyes and mouth are then closed and the entire face completely and carefully covered with salad oil. The plaster, mixed to the proper consistency, is then poured in large spoonfuls to the thickness of one-quarter or one-half inch. In a few minutes this can be taken off as if it were a film. When a cast of the entire head or of the whole human figure is required, either a cast of the face is added to a mass of clay, which is to be modeled to the required figure, or the whole figure is modeled from drawings prepared for the purpose This is the work of the sculptor.

When the clay model is finished, a mold is made from it as in the former cases. If the model be a bust, a thin ridge of clay is laid along the figure from the head to the base, and the front is first completed up to the ridge by filling up the depressions two or three inches deep. The ridge of clay is now removed, the edges of the plaster are oiled, and the other half is done in a similar way. The two halves are likewise tied together with cords, and the plaster is poured in. In complicated figures, say a "Laocoön," the statue is oiled and covered with gelatine, which is cut off in sections by means of a thin, sharp knife, each piece serving as a mold for its own part of the new statue.

MELTING POINTS OF METALS.

Metals.	Centigrade.		Fahrenheit.	
Aluminum	degrees	700	degrees	1,292
Antimony	"	425	"	797
Arsenic	"	185	"	365
Bismuth	"	264	"	507.2
Cadmium	"	320	"	608
Cobalt	"	1,200	"	2,192
Copper	"	1,091	"	1,995.8
Gold	"	1,381	"	2,485.8
Indium	"	176	"	348.8
Iron, wrought	"	1,530	"	2,786
Iron, cast	"	1,200	"	2,192
Iron, steel	"	1,400	"	2,552
Lead	"	334	"	617
Magnesium	"	235	"	455
Mercury	"	—40	"	—40
Nickel	"	1,600	"	2,912
Potassium	"	62	"	143.6
Platinum	"	2,600	"	4,712
Silver	"	1,040	"	1,904
Sodium	"	96	"	172.8
Tin	"	235	"	455
Zinc	"	412	"	773.6

According to experiments recently made at the Royal Polytechnic School at Munich, the strength of camel hair belting reaches 6,215 pounds per square inch, while that of ordinary belting ranges between 2,230 pounds and 5,260 pounds per square inch.

REMOVING CINDERS FROM THE EYE.

Nine persons out of every ten with a cinder or any foreign substance in the eye will instantly begin to rub the eye with one hand while hunting for their handkerchief with the other. They may, and sometimes do, remove the offending cinder, but more frequently they rub until the eye becomes inflamed, bind a handkerchief around the head and go to bed. This is all wrong. The better way is not to rub the eye with the cinder in it at all, but rub the other eye as vigorously as you like. A few years since I was riding on the engine of the fast express from Binghamton to Corning. The engineer, an old schoolmate of mine, threw open the front window, and I caught a cinder that gave me the most excruciating pain. I began to rub the eye with both hands, "Let your eye alone and rub the other eye" (this from the engineer). "I know you doctors think you know it all; but, if you will let that eye alone and rub the other one, the cinder will be out in two minutes," persisted the engineer. I began to rub the other eye, and soon I felt the cinder down near the inner canthus, and made ready to take it out. "Let it alone and keep at the well eye," shouted the doctor *pro tem.* I did so for a minute longer, and, looking in a small glass he gave me, I found the offender on my cheek. Since then I have tried it many times, and have advised many others, and I have never known it to fail in one instance (unless it was as sharp as a piece of steel or something that cut into the ball and required an operation to remove it). Why it is so, I do not know; but that it is so, I do know, and that one may be saved much suffering if one will let the injured eye alone and rub the well eye. Try it.

ELECTRIC LIGHTING IN FACTORIES

A very interesting correspondence has lately been carried on in the columns of the *Manufacturers' Gazette* as to the cost of electric lighting. The general tenor of the letters is very satisfactory to all who believe in the superiority of the electric light. Our contempororary remarks: "Many users of the electric light write, their dynamos, being driven from the prime motors direct, there is seen no appreciable difference in the amount of coal burned since the light was installed. Some writers state that their electric lights cost less than gas at prices varying from $1.25 to $3 per 1,000 feet. Nearly all the firms of which inquiries have been made state that the electric light gives much better satisfaction than gas. Electric light wiring cannot be set down as costing so much per light of so many candle-power, until a most careful examination and calculation has been made, the premises fully canvassed and plans drawn. Of all engineering, that relating to electric lighting offers the least inducement for 'office engineers,' who wish to do their work on paper at a distance." Emphasis is laid upon the necessity for careful wiring with good wire, and it is noted that a good, non-oxidizable lamp fixture for paper mills and like places is a desideratum.

INVENTIONS BY A NEGRO.

The Dallas (Texas) *News* gives an interesting account of the mechanical devices and machinery on exhibition at the State fair, now in progress there, invented by a negro named Frank Winnie, who is described as a prodigy of mechanical genius, and, being totally uninstructed in physical science, is to machinery what Blind Tom is to music. He has in the fair a steam engine which turns a wheel at the rate of 3,300 revolutions to the minute. It has no dead center, but its crank, so it is claimed, has as much pulling power at every point of revolution as the crank of an ordinary engine possesses at an angle of forty-five degrees. Among his other inventions is a machine for fishing by electricity. All that is necessary is to have the fish nibble the attractive bait. The next moment an electric bell on shore rings the death knell of the fish, and the fisherman, who is reading a novel under a tree, goes to the margin of the river and scoops in the finny beauties with a casting net. The inventor demonstrated the powers of this device by tests in the Trinity river, near Dallas.

COMPOSITION OF NATURAL GAS.

In a recent communication to the Franklin Institute, Professor Francis C. Phillips gives the results of his exhaustive inquiries into the chemical composition of natural gas, and also the relative value of the various gas wells as sources of fuel. He found that, as a rule, natural gas was a much less complicated compound than was generally supposed. The gas which is used largely in Pittsburgh, and comes directly, without any process of purification, from the Murraysville field, was found by him to be nearly pure gas, which contains, by weight, 74.97 per cent. of carbon and 25.03 per cent. of hydrogen. In this respect this well differed from all other wells which we examined. The gas supplied by the Bridgewater Natural Gas Company, of Rochester, Pa., which is produced wholly from one sand 1,200 feet below the surface, Raccoon creek, in Beaver county, contained, by weight, 9.91 per cent. of nitrogen, 90.09 per cent. of paraffines, and trace of carbon dioxide, oxygen and sulphureted hydrogen, the paraffines containing 76.40 per cent. of carbon and 23.60 per cent. of hydrogen. The Baden wells, which are on the same anticlinal axes as the Raccoon creek wells, but produce gas from a sand about 1,396 feet below the surface, show 12.32 per cent. nitrogen, 87.27 per cent. of paraffines, 41 per cent. carbon dioxide, and a trace of oxygen, paraffines, containing, by weight, 76.44 per cent. of carbon and 23.56 per cent. of hydrogen. The Houston well, at Canonsburgh, producing gas from a depth of 1,794 feet, shows 15.30 per cent. of nitrogen, 84.26 per cent. of paraffines, .44 per cent. carbon dioxide, and traces of oxyen and ammonia, the paraffines showing 76.80 per cent. of carbon and 23.30 per cent. of hydrogen. In a general way, it might be said that the samples examined, contained hydrocarbons of the paraffine series, among which methane predominated.

A LONG WIRE SPAN.

Indian Engineering says: "A remarkable engineering feat has just been carried out in China in the face of unusual physical obstacles. This was the stretching of a steel cable of seven strands across the Luan River by Mr. A. de Linde, a Danish civil engineer, aided only by unskilled Chinese labor. The cable is strung from two points 4,648 feet apart. The height of one support is 447 feet above the present level of the river, and the second support 737 feet above it. The vortex over the water is 78 feet. The Chinese cable is the longest but one in the world. The telegraph air cable across the Kistna has a span of 5,070 feet; two similar cables across the Ganges, one 2,900 and the other 2,830 feet. A third line of 1,135 feet crosses the Hooghly, and in the United States there is one over the Missouri of 2,000 feet."

There was a fellow in our shop,
His work was at the bench,
And every time he struck a blow
He used the monkey-wrench

And when he found his wrench was gone,
With all his might and main,
He went and got his neighbor's wrench
And commenced to strike again.

WHEN A DAY'S WORK BEGINS.

The decision of the Supreme Court that a workman who has agreed to do work at a specified sum per hour, is not entitled to charge for the time spent in going to or returning from work, is one that equitably applies to some kinds of business, but not to others. Where house-building mechanics have several days' work to do at a building, and their tools and materials are on the spot, they are expected to report at the building in time to do a full day's work. Where they are doing odd jobs and are obliged to start from the shop in the morning, they do so at the regular hour for beginning work, thus reducing the hours of actual labor. But they must be paid for the whole day, and the person for whom the work is done must be charged for the time occupied in going to and from the job; otherwise, the "boss" would have to pay his journeymen, for say ten hours' work, though accounting for only six hours work' in his bill to customers. In some of the small trades a journeyman will go to half a dozen houses in a day, doing an hour's work in each, and spending the other four hours in passing from one job to another. In one way or another he is bound to be paid for the whole time. If he can charge only for the actual working time, then his rates will be increased so as to compensate him for the time spent in service that is not to be paid for. The decision shows the importance of making agreements of this kind specific, both as to the rate of wages and the hours and kind of service.

CAMEL'S-HAIR BELTING.

Camel's-hair belting has been recently the subject of experiments at the Polytechnic school, at Munich, from which it appears that the strength of camel's-hair belting reaches 6,315 pounds per square inch, whilst that of ordinary belting ranges between 2,230 pounds and 5,260 pounds per square inch. A contemporary says the camel's-hair belt is said to work smoothly and well, and it is unaffected by acids.

TO PERFORATE GLASS.

In drilling glass, stick a piece of stiff clay or putty on the part where you wish to make the hole. Make a hole in the putty the size you want the hole, reaching to the glass, of course. Into this hole pour a little molten lead, when, unless it is very thick glass, the piece will immediately drop out.

A MONSTER FEAT IN CHICAGO.

RAISING A 20,000 TON BUILDING.

The completion of the new Jackson street bridge, and the building of the approaches and viaduct, left the entrance to the McCormick manufacturing offices some six or seven feet below the sidewalk. The building had to be raised six feet and five inches, and this enormous and probably unparalleled task was successfully accomplished. The building was prepared for the work by the removal from the basement of all the machinery, and 300 men began turning the screws of several thousand jacks, which were to slowly lift the immense weight to the new place. The building is about 100x125 feet, and six stories high, weighing between 16,000 and 20,000 tons. The whole had to be lifted at once, and there was an average of three jacks to the foot under the building. At a given signal the men turned their jacks a certain distance, and then waited for another whistle. The lift was about a foot a day, but it took a full day to reset the jacks. The total expense of the work was in the neighborhood of $40,000.

THE LIMA-CHICAGO OIL LINE.

The weight of seventy-five miles of the 8-inch wrought-iron pipe-line which the Standard Oil Company is laying from Lima, Ohio, to Chicago, for the transportation of crude petroleum to the latter city, is 28.35 pounds per foot. If the weight of the other part of the pipe is to be the same, the total weight of the entire line will be 15,717 net tons. The length of pipe required is 210 miles. The oil will be forced through the line by one pump, to be stationed at Lima. The pump will be of mammoth size, and the largest ever used in the oil trade. Forcing oil such a distance with one pump was never before attempted. When lines of this kind were first employed, pumps were stationed every five miles.

MINERAL PRODUCTION OF FRANCE.

Provisional returns of the mineral production of France in the first six months of the year give the output of coal, including anthracite and lignite, at 11,077,731 tons, an increase of 798,734 tons as compared with the same period of 1887. The production of pig iron was 821,824 tons in 1888, and 764,643 tons last year; of wrought iron, 428,076 tons, and 378,897 tons in the two years, respectively; and of steel, 239,624 tons, and 240,313 tons.

LIABLE TO SPONTANEOUS COMBUSTION.

Cotton-seed oil will take fire even when mixed with twenty-five per cent. of petroleum oil; but ten per cent. of mineral oil mixed with animal or vegetable oil, will go far to prevent combustion.

Olive oil is combustible, and, mixed with rags, hay or sawdust, will produce spontaneous combustion.

Coal dust, flour-dust, starch (especially rye flour), are all explosive when with certain proportions of air.

New starch is highly explosive in its comminuted state, also sawdust in a very fine state, when confined in a close chute, and water directed on it. Sawdust should never be used in oil shops or warehouses to collect drippings or leakages from casks.

Dry vegetable or animal oil inevitably takes fire, when saturating cotton waste, at 180° F. Spontaneous combustion occurs most quickly when the cotton is soaked with its own weight of oil. The addition of forty per cent. of mineral oil (density .890) of great viscosity, and emitting no inflammable vapors, even in contact with an ignited body at any point below 338° F., is sufficient to prevent spontaneous combustion, and the addition of twenty per cent. of the same mineral oil doubles time necessary to produce spontaneous combustion.

Greasy rags from butter, and greasy ham bags.

Bituminous coal in large heaps, refuse heaps of pit coal, hastened by wet, and especially when pyrites are present in the coal; the larger the heaps the more liable.

Timber dried by steam pipes or hot water, or hot air heating apparatus, owing to fine iron dust being thrown off, in close wood-casings, or boxings round the pipes, from the mere expansion and contraction of the pipes.

Patent dryers from leakages into sawdust, etc., oily waste of any kind, or waste cloths of silk or cotton, saturated with oil, varnish, turpentine.

HOW COMBUSTION IN COAL IS PRODUCED.

In a ton of anthracite coal, there is about 1,830 lbs. of carbon, 70 lbs. of hydrogen and 52 lbs. of oxygen; while a ton of good bituminous coal is composed of 1,600 lbs. of carbon, 108 lbs. of hydrogen and 32 lbs. of oxygen. The combustion of coal proceeds from its combination with oxygen gas, and, when fuel of any kind combines with oxygen, heat is produced. All bodies, substances, gases and liquids, are composed of separate particles, often of molecules of inconceivable smallness. These particles, it is scientifically conceded, are in motion among themselves, and this motion constitutes heat, for heat is only a kind of motion. This internal vibration of infinitesimal particles may be transmuted into a perceptible mechanical movement, or the mechanical movement may be converted into the invisible motion called heat. The oxygen combined with coal has a very considerable range of internal motion, and the combining process produces carbonic acid gas; and, the particles of this gas having a much smaller range of motion than the particles of the oxygen have, the difference appears in the form of heat.

CAPACITY OF CYLINDRICAL CISTERNS.

The following table shows the capacity in gallons for each foot in depth of cylindrical cisterns of any diameter:

Diameter.	Gallons.	Diameter.	Gallons.
25 ft.	3,059	7 ft.	239
20 ft.	1,958	6½ ft.	206
15 ft.	1,101	6 ft.	176
14 ft.	959	5 ft.	122
13 ft.	827	4½ ft.	99
12 ft.	705	4 ft.	78
11 ft.	592	3 ft.	44
10 ft.	489	2½ ft.	30
9 ft.	396	2 ft.	19
8 ft.	313		

A GREAT BRIDGE.

Comparatively little mention has been made of the new bridge, which is to connect Staten Island with New Jersey, and this is somewhat remarkable, considering the fact that the bridge is one of the largest, in the span covered by the draw, if not the largest in the world. The whole length of the draw is 500 feet.

The bridge consists of four spans, resting upon five big piers of solid masonry. Only one of these piers, that supporting the draw, stands in the channel, which is here 800 feet wide. On the edge of either bank stands another pier, supporting the ends of the draw when closed for traffic. The distance between each of these piers and the center pier is 250 feet, thus giving a clear waterway of over 200 feet on each side of the center pier. On each side of the draw-span is fixed a span 150 feet in length, making the connecting-links between the draw-span and the approaches. This makes the entire length of the structure 800 feet, with one mile and a half of approach at the Staten Island end, and half a mile on the New Jersey shore.

Four of these massive piers are already finished, and the fifth will be completed in a week. The foundations all rest upon bed-rock. Nothing has been spared, either in time, money or thought, to make the whole structure of first-class material, finished workmanship and colossal strength. The piers are tastefully finished in granite. The foundation for the central pier was laid by the pneumatic process, and it was no small undertaking to coffer-dam a sure resting-place for the massive superstructure, containing over 2,000 cubic yards of solid masonry, nearly 5,000 tons in weight, and reaching down 30 feet below the water.

HOW TO SELECT ROPE.

A German paper, in an article on the present methods of rope manufacture from hemp, and the determination of the different qualities and the probable strength simply from the appearance, lays down the following rules: A good hemp rope is hard but pliant, yellowish and greenish gray in color, with a certain silvery or pearly luster. A dark or blackish color indicates that the hemp has suffered from fermentation in the process of curing, and brown spots show that the rope was spun while the fibers were damp, and is consequently weak and soft in those places. Again, sometimes a rope is made with inferior hemp on the inside, covered with yarns of good material—a fraud, however, which may be detected by dissecting a portion of the rope, or, in practical hands, by its behavior in use; other inferior ropes are made with short fibers, or with strands of unequal strength or unevenly spun—the rope in the first case appearing wooly, on account of the number of ends of fiber projecting, and, in the latter case, the irregularity of manufacture is evident on inspection by any good judge.

THINGS THAT WILL NEVER BE SETTLED.

Whether a long screw-driver is better than a short one of the same family.

Whether water-wheels run faster at night than they do in the day time.

The best way to harden steel.

Which side of the belt should run next to the pulley.

The proper speed of line shafts.

The right way to lace belts.

Whether compression is economical or the reverse.

The principle of the steam injector.

Dominer has discovered that bronze is rendered malleable by adding to it from one-half to two per cent. of mercury.

An "inch of rain" means a gallon of water spread over a surface of nearly two square feet, or a fall of about 100 tons on an acre of ground.

A steam power plant is divided into five fundamental parts by a French author — the boiler, motor, condenser, distributing mechanism, and mechanism of transmission.

Turpentine and black varnish, put with any good stove polish, is the blackening used by hardware dealers for polishing heating stoves. If properly put on, it will last throughout the season.

A workman in the Carson mint has discovered that drill points, heated to a cherry-red and tempered by being driven into a bar of lead, will bore through the hardest steel or plate glass without perceptibly blunting.

To harden copper, melt together, and stir till thoroughly incorporated, copper and from one to six per cent. of mandganese oxide. The other ingredients for bronze and other alloys may then be added. The copper becomes homogeneous, harder and tougher.

SIMPLE TESTS FOR WATER.

Boiler-users who desire simple tests for the water they are using will find the following compilation of tests both useful and valuable:

Test for Hard or Soft Water—Dissolve a small piece of good soap in alcohol. Let a few drops of the solution fall into a glass of the water. If it turns milky, it is hard water; if it remains clear, it is soft water.

Test for Earthy Matters or Alkali—Take litmus-paper dipped in vinegar, and, if on immersion the paper returns to its true shade, the water does not contain earthy matter or alkali. If a few drops of syrup be added to a water containing an earthy matter, it will turn green.

Test for Carbonic Acid—Take equal parts of water and clear lime water. If combined or free carbonic acid is present, a precipitate is seen, to which, if a few drops of muriatic acid be added, effervescence commences.

Test for Magnesia—Boil the water to twentieth part of its weight, and then drop a few grains of neutral carbonate of ammonia into a glass of it and a few drops of phosphate of soda. If magnesia is present, it will fall to the bottom.

Test for Iron—Boil a little nut-gall and add to the water. If it turns gray or slate-black, iron is present. Second: Dissolve a little prussiate of potash, and, if iron is present, it will turn blue.

Test for Lime—Into a glass of water put two drops of oxalic acid, and blow upon it. If it gets milky, lime is present

Test for Acid—Take a piece of litmus-paper. If it turns red, there must be acid. If it precipitates on adding lime water, it is carbonic acid. If a blue sugar paper is turned red, it is a mineral acid.

Test for Copper—If present, it will turn bright polished steel a copper color. Second: A few drops of ammonia will turn it blue, if copper is present.

Tests for Lead—Take sulphureted gas and water in equal quantity to be tested. If it contains lead, it will turn a blackish brown. Again: The same result will take place if sulphate of ammonia be used.

Test for Sulphur—In a bottle of water add a little quicksilver, cork it for six hours, and, if it looks dark on the top, and on shaking looks blackish, it proves the presence of sulphur.

JAPANESE LACQUER FOR IRON SHIPS.

The Japanese Admiralty has finally decided upon coating the bottoms of all their ships with a material closely akin to the lacquer to which we are so much accustomed as a specialty of Japanese furniture work. Although the preparation differs somewhat from that commonly known as Japanese lacquer, the base of it is the same—viz., gum-lac, as it is commonly termed. Experiments, which have been long continued by the Imperial Naval Department, have resulted in affording proof that the new coating material remains fully efficient for three years, and the report on the subject demonstrates that, although the first cost of the material is three times the amount of that hitherto employed, the number of dockings required will be reduced by its use to the proportion of one to six. A vessel of the Russian Pacific fleet has already been coated with the new preparation, which, the authorities say, completely withstands the fouling influences so common in tropical waters. It took the native inventor many years to overcome the tendency of the lac to harden and crack; but having successfully accomplished this, the finely-polished surface of the mixture resists in an almost perfect degree the liability of barnacles to adhere or weeds to grow, while, presumably, the same high polish must materially reduce the skin friction which is so important an element affecting the speed of iron ships. The dealers in gum-lac express the fear lest the demand likely to follow on this novel application of it may rapidly exhaust existing sources of supply.

IRON IN THE CONGO.

Last year Mr. Dupont, director of the Museum of Natural History of Brussels, went to the Congo for the purpose of studying the geology of the valley from the Atlantic to the confluence of the Kassai River, over 400 miles from the coast. After eight months devoted to this work, he has returned to Europe, bringing some surprising reports with regard to the mineral resources of the region. He says that throughout the entire extent of the country he found in the plateaus skirting the river, under the thick alluvium, a stratum of iron ore from a foot and a half to three feet in thickness. In numerous places he saw blocks of iron ore sometimes many cubic feet in dimensions, upon the slopes of ravines, where they had been exposed by denudation. He asserts that there is scarcely a country in the world so rich in iron ore as the Congo basin, and the mineral is not only abundant, but can also be easily reduced. In his opinion, if the other continents ever exhaust their resources of iron, the Congo basin can supply the rest of the world for a long period.

GLASS CUTTING BY ELECTRICITY.

The cutting of glass tubes of wide diameter is another of the almost innumerable industrial applications of electricity. The tube is surrounded with fine wire, and the extremities of the latter are put in communication with a source of electricity, and it is of course necessary that the wire adhere closely to the glass. When a current is passed through the wire, the latter becomes red hot and heats the glass beneath it, and a single drop of water deposited on the heated place, will cause a clean breakage of the glass at that point. Contrary to what takes place with the usual processes in the treatment of this frangible material, it is found that, the thicker the sides of the tubes are, the better the experiment succeeds.

They have been making 38-ton guns at Portsmouth, England, and are talking of introducing the 47-ton variety. Nearly 35,000 people live at Portsmouth on wages earned in doing some kind of work on England's big guns.

DEAFNESS CAUSED BY THE ELECTRIC LIGHT.

A curious phenomenon was recently related by M. D'Arsonval before the French Academy of Medicine. After gazing for a few seconds on an arc light of intense brilliancy, he suddenly became deaf, and remained so for nearly an hour and a half. Surprised, and somewhat alarmed in the first instance, but reassured by the disappearance of the symptoms, he repeated the experiment with the same result. When only one eye was exposed to the light, no very marked effect was produced.

BROWNING GUN BARRELS.

Mix 16 parts sweet spirits niter, 12 parts saturated solution of sulphate of iron, 12 parts chloride of antimony. Bottle and cork the mixture for a day, then add 500 parts of water and thoroughly mix. Clean the barrel to a uniform grain free from grease and finger stains. Wipe with a staining mixture on a wad of cotton. Let it stand for twenty-four hours, scratch brush the surface and repeat twice. Rub off the last time with leather moistened with olive oil. Let dry a day, and rub down with a cloth moistened with oil to polish.

SPONTANEOUS COMBUSTION

There is a remarkable tendency observable in tissues and cotton, when moistened with oil, to become heated when oxidation sets in, and sad results often follow when this is neglected. A wad of cotton used for rubbing a painting has been known to take fire when thrown through the air. The waste from vulcanized rubber, when thrown in a damp condition into a pile, takes fire spontaneously. Masses of coal stored in a yard have been known to take fire without a spark being applied, and one cannot be too careful in storing any substance in which oxidation is liable to take place.

A LARGE LUMP OF COAL.

One of the largest lumps of coal ever mined in the Monongahela Valley was taken from J. S. Neels' Cincinnati mines, near Monongahela City, lately. The block measured 7 feet 8 inches long, 3 feet 5 inches high, and 3 feet 7 inches wide. A temporary track was laid to the river, and the big piece of coal loaded in a boat for Cincinnati.

SCREW-MAKING AT PROVIDENCE, RHODE ISLAND.

It is not known when screws were first made and brought into use. The first instance known of machinery being applied to the making of screws, was in France, in 1569, by a man named Besson, who contrived a screw-cutting gauge to be used in a lathe. The early method had been to make the heads by pinching the blanks while red hot between dies, and then to form the threads by the process of filing. In 1741 Besson's device was improved by Hindley, a watchmaker, of York, England; and for a long time the watch-makers of that country used this device in making the small screws used in their work. The first English patent appears to have been issued to Job and William Wyatt, in 1760, for three machines —one for making blanks, another for nicking the heads, and a third for cutting the threads. Between that date and 1840 about ten patents were issued, only one of which is worthy of notice, namely that of Miles Berry, dated January 28, 1837, which was for a gimlet-pointed screw. The first American patent was issued December 14, 1798, to David Wilkinson, a celebrated mechanic of Rhode Island. The next American patent was dated March 23, 1813, and was issued to Jacob Perkins, of Newburyport, Mass. In that year, also, a patent was granted to Jacob Sloat, of Ramapo, N. Y. At the extensive nail and iron works of the Piersons, established in Ramapo in 1798, Thomas W. Harvey in 1831 applied the toggle-joint to the headings of screws, rivets and spikes. In 1834 Mr. Harvey entered into partnership with Frederick Goodell, a cotton manufacturer of Ramapo, and established a small screw manufactory at Poughkeepsie, and early in the next year Mr. Harvey invented machines for heading, nicking and shaving screws. These and a thread-cutting machine, purchased from its inventors, Jacob Sloat and Thomas Springsteen, were successfully operated, producing a gimlet-pointed screw.

It is interesting to note that, while the manufacture of wood screws probably originated in Westphalia, Germany, and was subsequently carried on in eastern France and England before its introduction into this country, American inventors have supplied the machinery that is now universally employed. The popular feeling that the gimlet-pointed screw was a modern invention is erroneous. The company has in its possession sample cards of French screws, pointed, though not as perfectly made as at present, which were brought from France early in the present century, and from an old piano now at Northampton, made about the year 1750, screws have been taken showing the same feature. Patents have been issued on gimlet-pointed screws, but they covered only a peculiar form of point.

The Eagle Mill of the American Screw Company is devoted to the manufacture of wood screws. In the yard connected with this mill are landed the rods, in coils, from which the screws are to be manufactured. The larger portion of these rods is imported from Sweden, Germany and England. The first room into which the reader is to be conducted is the "pickling room." Here the rod is "pickled" for the purpose of removing the flinty scale on the outside; and the action of the mixture in that process tends to facilitate the drawing of the wire. After being annealed in furnaces the wire is subjected to the pointing process, the purpose of which is to reduce the end of the rod to enter the draw-plate. The wire is taken into the drawing room, where it is drawn in different sizes needed for the great variety of screws. The machinery for the different processes is the result of the skill of many inventors, who have produced a system of machines mostly automatic and beautiful in operation. By the automatic wire block used, if anything happens to the wire while going through the process, the whole apparatus stops. If it did not stop, the wire would break. By a machine, whose action is accurate and fascinating, the rod is cut into the sizes of the screws desired and the head put on almost at the same instant. The metal, in going through this process, necessarily becomes very oily. These "blanks," for such they are called at this stage of their manufacture, are put into what are called "rattlers," revolving boxes, hexagonal in shape, filled with sawdust, where they are cleansed of the oil that covers them, the oil being absorbed by the sawdust. The blanks are ready to have their heads "shaved," which consists in cutting the heads perfectly round. The blanks are put into a hopper, and by an automatic feeder they are let down into a trough, from which they are picked by a metal finger and put into a spindle. The heads are then "shaved," and by a revolving spindle the blank is taken to the small saw which cuts the slot in the head. The blank is then revolved back again and shaved again, to get rid of the "burr," or the rough edge left by the tool in cutting the slot. The blanks are then fired out of the machine absolutely perfect. The machine is an automatic but very complicated one; every part of it, however, does its work effectively. The blanks, after being shaved and slotted, are placed in another machine and threaded, when the screw is complete.

HOW THERMOMETERS ARE MADE.

The first point, in the construction of the mercurial thermometer, is to see that the tube is of uniform caliber throughout its whole interior. To ascertain this, a short column of mercury is put into the tube and moved up and down, to see if its length remains the same through all parts of the tube. If a tube whose caliber is not uniform is used, slight differences are made in its graduation to allow for this. A scale of equal parts is etched upon the tube; and from observations of the inequalities of the column of mercury moved in it, a table giving the temperatures corresponding to these divisions is formed. A bulb is now blown on the tube, and while the open end of the latter is dipped into mercury, heat is applied to the bulb to expand the air in it. This heat is then withdrawn, and the air within contracting, a portion of the mercury rises in the tube, and partly fills the bulb. To the open end of the bulb a funnel containing mercury is fitted, and the bulb is placed over a flame until it boils, thus expelling all air and moisture from the instrument. On cooling, the tube instantly fills with mercury. The bulb is now placed in some hot fluid, causing the mercury within it to expand and flow over the top of the tube, and, when this overflow has ceased, the open end of the tube is heated with a blow-pipe flame. To graduate the instrument, the bulb is placed in melting ice; and, when the top of the mercury column has fallen as low as it will, note is taken of its position as compared with the scale on the tube. This is the freezing point. It is marked as zero on the thermometers of Celsius and Reaumur, and as 32° on the Fahrenheit class.

To determine the boiling point, the instrument is placed in a metallic vessel with double walls, between which circulates the steam from boiling water. Between the freezing and boiling point of water, 100 equal degrees are marked in the centigrade graduation of Celsius, 180° on the Fahrenheit plan, and 80° on the Reaumur. In many thermometers, all three of these graduations are indicated on the frame to which the tube is attached. Some weeks after a thermometer has been made and regulated, it may be noticed that, when the bulb is immersed in pounded ice, the mercury does not quite descend to the freezing point. This is owing to a gradual expansion of the mercury, which usually goes on for nearly two years, when it is found that the zero point has risen nearly a whole degree. It is then necessary to slide down the scale to which the tube is fastened, so that it will accurately read the movements of the mercury. After this change, the accuracy of the thermometer is assured, as there is no further expansion of the mercury column.

POINTS FOR APPRENTICES.

In starting to learn a trade as an apprentice, first imagine yourself brighter, and more apt to learn, than the older apprentices in the shop. Criticise their work on the last range they blacked. Show the red spots under the doors or under the top plates, and if you are not dropped through the trap door into the cellar the first opportunity they get, it will be some good fortune that favors you. When working with a jour., tell him how Tom Jones does that, and his ways are not right, or tell him how to do it. Of course the jour. has worked fifteen years at the business, but that doesn't make any difference, you go ahead. If he does not call you cuss words and tell you to mind your business, he must have a mother-in-law who comes over to see him seven times a day, and stays all day Sunday.

When you have worked about a year at the business, and you think you are competent to take charge of the shop, and you are given a job of cleaning a furnace, which, of course, will smut a boiled shirt, you go home, and kick to the old folks; say you are not going to work for Smith any more, as he gives you all the dirty work to do, and get the old folks to go around and see Smith about their precious boy. It will make you, in the eyes of Smith, as large as Jumbo to a rat.

When you worry your term of apprenticeship through and you receive the title of jour., of course you demand jour.'s wages, say as much as old man Stewpot. He has worked eighteen years in the shop, but that doesn't matter. Why, you made six dozen joints of stove pipe in two hours and it took him three! Well, if you don't make satisfactory arrangements, I heard Billy Doepan say that Enos Kettle, at Inkville, wanted a man, and you, of course, strike; it pays big wages to a first-class man. You go and see Kettle and he asks you what you can do. Of course you worked on the cornice for the Grand Opera House, and on the button factory, and several other jobs too numerous to mention. You receive a position to help Kettle out on the Green building cornice. This being Thursday night, and he has to go to Plumtown to finish up a job, he would like to have you come on in the morning. He gives you a simple piece of cutting to keep you going until his return on Saturday night, when he makes a practice of paying off his help. You come under this head, and find that he offers you the enormous sum of seventy-five cents per day, and orders the stove porter to go and cover the pig trough with your two days' work to keep the pigs from making post holes in their trough, which his wife wanted him to do for the past nine months. You declare he is a crank; you are going West, or to some seaport town.

You strike out and get a position in a roofing shop painting tin. You write home to your brother chip telling what a position you have, what big wages, etc., but not giving original facts. In a few years you return home broken down, with no trade. You can't demand a mechanic's wages, and you look back and see your folly. How many are there in this boat? Boys, take my advice: Don't get to knowing too much. If you get into that way, it is little use for a mechanic to have anything to do with you.

THREE THERMOMETER SCALES.

Much annoyance is caused by the great difference in thermometer scales in use in the different civilized countries. The scale of Reaumur prevails in Germany. As is well known, he divides the space between the freezing and boiling points into 80°. France uses that of Celsius, who graduated his scale on the decimal system. The most peculiar scale of all, however, is that of Fahrenheit, a renowned German physicist, who in 1714 or 1715 composed his scale, having ascertained that water can be cooled under the freezing point without congealing. He therefore did not take the congealing point of water, which is uncertain, but composed a mixture of equal parts of snow and salammonia, about—14° R. This scale is preferable to both those of Reaumur and Celsius, or, as it is called, Centigrade, because: 1. The regular temperatures of the moderate zone move within its two zeros, and can therefore be written without + or —. 2. The scale is divided so finely that it is not necessary to use fractions, when careful observations are to be made. These advantages, although drawn into question by some, have been considered so weighty, that both Great Britain and America have retained the scales, while the nations of the Continent use the other two. The conversion of any one of these scales into another is very simple. 1. To change a temperature given by Fahrenheit's scale into the same given by the Centigrade scale, subtract 32° from Fahrenheit's degrees and multiply the remainder by $\frac{5}{9}$. The product will be the temperature in Centigrade degrees. To change from Fahrenheit's to Reaumur's scale, subtract 32° from Fahrenheit's degrees, and multiply the remainder by $\frac{4}{9}$. The product will be the temperature in Reaumur's degrees. 3. To change a temperature given by the Centigrade scale into the same given by Fahrenheit, multiply the Centigrade degrees by $\frac{9}{5}$, and add 32° to the product. The sum will be the temperature by Fahrenheit's scale. 4. To change from Reaumur's to Fahrenheit's scale, multiply the degrees on Reaumur's scale by $\frac{9}{4}$, and add 32° to the product. The sum will be the temperature by Fahrenheit's scale. Following is a table giving the equivalents in Centigrade, Reaumur and Fahrenheit, up to boiling point, which will be a convenience to all readers who do not like the labor of converting one scale to another:

C.	R.	F.	C.	R.	F.
—30	—24.0	—22.0	—1	—0.8	30.2
—29	—23.2	—20.2	0	0.0	32.0
—28	—22.4	—18.4	1	0.8	33.8
—27	—21.6	—16.6	2	1.6	35.6
—26	—20.8	—14.8	3	2.4	37.4
—25	—20.0	—13.0	4	3.2	39.2
—24	—19.2	—11.2	5	4.0	41.0
—23	—18.4	—9.4	6	4.8	42.8
—22	—17.6	—7.6	7	5.6	44.6
—21	—16.8	—5.8	8	6.4	46.4
—20	—16.0	—4.0	9	7.2	48.2
—19	—15.2	—2.2	10	8.0	50.0
—18	—14.4	—0.4	11	8.8	51.8
—17	—13.6	1.4	12	9.6	53.6
—16	—12.8	3.2	13	10.4	55.4
—15	—12.0	5.0	14	11.2	57.2
—14	—11.2	6.8	15	12.0	59.0
—13	—10.4	8.6	16	12.8	60.8
—12	—9.6	10.4	17	13.6	62.6
—11	—8.8	12.2	18	14.4	64.4
—10	—8.0	14.0	19	15.2	66.2
—9	—7.2	15.8	20	16.0	68.0
—8	—6.4	17.6	21	16.8	69.8
—7	—5.6	19.4	22	17.6	71.6
—6	—4.8	21.2	23	18.4	73.4
—5	—4.0	23.0	24	19.2	75.2
—4	—3.2	24.8	25	20.0	77.0
—3	—2.4	26.6	26	20.8	78.8
—2	—1.6	28.4	27	21.6	80.6

C.	R.	F.	C.	R.	F.
28	22.4	82.4	65	52.0	149.0
29	23.2	81.2	66	52.8	150.8
30	24.0	86.0	67	53.6	152.6
31	24.8	87.8	68	54.4	154.4
32	25.6	89.6	69	55.2	156.2
33	26.4	91.4	70	56.0	158.0
34	27.2	93.2	71	56.8	159.8
35	28.0	95.0	72	57.6	161.6
36	28.8	96.8	73	58.4	163.4
37	29.6	98.6	74	59.2	165.2
38	30.4	100.4	75	60.0	167.0
39	31.2	102.2	76	60.8	168.8
40	32.0	104.0	77	61.6	170.6
41	32.8	105.8	78	62.4	172.4
42	33.6	107.6	79	63.2	174.2
43	34.4	109.4	80	64.0	176.0
44	35.2	111.2	81	64.8	177.8
45	36.0	113.0	82	65.6	179.6
46	36.8	114.8	83	66.4	181.4
47	37.6	116.6	84	67.2	183.2
48	38.4	118.4	85	68.0	185.0
49	39.2	120.2	86	68.8	186.8
50	40.0	122.0	87	69.6	188.6
51	40.8	123.8	88	70.4	190.4
52	41.6	125.6	89	71.2	192.2
53	42.4	127.4	90	72.0	194.0
54	43.2	129.2	91	72.8	195.8
55	44.0	131.0	92	73.6	197.6
56	44.8	132.8	93	74.4	199.4
57	45.6	134.6	94	75.2	201.2
58	46.4	136.4	95	76.0	203.0
59	47.2	138.2	96	76.8	204.8
60	48.0	140.0	97	77.6	206.6
61	48.8	141.8	98	78.4	208.4
62	49.6	143.6	98	79.2	210.2
63	50.4	145.4	100	80.0	212.0
64	51.2	147.2			

WHY STEEL IS HARD TO WELD.

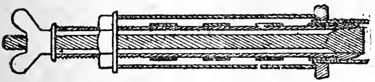
A metallurgist gives, as a reason why steel will not weld as readily as wrought iron, that it is not partially composed of cinder, as seems to be the case with wrought iron, which assists in forming a fusible alloy with the scale of oxidation on the surface of the iron in the furnace.

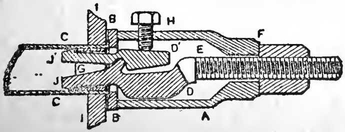
DIFFERENT COLORS OF IRON, CAUSED BY HEAT.

Deg. Cen.	Deg. Fah.	
261 370	502 680	Violet, purple and dull blue. Between 261° C. to 370° C. it passes to bright blue sea green, and then disappears.
500	932	Commences to be covered with a light coating of oxide ; becomes a deal more impressible to the hammer, and can be twisted with ease.
525	977	Becomes a nascent red.
700	1292	Somber red.
800	1472	Nascent cherry.
900	1657	Cherry.
1000	1832	Bright cherry.
1100	2012	Dull orange.
1200	2192	Bright orange.
1300	2372	White.
1400	2552	Brilliant white-welding heat.
1500 1600	2732 2912	Dazzling white.

TO DRAW FERRULES.

A useful tool for drawing thimbles or ferrules out of locomotive boiler tubes is here shown. It is an English invention, and it is not stated that it is patented. The tube *A* is split in quarters on the end so that it can be easily slipped in. The rest of the device explains itself, as does the second figure also, which is another device for the same purpose.





BELTING SHAFTING AT RIGHT ANGLES.

In Fig. 1 of the illustration, *A* is the driver. The belt leaves the pulley at *C*, goes to the driven pulley, and then down to the driver at *h*. In Fig. 2 this movement is re-

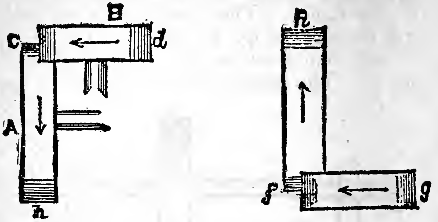
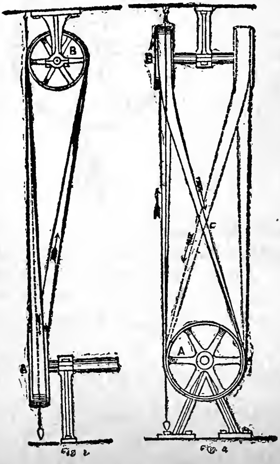


Fig. 1. Fig. 2.

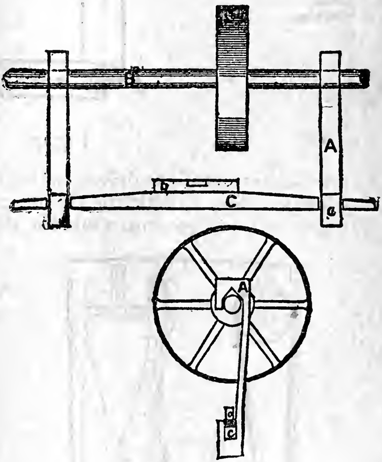
versed. Fig. 3 is a side view of the driven pulley *B*, and Fig. 4 shows the driving pulley *A*, with the driven pulley *B* inside, so as to run in the one direction, while the dotted linesf



show *B* outside, so as to run the opposite way. Figs. 1 and 2 show that centers of the faces of both pulleys must be in line with each other, and if this point is attended to the pulleys will run well together, although they may be of different diameters.

AN EASY WAY TO LEVEL SHAFTING.

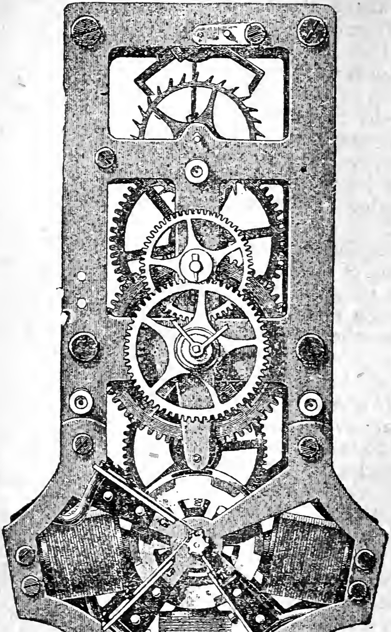
The device here illustrated for leveling shafting I have found to be very handy. The hangers *A* are made of wood and are cut at an angle of 45° at the top end, so that they will fit different sized shafts, and a slot is cut at (*a*) to receive the straight edge *C*. The hangers are placed on the shaft to be



tried, at any convenient place as near the bearings as possible, and the straight edge placed in the slots, in which it should fit tight. Then by placing the spirit level *D* on the parallel part of the straight edge, it will be seen whether the shaft is level or not. It is best if the hangers be made of hard wood.

A SELF-WINDING CLOCK MOVEMENT.

A self-winding clock is now on the market and we present herewith an engraving of one. It is made by the American Manufacturing and Supply Co., Limited, 10 and 12 Dey street, New York. Objection may be made to the employment of a battery as an auxiliary, and therefore that the clock is not self-winding, but the office of the battery is secondary, the operation of the clock opening the circuit while the battery is used only to interrupt it. Appended is a description of the movement:



The wheels and arbors below the center are removed from the clock. In their place a small electric motor is substituted. This motor connects with a spring barrel on the center arbor, which incloses a spring six feet long, three-sixteenths of an inch in width and six-one-thousandths of an inch in thickness. This spring, at its inner end, is attached to the arbor, and at the outer end to the periphery of the spring barrel. The spring is coiled around the arbor many times, but not so close as to produce friction between the coils; and being attached to the center arbor it follows that the inner end will unwind one turn every hour. By a simple attachment the electric circuit is made to pass into the motor already referred to, which quickly carries the spring barrel around once (being free on the arbor), and the outer end of the spring attached to its periphery with it. Upon the completion of one revolution of the spring barrel, as described, the electric circuit is broken and the motor stops. By this arrangement it will be observed that the inner end of the spring always has a motion from left to right, or in the direction the hands are moving, and the outer end of the spring a motion in the same direction when the clock is being wound.

Now, since the winding is done in the same direction as the unwinding of the inner end, and the spring is so wound originally as to avoid friction between the coils, it follows that the tension upon the train is absolutely uniform at all times whether the outer end of the spring is at a point of temporary rest or is being carried around the arbor at the time of winding, as above described. By actual experiment it is found that to obtain a given force at the escape wheel it is only necessary to apply a power in this manner at the center arbor equal to less than one-forty-sixth part of that used in the ordinary clock. The train work is not only shortened one-half, but the friction on the remainder is reduced in the proportion stated.

The invention lies in bringing a motor and clock-work together in a time piece, and is not limited to any particular device. Experiments prove that a motor as constructed for this purpose can be run for one year at an expense of less than twenty-five cents; hence a clock may be sealed up and left to itself for a period of at least one year with a certainty of closer time during that period than can be secured by any other known method of giving time. In short, a common clock constructed on this principle has been found to keep as accurate time as one of the higher grades with gravity escapements, etc., run by the old methods. The electric motor is normally out of circuit, but at stated intervals, by the operation of the clock itself, the circuit is completed and the motor is thus set in motion. To be more exact we will give a general description of the mechanism employed in the clock. Upon the center arbor there is placed a loose "arm" between the hour wheel and the wheel carrying the spring box. At one side of one of the "train plates" is secured an insulated spring connector, the free end of which extends to, and is within reach of, the "arm," when the same has been brought to a perpendicular position, which is done by means of a pin projecting from the hour wheel.

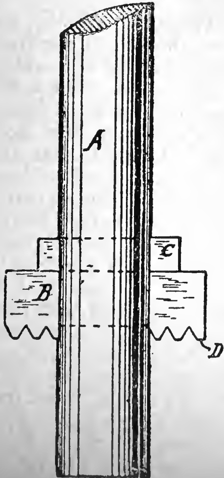
When the hour wheel has thus brought the "arm" to an upright position and in contact with the insulated spring connector, the circuit is completed through the motor, which at once commences to rotate the spring box one revolution from left to right, or in the direction that the hands move. The spring box wheel also carries a projecting pin, but set at a less distance from the axis than the other pin. Now, as the motor continues to rotate the spring box wheel, while the spring connector is resting upon the "arm," it follows that as soon as there has been one revolution of the spring box wheel the projecting pin upon this wheel will press the "arm" forward and out from under the spring connector, thereby breaking the circuit and stopping the motor. This arrangement prevents the possibility of the clock running beyond the regular limit for winding, and prevents the motor when once set in operation from performing more than the work required.

TESTS OF STEEL PIPE.

The Riverside Iron Works, of Wheeling, W. Va., has carried out a series of interesting experiments to ascertain the relative corrosive action of water acidulated with nitric acid upon iron and steel plates cut from pipe. The water was acidulated with one part of strong nitric acid in ninety parts, the plates being of the same dimensions, free from scale and grease and polished bright. In each case the pieces cut from iron and steel pipe were hung side by side in the same acidulated water, the loss of weight being determined at the end of twenty-four and of forty-eight hours. One test was made by exposing both surfaces and edges to the action of dilute acid, the result being that the loss in grains after twenty-four hours was 3.6 in the case of iron from standard iron pipe, and 1.15, or less than half, with steel pipe. In forty-eight hours the figures stood 6.53 and 2.21 grains, respectively. In a second test the edges of the pieces were protected from the action of the acid and the two opposite sides only exposed. In this test the loss of iron after twenty-four hours was 1.89 grains, against 0.49 grains with the steel, and after forty-eight hours 4.28 and 1.24, respectively. The dimensions of the test-pieces were 1¼ inches square by 3-16-inch thick. A series of comparative tests have also been made to ascertain the relative strength of the weld of Riverside steel and standard iron pipe. Two test-pieces were cut from Riverside pipe, mechanical lap-weld, with the weld at the middle, and in a similar way from mechanical lap-welded iron pipe, in each case with the weld in the middle. Not one of the tests broke at the weld, the steel showing a tensile strength of 52,400 and 66,330 pounds, with an elongation of 18.75 and 17.25 per cent. in 8 inches, while the iron pipe samples showed 62,480 and 35,240 pounds per square inch, and an elongation of 2.25 and 0.50 per cent. Two samples from a sheet of Riverside steel lap-welded by hand, with the weld in the middle, showed a tensile strength of 51,860 pounds, and an elongation of 7 per cent. in 8 inches, the fracture occurring at the weld. A second sample had an ultimate strength of 56,090 pounds, elongation 13 per cent., and did not break at the weld. Iron plates cut with the grain and hand-welded have a tensile strength of 44,630 and 43,500 pounds, respectively, with an elongation of 5 and 4.25 per cent., both breaking at the weld.

TOOL FOR COUNTER-BORING.

The above is a sketch of a tool that will be found very convenient on many occasions, when counter-boring work in the drill press; usually such work is done with a cutter of the same shape as it is desired to have the finished work, when if there is any scale, as in cast iron, it is very difficult to get the cutter started. The tool in the sketch entirely obviates that difficulty, as only the points come in contact with the scale at first and are easily forced through it. Referring to the sketch, *A* is the end of a cutter-bar, *B*, the cutter, and *C*, the wedge for keeping the cutter in place. It will be noticed that the teeth *D*, on one side of the bar will, as it is revolved, cover the space left by the part of the cutter on the other side of the bar, and thus rapidly remove the scale and metal, when the work may be finished by the ordinary flat cutter.



HOW TO MAKE A SMALL STORAGE BATTERY.

A storage battery, or accumulator, to light an incandescent lamp of 4 candle-power, would not go in an ordinary sized pocket, because one would require at least *four* cells, and if the plates were made too small, the charge put into them would last scarcely a few seconds. The following directions will enable any person to construct a storage battery, which, when charged, will light a 4-volt lamp.

The first thing to do is to procure of some dealer in electrical apparatus and material a hard rubber cell, about 3½ inches by 5 inches by 1 inch, having two compartments of equal dimensions. Such a cell can be purchased for about fifty cents.

Next, cut four plates from one-sixteenth inch sheet lead, 4½ inches by 1¼ inch, having an ear to each; punch as many holes in each plate as you can to within ¾ inch from the ear or top end. Then fill up the holes, and also smear the plates with a thick paste of red lead (minimum) and diluted sulphuric acid. Cut out a piece from thin — ⅛ of an inch — hard wood, 3½ inches long and 1 inch wide; pierce it with four slits large enough to allow the ears of the plates to come through (two to each cell), and, also, where convenient, two holes should be made and fitted with glass tubes for the purpose of filling the cells.

As soon as the red lead paste has become hard, plac thee four plates in their positions, and solder the ear of one plate to the ear piece of the next cell. This will leave one free end from each cell; to these a wire or terminal should be soldered. Now cement on the top and cover all over, except the glass tubes, with a composition of one part melted pitch and two parts of gutta-percha.

Having filled the cells three-quarters full with a 10 per cent. solution of sulphuric acid, connect the wires on a primary battery or small dynamo. Charge, discharge and reverse every three hours, and let the last charge remain in all night. Do this till you find your storage battery will ring a bell, with fifteen minutes' charging, for about ten. Then only charge one way, and mark the ends in some way so as to know where to connect one next time for charging.

This battery, when completed, will light a 3 or 4 volt lamp well during intervals for about two hours. A similar cell, having four compartments instead of two, would suffice to operate an 8 or 9 volt lamp, or one of about 6 candle-power.

Such a battery as has just been described may be veniently be formed by a ten-cell Daniel telegraph battery in about a fortnight's time.

A storage battery of this size should never be charged until within an hour or so of its being wanted for use, as it will run down a little by short circuiting, owing to the dampness of the inside.

Finally, it should be stated, that, before putting the plates in the cells for good, a piece of india rubber ought to be placed between the plates, as well as a piece on the two outsides, and held by a piece of asbestos fiber. This prevents the plates from touching each other, and also keeps them from shaking from side to side.

LUBRICATING WITHOUT OIL.

Several interesting facts in regard to cylinder lubrication were brought out at the recent meeting of the American Society of Mechanical Engineers, at Philadelphia. Among other things Mr. Denton stated as his opinion that the friction of an engine was independent of the lead, and, among other things, presented the subjoined interesting table:

Indicated H. P.	Friction, H. P.	Kind of engine.
84	7	Westinghouse, 12x11 inches, 300 revolut's.
Unloaded	10	
23	5	Buckeye, 7x14 inches, 280 revolutions.
Unloaded	5.1	
347	44	Compound condensing throttled.
185	40	
181	19	Compound condensing expansion.
137	25	

This table, it will be observed, shows that the friction is actually less in all cases but one when the load is greatest. Mr. Denton thought that the friction of a piston in a cylinder was slight, and that lubrication did not bring about any noticeable result so far as this particular part was concerned. In support of these statements he cited first the case of an engine in which the steam of the same pressure was admitted to both cylinder ends at the same time The difference in area between the two faces of the piston, owing to the presence of the piston-rod, and the consequently greater effective pressure on the back, as compared with the front face, caused the piston to move slowly to the front end of the cylinder. The friction, therefore, could not have been appreciable. As regards lubrication Mr. Denton gave an account of his experience with engines which had been cleaned out with ether, and in which no oil whatever had been used for months. The records obtained under such conditions, when compared with data from the same engines using oil in the cylinders, showed no difference worthy of special note. The fact that engines showed less friction under the heavier loads than under the lighter ones Mr. Denton explained by the assumption that the various journals, through the reversal of motion of the reciprocating parts of the engines, developed a suction-pump action, drawing in the lubricating oil, and that this action was more vigorous when the engines were fully loaded.

CALKING.

Calking is something that is not always done as it should be. In fact, in some sections of the country it is done as it shouldn't be, about as emphatically as it is possible to do anything. The thing most particularly referred to in this connection, and the practice of which should bankrupt any boilermaker, is known as "split calking." To do calking in the best manner, and as it should be done, the edges of the plates should be planed. They are planed in all first-class shops, and trouble caused by bad calking is something very rare with such work. But of course this refers to new work. Repair jobs, and boiler work turned out of the shops in remote sections of the country where planers are unknown, afford the demon of split calking a chance to get in his most effective work. He rarely neglects a chance that is offered him. Some one may inquire, what is split calking? To which we would reply, split calking consists in driving a thin caulking tool, scarcely one-sixteenth of an inch thick, against the edge of a sheet so that a thin section of the plate is driven in between the two plates, with the idea of making a joint tight. The result generally is that the plates are separated from the edge of the lap back to the line of rivets, sometimes as much as one-thirty-second of an inch, the only bearing surface outside of the rivets being the portion split off from the plate and driven in by the calking tool. This bearing surface may be an eighth of an inch wide, but it is apt to be much less, and no patent medicine yet discovered will keep the seam tight for any length of time. When a boiler thus calked gets to leaking so badly that it can't be run, the boiler-maker is sent for, and he usually proceeds to do more split calking, and in a short time the boiler leaks worse than ever. In one instance one of our inspectors examined a boiler and found one of the girth seams leaking badly. It had repeatedly been calked in the above manner; so many times, in fact, had the process been repeated, that there was not enough of the lap to perform another operation on. He, therefore, gave instructions for putting on a patch, with a special caution to the owner, to whom he explained the cause of the trouble, to allow no split calking to be done on it. On his next visit he examined the patch, and he declares that the boiler-maker had put in on it the worst job of split calking he ever saw in his life.

USEFUL NUMBERS.

3.1415926=ratio of diameter to circumference of circle.

.7854=ratio of area of circle to square of its diameter.

33,000 minute foot pounds=1 HP.

396,000 minute inch pounds=1 HP.

396,000 cubic inches piston displacement per minute of engine wheel would develop 1 HP. with 1 ℔. mean effective pressure on the piston.

23,760,000 cubic inches piston displacement per hour of engine developing 1 HP. with 1 ℔. mean effective pressure on the piston.

859,375 pounds of water per hour at 1 ℔. pressure per square inch to give 1 HP.

55 ℔s. mean effective pressure at 600 feet piston speed gives 1 HP. for each square inch of piston area.

0.301030=natural logarithm			2.
0.477121	"	"	3.
0.602060	"	"	4.
0.698970	"	"	5.
0.778151	"	"	6.
0.845098	"	"	7.
0.903090	"	"	8.
0.954243	"	"	9.
1.000000	"	"	10.

2.3025851 times natural logarithm gives hyperbolic logarithm.

.5000000=sine of	30°	with radius	1.
.7071068 "	45°	"	1.
.8660254 "	60°	"	1.

9,000 to 13,000 feet per minute velocity of circular saw rim.

27,000 ℔s. per square inch tensile strength of cast iron.

50,000 lbs. per square inch tensile strength of wrought iron.

120,000 lbs. tensile strength of steel.

30,000 lbs. tensile strength of sheet copper.

60,000 lbs. tensile strength of copper wire.

100,000 lbs. per square inch=crushing strength of cast iron.

35,000 lbs. per square inch=crushing strength of wrought iron.

225,000 lbs. crushing strength of steel.

300 to 1,200 tons per square foot crushing strength of granite.

6,500 lbs. per square inch crushing strength of oak.

(Above crushing strengths are for pieces not over 3 diameters in length.)

600 to 1,000 feet per minute of single leather belt 1 inch wide said to give 1 HP. on cast iron pulleys.

2.645 lbs. per lineal foot of 1 inch round wrought iron.

3.368 lbs. per lineal foot of 1 inch square wrought iron.

40 lbs. per square foot of 1 inch plate wrought iron.

2.45 lbs. per lineal foot of 1 inch round cast iron.

12 times weight of pine pattern = iron casting.

13 times weight of pine pattern = brass casting.

19 times weight of pine pattern = lead casting.

12.2 times weight of pine pattern = tin casting.

11.4 times weight of pine pattern = zinc casting.

.06363 times square of inches diameter, times thickness in inches = weight of grindstone in pounds.

.8862 times diam. of circle = side of a square equaling.

.7071 times diam. of circle = side of inscribed square.

1.1283 times square root of area of circle = diam. of circle.

57° 2958 in. arc having length = radius.

.017453 × radius = length of arc 1 deg.

$9.8696044 = 3.1415926^2 = \pi^2$.

$1.7724538 = \sqrt{(3.1415926)} = \sqrt{\pi}$.

0.49715 = nat. log. 3.1415926.

$.31831 = \text{reciprocal of } 3.1415926 = \frac{1}{\pi}$

.002778 = 1÷360 = 1-360.

114.59 = 360÷3.1415926.

3183 × circumf. = diam. of circle.

2786° F. = melting point of iron.

2016° F. = melting point of gold.

1873° F. = melting point of silver.

2160° F. = melting point of copper.

740° F. = melting point of zinc.
620° F. = melting point of lead.
475° F. = melting point of tin.
537 lbs. per cu. ft. = weight of copper.
450 lbs. per cu. ft. = weight of cast iron.
485 lbs. per cu. ft. = weight of wrought iron.
708 lbs. per cu. ft. = weight of cast lead.
490 lbs. per cu. ft. = weight of steel.
27.684 cubic inches of water per pound at 32° F.
27.759 cu. in. water per lb. at 70°
.036 lbs. per cu. in. water at 60° F.
62.355 lbs. per cu. ft. water at 62° F.
59.64 lbs per cu. ft. water at 212° F.
.54 lbs. anthracite per cu. ft.
40 to 43 cu. ft. anthracite per ton.
49 cu. ft. bituminous coal per ton.
39.3685 inches = 1 meter.
3.2807 feet = 1 meter.
1.0936 yards = 1 meter.
61.02 cubic inches = 1 meter.
2.113 pints = 1 liter.
1.057 quarts = 1 liter.

BUYING OIL AND COAL.

There are many establishments which, when buying oil, coal, and such supplies, consider merely the question of first cost irrespective of their economic value. The best is not necessarily the cheapest, nor is it necessarily the dearest. The true economic value is due to the service it will perform, divided by the price.

We will take the case of coal. Some coal will evaporate ten pounds of water per pound of coal under certain conditions, and others only seven. In the one case there will be $2240 \times 10 = 22,400$ pounds of water evaporated, and in the other only $2240 \times 7 = 15,680$ pounds, under the same conditions. If the first lot sold at $5.25 per ton, and the second at only $5 the first would be the cheapest, for in the one case (including freight and labor in stoking and cost of removing ashes) we would get $22,400 \div 5.25 = 4,266.66$ pounds of steam per dollar's worth of coal, and in the other only $15,680 \div 5 = 3,136$ pounds of steam per dollar's worth of coal. Not allowing for freight and the cost of removing ashes, and not considering the capacity of the boiler with good coal as compared with its capacity with poor, the first coal would be a scheap at $6.80 per ton as the second at $5; or, to put it the other way, the poorer coal ought to be sold at $3.85 per ton to make it as cheap as the better material at $5.25. When the other expenses are taken into consideration, the economy of buying the better coal becomes greater.

In the matter of oils: these vary in their lubricating powers, in their coolness of running, and in their durability. We will consider two oils, one at 25 cents per gallon and the other at 30, having the same lubricating power and running equally cool under free feed, but one requiring 100 gallons to keep the friction down to a minimum and the other taking only 75 gallons to effect the same object. The relative economy of these two oils is not as 30 to 25, or as 120 to 100, but as $30 \times 75 = 2,250$ to $25 \times 100 = 2,500$, or as 100 to 90; that is, the cost of the high-priced oil to effect a given desired condition is only .90 the cost of the poor oil to do the same thing; then the economy is as 100 to 90. At this rate the better grade of oil would be as cheap at

$$\frac{10 \times 30}{9} = 33\tfrac{1}{3} \text{ cents per gallon,}$$

as the cheaper at 25 cents; or the lower grade would have to be sold at

$$\frac{9 \times 25}{10} = 22\tfrac{1}{2} \text{ cents per gallon,}$$

to bring its economy down to that of the better grade; and this without counting freight, which, in many cases, should be added to the invoice price, or time in oiling, which is time lost.

NOTES ON PATTERN-MAKING.

Never work with a dull tool.

Take time to sharpen and put your tools in good order; it saves time in the end.

Above all, never use a dull or badly "set" saw. It will ruin your work, sour your temper, and make you disgusted with the whole world.

If you are varnishing or polishing a piece of work, have the room or shop warm, exclude draught and dust, and don't be in too big a hurry.

If you are polishing in the lathe, see to it that all dust and dirt are removed from the lathe-bed before you commence work.

It is better, when possible, to polish all turned work in the lathe. It always has a better appearance for it.

In making patterns for castings, if you have no experience you had better consult ome person who has had experience. Patterns are difficult things for amateurs to make if they do not understand the principles of molding and founding.

White pine or mahogany makes the best work for patterns. Lead, brass, copper and sometimes plaster of Paris are used for making patterns; especially is this so for small, fine castings.

Shellac varnish is the best material for coating patterns.

Beeswax may be used for stopping up holes or to cover defects in patterns if it is coated with shellac varnish afterward. The beeswax will "take" the varnish readily, and will not cling to the "sand," like ordinary putty.

Shellac varnish may be mixed with a little lampblack to give it body and make a black pattern.

Sometimes pattern-makers use stove polish or "black lead," as it is called, to finish their patterns. It is applied nearly dry, then polished with a brush.

Wood used for patterns must be of the very best finish, straight grained, free from knots or shakes, and well seasoned.

A clean pattern gives a clean casting, and much labor may be saved by making the pattern the right size, and smooth and clean.

After patterns have been used they should be kept in a dry place, as damp will distort and otherwise injure them.

Always make a drawing of patterns before making. Much time and labor will be saved.

Where patterns part in the center they should be made to separate easily.

Put on your best workmanship when pattern making.

AN INTERESTING EXPERIMENT.

You think you stand pretty straight, don't you? Well, just back up against the wall of a room and bear against it all over; you will find there more buckles, short bends and offsets between your head and your heels than you had any idea of.

While you have your heels against the baseboard, keep them there, and reach over forward and touch your fingers to the floor, if you want a specimen of upset gravity.

A steel wire nail mill has just begun work at Hamilton, Ont. The output at present is a ton a day.

THINGS TO REMEMBER ABOUT SHAFTING.

Don't buy light hangers, and think that they will do well enough, when your own judgment tells you that they will spring.

Remember that shafting is turned one-sixteenth inch smaller than the nominal size.

Cold-rolled and hot-rolled shafting can be obtained the full size.

The sizes of shafting vary by quarter inches up to three-and-a-half inches.

The ordinary run of shafting is not manufactured longer than from 18 to 20 feet.

For line shafts, never use any that is smaller than one-and-eleven-sixteenth inches in diameter, as the smallest diameters are not strong enough to withstand the strain of the belts without springing.

The economical speed of shafting for machine shops has been found to be from 125 to 150 revolutions per minute, and for woodworking shops from 200 to 300 revolutions.

A jack-shaft is a shaft that is used to receive the entire power direct from the engine or other motor, which it delivers to the various main shafts.

Keep the shafting well lined up at all times, as this will ward off a breakdown, and avoid a waste of power.

Know that the pulleys are well balanced before they are put in position, as a pulley much out of balance is quite a sure method to throw shafting out of line.

Look to the pulleys, and see that they have been bored to the size of the shaft, for unless this is done the pulley may be out of center on the shaft and prevent smooth running.

If possible, apply the power to a line of shafting at or near the center of its length, as this will enable you to use the lightest possible weight of shafting.

Hangers with adjustable boxes will be found to be the most convenient for keeping the shafting in line.

Keep your drip-cups cleaned, and do not allow them to overflow or get loose.

Have a supply of tallow in the boxes; in case of accidental heating it will melt and prevent cutting; this rule, while good for general use, applies particularly to special cases where there is a supposed liability to heating.

Never lay tools or other things on belts that are standing still, for they may be forgotten and cause a breakdown when the machinery is started.

Don't attempt to run a shaft in a box that is too large or too small, as you will waste time and fail to secure good results.

A loose collar held by a set screw will cause the collar to stand askew, and it will cut and wear the box against which it runs.

In erecting a line of shafting, the largest sections should be placed at the point where the power is applied. The diameter can then be gradually decreased toward the extremities remote from this point.

Don't put loose bolts in plate couplings, as this will give no end of trouble in cutting, shearing and the wearing away of the bolt holes.

Don't think that because your shafting has been well erected and you oil it regularly, that it will never need any inspection or repairs.

Don't try to economize in first cost by having long distances between hangers, for a well supported shaft will always do the best work ; short shafts are the surest to be straight and to remain so.

The length usually adopted for shafting bearings is twice to four times the diameter of the shaft, varying with the diameters of shaft, kind of bearings and the material used in them. Large shafts in the gun-metal or bronze boxes may have bearings only twice their diameter in length. Cast iron bearings up to and including three inch shafts are often made four diameters of the shaft in length, particularly for self-adjusting hangers.

If Babbit is used for the boxes, use only a good metal; do not adopt the common mixture of tin, antimony and lead.

Insist upon having good iron in your shafting, as the bearings will take a finer polish, and you will not be subject to sudden ruptures.

If the strain on a pulley is so great that the set-screws already in will not hold it, do not let them score into the shaft, but put in an extra screw, or cut a key-way and put in a key.

The width of a key-way should be one-quarter of an inch for each inch of diameter of the shaft.

The depth of a key-way is one-half its width.

To Prepare Zinc for Painting—Apply sulphuric acid and water for a quarter of an hour; then wash off clean with water and dry.

Moisture-Resisting Glue—A glue which is proof against moisture may be made by dissolving 16 ounces of glue in 3 pints of skim milk. If a stronger glue be wanted, add powdered lime.

A Good Lubricator—It may not be generally known that tallow and plumbago thoroughly mixed make the best lubricator for surfaces when one is wood or when both are wood. Oil is not so good as tallow to mix with plumbago for the lubrication of wooden surfaces, because oil penetrates and saturates the wood to a greater degree than tallow, causing it to swell more.

To Prevent Metals Rusting—The following is said to be a good application to prevent metals rusting: Melt 1 oz. of resin in a gill of linseed oil, and while hot mix with it two quarts of kerosene oil. This can be kept ready to apply at any time with a brush or rag to any tools or implements required to lay by for a time, preventing any rust, and saving much vexation when the tool is to be used again.

To Prevent Slipping of Belts—Belts conveying power are very apt to slip on pulleys, but a new pulley has been devised to prevent this. The pulley is covered with perforated sheet iron one-sixteenth of an inch thick, which is riveted to the pulley. The tension of the belt causes it to grip slightly the holes, and thus slipping is avoided, while at the same time the pulley is strengthened.

To Calculate Water in a Pipe—To calculate roughly the quantity of water in any given pipe or other cylindrical vessel, it is only necessary to remember that a pipe one yard, or three feet, long will hold about as many pounds of water as the square of its diameter in inches. Thus: If we have a pipe 20 inches in diameter and 16 feet long, we have simply to square 20 ($20^2=400$), and multiply the result by the number of times 3 feet is contained in 16 feet$=5\frac{1}{3}$ times; hence, $400 \times 5\frac{1}{3}=2{,}133$ pounds. By increasing the result by 2 per cent., or 1-50th, a more nearly exact figure can be obtained.

BRASS AND ITS TREATMENT.

Brass, as previously stated, is perhaps the best known and most useful alloy. It is formed by fusing together copper and zinc. Different proportions of these metals produce brasses possessing very marked distinctive properties. The portions of the different ingredients are seldom precisely alike; these depend upon the requirements of various uses for which the alloys are intended. Peculiar qualities of the constituent metals also exercise considerable influence on the results.

Brass is fabled to have been first accidentally formed at the burning of Corinth, 146 B. C., but articles of brass have been discovered in the Egyptian tombs, which prove it to have had a much greater antiquity. Brass was known to the ancients as a more valuable kind of copper. The yellow color was considered a natural quality, and was not supposed to indicate an alloy. Certain mines were much valued, as they yielded this gold-colored copper, but after a time it was found that by melting copper with a certain earth (calamine), the copper was changed in color. The nature of the change was still unsuspected.

Alloy of copper and zinc retain their malleability and ductility when the zinc is not above 33 to 40 per cent. of the alloy. When the zinc is in excess of this, crystalline character begins to prevail. An alloy of one copper to two zinc may be crumbled in a mortar when cold.

Yellow brass that files and turns well may consist of copper 4, zinc 1 to 2. A greater proportion of zinc makes it harder and less tractable; with less zinc it is more tenacious and hangs to the file like copper. Yellow brass (copper 2, zinc 1) is hardened by the addition of two to three per cent. of tin, or made more malleable by the same proportion of lead.

There would be less diversity in the results of brass castings if what was put in a crucible came out of it. The volatility of some metals, and the varied melting points of others in the same mix, greatly interfere with the uniformity in ordinary work. Zinc sublimes (burns away) at 773 to 800 degrees, while the melting heat of the copper — with which it should be intimately mixed in making brass — is nearly 1,750 degrees. Copper, zinc, tin and lead in varying proportions form alloys, always in definite quantity for a given alloy. The ease with which some of the metals are burned away at comparatively low temperatures renders it a very easy matter to make several different kinds of metal with the same mix. This very thing occurs, and the great difficulty in getting bearing brasses uniform in quality causes some engineers to babbitt all bearings as the best way to insure uniformity. One lot of castings may be soft and tough, another hard, and so on.

Zinc is added the last thing as the crucible comes out of the furnace, and the mixing of the mass is a matter of uncertainty. If the metal is too hot for the zinc a large percentage goes off in the form of a greenish cloud of vapor, and the longer the stirring goes on the more escapes. The two metals which enter into the composition of brass have an affinity for each other, but they must be brought into intimate contact before they will combine. Some brass founders use precautions to prevent volatilization of the more fusible metals, introducing them under a cover of powdered charcoal on top of the copper.

"Brass finisher" is a term many understand as applied only to those who produce highly-finished brass work; but it is not so; the brass finisher's work is not the superior class of work supposed, most of it being comprised in gas fittings, ormolu mounts, etc., but the highest class of brass finishing is a totally different process. Fittings for gas work, all finished well enough for their several purposes, and as well done as the price paid for them will allow, as well as the mountings for furniture, must obviously be produced at a low price, in order to supply the demand for cheap work of this character, most of which is simply dipping, burnishing and lacquering.

Let us follow the process of finishing the highest class of brass work. Before commencing to polish, all marks of the file must be removed, and this is done thus: Having used a superfine Lancashire file to smooth both the edges and surfaces, take a piece of moderately fine emery paper and wrap it tightly, once only, round the file. By having many folds round the file the work becomes rounded at the edges, and so made to look like second-rate things. Some use emery sticks, made of pieces of planed wood about ⅜ inch thick and ¾ inch wide, quite flat on the surfaces. They are covered with thin glue, and the emery powdered onto them, and then allowed to dry hard. Most common work is rubbed over, not to say finished, with emery cloth. This will not do for good work. The paper folded once round the file is used in a similar manner to the file, and when the file-marks disappear, and the paper is worn, a little oil is used, which makes it cut smoother. The edges and surfaces being prepared to this extent, the edges must be finished. To effect this take a piece of flat, soft wood, and apply to its surface a little fine oil-stone powder; be sure that it is quite clean, as it is very annoying to make a deep scratch in the work just as it is finished; perhaps so deep that it will require filing out.

RECIPES FOR MAKING SEALING WAX.

1. WHITE.

Bleached shellac	340	parts.
Venice turpentine	160	"
Plaster of paris	100	"
Magnesia	15	"
Subnitrate of bismuth	150	"
Carbonate of lead	235	"

Melt the turpentine in a capacious copper kettle over a charcoal fire, and gradually add the shellac. When a uniform melted mass has resulted, gradually add the solid ingredients, which must be in form of finest (bolted) powder, under constant stirring. Then remove the kettle, keep stirring until the mass cools short of solidifying, and pour it out into forms.

2. YELLOW.

Shellac	380	parts.
Venice turpentine	320	"
Rosin	160	"
Plaster of paris	50	"
Magnesia	10	"
Chrome yellow	80	"

Proceed as directed under 1.

3. GREEN.

Shellac	500	parts.
Venice turpentine	250	"
Rosin	150	"
Magnesia	20	"
King's yellow (yellow litharge)	60	"
Mountain (Sanders') blue	30	"
Oil of turpentine	20	"

Proceed as before, except that the coloring matters are best triturated to a fine paste with the oil of turpentine, and this paste added to the melted mass in small quantities at a time. Mountain blue is a copper color.

ELECTRIC RAILWAYS FOR JAPAN.

Japan goes ahead. The Mikado has now commissioned an engineer to visit the States, to gain information with the intention of introducing electric railways into Japan.

METAL-WORKING DIES AND THEIR USES.

BY HENRY LONG.

In the following pages, which have been specially prepared for this work, will be found a condensed description of the commoner kinds of dies now in use for sheet-metal work. There being several kinds of punching presses, I will specify the variety in which each die can be used as I describe it. The commonest in use is the simple cutting-die, and I will describe it first. It can either be made by welding a steel ring of the shape desired on a wrought iron plate, and then dressing the hole out roughly to pattern while hot, or by drilling out a hole of the shape required through a piece of flat steel of proper dimensions, and then dressing it out with files, etc., to exact size. While the former plan is most expensive, it is the best in regard to wear and quality of work. Fig. 1 represents a die of this kind. The forging for this die would be made as I explained above; that is, by welding a steel ring of the shape of the pattern on an iron plate, and cutting the hole through the iron afterward. The punch for this would be made similarly, only that the ring is the shape of pattern outside, and after welding to the iron plate it is trimmed off outside. There is also a shank to be welded on the other side of plate, as nearly central as possible, and large enough to finish up easily to size required. In making this die the two faces are planed off clean, and then the pattern is laid on top face and the die is marked from it. When this is done, it is put in the shaper and planed out to the marks, care being taken to throw the work forward in the chuck to give about $\frac{1}{16}$ in. clearance to the inch, in depth.

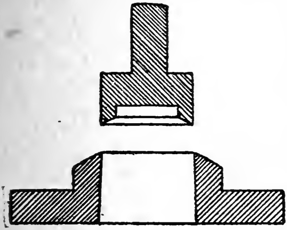


Fig. 1.

It is now filed out and champfered off on face, as shown, the face being hollowed out $\frac{1}{32}''$ on three or four sides afterward to give it a shearing edge. It is now ready for tempering. As the tempering requires great care it is very necessary to watch your heat closely, and while making it even, do not heat any higher than necessary, and plunge it carefully into cold soft water with one edge down, keeping it in there until perfectly cold. Now take it out and polish the face and inside well, and reheat very evenly as before until you observe a dark straw color, when you can cool it off, as that is considered a good temper, and one that will stand wear without breaking. The punch is pared off on both sides and shank turned up to size, and then the die is laid on it face to face and the shape marked out. Now it is shaped off to the lines and fitted closely in the die, the inside edge of punch being afterward champfered off as shown. This die can be used in any press, and is particularly designed for light metals such as zinc, tin, etc. A flat-cutting die would be made by taking a piece cut from the bar at least 1¼″ longer and wider than your pattern, and, after planing it, lay your pattern on and mark the hole. Then drill around inside the marks and file out in same way as you do the other. The punch would be made same as last, but without champfering off the edge. This die can be used in any press, and is designed for heavy work, such as hard brass, steel, etc. Sometimes there may be some narrow or weak part in the die which is likely to break out in time, in which case it is economical to insert a plug as shown in Fig. 2. Of course these plugs can be renewed as often as necessary without disturbing the form of the die. For round holes of small size, a steel plug is fitted in a soft steel plate, and the hole drilled and reamed through it, after which the plug is tempered.

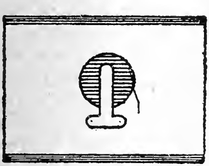


Fig. 2.

The punch is simply a socket with a set screw in which round steel of the right size is used, in this way saving any turning or fitting. Sometimes a gang of punches is used, as is shown in Fig. 3, for which a special punch is designed. In this, the shank is a separate piece, and has a dove-tailed groove planed through it. This groove should be from ⅜″ to ½″ larger in every way than the dimensions you wish to punch. It should also have $\frac{1}{32}$″ draft, or taper endwise to allow of a driving bit on the plate fitted in. This plate should be ½″ thick at least. You first drill all the holes in your die in the right position, and after reaming them out, harden and temper it. You now place this plate, which you have fitted in the shank, on the face of the die in its true position and fasten it securely there. The next thing is to run the drill you used on the

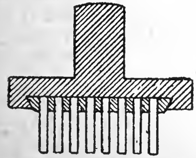


Fig. 3.

die, through the die holes, and mark their exact position on this plate. When this is done, remove the die and drill the holes through from these marks, and countersink them from behind. Now, the stripper or guide, which should be about ⅜″ thick, is fastened on in the position you wish it, and marked and drilled in the same way. The wire punches are made by riveting over a head on one end and then driving them in from the back, afterward filing off any superfluous metal which extends above the back. When you have made a gauge and placed it under the stripper, fastening securely, the die will be finished.

The punches should be filed to an even face, and then hollowed out a little to give more ease in cutting. All the dies mentioned thus far can be used in any ordinary press. We will now take up the different kinds of forming dies. There are only two kinds, half-round and square; all others are modifications of these. The depth of a half-round forming die should be two-thirds of the diameter to give the best results, and the punch should go down into the groove as shown in Fig. 4. A mandril is necessary to form the work over in the die. A square or box-forming die is simply a square hole of the right size, cut through the die, perfectly parallel, and with the upper corners rounded a little. If a smooth flat bottom is required it is usual to make the die of thinest steel, and put a plate under it as in Fig. 5, with a pad and spring, to throw it out. The punch is size of the inside of box, and a close fit. A die for forming a shape at any angle is simply a groove planed thro' the block and having a punch to fit it. Fig. 6 is a view of a common form of drawing die for deep work. They are used for making caps, cartridge cases, etc. It consists of a round disk of steel about ⅞″ deep with a hole the size of shell required bored in it.

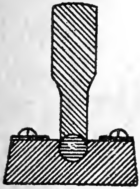


Fig. 4.

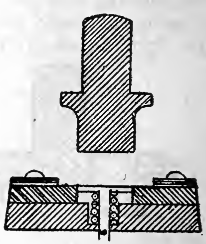


Fig. 5.

This hole is well rounded off at the corner, and counterbored from the bottom with a square, sharp shoulder for stripping the work off the punch after it has passed through the die. A cast-iron holder with set screw is generally used with these dies for convenience in changing. The punch is

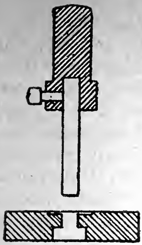


Fig. 6.

fitted into a socket in the shank and held by a set screw. It is rounded on the corners to give the metal a better chance to turn up around it. When the punch and die are set the blank is laid on the die, and the punch should be tight enough to carry it through without a wrinkle. If the shell is not long enough after this operation, make a die a little smaller and a punch the same, and after annealing the shells pass them through it. By repeating this operation you can produce shells of almost any length. Sometimes it is necessary to make a die to perform some operation on the edge of a box which has already been formed. In this case the die is made in such a way that the box can be put on it, thus placing the die on the inside. A hub is made the shape of the box, and with the die dovetailed into its upper side, a hole being bored down through the hub to allow the cuttings to fall through. This hub is fitted into a special holder as shown. The punch is made in the same way as others. These dies can be used for any operation that a flat die performs, such as cutting, forming, etc. As I have given a description

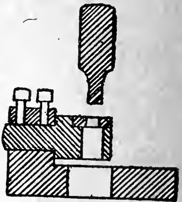


Fig. 7.

of the different forms of simple dies, I will now explain some double and combination dies. A double die is two distinct dies in one plate, and it may be extended to include three or four, although the work gets complicated in this case, and the economy is doubtful.

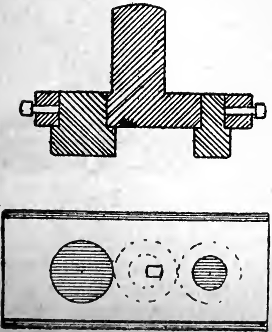


Fig. 8.

This die may be composed of two cutting dies, or one cutting and one forming die, or, in fact, any combination which may seem desirable. It is generally used for cutting dies, such as washers, etc. Fig. 8 shows the plan of one of these dies designed to make a washer. You will perceive that the first punch is the size of the hole in the washer and the second cuts out the washer itself. The punches are set in a long, flat socket, and fastened with set screws. The main point in these dies is to get them correctly spaced so as to cut out all the stock. They can be used in a power or foot press. A combination die is one which performs two or more operations in one die. Fig. 9 is one of these, designed to make a blacking-box cover. In this die the punch comes down and cuts out the blank which is immediately gripped between the two face *a* and *b*, and held firmly enough to prevent wrinkling, but still to allow of its being drawn through and over the form which is in the center of the die. When tne press is on the return stroke, the ring *b* follows the punch up and pushes the cover off again, while the pad in the punch does the same there, thus having the cover loose on the top of the die. These dies

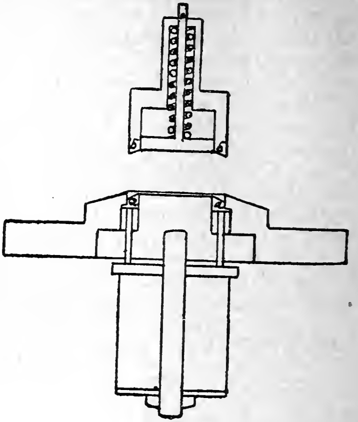


Fig. 9.

must be operated in a power press, or one specially designed for the purpose, and they are more conveniently worked in an inclined than a horizontal press, as the work will then fall off by the force of its own gravity.

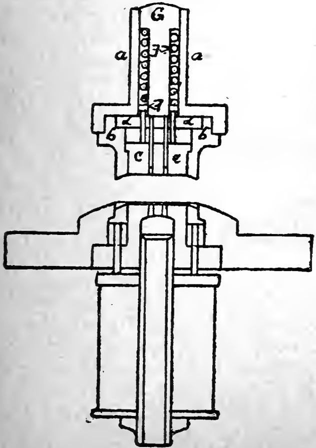


Fig. 10.

Fig. 10 is a die of the same class, but with another operation added. It is designed to make a pepper-box cover, and perforates four holes in it after it is drawn. The punch,as you will perceive, is entirely different in its construction. The die is the same, excepting that four cutting holes or dies are drilled in the top of the form or plug, and the inside is bored out to allow the cuttings to fall through. The stub is also bored out for the same reason. In the punch *a* is the shank, bored out as shown. *b* is the cutting edge or punch proper; it is bored or chambered out for the pad *c* to work in it. *d* is a plate that screws into the top of the punch *b*, to act as a back for the pad *c* to press against, and also as a holder for the four small punches. It has three holes in it, through which short pins work to communicate the power of spring E to the pad *c*. *H* is a washer under the spring, and *G* is a plug or pin that screws in the top of shank, and extends down to the plate *d*, against which it presses, in this way hold-ing the small pin punches down to place, and guiding and regulating the spring at the same time. The operation of the die is the same as Fig. 9, only that after the tin has been drawn down its full length, the small punches cut the holes through the top, and then the pad *c* acts as a stripper for these punches at the same time as it punches the cap out of the large punch.

As all other combinations are made on this plan, it is hardly necessary to describe any others.

Fig. 11 represents a die for doing the same work, but in what is called a cam or double-action press. These dies are much simpler and cheaper to make and do equally good work with the others. The piece A is the cutting punch, and works in the die B. After cutting the blank it passes down until it presses the blank against the face shown on the inside of the die. While it is holding the blank firmly there the forming punch C passes down through the cutting punch and forces the tin down through the inside die B, in this way forming it into any shape desired. In passing up again it strips the box off against the underpart of the die, allowing it to fall into a box underneath. This covers the list as announced in the beginning of this article, and although the different kinds of dies are endless, the foregoing description will enable the reader to judge of the best way of doing work, and there is hardly any pattern which cannot be produced by one or more of these dies in combination.

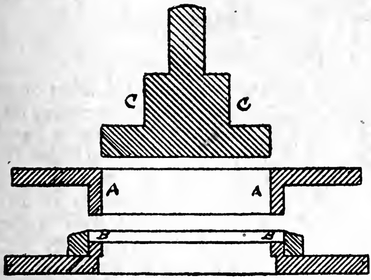


Fig. 11.

RULE TO FIND THE STRENGTH OF BOILER SHELLS AND FLUES.

The pressure for any dimension of boiler can be ascertained by the following rule, viz.:

Multiply one-sixth ($\frac{1}{6}$th) of the lowest tensile strength found stamped on any plate in the cylindrical shell by the thickness — expressed in inches, or parts of an inch — of the thinnest plate in the same cylindrical shell, and divided by the radius or half diameter — also expressed in inches — and the quotient will be the pressure allowable per square inch of surface for single riveting, to which add twenty per centum for double riveting.

Boilers built prior to February 28, 1872, shall be deemed to have a tensile strength of 50,000 pounds to the square inch, whether stamped or not.

For cylindrical boiler *flues* over 16, and less than 40 inches in diameter, the following formulas shall be used in determining the pressure allowable.

Let D = diameter of flue in inches.

1760 = A constant.

T = thickness of flue in decimals of an inch.

P = pressure of steam allowable, in pounds.

$$\frac{1760}{D} = F, \text{ a factor.}$$

.31 = C, a constant.

$$\text{Formula: } \frac{F \times T}{C} = P.$$

EXAMPLE.

Given, a flue 20 inches in diameter, and .37 of an inch in thickness; what pressure could be allowed by the inspectors?

$$F = \frac{1760}{20.} = 88; \text{ then, } \frac{88 \times .37}{.31} = 105 + \text{ pounds as the allowable pressure.}$$

TO CALCULATE THE SPEED OF A BELT.

To find the speed a belt is traveling per minute, multiply the diameter in feet of either pulley by 3.7 times its revolutions per minute; the result is the feet travel of belt per minute if there is no slip. At the recent "Inventions Exhibition" in Liverpool, the indicated horse-power transmitted by the belting averaged, on trial, per one inch width of belt a horse power, a speed of 200 feet per minute; it would seem that a liberal factor of slip should be allowed outside of this.

SIZES AND WEIGHT OF SHEET TIN.

Mark.	No. of sheets in Box.	Dimensions. Length	Dimensions. Brdth.	Wt. of Box.
		Inches.	Inches.	Lbs.
IC..........	225	13¾	10	112
IIC..........	"	13¼	9¾	105
IIIC.........	"	12¾	9½	98
IX	"	13¾	10	140
IXX.........	"	"	"	161
IXXX.......	"	"	"	182
IXXXX	"	"	"	203
DC..........	100	16¾	12½	105
DX..........	"	"	"	126
DXX........	"	"	"	147
DXXX......	"	"	"	168
DXXXX....	"	"	"	189
5 DC........	200	15	11	168
5 DX........	"	"	"	189
5 DXX......	"	"	"	210
5 DXXX....	"	"	"	231
5 DXXXX...	"	"	"	252
ICW.........	225	13¾	10	112

The following table, showing the number of pounds per foot in various woods, in different stages of dryness:

	Green.	Shipping dry.	Thoroughly air dried.	Kiln dried.
White ash...........	4¾	4	3½	2 4-5
Gray ash............	4½	3¾	3	2½
Birch...............	5½	4½	4	3½
Basswood	3¾	3	2½	2⅛
Cottonwood..........	3¾	3	2½	2⅛
Cherry..............	5	4½	3½	3
Chestnut............	4¼	3½	2¾	2¼
Soft elm	4	3½	3	2½
Rock elm............	5	4¼	3¾	3¼
Hickory	5½	4¾	4	3⅓
Hard maple..........	5¼	4½	3¾	3
Bird's-eye maple	5¼	4¼	3¾	3
Curly maple.........	4¾	4	3½	2¾
White oak...........	6	5	4½	4
Red oak.............	5½	4½	3½	3
Sycamore	5	4	3	2¾
Walnut	6	5	4	3¾
Whitewood...........	4½	3½	2¾	2½

CALIBER AND WEIGHTS OF LEAD PIPES.

CALIBER.	WEIGHT PER FOOT. LBS.	OZ.
¼ in. tubing		6
⅜ in. aqueduct		8
light		12
medium	1	
strong	1	8
ex. strong	2	
½ in. aqueduct		10
ex. light		12
light	1	
medium	1	4
strong	1	12
ex. strong	2	8
⅝ in. aqueduct		12
ex. light	1	4
light	1	12
medium	2	
strong	2	8
ex. strong	3	
¾ in. aqueduct	1	
ex. light	1	8
light	2	
medium	2	4
strong	3	
ex. strong	3	8
⅞ in. aqueduct	1	8
ex. light	2	
light	2	8
1 in. aqueduct	1	8
ex. light	2	
light	2	8
medium	3	4
strong	4	
ex. strong	4	12
1¼ in. aqueduct	2	
ex. light	2	8
light	3	
medium	3	12
strong	4	12
ex. strong	6	
1½ in. aqueduct	3	
ex. light	3	8
light	4	
medium	5	
strong	6	
ex. strong	7	8
1¾ in. light	3	12
light	4	8
medium	5	8
strong	6	8
ex. strong	8	
2 in. waste	3	
2 in. ex. light	4	
light	5	
medium	7	8
strong	8	
ex. strong	9	
2½ in. 3-16 thick	8	
¼ thick	11	
5-16 thick	14	
⅜ thick	17	
3 in. waste	5	
3-16 thick	9	
¼ thick	12	
5-16 thick	16	
⅜ thick	20	
3½ in. ¼ thick	15	
5-16 thick	18	
⅜ thick	21	
4 in. waste	5	
¼ thick	16	
5-16 thick	21	
⅜ thick	25	
7-16 thick	30	
4½ in. waste	6	
5 in. waste	8	

WEIGHT OF CIRCULAR BOILER HEADS.

Diam. in inches.	Thickness of Iron.— Inches.						
	3-16	¼	5-16	⅜	7-16	½	9-16
16	11	14	18	21	25	28	32
18	13	18	22	27	31	36	40
20	17	22	27	33	38	44	50
22	20	27	33	40	47	54	60
24	24	32	40	47	55	64	71
26	28	37	46	56	64	75	84
28	32	43	53	65	75	86	97
30	37	50	62	74	87	100	112
32	42	56	70	84	99	112	127
34	48	64	79	96	111	128	143
36	54	71	89	108	125	142	161
38	60	79	99	120	139	158	179
40	66	88	110	132	154	176	198
42	73	97	121	146	170	194	220
44	80	107	133	160	187	214	240
46	88	117	145	176	204	234	262
48	95	127	158	190	222	254	286
50	103	138	172	206	241	276	310
52	112	149	186	224	260	298	335
54	121	160	200	242	281	320	362
56	130	172	214	260	302	344	389
58	139	185	231	278	324	370	417
60	149	198	247	298	336	396	446

HOW TO CALCULATE THE CAPACITY OF TANKS.

In circular tanks, every foot of depth, five feet diameter, gives 4½ barrels of 31½ gallons each; six feet diameter, 6¾ barrels; seven feet diameter, 9 barrels; eight feet diameter, 12 barrels; nine feet diameter, 15 barrels; ten feet diameter, 18¾ barrels. In the case of square tanks, for every foot of depth 5 feet by 5 feet gives 6 barrels; 6 by 6 feet, 8½ barrels; 7 by 7 feet, 11½ barrels; 8 by 8 feet, 15½ barrels; 9 by 9 feet, 19½ barrels; 10 by 10 feet, 23¾ barrels.

NUMBER OF BOILER RIVETS IN A 100 POUND KEG.

Length.	½ Inch.	9-16 Inch.	⅝ Inch.	11-16 Inch.	¾ Inch.	⅞ Inch.
1	990	760	560	450		
1⅛	875	725	530	415		
1¼	800	690	490	389	356	228
1⅜	760	650	460	370	329	211
1½	730	625	425	357	290	180
1⅝	710	595	505	340	271	174
1¾	690	550	390	325	264	169
1⅞	665	530	375	312	257	165
2	630	510	360	297	248	156
2⅛	590	500	354	289	237	152
2¼	555	490	347	280	232	149
2½	525	475	335	260	219	141
2¾	500	440	312	242	211	133
3	460	410	290	224	203	127
3¼	430	380	267	212	190	115
3½	410	350	248	201	180	108
3¾	395	335	241	192	162	102
4		326	230	184	158	99
4¼		312	220	177	150	96
4½		298	210	171	146	94
4¾		284	200	166	138	89
5		270	190	161	135	87
5¼		256	180	156	130	84
5½		244	172	151	124	80
5¾		233	164	145	120	77
6		223	157	140	115	74
6¼		213	150	137	111	71
6		207	146	134	107	69
6		203	143	129	104	67
7		198	140	125	100	64

To Bronze Iron Castings.—After having thoroughly cleaned the castings, immerse them in a solution of sulphate of copper. The castings will then take on a coating of copper. Then wash thoroughly in water.

Copper is said to lose 18 per cent. of its tenacity upon being raised from 60° to 360°.

NUMBER OF "AMERICAN" NAILS AND CUT SPIKES IN A POUND.

Length in Inches.	Size.	Common.	Fence.	Casing.	Box.	Finishing.	Cut Spike.
1	2 F	1050					
1⅛	3 F	860					
1	2	900					
1¼	3	500		650		670	
1½	4	300		480	450	500	
1¾	5	212		350	300	370	
2	6	160	85	240	212	260	
2¼	7	135	65	190	160	210	
2½	8	95	50	135	120	155	
2¾	9	75	40				
3	10	60	35	115	100	135	16
3¼	12	48	30	100		120	
3½	16	34	25	80		100	14
4	20	24	20	65		85	12
4½	30	18		50		70	10
5	40	15		40		60	9
5½	50	12					8
6	60	10					6
7							4½
8							4

Clinch-nails weigh about the same as common.

Box-nails are made ⅛ inch shorter than common nails of same sizes.

5 lbs. of 4d or 3¾ lbs. of 3d will lay 1,000 shingles. 5¾ lbs. of 3d fine will put on 1,000 laths, four nails to the lath.

Bricks made from the refuse of slate quarries are stronger than stone; they stand 7,200 lbs. compression against 6,000 for stone, and 3,200 lbs. for common brick. The cost is from $12 to $20 per thousand.

In London 20,000 men earn their living at carpenter work, 4,000 in Paris, and 4,000 in Berlin. Hours in London are 52½ per week.

WAXING FLOORS.

Take a pound of the best beeswax, cut it up into very small pieces, and let it thoroughly dissolve in three pints of turpentine, stirring occasionally if necessary. The mixture should be only a trifle thicker than the clear turpentine. Apply it with a rag to the surface of the floor, which should be smooth and perfectly clean. This is the difficult part of the work, for, if you put on either too much or too little, a good polish will be impossible. The right amount varies, less being required for hard, close-grained wood, and more if the wood is soft and open-grained. Even professional "waxers" are sometimes obliged to experiment, and novices should always try a square foot or two first. Put on what you think will be enough, and leave the place untouched and unstepped on for twenty-four hours, or longer if needful. When it is thoroughly dry, rub it with a hard brush until it shines. If it polishes well, repeat the process over the entire floor. If it does not, remove the wax with fine sandpaper and try again, using more or less than before, as may be necessary, and continuing your experimenting until you secure the desired result. If the mixture is slow in drying, add a little of any of the common "dryers" sold by paint dealers, japan for instance, in the proportion of one part of the drier to six parts of turpentine. When the floor is a large one, you may agreeably vary the tedious work of polishing by strapping a brush to each foot and skating over it.

HOW TO MAKE AN IVORY GLOSS ON WOOD.

A most attractive ivory gloss is now imparted to wood surfaces by means of a simple process with varnish, the latter being of two kinds, namely, one a solution of colorless resin in turpentine, the other in alcohol. For the first, the purest copal is taken, while for the second sixteen parts of sandarac are dissolved in sufficient strong alcohol, to which are added three parts of camphor, and finally, when all these are dissolved, they are combined with five parts of well-shaken Venice turpentine. In order to insure the color remaining a pure white, particular care is essential that the oil be not mixed with the white paint previously put on. The best French zinc paint, mixed with turpentine, is employed, and, when dry, this is rubbed down with sandpaper, following which the varnish described is applied.

CARE OF OAK LUMBER.

Throughout the civilized world, except in extremely hot countries, one or more species of the oak is found. In this country oak forests abound in almost all the Southern and Central States. In species there are so many that even experienced lumbermen are frequently perplexed to correctly designate to which class a sample piece of wood belongs. Ordinarily in the yard trade but two kinds are known—white and red. Among shipbuilders, carriage-makers and machinists may be found live oak, a species of wood that is peculiarly adapted to purposes where immense strength is necessary. The average lumberman, when he talks about white oak or red oak, is influenced solely by the color of the wood when it becomes partially seasoned. Again and again veterans in the wood-working business have been known to select red oak for white, and *vice versa* in fact, from a dozen specimens of six different species of oak, they have been unable to correctly name a single sample.

Oak is a wood which calls for unusual and unceasing care in its manufacture. The tendency of oak, from the moment an ax is planted in the side of the tree, is to split, crack, and play all sorts of mean tricks on the owner. Such tendencies can be held in hand, and almost absolutely obviated, by following certain rules. A thick coat of water-proof paint applied to the ends of the logs is a wise expenditure; it prevents the absorption of moisture. Oak, when piled, should have the ends protected so as to prevent absorption of rain and moisture, followed by the baking process of a hot sun Alternate moisture and heat is the prime cause of checks and cracks, and when such defects begin in oak they are bound to increase and ruin otherwise perfect stock.

Oak should be stuck as fast as sawed. It is a mistake to permit it to lie in a dead pile even for a single day. It is a wood that contains a large amount of acid, which oozes to the surface as fast as the lumber is sawed, and, if the stock is allowed to remain piled solid, it is apt, even in a few hours, to cause stain on the surface. The lumber should be stuck in piles not over six feet in width. The bottom course should be raised two feet from the ground, and a space of five inches left between the pieces. It is advisable to follow this rule up to about the fifth course, when the space can be gradually diminished to two inches, and continued to the top of the pile. In this way air has free circulation through the pile, and the lumber will dry readily. The pile should cant toward the back, so that rain will follow the inclination.

Board sticks not over three inches wide should be used, the front stick placed so as to project a half inch beyond the lumber. This plan permits moisture to gather in the stick, not the lumber. Other sticks should be placed not over four feet apart, and in building the pile the sticks should be exactly over one another. By this plan, warps, twists and sags are avoided.

It is advisable to pile every length by itself. This rule permits more systematic piling, and, in shipping, consignments can be made of lengths precisely as wanted. Thicknesses in piling should never be mixed. Twisted stock is certain to be the result if this advice is ignored.

The sap should be placed downward. The draft is upward, and any practical lumberman can readily observe the advantage of this advice. Every pile should be well covered with sound culls, the covering so placed as to project beyond all sides of the pile. Raise it a foot from the top course. The piles should not be nearer than twenty inches apart; twenty-four inches is better.

HOW TO SHARPEN A PLANE-IRON.

The simple art of sharpening a plane-iron is supposed to be understood by every mechanic, remarks a writer in a contemporary, but there are hundreds of men who cannot do a creditable job in this respect. The common tendency is to round off the edge of the tool until it gets so stunted that under a part of the cutting the tool strikes the work back of the cutting edge. To do the job correctly we will begin at the beginning, and grind the tool properly. First, the kind of wood to be cut must be taken into consideration. Common white pine can best be worked with a very thin tool, ground down even to an angle of 30 degrees, provided the make of the tool will allow it. Some planes will not, for the iron stands so "stunt," or nearly perpendicular, that its grinding causes a severe scraping action, which soon wears away the tool. In such cases, from 45 to 60 degrees is the proper angle for plane-irons, and this, too, is about right for hardwood planing.

Determine the angle you want on the plane-iron and then grind to that angle, taking care to grind one flat bevel, and not work up a dozen facets. If the stone be small, say 12 to 18 inches in diameter, the bevel will be slightly concave like the side of a razor, and this is a quality highly prized by many good workmen. In grinding, take care to avoid a "feather edge." If the tool already possesses the right shape, grind carefully right up to this edge, but not grinding it entirely off. The time to stop grinding a tool is just before the old bevel is ground off.

Should the tool need any change of shape, such as the grinding out of a nick or a broken place, then put the edge of the tool against the stone and bring the tool to the desired shape before touching the bevel.

Let the iron lay perfectly flat upon the stone, with a tendency only to bear harder upon the edge of the bevel than upon the heel. Move the iron back and forth on the stone as fast as your skill will allow, taking care that the heel of the bevel is not lifted from the stone. As you become proficient in whetting an iron, the heel may be lifted from the stone about the thickness of a sheet of paper, or just enough to prevent it from touching. The reason why many carpenters cannot set an edge is because they raise their hand too much, and perhaps rock the tool, thus forming a rounding bevel, the sure mark of a poor edge-setter.

The proper way to oil-stone a tool is to continue the grinding by rubbing on the oil-stone until the bevel left by the grindstone is entirely moved and the edge keen and sharp. If this be properly done the tool need not be touched upon its face to the stone, but among a dozen good edge-setters not more than one can do it. It is a delicate operation, and can only be acquired by long practice. Nine times out of ten the average workman is obliged to turn the plane-iron over and wet the face thereof, and here is where many men fail who have done the other things well. By raising the back of the tool only a very little the edge is "dubbed off," and regrinding of the face becomes an immediate necessity. A good stone should "set" an edge on a tool which will shave off the hair on a person's wrist without cutting the skin or missing a single hair.

VALUE OF MAHOGANY.

As is known to every woodworker, mahogany has no equal for durability, brilliancy, and intrinsic value for any work which requires nicety of detail and elegance of finish. Cherry, which is a pretty wood for effect, and extremely pleasing when first finished, soon grows dull and grimy-looking. Oak, which has been so much used of late, is attractive when first finished, but experience teaches that it does not take many months to change all this, and instead of a light, fresh looking interior, one that has a dusty appearance is presented, which no amount of scraping and reoaking will restore to its original beauty. What applies to in this yet more applicable to ash.

Mahogany, however, seems to thrive best under the conditions which are detrimental to these other woods. At first of a light tone, it grows deeper and more beautiful in color with age, and although its first cost is more than these other woods, yet its price is much less than is popularly supposed; and the only objection urged against it has been cost. What is more valuable, however, and what makes mahogany in reality a less costly wood, is the fact that, unlike cherry, oak or ash, it is easily cleaned, because it is impervious to dust or dirt, while it does not show wear, and instead of growing duller, grows brighter and more pleasing in appearance. While first cost is more than that of cherry, oak or ash, it is nevertheless true that the judgment of many men has led them to regard mahogany as the cheaper wood when its durability and cleanly qualities are considered, and to-day it takes front rank in first-class material.

POLISHING GRANITE.

The form is given to the stone by the hands of skilled masons in much the same way as is done with other stone of softer nature. Of course, the time required is considerably greater in the case of granite as compared with other stones. If the surface is not to be polished, but only fine-axed, as it is called, that is done by the use of a hammer composed of a number of slips of steel of about a sixteenth of an inch thick, which are tightly bound together, the edges being placed on the same plane. With this tool the workman smooths the surface of the stone by a series of taps or blows given at a right angle to the surface operated upon. By this means the marks of the blows as given obliquely on the surface of the stone are obliterated, and a smooth face produced. Polishing is performed by rubbing, in the first place, with an iron tool and with sand and water. Emery is next applied, then putty with flannel. All plain surface and molding can be done by machinery, but all carvings, or surfaces broken into small portions of various elevations, are done by the hands of the patient hand-polishers.

The operation of sawing a block of granite into slabs for panels, tables or chimney-pieces is a very slow process, the rate of progress being about half an inch per day of ten hours. The machines employed are few and simple; they are technically called lathes, wagons and pendulums or rubbers. The lathes are employed for the polishing of columns, the wagons for flat surfaces, and the pendulums for molding and such flat work as is not suitable for the wagon. In the lathe the column is placed and supported at each end by points upon which it revolves. On the upper surface of the column there are laid pieces of iron segments of the circumference of the column. The weight of these pieces of iron lying upon the column, and the constant supply of the lathe-attendant of sand and water, emery or putty, according to the state of finish to which the column has been brought, constitute the whole operation. While sand is used during the rougher state of the process these irons are bare, but when using emery and putty, the surface of the iron next to the stone is covered with thick flannel.

The wagon is a carriage running upon rails, in which the pieces of stone to be polished are fixed, having uppermost the surface to be operated upon. Above this surface there are shafts placed perpendicularly, on the lower end of which are fixed rings of iron. These rings rest upon the stone, and when the shaft revolves they rub the surface of the stone. At the same time the wagon travels backward and forward upon the rails, so as to expose the whole surface of the stone to the action of the rings. The pendulum is a frame hung upon hinges from the roof of the workshop. To this frame are attached iron rods, moving in a horizontal direction. In the line upon which these rods move, and under them, the stone is firmly placed upon the floor. Pieces of iron are then loosely attached to the rods, and allowed to rest upon the surface of the stone. When the whole is set in motion, these irons are dragged backward and forward over the surface of the stone, and so it is polished. When polishing plain surfaces, such as the needle of an obelisk, the pieces of iron are flat; but when we have to polish a molding, we make an extra pattern of its form, and the irons are cast from that pattern.

IN FAVOR OF SMALL TIMBER.

The statement that a 12x12 inch beam, built up of 2x12 planks spiked together, is stronger than a 12x12 inch solid timber, will strike a novice as exceedingly absurd. An authority on the subject says every millwright and carpenter knows that it is so, whether he ever tested it by actual experience or not. The inexperienced will fail to see why a timber will be stronger simply because the adjacent vertical longitudinal portions of the wood have been separated by a saw, and if this were the only thing about it, it would not be stronger, but the old principle that a chain is no stronger that its weakest link comes into consideration. Most timbers have knots in them, or are sawed at an angle to the grain, so that they will split diagonally under a comparatively light load. In a built-up timber no large knots can weaken the beam except so much of it as is composed of one plank, and planks whose grain runs diagonally will be strengthened by the other pieces spiked to them.

VALUABLE ARTESIAN WELLS.

Two artesian wells recently sunk in Sonoma Valley, Cal., are considered to be worth not less than $10.000 each. One of them flows 90,000 gallons of water per day, and the other 100,000.

The cement by which many stone buildings in Paris have been renovated is likely to prove useful in preparing the foundations for machinery. The powder which forms the basis of the cement is composed of two parts of oxide of zinc, two of crushed limestone and one of pulverized grit, together with a certain proportion of ochre, as a coloring agent. The liquid with which this powder is to be mixed consists of a saturated solution of six parts of zinc in commercial muriatic acid, to which is added one part of sal-ammoniac. This solution is diluted with two-thirds of its volume of water. A mixture of one pound of the powder to two and a half pints of the liquid forms a cement which hardens quickly, and is of great strength.

Large cylinders of window-glass are now cut by encircling the cylinder with a fine wire, which is then heated to redness by an electric current, and a drop of water being allowed to fall upon the hot glass a perfectly clean cut is obtained. The old method was to draw out a fiber of white-hot semi-molten glass from the furnace by means of tongs, and to wrap it round the cylinder.

The Hudson Bay Company, which was incorporated 225 years ago, is the oldest incorporated company.

The grindstone quarries along the shores of the Bay of Fundy are developed when the tide is down. The best material is down low in the bay.

Some fine pearls were recently discovered in Tyrone (Ireland) rivers.

WOODEN BEAMS.

Safe Load. Uniformly Distributed, for Rectangular White or Yellow Pine Beams one inch thick,

allowing 1,200 lbs. per square inch fibre strain.

To obtain the safe load for any thickness, multiply the safe load given in table by the thickness of beam.

To obtain the required thickness for any load, divide by the safe load for 1 inch given in table.

Span in Feet	DEPTH OF BEAM.										
	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″	16″
Feet.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
5	960	1310	1710	2160	2670	3230	3840	4510	5230	6000	6830
6	800	1090	1420	1800	2220	2690	3200	3760	4360	5000	5690
7	690	930	1220	1540	1900	2300	2740	3220	3730	4290	4880
8	600	820	1070	1350	1670	2020	2400	2820	3270	3750	4270
9	530	730	950	1200	1480	1790	2130	2500	2900	3330	3790
10	480	650	850	1080	1330	1610	1920	2250	2610	3000	3410
11	440	590	780	980	1210	1470	1750	2050	2380	2730	3100
12	400	540	710	900	1110	1340	1600	1880	2180	2500	2840
13	370	500	660	830	1030	1240	1480	1730	2010	2310	2630
14	340	470	610	770	950	1150	1370	1610	1870	2140	2440
15	320	440	570	720	890	1080	1280	1500	1740	2000	2280
16	300	410	530	680	830	1010	1200	1410	1630	1880	2130
17	280	380	500	640	780	950	1130	1330	1540	1760	2010
18	270	360	470	600	740	900	1070	1250	1450	1670	1900
19	250	340	450	570	700	850	1010	1190	1380	1580	1800
20	240	330	430	540	670	810	960	1130	1310	1500	1710
21	230	310	410	510	630	770	910	1070	1240	1430	1630
22	220	300	390	490	610	730	870	1020	1190	1360	1550
23	210	280	370	470	580	700	830	980	1140	1300	1480
24	200	270	360	450	560	670	800	940	1090	1250	1420
25	190	260	340	430	530	650	770	900	1050	1200	1370
26	180	250	330	420	510	620	740	870	1010	1150	1310
27	180	240	320	400	500	600	710	830	970	1110	1260
28	170	230	300	390	480	580	690	800	930	1070	1220
29	170	230	290	370	460	560	660	780	900	1030	1180

WEIGHT OF

A CUBIC FOOT OF SUBSTANCE.

Names of Substances.	Average Weight. Lbs.
Anthracite, solid, of Pennsylvania,	93
" broken, loose,	54
" " moderately shaken,	58
" heaped bushel, loose,	(80)
Ash, American white, dry,	38
Asphaltum,	87
Brass, (Copper and Zinc,) cast,	504
" rolled,	524
Brick, best pressed,	150
" common hard,	125
" soft, inferior,	100
Brickwork, pressed brick,	140
" ordinary,	112
Cement, hydraulic, ground, loose, American, Rosendale,	56
" " " " " Louisville,	50
" " " " English, Portland,	90
Cherry, dry,	42
Chestnut, dry,	41
Coal, bituminous, solid,	84
" " broken, loose,	49
" " heaped bushel, loose,	(74)
Coke, loose, of good coal,	27
" " heaped bushel,	(38)
Copper, cast,	542
" rolled,	548
Earth, common loam, dry, loose,	76
" " " " moderately rammed,	95
" as a soft flowing mud,	108
Ebony, dry,	76
Elm, dry,	35
Flint,	162
Glass, common window,	157

WEIGHT OF SUBSTANCE.

(CONTINUED.)

Names of Substances.	Average Weight. Lbs.
Gneiss, common,	168
Gold, cast, pure, or 24 carat,	1204
" pure, hammered,	1217
Granite,	170
Gravel, about the same as sand, which see.	
Hemlock, dry,	25
Hickory, dry,	53
Hornblende, black,	203
Ice,	58.7
Iron, cast,	450
" wrought, purest,	485
" " average,	480
Ivory,	114
Lead,	711
Lignum Vitæ, dry,	83
Lime, quick, ground, loose, or in small lumps,	53
" " " " thoroughly shaken,	75
" " " " per struck bushel,	(66)
Limestones and Marbles,	168
" " loose, in irregular fragments,	96
Mahogany, Spanish, dry,	53
" Honduras, dry,	35
Maple, dry,	49
Marbles, see Limestones.	
Masonry, of granite or limestone, well dressed,	165
" " mortar rubble,	154
" " dry " (well scabbled,)	138
" " sandstone, well dressed,	144
Mercury, at 32° Fahrenheit,	849
Mica,	183
Mortar, hardened,	103
Mud, dry, close,	80 to 110
" wet, fluid, maximum,	120
Oak, live, dry,	59

WEIGHT OF SUBSTANCES.

(CONTINUED.)

NAMES OF SUBSTANCES.	Average Weight Lbs.
Oak, white, dry,	52
" other kinds,	32 to 45
Petroleum,	55
Pine, white, dry,	25
" yellow, Northern,	34
" " Southern,	45
Platinum,	1342
Quartz, common, pure,	165
Rosin,	69
Salt, coarse, Syracuse, N. Y.	45
" Liverpool, fine, for table use,	49
Sand, of pure quartz, dry, loose,	90 to 106
" well shaken,	99 to 117
" perfectly wet,	120 to 140
Sandstones, fit for building,	151
Shales, red or black,	162
Silver,	655
Slate,	175
Snow, freshly fallen,	5 to 12
" moistened and compacted by rain,	15 to 50
Spruce, dry,	25
Steel.	490
Sulphur,	125
Sycamore, dry,	37
Tar,	62
Tin, cast,	459
Turf or Peat, dry, unpressed,	20 to 30
Walnut, black, dry,	38
Water, pure rain or distilled, at 60° Fahrenheit,	62⅓
" sea,	64
Wax, bees,	60.5
Zinc or Spelter,	437

Green timbers usually weigh from one-fifth to one-half more than dry.

ROUND CAST IRON COLUMNS.—*Safe Load in Tons of 2,000 pounds ; safety, 6.*—These tables are based on columns made of the best iron, perfectly molded and with both ends turned.

Outside Diameter, 3 in.

Length.	½ in.	¾ in.	1 in.
3	44,070	59,890	71,190
4	39,394	53,535	63,636
5	34,579	46,992	55,859
6	30,231	41,083	48,835
7	26,268	35,698	42,433
8	22,812	31,001	36,851
9	19,844	26,967	32,056
10	17,339	23,564	28,010
11	15,147	20,694	24,630
12	13,402	18,213	21,650
13	11,785	16,123	19,223
14	10,469	14,335	17,097
15	9,453	12,847	15,271

Outside Diameter, 4 in.

Length.	½ in.	¾ in.	1 in.
4	61,020	85,880	106,220
5	56,140	79,202	98,020
6	51,246	72,124	89,206
7	46,552	65,968	82,035
8	41,858	58,912	72,865
9	37,912	53,303	65,925
10	33,885	47,690	58,985
11	30,701	42,681	53,011
12	27,476	38,671	47,830
13	25,000	34,794	43,167
14	22,464	31,616	39,104
15	20,511	28,567	35,504
16	18,557	26,118	32,304

Outside Diameter, 5 in.

Length.	½ in.	¾ in.	1 in.
5	79,100	141,250	113,000
6	74,118	132,353	105,833
7	68,996	123,207	98,566
8	63,886	114,082	91,266
9	58,951	105,270	84,216
10	54,261	96,895	77,516
11	49,875	89,062	71,250
12	45,826	81,832	65,466
13	42,105	75,187	60,150
14	38,710	69,125	55,300
15	35,618	63,603	50,833
16	32,830	58,625	46,900
17	30,298	54,103	43,283
18	28,003	50,006	40,005
19	25,931	46,306	37,045
20	24,056	42,957	34,366

Outside Diameter, 6 in.

Length.	¾ in.	1 in.	1¼ in.
6	140,120	177,410	210,180
7	132,782	168,120	199,174
8	125,253	158,587	187,880
9	117,676	148,993	176,514
10	109,945	139,205	164,908
11	103,021	130,438	154,532
12	96,119	121,700	144,179
13	89,612	113,448	134,403
14	83,514	105,739	125,271
15	77,810	98,517	116,715
16	72,532	91,835	108,798
17	67,633	85,632	101,449
18	63,094	79,886	94,642
19	58,962	74,653	88,443
20	55,131	69,803	82,697
21	51,584	65,312	77,376
22	48,348	61,215	72,523
23	45,365	57,438	68,048

Outside Diameter, 7 in.

Length.	¾ in.	1 in.	1¼ in.
7	166,110	212,440	255,380
8	158,664	202,917	243,933
9	151,086	193,226	232,282
10	143,283	183,375	220,440
11	135,769	173,636	208,733
12	128,198	163,954	197,094
13	120,936	154,667	185,930
14	113,948	145,730	175,186
15	107,824	137,258	165,002
16	101,062	129,250	155,375
17	95,123	121,654	146,244
18	89,567	114,548	137,701
19	84,275	107,780	129,565
20	79,380	101,520	122,040
21	74,798	95,660	114,995
22	70,589	90,277	108,525
23	66,635	85,220	102,458
24	62,930	80,482	96,750

Outside Diameter, 8 in.

Length.	¾ in.	1 in.	1¼ in.
8	193,230	248,600	299,450
9	185,671	238,876	287,737
10	177,942	228,932	275,759
11	170,110	218,856	263,622
12	162,279	208,780	251,485
18	154,359	198,638	239,268
14	146,700	188,738	227,343
15	139,655	179,674	216,425
16	132,552	170,535	205,417
17	125,787	161,832	194,934
18	119,323	153,516	184,917
19	113,150	145,574	175,350
20	107,302	138,050	166,487
21	101,796	130,966	157,754
22	96,580	124,256	149,672
23	91,656	117,920	142,040
24	87,009	111,942	134,839
25	82,695	106,392	128,154

ROUND CAST IRON COLUMNS — (Continued).

Length.	Outside Diameter, 15 in.			Length.	Outside Diameter, 16 in.		
	1 in.	1½ in.	2 in.		1½ in.	2 in.	2½ in.
15	496,974	718,793	922,884	16	772,129	993,648	1,198,139
16	486,727	703,972	903,953	17	757,143	974,785	1,175,918
17	476,259	688,833	884,513	18	741,995	955,158	1,151,380
18	465,654	673,566	864,910	19	726,521	935,397	1,127,523
19	454,973	658,045	844,980	20	711,042	915,312	1,103,348
20	444,242	642,525	825,050	21	695,394	895,149	1,079,067
21	433,467	626,940	805,038	22	679,610	874,750	1,054,574
22	422,736	611,419	785,108	23	664,031	854,795	1,030,400
23	412,005	595,898	765,178	24	648,452	834,740	1,006,225
24	401,405	580,568	745,493	25	632,941	814,773	982,156
25	390,938	565,429	726,054	26	617,567	794,082	958,299
26	380,559	550,417	706,777	27	602,329	775,367	934,657
27	370,400	535,733	687,909	28	587,296	756,016	911,328
28	360,240	521,220	669,286	29	572,537	737,017	888,365
29	350,565	507,035	651,071	30	557,983	718,281	865,841
30	340,933	493,105	633,183	31	548,702	699,918	843,681
31	330,921	479,492	615,704	32	529,694	681,866	822,345
32	322,329	466,198	598,633	33	515,960	664,186	800,033

Length.	Outside Diameter, 17 in.			Length.	Outside Diameter, 17 in.		
	1½ in.	2 in.	2½ in.		1½ in.	2 in.	2½ in.
17	825,352	1,065,025	1,286,844	26	686,503	885,856	1,070,358
18	809,752	1,045,798	1,263,612	27	671,018	865,875	1,046,216
19	795,338	1,026,198	1,240,039	28	655,753	846,176	1,022,415
20	779,994	1,006,495	1,216,125	29	640,634	825,667	998,841
21	764,510	986,515	1,191,982	30	625,661	807,345	975,496
22	748,952	966,439	1,167,726	31	610,907	788,807	952,492
23	733,832	946,270	1,143,355	32	596,455	769,645	929,944
24	717,618	226,006	1,118,871	33	582,132	744,267	907,737
25	702,060	905,931	1,094,615	34	566,206	730,626	882,798

NEW STEEL RAILS USED AS LINTELS OR GIRDERS.

Safe load in tons of 2000 lbs.

Length	2	3	4	5	6	7	8	9
52 lb. rail, per yard	10.75	7.00	5.50	4.25	3.50	3.	2.75	2.50
60 lb. rail, per yard	12.	8.00	5.65	4.75	4.00	3.50	3.	2.70
Deflection in inches	0.045	0.050	0.075	0.090	0.125	0.170	0.225	0.800
Length	10	11	12	13	14	15	16	
52 lb rail, per yard	2.	1.90	1.80	1.70	1.50	1.40	1.30	
60 lb rail, per yard	2.40	2.20	2	1.80	1.70	1.60	1.50	
Deflection in inches	0.375	0.450	0.535	0.630	0.730	0.830	0.930	

AREAS OF CIRCLES.

Advancing by Eighths.

Diam.	AREAS. .0	.⅛	.¼	.⅜	.½	.⅝	.¾	.⅞
0	.0	.0122	.0490	.1104	.1963	.3068	.4417	.6013
1	.7854	.9940	1.227	1.484	1.767	2.073	2.405	2.761
2	3.1416	3.546	3.976	4.430	4.908	5.411	5.939	6.491
3	7.068	7.669	8.295	8.946	9.621	10.32	11.04	11.79
4	12.56	13.36	14.18	15.03	15.90	16.80	17.72	18.66
5	19.63	20.62	21.64	22.69	23.75	24.85	25.96	27.10
6	28.27	29.46	30.67	31.91	33.18	34.47	35.78	37.12
7	38.48	39.87	41.28	42.71	44.17	45.66	47.17	48.70
8	50.26	51.84	53.45	55.08	56.74	58.42	60.13	61.86
9	63.61	65.39	67.20	69.02	70.88	72.75	74.66	76.58
10	78.54	80.51	82.51	84.54	86.59	88.66	90.76	92.88
11	95.03	97.20	99.40	101.6	103.8	106.1	108.4	110.7
12	113.0	115.4	117.8	120.2	122.7	125.1	127.6	130.1
13	132.7	135.2	137.8	140.5	143.1	145.8	148.4	151.2
14	153.9	156.6	159.4	162.2	165.1	167.9	170.8	173.7
15	176.7	179.6	182.6	185.6	188.6	191.7	194.8	197.9
16	201.0	204.2	207.3	210.5	213.8	217.0	220.3	223.6
17	226.9	230.3	233.7	237.1	240.5	243.9	247.4	250.9
18	254.4	258.0	261.5	265.1	268.8	272.4	276.1	279.8
19	283.5	287.2	291.0	294.8	298.6	302.4	306.3	310.2
20	314.1	318.1	322.0	326.0	330.0	334.1	338.1	342.2
21	346.3	350.4	354.6	358.8	363.0	367.2	371.5	375.8
22	380.1	384.4	388.8	393.2	397.6	402.0	406.4	410.9
23	415.4	420.0	424.5	429.1	433.7	438.3	443.0	447.6
24	452.3	457.1	461.8	466.6	471.4	476.2	481.1	485.9
25	490.8	495.7	500.7	505.7	510.7	515.7	520.7	525.8
26	530.9	536.0	541.1	546.8	551.5	556.7	562.0	567.2
27	572.5	577.8	583.2	588.5	593.9	599.3	604.8	610.2
28	615.7	621.2	626.7	632.3	637.9	643.5	649.1	654.8
29	660.5	666.2	671.9	677.7	683.4	689.2	695.1	700.9
30	706.8	712.7	718.6	724.6	730.6	736.6	742.6	748.6
31	754.8	760.9	767.0	773.1	779.3	785.5	791.7	798.0
32	804.3	810.6	816.9	823.2	829.6	836.0	842.4	848.8
33	855.3	861.8	868.3	874.9	881.4	888.0	894.6	901.3
34	907.9	914.7	921.3	928.1	934.8	941.6	948.4	955.3
35	962.1	969.0	975.9	982.8	989.8	996.8	1003.8	1010.8
36	1017.9	1025.0	1032.1	1039.2	1046.3	1053.5	1060.7	1068.0
37	1075.2	1082.5	1089.8	1097.1	1104.5	1111.8	1119.2	1126.7
38	1134.1	1141.6	1149.1	1156.6	1164.2	1171.7	1179.3	1186.9
39	1194.6	1202.3	1210.0	1217.7	1225.4	1233.2	1241.0	1248.8
40	1256.6	1264.5	1272.4	1280.3	1288.2	1296.2	1304.2	1312.2
41	1320.3	1328.3	1336.4	1344.5	1352.7	1360.8	1369.0	1377.2
42	1385.4	1393.7	1402.0	1410.3	1418.6	1427.0	1435.4	1443.8
43	1452.2	1460.7	1469.1	1477.6	1486.2	1494.7	1503.3	1511.9
44	1520.5	1529.2	1537.9	1546.6	1555.3	1564.0	1572.8	1581.6
45	1590.4	1599.3	1608.2	1617.0	1626.0	1634.9	1643.9	1652.9

CIRCUMFERENCES OF CIRCLES.

Advancing by Eighths.

Diam.	CIRCUMFERENCES.							
	.0	.⅛	.¼	.⅜	.½	.⅝	.¾	.⅞
0	.0	.3927	.7854	1.178	1.570	1.963	2.356	2.748
1	3.141	3.534	3.927	4.319	4.712	5.105	5.497	5.890
2	6.283	6.675	7.068	7.461	7.854	8.246	8.639	9.032
3	9.424	9.817	10.21	10.60	10.99	11.38	11.78	12.17
4	12.56	12.95	13.35	13.74	14.13	14.52	14.92	15.31
5	15.70	16.10	16.49	16.88	17.27	17.67	18.06	18.45
6	18.84	19.24	19.63	20.02	20.42	20.81	21.20	21.59
7	21.99	22.38	22.77	23.16	23.56	23.95	24.34	24.74
8	25.13	25.52	25.91	26.31	26.70	27.09	27.48	27.88
9	28.27	28.66	29.05	29.45	29.84	30.23	30.63	31.02
10	31.41	31.80	32.20	32.59	32.98	33.37	33.77	34.16
11	34.55	34.95	35.34	35.73	36.12	36.52	36.91	37.30
12	37.69	38.09	38.48	38.87	39.27	39.66	40.05	40.44
13	40.84	41.23	41.62	42.01	42.41	42.80	43.19	43.58
14	43.98	44.37	44.76	45.16	45.55	45.94	46.33	46.73
15	47.12	47.51	47.90	48.30	48.69	49.08	49.48	49.87
16	50.26	50.65	51.05	51.44	51.83	52.22	52.62	53.01
17	53.40	53.79	54.19	54.58	54.97	55.37	55.76	56.15
18	56.54	56.94	57.33	57.72	58.11	58.51	58.90	59.29
19	59.69	60.08	60.47	60.86	61.26	61.65	62.04	62.43
20	62.83	63.22	63.61	64.01	64.40	64.79	65.18	65.58
21	65.97	66.36	66.75	67.15	67.54	67.93	68.32	68.72
22	69.11	69.50	69.90	70.29	70.68	71.07	71.47	71.86
23	72.25	72.64	73.04	73.43	73.82	74.22	74.61	75.00
24	75.39	75.79	76.18	76.57	76.96	77.36	77.75	78.14
25	78.54	78.93	79.32	79.71	80.10	80.50	80.89	81.28
26	81.68	82.07	82.46	82.85	83.25	83.64	84.03	84.43
27	84.82	85.21	85.60	86.00	86.39	86.78	87.17	87.57
28	87.96	88.35	88.75	89.14	89.53	89.92	90.32	90.71
29	91.10	91.49	91.89	92.28	92.67	93.06	93.46	93.85
30	94.24	94.64	95.03	95.42	95.81	96.21	96.60	96.99
31	97.39	97.78	98.17	98.57	98.96	99.35	99.75	100.14
32	100.53	100.92	101.32	101.71	102.10	102.49	102.89	103.29
33	103.67	104.07	104.46	104.85	105.24	105.64	106.03	106.42
34	106.81	107.21	107.60	107.99	108.39	108.78	109.17	109.56
35	109.96	110.35	110.74	111.13	111.53	111.92	112.31	112.71
36	113.10	113.49	113.88	114.28	114.67	115.06	115.45	115.85
37	116.24	116.63	117.02	117.42	117.81	118.20	118.61	118.99
38	119.38	119.77	120.17	120.56	120.95	121.34	121.74	122.13
39	122.52	122.92	123.31	123.70	124.09	124.49	124.88	125.27
40	125.66	126.06	126.45	126.84	127.24	127.63	128.02	128.41
41	128.81	129.20	127.59	129.98	130.38	130.77	131.16	[illegible]1.55
42	131.95	132.34	132.73	133.13	133.52	133.91	134.30	134.70
43	135.09	135.48	135.87	136.27	136.66	137.05	137.45	137.84
44	138.23	138.62	139.02	139.41	139.80	140.19	140.59	140.98
45	141.37	141.76	142.16	142.55	142.94	143.34	143.73	144.12

Weight of Cast Iron Columns Per Lineal Foot
Foot of Plain Shaft.

Diam.	THICKNESS OF METAL.											
	¼ in.	⅜ in.	½ in.	⅝ in.	¾ in.	⅞ in.	1 in.	1⅛ in.	1¼ in.	1½ in.	1¾ in.	2 in.
2	4.3	6.0	7.4	8.4	9.2	9.7	9.8	....	....	....	....	....
2½	5.5	7.8	9.8	11.5	12.9	14.0	14.7	....	....	....	....	....
3	6.8	9.7	12.3	14.6	16.6	18.3	19.6	....	....	....	....	....
3½	8.0	11.5	14.7	17.6	20.3	22.6	24.6	....	....	....	....	....
4	9.2	13.3	17.2	20.7	23.9	26.8	29.5	....	....	....	....	....
4½	10.4	15.2	19.6	23.8	27.6	31.1	34.4	37.3	39.9	....	....	....
5	11.7	17.0	22.1	26.9	31.3	35.4	39.3	42.8	46.0	....	....	....
5½	12.9	18.9	24.5	29.9	35.0	39.7	44.2	48.3	52.2	....	....	....
6	14.1	20.7	27.8	33.0	38.7	44.0	49.1	53.9	58.3	....	....	....
6½	15.3	22.6	29.5	36.1	42.3	48.3	54.0	59.4	64.4	....	....	....
7	16.6	24.4	31.9	39.1	46.0	52.6	58.9	64.9	70.6	81.0	....	....
7½	17.8	26.2	34.4	42.2	49.7	56.9	63.8	70.4	76.7	88.4	....	....
8	19.0	28.1	36.8	45.3	53.4	61.2	68.7	75.9	82.8	95.7	....	....
8½	20.2	29.9	39.3	48.3	57.1	65.5	73.6	81.5	89.0	103.1	....	....
9	21.5	31.8	41.7	51.4	60.8	69.8	78.5	87.0	95.1	110.5	....	....
9½	22.7	33.6	44.2	54.5	64.4	74.1	83.5	92.5	101.2	117.8	133.2	....
10	23.9	35.4	46.6	57.5	68.1	78.4	88.4	98.0	107.4	125.2	141.7	157.1
10½	25.2	37.3	49.1	60.6	71.8	82.7	93.3	103.5	113.5	132.5	150.3	166.9
11	26.4	39.1	51.6	63.7	75.5	87.0	98.2	109.1	119.7	139.9	158.9	176.7
11½	27.6	41.0	54.8	66.7	79.2	91.3	103.1	114.6	125.8	147.3	167.5	186.5
12	28.8	42.8	56.5	69.8	82.8	95.6	108.0	120.1	131.9	154.6	176.1	196.3
12½	....	44.6	58.9	72.9	86.5	99.9	112.9	125.6	138.1	162.0	184.7	206.2
13	....	46.5	61.4	75.9	90.2	104.2	117.8	131.2	144.2	169.4	193.3	216.0
13½	....	....	63.8	79.0	93.9	108.5	122.7	136.7	150.3	176.7	201.9	225.8
14	....	....	66.3	82.1	97.6	112.8	127.6	142.2	156.5	184.1	210.5	235.6
14½	....	....	68.7	85.2	101.2	117.0	132.5	147.7	162.6	191.4	219.1	245.4
15	....	....	71.2	88.2	104.9	121.3	137.5	153.2	168.7	198.8	227.6	255.2
16	....	....	76.1	94.3	112.3	129.9	147.3	164.3	181.0	213.5	244.8	274.9
17	....	....	81.0	100.5	119.7	138.5	157.1	175.3	193.3	228.3	262.0	294.5
18	....	....	85.9	106.6	127.0	147.1	166.9	186.4	205.6	243.0	279.2	314.1
19	....	....	90.8	112.8	134.4	155.7	176.7	197.4	217.8	257.7	296.4	333.8
20	....	....	95.7	118.9	141.7	164.3	186.5	208.5	230.1	274.4	313.5	353.4

INCREASE IN WEIGHT FOR ½ IN INCREASE IN DIAMETER.

¼ in.	⅜ in.	½ in	⅝ in.	¾ in.	⅞ in.	1 in	1⅛ in.	1¼ in.	1½ in.	1¾ in	2 in.
1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	7.4	8.6	9.8

Weight of Square or Rectangular Cast Iron Column Shafts Per Lineal Foot.

EXAMPLE: Column 6″ × 10″ × 1′ + 10′ 0′. 6″ × 10″ = 16″ × 2 = 32. Following out line on which 32 is found in left hand column to column headed 1″, we find the weight per foot to be 87.5 pounds, which, multiplied by 10′ 1″ = 875 pounds.

A, B 2a + 2b	METAL.								
	5/8″	3/4″	7/8″	1″	1 1/8″	1 1/4″	1 1/2″	1 3/4″	2″
12	18.6	21.1	23.3	25.0	26.4	27.3	28.1	....	....
14	22.5	25.8	28.7	31.3	33.4	35.1	37.5	....	....
16	26.4	30.5	34.2	37.5	40.4	43.0	46.9	49.2	50.0
18	30.3	35.2	39.7	43.8	47.4	50.8	56.3	60.2	62.5
20	34.2	39.8	45.1	50.0	54.5	58.6	65.6	71.1	75.0
22	38.1	44.5	50.6	56.3	61.5	66.4	75.0	82.0	87.5
24	42.0	49.2	56.1	62.5	68.5	74.2	84.4	93.0	100.0
26	45.9	53.9	61.5	68.8	75.6	82.0	93.8	103.9	112.5
28	49.8	58.6	67.0	75.0	82.6	89.8	103.7	114.8	125.0
30	53.7	63.3	72.5	81.3	89.6	97.7	112.5	125.8	137.5
32	57.6	68.0	77.9	87.5	96.7	105.5	121.9	137.7	150.0
34	61.5	72.7	83.4	93.8	103.7	113.3	131.3	147.7	162.5
36	65.4	77.3	88.9	100.0	110.7	121.1	140.6	158.6	175.0
38	69.3	82.0	94.3	106.3	117.8	128.9	150.0	169.5	187.5
40	73.2	86.7	99.8	112.5	124.8	136.7	159.4	180.5	200.0
42	77.1	91.4	105.3	118.8	131.8	144.5	168.8	191.4	212.5
44	81.0	96.1	110.8	125.0	138.8	152.3	178.1	202.3	225.0
46	84.9	100.8	116.2	131.3	145.9	160.2	187.5	213.3	237.5
48	88.8	105.5	121.7	137.5	152.9	168.0	196.9	224.2	250.0
50	92.8	110.2	127.2	143.8	159.9	175.8	206.3	235.2	262.5
52	96.7	114.8	132.6	150.0	167.0	183.6	215.6	246.3	275.0
54	100.6	119.5	138.1	156.3	174.0	141.4	225.0	257.0	287.6
56	104.5	124.2	143.6	162.5	181.0	199.2	234.4	268.0	300.0
58	108.4	128.9	149.0	168.8	188.1	207.0	243.8	278.9	312.5
60	112.3	133.6	154.5	175.0	195.1	214.9	253.2	289.8	325.0
62	116.2	138.3	160.0	181.3	202.1	222.7	262.5	300.8	337.5
64	120.1	143.0	165.4	187.5	209.2	230.5	271.9	311.7	350.0
66	124.0	147.7	170.9	193.8	216.2	238.3	281.3	322.7	362.5
68	127.9	152.3	176.4	200.0	223.2	246.1	290.6	336.6	375.0
70	131.8	157.0	181.8	206.3	230.3	253.9	300.0	344.5	387.5
72	135.7	161.7	187.7	212.5	237.3	261.7	309.4	355.5	400.0
74	139.5	166,4	192.8	218.8	244.3	269.5	318.8	366.4	412.5
76	143.5	171.1	198.3	225.0	251.3	277.3	328.1	377.3	425.0
78	147.4	175.8	203.7	231.3	258.4	285.2	337.5	388.3	437.5
80	151.3	180.5	209.2	237.5	265.4	293.0	340.9	399.2	450.0

CUBIC MEASURE.

Inches.	Feet.	Yard.	Cubic Metres.
1.	= .0005788	= .000002144	= .000016386
1728.	1.	.03704	.028315
46656.	27.	1.	.764513

A CUBIC FOOT IS EQUAL TO

1728 cubic inches
.037037 cubic yard.
803564 U S struck bushel of 2150 42 cub. in.
3 21426 U S. pecks
7.48052 U. S liquid gallons of 231 cub in.
6.42851 U. S dry gallons of 268.8025 cub in.
29.92208 U. S. liquid quarts.
25.71405 U S. dry quarts
59 84416 U S liquid pints.
51.42809 U S. dry pints.
239.37662 U. S. gills.
.26667 flour barrel of 3 struck bushels.
.23748 U. S. liquid barrel of 31½ gallons.

A cubic inch of water at 62° Fahr weighs 252.458 grains.
A cubic foot of water at 62° Fahr weighs 1002.7 ounces.
A cubic yard of water at 62° Fahr. weighs 1692. pounds.

FRECNH CUBIC OR SOLID MEASURE.

		Pint	Quart.	Bush.	Cubic Inch.	Cu. Ft.
Centilitre ..	Dry ..	.0181	......	......	61016	
	Liquid	.0211	......	......		
Decilitre ...	Dry ..	.1816	0908	......	6.1016	
	Liquid	.2113	1056	......		
Litre.......	Dry ..	1.816	.908	......	61.016	.0353
	Liquid	2.113	1.056	......		
Decalitre ...	Dry ..	....	9 08	2837	610.16	.3531
	Liquid	21 13	10 56	......		
Hectolitre ..	Dry .	....	90.8	2.837	6101 6	3.531
	Liquid	211 3	105 6	...		
Kilolitre or Cubic Metre	Dry	...	.....	28.37	61016.	35.31
	Liquid	....	1056.5	......		
Myriolitre	Dry .	....	.....	283.7	......	353.1
	Liquid	..	10565.	.....		

AVOIRDUPOIS WEIGHT.

The standard avoirdupois pound is the weight of 27.7015 cubic inches of distilled water, weighed in the air, at 39.83 degrees Fahr., barometer at thirty inches.

Ounces.		Pounds.		Quarters.		Cwts.		Ton.
1.	=	.0625	=	.00223	=	.000558	=	.000028
16.		1.		.0357		.00893		.000447
448.		28.		1.		.25		.0125
1792.		112.		4.		1.		.05
35840.		2240.		80.		20.		1.

A drachm = 27.343 grains.
A stone = 14 pounds.
A quintal = 100 kilogrammes.

7000 grains = 1 avoir. pound = 1.21528 troy pounds.
5760 grains = 1 troy pound = .82285 avoir. pound.

Kilos p. sq. centim. × 14.22 = Pounds p. sq. inch.
Pounds p. sq. inch × .0703 = Kilos p. sq. centim.

FRENCH WEIGHTS.

EQUIVALENT TO AVOIRDUPOIS.

	Grains.	Ounces.	Pounds.
Milligramme	.015433		
Centigramme	.154331	.000352	.000022
Decigramme	1.54331	.003527	.000220
Gramme	15.4331	.035275	.002204
Decagramme	154.331	352758	.022047
Hectogramme	1543.31	3.52758	.220473
Kilogramme	15433.1	35.2758	2.20473
Myriogramme	....	352.758	22.0473
Quintal	....	3527 58	220.473
Millier or Tonne	....	35275.8	2204.73

SQUARE MEASURE.

Inches.	Feet.	Yard	Perches.	Acre.
1. =	.00694 =	000772 =	.0000255 =	.000000159
144.	1.	.111	.00367	.000023
1296.	9.	1.	.0331	.0002066
39204.	272¼.	30¼.	1.	.00625
6272640.	43560.	4840.	160.	1.

100 square feet = 1 square.
10 square chains = 1 acre.
1 chain wide = 8 acres per mile.
1 hectare = 2.471143 acres.

1 square mile = 27,878,400 square feet.
= 3,097,600 square yards.
= 640 acres.

Acres × .0015625 = square mile.
Square yard × 000000323 = square miles.
Acres × 4840 = square yards.
Square yards × 0002066 = acres.

A section of land is 1 mile square, and contains 640 acres.
A square acre is 208 71 ft at each side; or, 220 × 198 ft.
A square ½ acre is 147 58 ft at each side, or, 110 × 198 ft.
A square ¼ acre is 104.355 ft. at each side; or, 55 × 198 ft.
A circular acre is 235 504 ft in diameter.
A circular ½ acre is 166.527 ft. in diameter.
A circular ¼ acre is 117.752 ft. in diameter.

FRENCH SQUARE MEASURE.

Square	Square Inches	Square Feet	Square Yards
Millimetre.	00154	0000107	000001
Centimetre	.15498	.0010763	.000119
Decimetre	15 498	1076305	.011958
Met or Cen	1549 8	10 76305	1 19589
Decametre	154988	1076 305	119.589
Hectare ..	....	107630 58	11958 95
Kilometre .	.38607 □ mls	10763058	1195895.
Myriamet. .	38.607 ··	....	....

SURVEYING MEASURE.

(LINEAL.)

Inches.		Feet.		Yards.		Chains.		Miles.
1.	=	.0833	=	.0278	=	.00126	=	.0000158
12.		1.		.333		.01515		.000189
36.		3.		1.		.04545		.000568
792.		66.		22.		1.		.0125
63360.		5280.		1760.		80.		1.

One knot or geographical mile = 6086.07 feet = 1855.11 metres = 1.1526 statute mile.

One admiralty knot = 1.1515 statute miles = 6080 feet.

LONG MEASURE.

Inches.		Feet.		Yards.		Poles.		Furl.		Miles.
1.	=	.083	=	.02778	=	.005	=	.000126	=	.0000158
12.		1.		.333		.0606		.00151		.0001894
36.		3.		1.		.182		.00454		.000568
198.		16½.		5½.		1.		.025		.003125
7920.		660.		220.		40.		1.		.125
63360.		5280.		1760.		320.		8.		1.

A palm = 3 inches. A hand = 4 inches.
A span = 9 inches. A cable's length = 120 fathoms.

FRENCH LONG MEASURE.

	Inches.	Feet.	Yards.	Miles.
Millimetre......	.03937	.0033	....	....
Centimetre	.39368	.0328	....	....
Decimetre	3.9368	.3280	.10936	....
Metre	39.368	3.2807	1.09357	....
Decametre	393.68	32.807	10.9357	....
Hectometre.....	....	328 07	109 357	.062134
Kilometre	....	3280.7	1093 57	621346
Myriametre.....	....	32807.	10935.7	6.213466

STRENGTH OF MATERIALS.

ULTIMATE RESISTANCE TO TENSION

IN LBS. PER SQUARE INCH.

METALS.

	Average.
Brass, cast,	18000
" wire,	49000
Bronze or gun metal,	36000
Copper, cast,	19000
" sheet,	30000
" bolts,	36000
" wire,	60000
Iron, cast, 13400 to 29000,	16500
" wrought, round or square bars of 1 to 2 inch diameter, double refined,	50000 to 54000
" wrought, specimens ½ inch square, cut from large bars of double refined iron,	50000 to 53000
" wrought, double refined, in large bars of about 7 square inches section,	46000 to 47000
" wrought, plates, angles and other shapes,	48000 to 51000
" " plates over 36″ wide,	46000 to 50000

Wrought iron, suitable for the tension members of bridges, should be double refined, and show a permanent elongation of 20 per cent in 5″, when broken in small specimens, and a reduction of area of 25 per cent at point of fracture

The modulus of elasticity of Union Iron Mills' double refined bar iron is 25000000 to 26000000, from tests made on finished eyebars

Iron, wire,	70000 to 100000
" wire-ropes,	90000
Lead, sheet,	3300
Steel,	65000 to 120000
Tin, cast,	4600
Zinc,	7000 to 8000

STRENGTH OF MATERIALS.

(CONTINUED.)

TIMBER, SEASONED, AND OTHER ORGANIC FIBER.

	Average
Ash, English,	17000
" American,	11000 to 14000
Beech, "	15000 to 18000
Box,	20000
Cedar of Lebanon,	11400
" American, red,	10300
Fir or Spruce,	10000 to 13600
Hempen Ropes,	12000 to 16000
Hickory, American,	12800 to 18000
Mahogany,	8000 to 21800
Oak, American, white,	18000
" European,	10000 to 19800
Pine, American, white, red and pitch, Memel, Riga,	10000
" " long leaf yellow,	12600 to 19200
Poplar,	7000
Silk fiber,	52000
Walnut, black,	16000

STONE, NATURAL AND ARTIFICIAL.

Brick and Cement,	280 to 300
Glass,	9400
Slate,	9600 to 12800
Mortar, ordinary,	50

ULTIMATE RESISTANCE TO COMPRESSION.

METALS.

Brass, cast,	10300
Iron, "	82000 to 145000
" wrought,	36000 to 40000

STRENGTH OF MATERIAMS.

(CONTINUED.)

TIMBER, SEASONED, COMPRESSED IN THE DIRECTION OF THE GRAIN

	Average.
Ash, American,	4400 to 5800
Beech, "	5800 to 6900
Box,	10300
Cedar of Lebanon,	5900
" American, red.	6000
Deal, red,	6500
Fir or Spruce,	5100 to 6800
Oak, American, white,	7200 to 9100
" British,	10000
" Dantzig,	7700
Pine, American, white,	5000 to 5600
" " long leaf yellow.	8000
Spruce or Fir,	5800 to 6900
Walnut, black,	7500

STONE, NATURAL OR ARTIFICIAL.

Brick, weak,	550 to 800
" strong.	1100
" fire,	1700
Brickwork, ordinary, in cement,	300 to 450
" best,	1000
Chalk,	330
Granite,	5500 to 11000
Limestone,	4000 to 11000
Sandstone, ordinary,	4000

ULTIMATE RESISTANCE TO SHEARING.

METALS.

Iron, cast,	27700
" wrought, along the fiber	45000

TIMBER, ALONG THE GRAIN

White Pine, Spruce, Hemlock,	500 to 800
Yellow Pine, long leaf,	630 to 960
Oak, European,	2300
Ash, American,	2000

Table of Safety Load of Cast Iron Columns—Factor of Safety 10.

This factor of safety of 10 has been adopted to allow for imperfections in casting; such as air-holes, unequal thickness of metal, etc., devietion of pressure from axis of columns, and the effect of latenal forces accidentally applied. Where these risks do not occur, a factor of 6 may be taken for safe load. Ends of columns should always be turned true.

Outside Diameter in inches.	Thickness of Metal.	LENGTH OF COLUMNS IN FEET. BOTH ENDS TURNED. 6	8	10	12	14	16	18	20	22	24	26	28	30	Sectional area in inches.	Weight in lbs. of Columns per foot of length.
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.		
4	½	11.	8.1	6.1	4.7	3.6	3.4	2.8	2.0	.....	.....	.....	.....	.....	5.492	17.14
	¾	15.2	11.3	8.5	6.5	4.8	3.8	3.3	2.8	.....	.....	.....	.....	.....	7.66	23.90
5	½	16.8	13.3	10.4	8.8	6.7	5.4	5	4	.....	.....	.....	.....	.....	7.07	22.06
	¾	24	19	15	12	9	7.7	6.5	5.7	.....	.....	.....	.....	.....	10.01	31.23
6	½	23	19	15.5	12.7	9.5	8.7	7.3	6.2	.....	.....	.....	.....	.....	8.64	26.95
	¾	33	27	22	18	15	13	11	9	.....	.....	.....	.....	.....	12.37	38.59
	⅞	37	31	25	21	17	14	12	10	.....	.....	.....	.....	.....	14.09	48.96
	1	42	35	28	23	19	16	13	11	.....	.....	.....	.....	.....	15.71	49.01
	1⅛	47	40	32	26	22	18	14	12	.....	.....	.....	.....	.....	17.23	58.76
7	⅝	36	31	26	22	19	16	13	11	.....	.....	.....	.....	.....	12.52	39.06
	¾	42	36	31	26	22	19	16	13	11	10	.....	.....	.....	14.73	45.96
	⅞	48	41	35	29	25	21	18	15	13	11	.....	.....	.....	16.84	52.54
	1	54	46	39	33	29	24	20	17	14	12	.....	.....	.....	18.85	58.90
	1⅛	60	52	44	37	32	27	23	19	16	13	.....	.....	.....	20.76	64.77
8	¾	51	45	39	34	29	25	22	19	16	14	.....	.....	.....	17.08	53.29
	⅞	59	52	45	39	34	29	25	22	19	16	.....	.....	.....	19.59	61.12
	1	66	58	51	44	38	33	28	24	21	18	.....	.....	.....	21.99	68.64
	1⅛	73	64	56	48	42	36	31	26	23	20	.....	.....	.....	24.30	75.82
	1¼	79	70	61	52	45	39	34	29	25	22	.....	.....	.....	26.51	82.71
	1⅜	86	76	66	57	48	42	37	33	27	24	.....	.....	.....	28.62	89.29
9	¾	60	54	49	43	37	33	29	24	22	20	18	16	.....	19.44	60.65
	⅞	69	63	56	49	43	38	33	29	26	23	20	18	15	22.33	69.97

TABLE OF SAFETY LOAD OF CAST IRON COLUMNS.

(CONTINUED.)

Outside Diameter in inches.	Thickness of Metal.	LENGTH OF COLUMNS IN FEET. BOTH ENDS TURNED. 6	8	10	12	14	16	18	20	22	24	26	28	30	Sectional area in inches.	Weight in lbs. of Columns per foot of length.
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.		
9	1	78	71	63	55	48	42	37	33	29	26	23	20	17	25.18	78.40
	1⅛	87	78	69	62	53	47	41	36	32	29	25	22	19	27.83	86.83
	1¼	95	85	76	67	58	51	45	39	35	32	28	25	22	30.43	94.94
	1⅜	102	92	82	72	63	55	48	43	39	35	31	27	23	32.94	102.77
	1½	110	99	88	78	68	59	52	46	42	38	34	30	26	35.34	110.26
	1⅝	118	106	94	84	73	63	56	49	45	41	37	33	29	37.65	117.47
	1¾	126	113	100	90	78	67	60	51	48	44	40	36	32	39.86	124.36
10	⅞	80	73	67	60	53	47	42	37	34	30	27	24	21	25.09	78.28
	1	90	83	75	67	60	53	47	42	38	34	30	27	24	28.28	88.23
	1⅛	100	92	83	74	66	58	52	47	42	38	34	30	26	31.37	97.87
	1¼	110	101	91	82	73	64	57	51	47	42	38	33	28	34.37	107.23
	1⅜	119	109	98	88	79	69	62	55	51	46	41	36	31	37.26	116.25
	1½	128	117	106	95	85	75	67	59	54	49	44	39	34	40.06	124.99
	1⅝	146	133	122	109	97	85	77	67	60	56	50	45	40	45.36	141.52
11	1	102	95	87	79	71	64	58	52	48	43	38	34	30	31.42	98.08
	1⅛	114	105	96	88	79	71	64	58	53	48	42	37	32	34.90	108.89
	1¼	125	116	106	97	87	78	70	63	58	52	46	41	35	38.29	119.46
	1⅜	135	126	115	105	94	85	76	68	62	56	50	44	38	41.58	129.73
	1½	146	136	124	113	102	92	82	74	68	61	54	48	43	44.77	139.68
	1¾	166	156	142	129	118	106	94	86	79	71	62	56	49	50.86	158.68
	2	186	176	160	147	134	120	106	98	90	81	70	64	55	56.55	176.44
12	1	116	107	97	92	83	76	69	62	58	53	48	44	40	34.46	107.51
	1⅛	128	119	108	102	92	84	78	69	63	58	53	48	43	38.34	119.62
	1¼	141	131	119	112	101	93	84	76	70	64	58	52	46	42.12	131.41

TABLE OF SAFETY LOAD OF CAST IRON COLUMNS.

(CONTINUED.)

Outside Diameter in inches.	Thickness of Metal.	LENGTH OF COLUMNS IN FEET. BOTH ENDS TURNED. 6	8	10	12	14	16	18	20	22	24	26	28	30	Sectional area in inches.	Weight in lbs. of Columns per foot of length.
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.		
12	1⅜	153	142	129	121	110	101	91	82	75	69	62	56	50	45.80	142.90
	1½	165	154	139	131	119	109	99	89	82	75	68	60	53	49.30	154.10
	1¾	189	178	159	150	137	125	115	108	94	85	78	68	60	56.26	175.53
	2	213	201	179	170	155	141	131	117	108	96	88	76	67	62.74	195.75
13	1	127	119	111	104	97	90	81	73	67	61	56	51	46	37.67	117.53
	1⅛	142	134	126	117	109	101	91	82	75	69	63	58	52	41.94	130.85
	1¼	158	149	140	130	121	112	101	91	84	77	70	64	58	46.11	143.86
	1⅜	174	163	154	144	133	122	111	101	93	84	78	70	64	50.19	156.59
	1½	190	178	168	157	145	133	121	110	101	92	85	77	70	54.16	168.98
	1¾	214	201	189	176	164	151	137	124	114	104	95	87	78	61.82	192.88
	2	237	224	210	195	182	168	152	137	120	116	105	96	87	69.09	215.56
14	1	138	131	125	117	109	101	92	85	78	72	66	61	56	40.9	127.60
	1⅛	153	145	139	130	121	112	103	94	87	80	73	68	62	45.5	141.96
	1¼	168	160	153	143	133	123	113	104	95	88	80	74	68	50.1	156.31
	1⅜	183	174	167	156	145	134	123	113	104	95	87	81	74	54.5	170.04
	1½	198	189	180	168	156	145	133	122	112	103	94	87	80	58.87	183.67
	1¾	226	216	206	192	179	166	152	140	128	118	107	99	91	67.31	210.00
	2	254	242	232	216	201	186	171	157	143	132	120	111	102	75.36	235.12
15	1	150	148	136	128	120	112	104	97	90	83	76	71	65	44.00	137.28
	1⅛	167	159	152	143	136	125	116	108	100	93	85	78	72	49.1	153.19
	1¼	184	175	167	157	148	138	128	119	110	102	93	84	79	54.0	168.48
	1⅜	201	191	182	172	161	151	140	130	120	111	102	93	87	58.9	183.77
	1½	217	207	197	186	175	163	151	141	130	120	110	102	94	63.7	198.74
	1¾	248	236	225	212	202	190	175	160	148	137	126	115	107	72.9	227.45

Crushing and Tensile Strength, in lbs., per square inch of Natural and Artificial Stones.

DESCRIPTION.	Weight per Cubic ft in lbs	Crushing Force. Lbs. per Square Inch.
Aberdeen Blue Granite	164	8,400 to 10,914
Quincy Granite	166	15,300
Freestone, Belleville	....	3,522
Freestone, Caen	....	1,088
Freestone, Connecticut	....	3,319
Sandstone, Acquia Creek, used for Capitol Washington	....	5,340
Limestone, Magnesian, Grafton, Ill	....	17,000
Marble, Hastings, N. Y	....	18,941
Marble, Italian	....	12,624
Marble, Stockbridge, City Hall, N. Y	....	10,382
Marble, Statuary	....	3,216
Marble, Veined	165	9,681
Slate	....	9,300
Brick, Red	135.5	808
Brick, Pale Red	130.3	562
Brick, Common	....	800 to 1,000
Brick, Machine Pressed	....	6,222 to 14,216
Brick, Stock	....	2,177
Brick-work, set in Cement, bricks not very hard,	....	521
Brick, Masonry, Common	....	500 to 800
Cement, Portland	....	1,000 to 8,300
Cement, Portland, Cement 1, Sand 1	....	1,280
Cement, Roman	....	342
Mortar	....	120 to 240
Crown Glass	....	31,000
		TENSION.
Portland Cement	....	427 to 711
Portland Cement, with Sand	....	92 to 284
Glass, Plate	....	9,420
Mortar	....	50
Plaster of Paris	....	72
Slate	....	11,000

Capacity of Cylindrical Cisterns.

FOR EACH FOOT OF DEPTH.

Diameter in Feet.	Gallons.	Pounds.	Diameter in feet.	Gallons.	Pounds.
2.0	23.5	196	9.0	475.9	3,968
2.5	36.7	306	9.5	530.2	4,421
3.0	52.9	441	10.0	587.5	4,899
3.5	72.0	600	11.0	710.9	5,928
4.0	94.0	784	12.0	846.0	7,054
4.5	119.0	992	13.0	992.9	8,280
5.0	146.9	1,225	14.0	1,151.5	9,602
5.5	177.7	1,482	15.0	1,321.9	11,023
6.0	211.5	1,764	20.0	2,350.1	19,596
6.5	248.2	2,070	25.0	3,672.0	30,620
7.0	287.9	2,401	30.0	5,287.7	44,093
7.5	330.5	2,756	35.0	7,197.1	60,016
8.0	376.0	3,135	40.0	9,400.3	78,388
8.5	424.5	3,540	----	------	------

DESCRIPTION.	Weight per Cubic Foot in lbs.	Weight per foot B. M. in lbs., average	Tensile strength per sq. in., in lbs.	Crushing strength per sq. in., in lbs.	Relative strength for cross breaking. White Pine = 100.	Shearing strength with the grain, lbs. per sq. in.	Pressure in lbs. per sq in. to indent 1-20"
Ash	43 to 55.8	4.1	11,000 to 17,207	4,400 to 9,363	120 to 130	458 to 700	1,800 to 1,850
Beech	43 to 53.4	3.9	11,500 to 18,000	5,800 to 9,363	100 to 104		
Cedar	50 to 56.8	4.5	10,300 to 11,400	5,600 to 6,000	55 to 63		
Cherry					130		
Chestnut	33	2.75	10,500	5,350 to 5,600	96 to 128		
Elm	34 to 36.7	2.9	13,400 to 13,489	6,831 to 10,331	96		
Hemlock			8,700	5,700	88 to 95		
Hickory			12,800 to 18,000	8,925	150 to 210		
Locust	44	3.7	20,500 to 24,800	9,113 to 11,700	132 to 227		
Maple	49	4.1	10,500 to 10,584	8,150	122 to 220	367 to 647	1,700 to 1,900
Oak, White	45 to 54.5	4.1	10,253 to 19,500	4,684 to 9,509	130 to 177	752 to 966	2,300 to 3,350
Oak, Live	70	5.8		6,850	155 to 189		
Pine, White	30	2.5	10,000 to 12,000	5,000 to 6,650	100	225 to 423	875 to 1,160
Pine, Yellow	28.8 to 33	2.6	12,600 to 19,200	5,400 to 9,500	98 to 170	286 to 415	1,900
Spruce			10,000 to 19,500	5,050 to 7,850	86 to 110	253 to 874	875 to 1,028
Walnut, Black	42	3.5	9,286 to 16,000	7,500			2,200 to 2,600

SQUARE CAST IRON COLUMNS.

Safe Load in Pounds. Safety 6.

BOTH ENDS TURNED.

Length.	Outside Size Column, 8x8.			Length.	Outside Size Column, 10x10.		
	¾ in.	1 in.	1½ in.		¾ in.	1 in.	1½ in.
8	255,485	328,902	458,113	10	325,965	422,874	599,071
9	247,656	318,822	444,073	11	318,015	412,560	584,460
10	239,457	308,266	429,370	12	309,751	401,839	569,272
11	231,785	298,430	415,670	13	301,232	390,787	553,615
12	222,400	286,308	898,787	14	292,540	379,512	537,662
13	213,752	275,176	383,280	15	283,752	368,111	521,790
14	204,896	263,774	267,399	16	274,925	356,659	505,267
15	196,642	253,153	252,606	17	266,109	345,229	489,075
16	188,268	242,368	337,584	18	257,362	333,875	472,989
17	180,126	231,887	322,986	19	248,709	322,650	457,087
18	172,220	221,709	808,810	20	240,204	311,616	441,456
19	164,589	211,884	295,125	21	231,873	300,809	426,146
20	157,242	202,426	281,950	22	223,720	290,232	411,162
21	150,225	193,354	269,314	23	215,881	280,062	396,754
22	143,452	184,674	257,224	24	208,083	269,946	382,423
23	137,014	176,376	245,552	25	200,619	260,263	368,704
24	130,881	168,490	234,682	26	193,398	250,895	355,434
25	125,349	160,809	223,985	27	186,411	241,830	342,592
	Outside Size Column, 12x12.				Outside Size Column, 12x12.		
	1 in.	1½ in.	2 in.		1 in.	1½ in.	2 in.
12	516,846	740,029	939,720	21	414,986	594,184	754,520
13	506,383	725,048	920,696	22	403,458	577,678	733,560
14	495,550	709,537	901,000	23	392,093	561,406	712,896
15	484,418	693,598	880,765	24	380,864	545,328	692,480
16	473,057	677,332	860,104	25	369,829	529,527	672,416
17	461,579	660,838	839,160	26	359,005	514,030	652,736
18	449,913	644,194	818,024	27	348,401	498,847	633,456
19	438,253	627,499	796,824	28	337,731	483,569	614,056
20	426,593	610,804	775,624	29	329,941	469,552	596,256

COST OF LIVING IN CHINA.

Land in China is divided into more holdings than any other land in the world. It takes but a very small piece of land to support a Chinese family. The Chinese are the closest and most thorough cultivators in the world. Field hands in China are paid $12 per annum. The food is cooked by the employer. With his food he is furnished straw, shoes and free shaving — the last a matter which a Chinaman never neglects for any great length of time where it is possible to secure the luxury. It costs about $4 a year to clothe a Chinaman. Much of the land in China is divided up into gardens of areas as small as one-sixth of an acre.

NOTES ON HOT WATER SYSTEMS.

Let your "risers" not be less than 1¼″, for smaller pipes soon become coated, if the water used contains lime or other matters in solution or suspension.

Galvanized pipe is best; it does not become rusty and discolor the water.

In ordinary pipe be sure to get "galvanized steam," and not "galvanized gas."

Let your draw-off services be for bath 1″, to lavatories 1″, for hot water ½″. Do not make the "draw-offs" too small, it takes too long to drain a pipe of cold water.

The larger the pipes the freer the circulation, and, if you have hard water, they will remain in good order longer.

Be sure that all joints are secure and free from leaks, and always look through a pipe before fitting it in place, to see that there is no dirt or impediment to the flow of water through it.

Avoid the use of elbows in circulating pipes, use only bends; if you cannot avoid using an elbow, see that it is a round one.

TO SOLDER ALUMINUM.

M. Bourbouze has formed an alloy of 45 parts of tin and 55 parts of aluminum, which answers for soldering aluminum. This alloy possesses almost the same lightness as the pure aluminum, and can be easily soldered. M. Bourbouze has invented another containing only ten per cent. of tin. This second alloy, which can replace aluminum in all its applications, can be soldered to tin, while it preserves all the principal qualities of the pure metal.

A new and curious alloy is produced by placing in a clean crucible an ounce of copper and an ounce of antimony, and fusing them by a strong heat. The compound will be hard, and of a beautiful violet hue. This alloy has not yet been applied to any useful purpose, but its excellent qualities, independent of its color, entitle it to consideration.

A CHEAP FILTER.

A cheap filter which any tinner can make is 12x6 inches in size, and 8 inches high. The water flows in near the top, and on the top is a door through which to get into it to clean it. The outlet pipe at the bottom projects two inches up on the inside to hold the dirt back. A large sponge is placed inside, which forms the filtering medium, which, of course, can be cleaned as often as desired.

COMPOSITION OF BABBITT METAL.

Genuine Babbitt metal, according to the formula of the inventor, is 9 of tin, 1 of copper. Antimony has been added since, so that the proportions by hundreds will stand 80 tin, 5 copper, 15 antimony. For high speeds the metals should be cooler, giving a larger proportion of tin; for weight the metal should be harder, giving a larger proportion of antimony.

THE HEATING SURFACE OF A STEAM RADIATOR.

For instance, the radiator contains 300 feet of one-inch pipe; what will be its heating surface in square feet? A. 300 feet = 3,600 inches. The outside circumference of one-inch pipe = 4 inches. And 3,600 × 4 = 14,400 square inches of heating surface. Lastly,

$$\frac{14,400}{144} = 100$$

square feet of heating surface. The way you have calculated the heating surface is not correct, because you did not multiply the length of the pipe by the circumference.

A CHIMNEY THAT WILL DRAW.

To build a chimney that will draw forever, and not fill up with soot, you must build it large enough, sixteen inches square; use good brick, and clay instead of lime up to the comb; plaster it inside with clay mixed with salt; for chimney tops use the very best of brick, wet them and lay them in cement mortar. The chimney should not be built tight to beams and rafters; there is where the cracks in your chimney comes, and where most of the fires originate, as the chimney sometimes get red hot. A chimney built from the cellar up is better and less dangerous than one hung on the wall.

ANCIENT USE OF LEAD.

The ancients, like the moderns, used lead to fasten iron into stone, to give a glaze to pottery, and as a help to the manufacture of glass. Very singular were the "imprecation tablets, surreptitiously deposited in tombs, and sometimes even in the coffin of the deceased, that a curse might follow him to the other world," which seem "to have been more frequently deposited by women than by men." Vitruvius describes elaborately a vast aqueduct, the lead in which would cost to-day two millions. The leaden bullets of the ancient slingers often bore an inscription in relief, such as "Appear," "Show yourself," "Desist," "Take this," "Strike Rome." The Greeks were especially fond of bullets with such mottoes, and they have been found upon Marathon and many other famous fields.

A RUSSIAN WELDING PROCESS.

The process of welding, invented by Mr. Be Benardox, of Russia, is now applied industrially by the Society for the Electrical Working of Metals. The pieces to be welded are placed upon a cast-iron plate supported by an insulated table, and connected with the negative pole of a source of electricity. The positive pole communicates with an electric carbon inserted in an insulating handle. On drawing the point of the carbon along the edges of the metal to be welded, the operator closes the circuit. He has then merely to raise the point slightly to produce a voltaic arc, whose high temperature melts the two pieces of metal and causes them to unite. The intensity of the current naturally varies with the work to be done. For regulating it, a battery of accumulators is used, and the number of the latter is increased or diminished as need be. This process of welding is largely employed in the manufacture of metallic tanks and reservoirs.

COLD SOLDER.

La Metallurgie gives the following receipt for cold solder: Precipitate copper in a state of fine division from a solution of sulphate of copper by the aid of metallic zinc. Twenty or thirty parts of the copper are mixed in a mortar with concentrated sulphuric acid, to which is afterward added seventy parts of mercury, and the whole triturated with the pestle. The amalgam produced is copiously washed with water to remove the sulphuric acid, and is then left for twelve hours. When it is required for soldering, it is warmed until it is about the consistency of wax, and in this state it is applied to the joint, to which it adheres on cooling.

TO TIN MALLEABLE IRON.

W. M. writes: I tin malleable iron, which comes from the bath nice and bright, but although I keep it covered, after a few days it gets red, copper colored in spots, and this color gradually spreads all over the work. Can you tell me the cause? A.—The red color is probably derived from oxidation of the iron by the acid left in the pores of the iron. The acid rusts the iron and oozes out through the pores of the tin by the pressure due to increase of bulk by the action of the acid upon the iron; possibly also moisture may be absorbed by the acid through the tin, which is porous. Rinse the work immediately after tinning in boiling water, holding 2 oz. sal soda to the gallon in solution.

OLD TINS NO LONGER USELESS.

A number of people recently gathered at the Columbia rolling mill, Fourteenth street and Jersey avenue, Jersey City, at the formal opening of the mill. The industry is a novel one, being the manufacture of taggers' iron from old tin cans, and other waste sheet metal. This iron has heretofore been manufactured almost exclusively in Europe, and the Columbia Rolling Mill Company is the only American company which turns out the product in large quantities. The process is simple. The tin cans are first heated in an oven raised to a temperature of about 1,000°, which melts off the tin and lead. The sheet iron which remains is passed first under rubber-coated rollers, and then chilled iron rollers, which leaves the sheet smooth and flat. After annealing and trimming, they are ready for shipment. The tin and lead which is melted from the cans is run into bars, and is also placed upon the market. All the raw material used is waste, but the sheet iron turned out is said to be of good quality. It is used for buttons, tags, and objects of a like nature. The material used costing little, and the demand for taggers' iron being considerable, it is thought that this is a good opportunity to build up another American industry.

LEAD ON ROOFS AND IN SINKS.

Tenacity is very slight in some of the metals. An instance may be seen where roofs are covered with lead. The heat of the sun will expand them, and, of course, it is easier for the sheets to expand down-hill than up; then, when they get cold, their own weight will be too great for them, and they will sooner stretch than creep back up hill; so, in fact, unless properly laid, the lead roof will to some extent crawl off its frame-work. The same thing will be seen in kitchen sinks of lead, where very hot water is run into them. The lining gets wrinkled, because, after buckling by reason of the expansion, it will sooner pull thinner than come back to the ordinary position and condition of surface.

A NEW PROCESS FOR COATING IRON WITH LEAD.

Mr. R. N. P. Richardson, of Pittsburgh, has invented a new process for coating iron or any metallic surface with lead. The following description is given of the process: The pure lead in pig form is first put into the melting pot and brought to a standing temperature of high degree. The various solutions and mixtures are then heated, tested and the machinery started. The sheets, after being pickled, are put into a washing vat, as is usual in cleaning the surface of iron in the tin-plating process. Afterward the sheets are immersed in pure water to prevent oxidation by contact with the atmosphere, until they are placed in the solution vat containing various chemicals in dilute hydrochloric acid. The sheets are then passed through the molten lead, and, after being passed through the first time, come out with a clean, bright, even and pure coating of lead. Mr. Richardson states that, while there is a similarity in all processes of coating metals, whether done by immersion of the sheets by a direct process in the molten metal, or by electric deposition of the metal from some of its salts, the whole secret of his process, after pickling and washing of the sheet, is simply in the solution to which the sheet is subjected before its immersion in the molten lead. The solution also forms the flux for the sheet, bone ash mixed with the charcoal being used to prevent the oxidation of the metal.

NICKEL PLATING.

The following solution for electro-plating with nickel is used by several firms in Hainault: 500 grms. of nickel sulphate, 365 grms. of neutral ammonium tartrate, 2.5 grms. of tannin dissolved in ether, and 10 liters of water. One and one-half liters of water are first added, and the mixture boiled for fifteen minutes. The remainder of the water is then added, and the whole filtered. The *Electrician* says: "Solution yields an even white deposit, which is not brittle, and the cost of which is hardly more than that of electroplating with copper."

Nickel plating is now effected at several works in Belgium with the following bath: Sulphate of nickel, 1 kilog. = 2.2 lbs.; tartrate of ammonia, 0.725 kilog.; tannic acid with ether, 0.005 kilog.; water, 20 liters = 4.4 gallons. With this formula a thick coat is deposited on all metals in a short space of time, and by a weak current.

ENDLESS TIN PLATES.

A patent has been recently granted for a novel process of manufacturing continuous tin plates. The plates are made of steel, and the process consists of producing a sheet of steel of any continuous length and of required width, by first rolling the metal hot and afterward rolling it cold, until a proper thickness and perfectly smooth surface is obtained. Next, the surface of the sheet is scoured, and then it is afterward passed through a bath of molten tin, thus receiving its coating. Finally the sheet is subjected to a rolling operation, under heavy pressure, between highly polished rolls, by which the tin and steel are condensed and consolidated together, and the surface hardened and polished. The inventor states that, by this method, the tin will be found to be so hardened upon and incorporated with the steel, as to produce a tin plate which is superior, in most respects, to any tin plate, wherever produced.

HARDWARE IN HAVANA.

The annual value of the imports into Havana of ironmongery and hardware is about $600,000, of which England supplies barely one-half. Consul-General Crowe states that German trade in these branches is constantly increasing, but so far has been confined to such articles as white metal spoons and forks, locks, cutlery and wire nails, which, however, form an important aggregate, as the consumption is considerable. The German goods are generally inferior to the English, which are often of better quality than is actually required. German travelers pay more frequent visits, offer better terms, and give more attention to the requirements of the country than the representatives of English firms. The United States supplies barbed fence wire, cut nails, carpenter's tools, wheelbarrows, bolts and padlocks, and, according to the British Consul-General, "inferior gas and water valves." Their pumps and plows are described as superior to the European articles.

CRYSTALLIZED TIN PLATE.

Crystallized tin plate has a variegated primrose appearance, produced upon the surface by applying to it, in a heated state, some dilute nitro-muriatic acid for a few seconds, then washing it with water, drying, and coating it with lacquer. The figures are more or less diversified, according to the degree of heat and relative dilution of the acid. Place the tin plate, slightly heated, over a tub of water, and rub its surface with a sponge dipped in a liquid composed of four parts of aquafortis and two of distilled water, holding one common salt or sal-ammoniac in solution. When the crystalline spangles seem to be thoroughly brought out, the plate must be immersed in water, washed either with a feather or a little cotton, taking care not to rub off the film of tin that forms the feathering, forthwith dried with a low heat, and coated with a lacquer varnish, otherwise it loses its luster in the air. If the whole surface is not plunged at once in cold water, but is partially cooled by sprinkling water on it, the crystallization will be obtained by blowing cold air through a pipe on the tinned surface, while it is just passing from the fused to the solid state.

USEFUL RECIPES.

Tinning Acid for Zinc or Brass. — Zinc, 3 oz.; muriatic acid, 1 pt. Dissolve, and add 1 pt. water and 1 oz. sal-ammoniac.

To Solder Brass Easily — Cut out a piece of tin foil the size of the surface to be soldered. Then apply to the surface a solution of sal-ammoniac for a flux. Place the tin foi between the pieces, and apply a hot soldering-iron until the tin foil is melted.

To Solder Without Heat — Steel filings, 2 oz.; brass filings, 2 oz.; fluoric acid, 1¼ oz. Dissolve the filings in the acid, and apply to the parts to be soldered, having first thoroughly cleaned the parts to be connected. Keep the fluoric acid in earthen or lead vessels only.

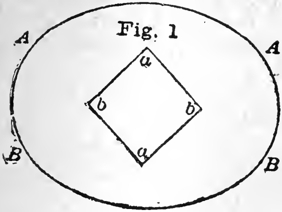
To Tin Brass and Copper — Make a mixture of 3 lbs. cream of tartar, 4 lbs. tin shavings, and 2 gallons water, and boil. After the mixture has boiled sufficiently, put in the articles to be tinned, and continue the boiling. The tin will be precipitated on the articles.

TO POLISH NICKEL-PLATE.

To brighten and polish nickel-plating and prevent rust, apply rouge with a little fresh lard or lard oil on a wash-leather or piece of buckskin. Rub the bright parts, using as little of the rouge and oil as possible; wipe off with a clean rag slightly oiled. Repeat the wiping every day, and the polishing as often as necessary.

PATTERN FOR FLARING OVAL ARTICLES.

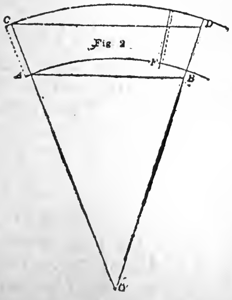
Of all the great variety of patterns with which the tin man has to deal, there is probably none that seems more difficult and causes more trouble and perplexity to make than a flaring oval pan. By following the annexed diagrams and explanations, the development of this pattern will be seen to be simple, easy and quickly performed.

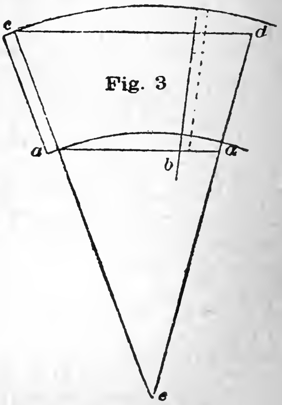


First, always describe the oval from two centers — thus making the bottom of the dish —parts of two diameters or circles. Separate the circles when they intersect each other, and proceed the same as in any round, flaring article.

In Fig. 1 the compasses are set at *a a*, and the large circles described as A A B B, then set the compasses at *b b* and describe the smaller circles, thus completing the oval or bottom of pan.

To make the pattern for the body: In Fig. 2 mark A B





the size of large diameter. Then draw the depth of vessel and flare desired, as A B C D. Extend the lines C A and

D B until they cross at *e*, set the compasses at *e*, and describe the curved lines C D and A B. Make the length A F equal to A A in Fig. 1. Add the locks as shown in dotted lines; this will be the pattern for side of dish.

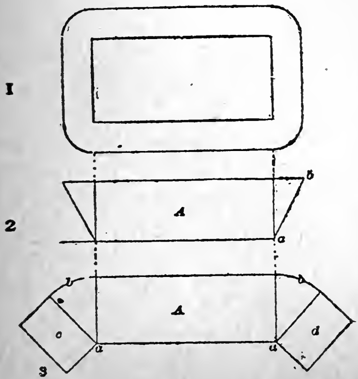
In Fig. 3, make *a a* equal to the small diameter and proceed the same as in Fig. 2, this will be the end pattern. It takes two pieces of the large pattern and two of the small to

FIG 4.

make the dish. Should it be found desirable to make the body of pan in only two pieces, then cut the smaller or end pattern in two and place it upon each side of the large pattern, as shown in Fig. 4.

An oval can be made from three or more centers upon the same plan when desired.

FLARING ARTICLES WITH ROUND CORNERS.



First, to cut the pattern of an oblong flaring dish with square-cornered bottom and round cornered top, in two pieces, of which Fig. 1 is the ground plan, and Fig. 2 the side elevation.

The height of side A, Fig. 2, is from *a* to *b*, which is also the radius for the corners. First mark off the side A, Fig. 3; then strike the segments of thecircles *a b;* this gives the corner. Then mark off one-half of end on each side of $a\ b$ (c and d), which completes the pattern for one-half the dish.

Fig. 4.

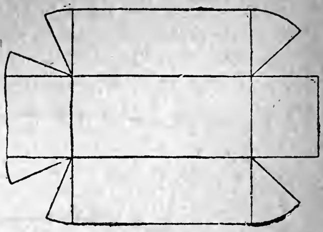
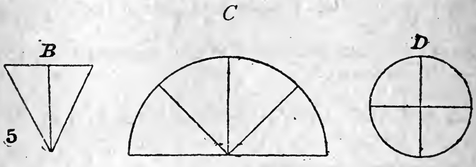


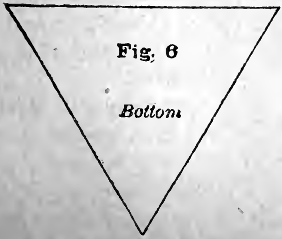
Fig. 4. For practice, we will now cut the pattern so the bottom, sides and corners will be in one piece.

One end of the seam comes on the end piece, and on the other end in the center of the corner piece.

Fig. 5, B, shows cone made by putting together the two flaring sides shown in Fig. 2, A and C, the pattern required to construct said cone. D is the ground plan of cone B

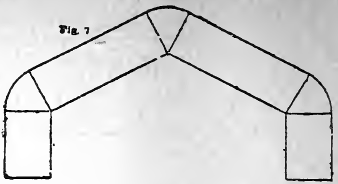


divided into four parts. It will be noticed that the four corners in Fig. 1 will make D, and that the pattern for the four corners (*a b* A, Fig. 3) are equal to C, Fig. 5.



As each corner of Fig. 1 is one-fourth of a cone, so the pattern of each corner, Fig. 4, is one-fourth of the pattern C, required to make the cone B, Fig. 5.

We will now suppose A, Fig. 2, to be the side view of a triangular dish constructed on the same princiciple as A. Each of the sides will be the same size as required to make the square dish, only the pattern C, Fig. 5, will be required to be divided into three parts for each corner of the triangle. Fig. 6 is a ground plan of bottom of dish. We will cut this pattern in one piece by marking off one of the rides, and then transferring one-third of pattern



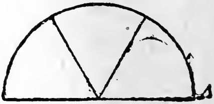
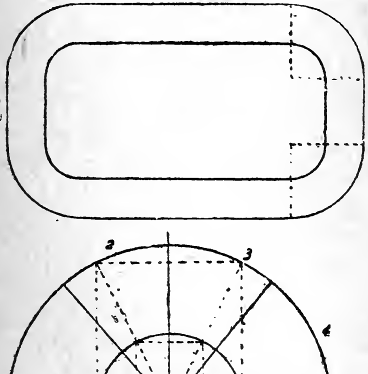
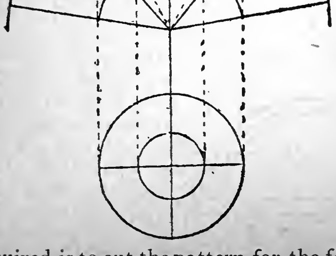


Fig. 8.

A



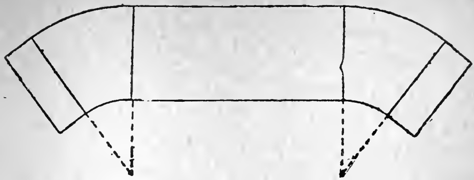


A, Fig. 7, to each side, until we have used the three sides and three corner pieces.

The next step will be to cut the pattern of a flaring oblong dish, top and bottom having round corners, of which Fig. 2 will be a side view, and A, Fig. 8, the ground plan.

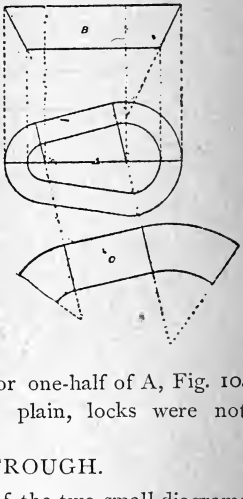
If the side and end pieces in A, Fig. 8, were removed, B would be the result. C is a side view and pattern for B. Now, if we wish a pattern for the A, all that is required is to cut the pattern for the four corners (C) into four pieces, and place the side and end pieces between, or, if the

Fig. 9.



pattern is wanted in two pieces, take a side on which we place two corners and a half of an end against each corner, as follows:

Fig. 10



Or we can suppose Fig. 10, B, to be the side view of dish having half-round flaring ends, but ends of different diameters, as shown by Fig. 10, A.

We will have the small end the same as in Fig. 8, so as to use the same pattern.

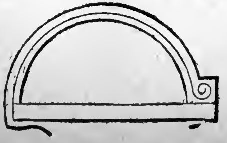
B, Fig. 10, showing side view and radius of large and small circle.

Fig. 10, C, giving the pattern for one-half of A, Fig. 10.

To have the drawings appear plain, locks were not added.

MAKING EAVE TROUGH.

The outside line on the larger of the two small diagrams represents a No. 9 spring wire clamp, one to be used at each seam of the trough. The dark line on outside of the smaller diagram represents a small clamp

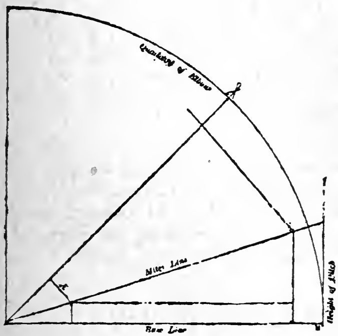


used to hold the bead down at the ends of the log. The large diagram shows the log with the trough clamped to it. It will be seen that a ¾-inch piece is secured to the flat side of the log, which piece projects ¾ of an inch beyond one edge

of the log. A rocker may also be placed under the log. The log is secured to the bench by hooks or staples with a long shank fastened to the bench and hooking onto spikes driven into the ends of the log.

TABLE OF HEIGHT OF ELBOW ANGLES.

The following table gives the height of pitch of miter lines for elbows from one inch to twenty-five inches in diameter. It will be found of great assistance in describing elbow patterns quickly and accurately, by doing away with drawings and geometrical calculations, which would otherwise be necessary to get the correct pitch of elbows. The accompanying diagram indicates the position of base and miter lines. The height of pitch, that is, the length from O to W, is shown by the table for all elbows from one inch to twenty-five inches in diameter, and of from two to ten pieces. In two-piece elbows the height of pitch is the diameter of the elbow, and this column is added to make the table complete. No matter how large the sweep of an elbow, the angle of pitch remains the same, and the only difference to be made in cutting the pattern is to add space as desired, as indicated at X in the diagram. Locks and seams are to be added.



Size in inches	NO. OF PIECES IN ELBOW.								
	2	3	4	5	6	7	8	9	10
1	1	7-16	9-32	7-32	6-32	5-32	1-8	1-8	3-32
2	2	27-32	18-32	13-32	11-32	9-32	1-4	7-32	6-32
3	3	1 1-4	13-16	5-8	1-2	7-16	11-32	5-16	9-32
4	4	1 21-32	1 1-16	13-16	21-32	9-16	15-32	13-32	3-8
5	5	2 1-16	1 5-16	1	13-16	11-16	9-16	1-2	7-16
6	6	2 1-2	1 5-8	1 3-16	31-32	13-16	11-16	5-8	9-16
7	7	2 29-32	1 7-8	1 3-8	1 1-8	15-16	13-16	9-16	5-8
8	8	3 5-16	2 1-8	1 9-16	1 1-4	1 1-16	29-32	13-16	23-32
9	9	3 23-32	2 13-32	1 13-16	1 7-16	1 3-16	1	29-32	13-16
10	10	4 1-8	2 11-16	2	1 9-16	1 5-16	1 1-8	1	29-32
11	11	4 1-2	2 15-16	2 3-16	1 3-4	1 7-16	1 1-4	1 3-32	1
12	12	4 15-16	3 3-16	2 3-8	1 7-8	1 9-16	1 3-8	1 3-16	1 1-16
13	13	5 3-8	3 7-8	2 9-16	2 1-16	1 23-32	1 15-32	1 5-16	1 5-32
14	14	5 3-4	3 23-32	2 3-4	2 7-32	1 7-8	1 9-16	1 3-8	1 1-4
15	15	6 5-32	4	2 31-32	2 3-8	2	1 11-16	1 1-2	1 11-32
16	16	6 19-32	4 1-4	3 5-32	2 17-32	2 1-8	1 13-16	1 19-32	1 7-16
17	17	7	4 7-32	3 6-16	2 11-16	2 1-4	1 15-16	1 11-16	1 1-2
18	18	7 3-8	4 25-32	3 9-16	2 27-32	2 3-8	2 1-32	1 25-32	1 19-32
19	19	7 13-16	5 1-16	3 3-4	3	2 1-2	2 1-8	1 7-8	1 11-16
20	20	8 1-4	5 5-16	3 31-32	3 3-16	2 21-32	2 1-4	2	1 25-32
21	21	8 5-8	5 19-32	4 5-32	3 11-32	2 13-16	2 3-8	2 1-16	1 7-8
22	22	9 1-16	5 27-32	4 3-8	3 1-2	2 15-16	2 1-2	2 3-16	1 15-16
23	23	9 7-16	6 3-32	4 9-16	3 21-32	3 1-16	2 19-32	2 9-32	2 1-32
24	24	9 7-8	6 3-8	4 3-4	3 13-16	3 3-16	2 11-16	2 3-8	2 1-8
25	25	10 9-32	6 5-8	4 15-16	3 15-16	3 5-16	2 13-16	2 7-16	2 3-16

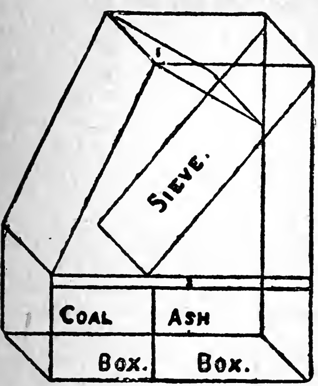
The table is adapted to right-angled elbows only. The line of figures at the top of the table indicate the number of pieces of which elbows are to be made. All other figures are in inches, the first or left hand column being the diameter of elbows, the remaining column being the height of pitch required.

ZINC AS A FIRE EXTINGUISHER.

Zinc, placed upon the stove, in fire or in grate, is said to have proved itself an effective extinguisher of chimney fires. To a member of the Boston Fire Department is reported to be due the credit of successfully introducing this simple scheme. When a fire starts inside a chimney, from whatever cause, a piece of tin sheet zinc, about four inches square, is merely put into the stove or grate connecting with the chimney. The zinc fuses and liberates acidulous fumes, which, passing up the flue, are said to almost instantly put out whatever fire may be there. It certainly sounds simple enough.

HOME-MADE ASH SIFTER.

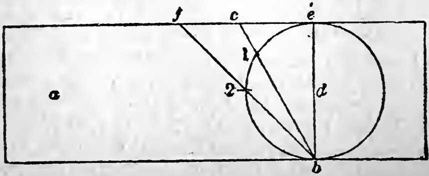
An Iowa correspondent sent *Good Housekeeping* the following diagram and description of a home-made ash-sifter, any tinner or other person may construct: "I got my idea of it from seeing sand sifted by throwing it on a sieve that stood slanting. The wire sieve (already wove) can be bought at a hardware store for twenty cents a running foot, and it is two or two and a half feet wide, and this can be tacked to a frame made to fit the sifter, one end just reaching over the box for coal, and the other end extending nearly to the top of the sifter. There is no shaking, nor any dust. Ashes are emptied in the top of the sifter, the coal being carried over the sieve to the coal box, while the ashes go through into the ash box. The sieve should be two and a half feet long. Can use a sliding or swinging cover."



TO DESCRIBE A MITER.

As there seems to be some interest manifested in regard to the miter question, and nothing definite as to the desired miter has been given, I wish to submit the following rule:

Let *a* in diagram be the size of the article upon which the miter is to be cut; strike a circle full size, or from edge to edge as shown at *e* and *b* of the diagram; draw a line as shown by *d*, from *e* to *b*, which divides the circle equally. If

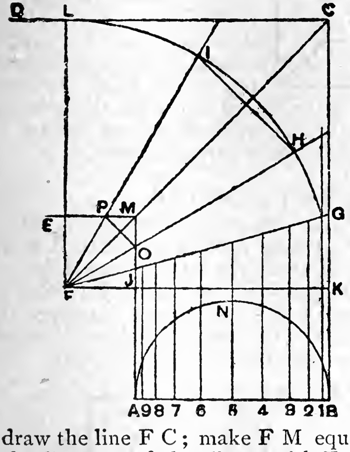


you wish a square miter set compass at *e* and obtain one-fourth of the circle as shown at figure 2, and draw line *b f* intersecting the circle where the point of the compass shows one-fourth of circle. Cutting this line you have a square miter. Should you wish your work to form six squares, take the sixth of a circle as shown at figure 1 by line *c b;* or, if eight squares, one-eighth of circle, and intersect the circle at point designated by compass.

A miter may be cut for any angle desired by the same rule; divide the circle into the number of squares wanted, and proceed as shown above. This rule does not apply to forming a miter for gutters.

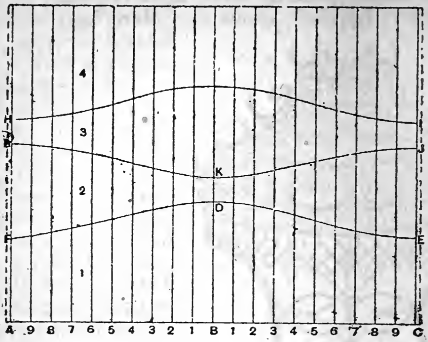
TO DESCRIBE A PATTERN FOR A FOUR-PIECE ELBOW.

Three and four piece elbows have very largely taken the place of the old right-angled elbow, on account of their better appearance, and also because they lessen obstruction to draft. The machine-made article is kept in stock for all common sizes, but the tinner is liable to be called upon at any time to make such an elbow, on account of stock being sold out or of unusual size, or other cause. Herewith are given diagrams and explanations which will enable any tinner to construct a pattern for any desired size.



Let A B E D, Fig. 1, be the given elbow; draw the line F C; make F M equal in length to one-half the diameter of the elbow, with F as a center; describe the arc K L; divide the arc K L into three equal parts; draw the lines F H and F I; also the line I H; divide the section H K into two equal parts, and draw the line F G; draw the line A B at right angles to B C; describe the semi-circle A N B; divide the semi-circle into any number of equal parts; from the points draw lines parallel to B C, as 1, 2, 3, etc.

Set off the line A B C, Fig. 2, equal in length to the circumference of elbow A B; erect the lines A F, B D and



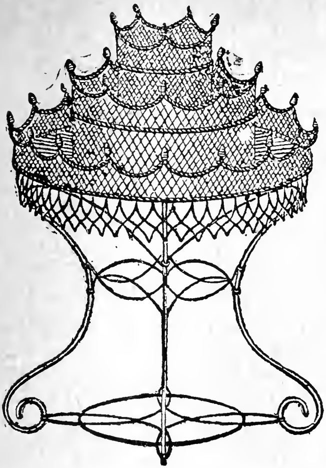
C E; set off on each side of the line B D the same number of equal distances as in the semi-circle A N B; from the points draw lines parallel to B D, as 1, 1, 2, 2, etc.; make B D equal to B G; make A F and C E equal to A J; also each of the parallel lines, bearing the same number as 1, 1, 2, 2, 3, 3, etc.; then a line traced through the points will form the first section; make F G and E J equal to H I; reverse section No. 1; place E at G and F at J; trace a line from G to J; make G H and J I equal to P O, Fig. 67, or to D K, Fig. 68; take Sec. No. 1, place F at H and E at I, and trace a line from H to I; this forms Sec. No. 3 and 4.

Edges to be allowed.

In the West Indies the work of coaling ships is performed by negresses. Like ants going to and fro, each of these women, with a load of coal weighing about forty pounds, carried in a basket on top of the head, climbs the gang-plank, and the bunkers are filled in a wonderfully short time. For this arduous work, a cent a basket is the general price, but night work and emergencies double the rate. A penny is given to each woman as she fills her basket, and the number given out forms a check on the tally kept by the parties receiving the coal. The name of the firm owning the coal pile is stamped on the coins, which are current throughout the islands.

A WIRE FLOWER STAND.

Tinners are ingenious, and can generally make anything from sheet metal, wire, or other light material, which they take a fancy to try their hands at. Many have made ornamental articles at odd moments with which to beautify their own home, or possibly that of some young lady. By their skill in this direction they are frequently able to make presents of articles of their own make, which are not merely ornamental, but also useful. This is commendable, and such skill and enterprise is worthy of encouragement.



We here present an illustration of a new round flower-stand constructed in three parts, which can be taken asunder so as to convert the stand at will into a rustic table. The cut is taken from the London *Ironmonger*, which says that the originator of the flower-stand is doing well with it.

TO STRIKE AN OVAL OF ANY LENGTH OR WIDTH

In a recent number of the *American Artisan*, which I have mislaid, some one asks for a rule to strike an oval of any desired width and length. There are several different ways of striking an oval or ellipse, but I find the one I enclose you the most practical.

Let A B and C D equal width and length. On the line C D lay off the width of oval as C C. Divide the distance from E to D into three equal parts, and lay off two of the parts thus formed on either side of the center F, as G and H. Span the dividers from H to G, and, with F as a center, check the line A B, as at M and K. Draw line intersecting the points H M G K, and, with the radius G D and K B strike the ends and sides of oval.

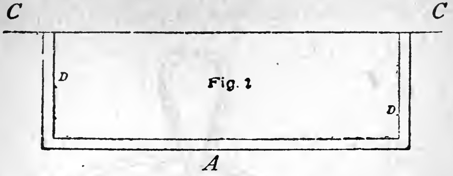
AN ORNAMENTAL PAPER HOLDER.

Tinners with leisure who desire to use their handiwork in making something for Christmas, will be interested in the

accompanying illustration which we reproduce from a European journal. It is intended for a holder for paper, magazines, or sheet music.

HEATING AND VENTILATION.

Much continues to be said and written about heating and ventilation, and some may consider it a worn-out subject; but so long as millions of people continue to be poisoned by impure air, agitation to secure reform cannot be overdone. It will do no harm, therefore, to again name some of the evidences and consequences of a lack of ventilation: Headache; dull pressure on the lungs; lungs become parched, producing irritation; dryness of the throat, producing sore throat; a feverish condition of the whole system. These are some of the immediate consequences, but by no means embrace all the ultimate evil effects. It should be the duty of all furnacemen to call the attention of their patrons to these



matters. Furnaces are often blamed for the quality of air supplied, while the fault lies solely with the operators in not making provision for the supply of pure air to the furnace, and proper ventilation.

This subject will not take care of itself. We must first feel that fresh air is worth taking some trouble to obtain, and then we must study how to obtain it without the body's becoming either chilled or overheated in summer or winter, in the daytime or in the night. At night more care needs to be taken to secure ventilation, because there are no doors being opened; no stirring about to promote circulation. Especially should pure air be supplied to the sick room, and the vitiated air removed.

In summer we depend on the natural movement of the air for ventilation, windows and doors being open more or less. In winter, with the house closed up, it requires thought and effort to provide for a change of air in apartments. It must be remembered that, under natural conditions, air moves horizontally, according to the direction of the wind. Heat causes air to move in a perpendicular direction. In dry weather, heated air and smoke will rise until the same density of atmosphere is reached, which soon results from loss of heat. When the atmosphere contains a great deal of moisture, smoke will descend, on account of quick condensation and loss of heat.

This principle, understood by all must be kept in view in any plan for ventilation. Suppose we wish to ventilate a room in the morning when the air outside has become a little warmer than the air inside. The upper part of a window being opened the warmer air outside would blow across the top of the room, leaving the air below undisturbed Now, if we open the window at the bottom we shall secure a circulation of air in the room. While the outside air is warmer we do not notice the draft. Suppose we now go into the kitchen, where the windows are only opened at the bottom and raised half way up; we shall feel the lower part is cool, while the air in the upper part is undisturbed. Now, if we open the top of the window and divide the difference so as to have the top and bottom open, we shall have a circulation. Or if we open a door and hold a candle at the top and then at the bottom, we will see the same circulation illustrated by the cold air flowing in at the bottom and the hot air out at the top. These experiments furnish the natural laws which should govern ventilation.

Carbonic acid gas from respiration and other exhalations of the body, as well as gases caused by decayed vegetation in cellars, or from garbage, sewer emanations or any kind of

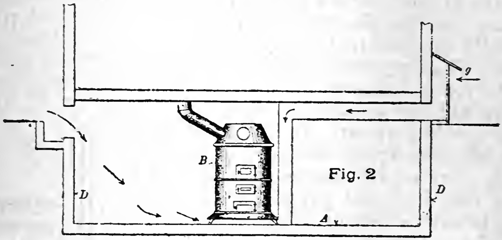


Fig. 2

filth, are all poisonous, and, being heavier than pure air, sink to the bottom of a room by gravitation. It is a gross error to suppose, as many do, that the foul air rises to the ceiling and remains there. The sickness and death of children, often attributed to other causes, arises from blood-poisoning from the foul air near the floor to which children are much more exposed than grown persons.

The illustrations given herewith will show where the foul air is and how it is confined unless drawn off by some superior force. In Fig. 1, *A* represents a cellar, *DD* the walls, *CC* the surface of the ground outside of the house. Foul air seeks the lowest space by gravitation, therefore all below *CC* is foul air because there is no ventilation to draw it away. So long as it remains stagnant, pure air will not take the place of the foul. Now, if we place a furnace in the cellar, as shown in Fig. 2, and take the air from the same, it would amount to almost the same thing as living in the cellar, for you breathe the same air. Opening the windows furnishes an outlet for the warm air and thus cools off the furnace; but the same foul air, dust and ashes are brought up from the furnace for inhalation.

Again, if the rooms are closed, the air from the furnace will rise to the ceiling, then pass to the windows, where the temperature will be reduced, and will then descend to the floor and down the sides of the hot-air flue to the furnace to be reheated and sent up again. This has been proven by experiment. The children will be the first to be affected by this reheated foul air.

How can we obtain pure air? By ventilation. How can ventilation be secured? In various ways. The principal method used is the ventilating shaft. One shaft is generally sufficient for one dwelling, and is usually in the form of a large chimney, as shown in Fig. 3. *A* is the chimney; *B* is a heavy sheet-iron pipe, with air space around the pipe for ventilation; *C* is an opening into the pipe *B* for connection with the furnace; *D* is a place for cleaning out just below the furnace opening; these two openings should be in the cellar where the furnace is; *C* is the place for the kitchen stove, which will supply sufficient heat for ventilating the house during the summer season.

Fig. 3.

We will next consider how to supply the furnace with pure air. It should be taken from the side from which come the prevailing winds. Of course, care should be taken that it is not polluted by a sewage hopper, water closet or other source of containation. The opening into the air-duct should be two feet or more above the ground, and should be covered with fine wire gauze. The air-duct should be carried along the ceiling of the cellar until it reaches the furnace, as shown by dotted lines in Fig. 2, then drop down at the side of the furnace to the bottom. The space around the furnace should be made air-tight. Any foul air in the cellar will be drawn into the fire-box of the furnace to promote the combustion of the fuel. The area of the cold-air duct should, in no case, be less than half the area of the hot-air pipes.

In setting a furnace, particular care snould be taken to see that the chimney has a good draught. There should be sufficient height between the top of the furnace and the ceiling of the cellar to permit a good rise for all the hot-air pipes from the furnace. If there is not sufficient height in the collar to admit of this, the furnace should be set into a pit dug out below the cellar floor and bricked up. Ample room should be allowed in front of the furnace for cleaning out ashes. All the pipes should be kept as close to the furnace as possible. If any hot-air pipe is extended more than fifteen feet from it, it should be encased with about half an inch space around, with both ends of casing entirely closed, to prevent the loss of heat. The location of the furnace should be so that the length of hot-air pipes shall be about equal. The smoke-pipe should be run directly to the chimney. Dampers should be placed in all the hot-air pipes close to the furnace, and, when the pipes are not in use, the dampers should be closed. The vapor-pan should be placed where the water will not boil. In some cases, if set on the top of the furnace, the water will boil over and crack the furnace. A proper place must be provided for it. In a brick-set furnace, the vapor-pan should be automatic in action, being connected with an outside pan with a ball and cock. Without this arrangement it is hard to keep up a regular supply of vapor, as this is a point generally neglected.

In order to distribute the heat through the rooms, the ventilating registers must be located in the proper places. They should be placed in the floor near the windows or in the coldest part of each room, so as to draw the heat to that part. Never run a hot-air pipe up an outside wall if you wish success with your work. If ventilators are put into a side wall, be sure that they extend down entirely to the floor, otherwise there will be a cold stratum of air next the floor, causing cold feet. A failure to do this, causes children to have cold feet at school. People frequently suffer in a similar way at church.

TWO SPINDLE MILLING MACHINE.

The illustration represents a milling machine of new design, recently built by E. W. Bliss Company, of Brooklyn, N. Y., for use in their own works.

As will be seen, the general arrangement is that of a planer, but, in the place of the ordinary planer tools, are substituted vertical spindles for butt milling.

The table has a longitudinal travel of 36 inches, and is fed by a screw which may be operated by the hand-wheel shown at right side of bed, or fed by power, in either direction.

Four speeds for feed for the table are provided, and in addition a power "rapid transit" motion, which is operated to run the table in either direction, by means of the hand-lever shown to the right of bed. The quick motion is especially intended for running the table back after the cut is finished, and being entirely independent of the cone feed, both can be in operation at one and the same time, thus saving the trouble of throwing off the cone-feed in order to run the table back for starting a new cut.

The cross-head is raised and lowered by power, much in the same manner as in a planer, and in addition each spindle has an independent vertical adjustment of two inches operated by the hand cranks shown at the upper boxes on saddles. Each saddle is capable of independent lateral motion, operated by the large hand-wheel at front, and has also a power attachment for feeding, supplied with four changes of speed.

As in the case of the table, the saddles may be moved independently from the power feed while the latter is in opertion. The cross-head is made of sufficient length to allow the saddles to be run out far enough to bring the milling cutters outside of the housings, between which the distance is fifty-four inches.

The machine illustrated was built for special work not requiring a long table, but the latter can be made of any length required, and the builders are now filling several orders for machines with five to six feet length of table.

The driving-shaft, carried by cross-head, is splined its length between bearings to allow for the lateral motion of the saddles, and is driven from the floor counter by the familiar arrangement of belting shown, which dispenses with the necessity of a tightener to make up for the vertical adjustment of the cross-head.

In some of the machines now in course of construction, the arrangement is such as to allow the floor counter to be dispensed with, and one at top of machine to be substituted, which, in some cases, might be considered preferable.

By the use of the two spindles on the work for which this machine was designed, and with special attachments to facilitate the setting, this tool is now doing work that heretofore required the use of five planers, thus proving itself a most valuable addition to the equipment of a machine shop.

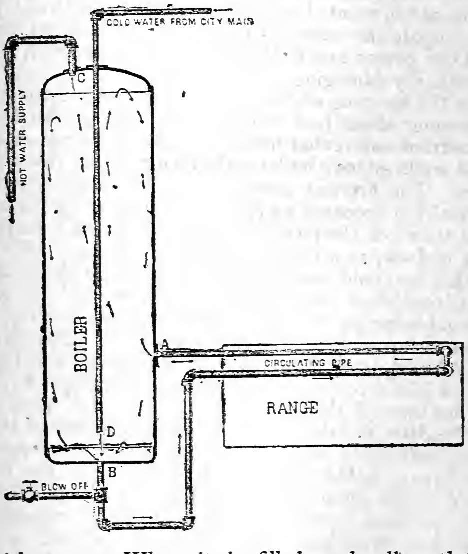
EXPLOSION OF A DOMESTIC HOT WATER BOILER.

Explosions of domestic hot water boilers attached to cooking ranges, water-backs in ranges, etc., through freezing up of the pipes in cold weather, are becoming so frequent that it may not be out of place to give an account of one of the most destructive ones that has occurred recently, and point out its cause.

The boiler in question was used in an hotel in a large city in one of the Northwestern States, where the temperature is very low at times. It was connected to the kitchen range, the range was a very large one, and the heating surface was furnished by a coil of 1½ inch pipe, placed near the top, instead of the cast-iron front or back, such as is commonly used in the smaller ranges in private dwellings. The connections to the boiler were made in the usual manner; the accompanying cut shows its essential features.

The operation of all boilers of this sort is as follows:

The connections being made, as shown in cut, the water is turned on from the main supply, and the entire system is



filled with water. When it is filled, and all outlets are closed, it is evident that no more water can run in, although the boiler is in free connection with, and is subjected to, the full pressure of the source of supply. When a fire is started in the range, and the water in the circulating pipes, or water-back, is heated, the water expands, is consequently lighter, and flows out through the pipe into the boiler at A, as this connection is placed higher up than the one at B; this starts the circulation, and the water, as it becomes heated, constantly flows into the boiler at A, and rises to the upper part of the boiler, while the cooler water at the bottom of the boiler flows out into the circulating pipes at B, and, if no water is drawn, a slow circulation goes on, as heat is radiated from the boiler, in the direction indicated by the arrows, the water at the top of the boiler always being much hotter than at the bottom. When the hot cock is opened, cold water instantly begins to flow into the boiler at D, by reason of the pressure on the city main, and forces hot water out of the boiler at C. Thus it will be seen that hot water cannot be drawn unless the cold water inlet is free, and it is equally evident that cold water cannot enter the boiler unless the hot water cock or some other outlet is open.

The above points being understood, we are in a position to investigate the cause of the explosion referred to, which killed one person and badly injured twelve or thirteen others, besides badly damaging the building.

On the morning of the explosion fire was started as usual in the range about four o'clock a. m. It was found, on trying to draw water, that none could be had from either cold or hot water pipes; it was rightly judged that the pipes were frozen. The fire was continued in the range, however, and the breakfast prepared as best it could be, and a plumber sent for to thaw out the pipes. He arrived on the premises about seven o'clock, as would naturally be the case. He opened both hot and cold water cocks, and, getting neither steam nor water, *concluded there was no danger*, and proceeded to thaw out some pipes in the laundry department first. About an hour afterward the explosion occurred. The lower head of the boiler let go, and the main portion of the boiler shot upward like a rocket through the four stories of the hotel and out through the roof.

The coroner held an inquest on the remains of the person killed, and some of the testimony given, as reported in a local paper, would be amusing were it not for the tragic nature of the affair which called it out. The usual expert, with the usual vast and unlimited years of experience, was there, and swore positively to statements which a ten-year-old boy who had been a week in the business ought to be ashamed to make. He had examined the wreck with a view to solving the mystery (?) The matter was as much of a mystery now as on the day of the explosion. His theories were exploded as fast as he presented them. The boiler must have been empty. If it had been full of water, it could not possibly have exploded, etc., etc. And then a lot more nonsense about the "peculiar" construction of the boiler.

As a matter of fact, there was nothing peculiar about the boiler or its connections. Everything was precisely like all boilers of its class, of which there are probably hundreds of thousands in daily operation throughout the country, and, moreover, they were *all right.*

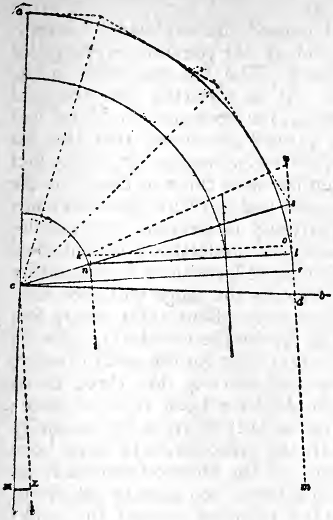
Now let us inquire what caused the explosion. Everything was all right at eight o'clock the previous evening, for water was drawn at that time. The fire was built in the range at four o'clock a. m. It is admitted that the cold water supply pipes were frozen, for no water could be had for kitchen use. It is also proved absolutely that the *hot water supply was frozen or otherwise stopped up*, by the fact that at seven o'clock the plumber who came to thaw out the pipes opened the hot water cock and got "neither water nor steam." Here was his opportunity to prevent any trouble, but he let it pass. Any one who understood his business would have known that there must have been a tremendous pressure in the boiler at this time, as the range had been fired steadily for three hours; there were about eight square feet heating surface exposed to the fire by the circulating pipe in the range, and there had been no outlet for the great pressure which must have been generated during this three hours firing. The blow-off cock should have been tried at once; if this were clear, and the probability is, from its proximity to the range, that it was clear, the pressure could have been relieved, and disaster averted. If the blow-off proved to be stopped up, then the fire should have been at once taken out of the range. At the time the plumber opened the cocks connecting with the boiler, it probably was under a pressure of 400 or 500 pounds per square inch. An ordinary cast-iron waterback such as is used in small ranges in private houses would have exploded shortly after the fire was built, but it will be noticed that the heating surface in this case was furnished by a coil of 1½-inch pipe; this was very strong, and the boiler was the first thing to give way, simply because it was the weakest part of the system.

Accidents of this sort can be easily avoided by exercising a little intelligence and care. The hot water cock should always be opened the first thing on entering the kitchen every morning. If the water flows freely, fire may then be started in the range without danger. If it does *not* flow freely, don't build a fire until it *does.*

A Cement to Make Joints for Granite Monuments—Use clean sand, twenty parts; litharge, two parts; quicklime, one part, and linseed oil s to form a thin paste.

USEFUL SHOP KINKS.

Fig. 1. A rule for different angles, or rise of elevations for elbows:



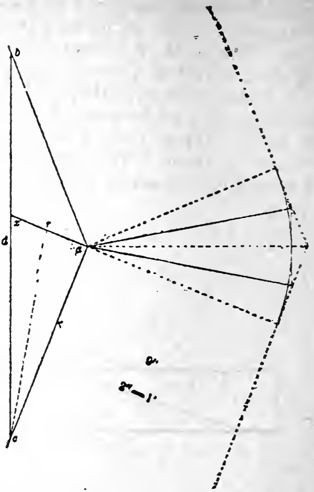
The usual rise given to furnace pipe elbows is one inch to the foot. A rule to obtain the desired result is as follows, and is almost identical with the one commonly used to get the height and pitch of miter line of right-angled elbows. It is applicable to any sized throat and any sized elbow; also, to elbows with any number of pieces or sections.

First draw lines *a c* and *c b*, Fig. 1, at right angles to each other. From point *c* on line *c b*, measure off 1 foot, and perpendicular from the point thus obtained erect line *d* to *r*, which is the desired height you wish the elbow to rise, or angle from a true right-angled elbow, in this case one inch to the foot. From point *c* as center, draw the arc *a* to *r*. From point *r* draw the line *r c* for base line. This will give the correct elevation, as proof clearly shows by the dotted lines *c* to *z* and *r* to *m;* these show the continuation that the elbow leads to, namely, as in this instance, 1 inch to the foot, or 1 foot in 12 feet. The line *c* to *x* is 1 foot, and from *x* to *z*, 1 inch.

If an elbow of four pieces is desired, divide the arc or curve *r* to *a* into six equal parts; if an elbow of three pieces or sections is wanted, divide same into four equal parts. From point *c* for a four-piece elbow, draw line *c* to *s*. and from point *n*, where inner curve of elbow intersects line *c s*, draw line *n* to *l* parallel to line *c r*, and same intersecting line *r s* at *l*. This much gives the pitch and rise for miter line for a four-piece elbow of the desired elevation. For a three-piece elbow the dotted lines from point *k* on the inner curve to points *u* and *o* on outer curve, give the miter desired.

I have also shown a smaller-sized elbow in the drawing to show how the rule works, and is applied on same. It is, of course, not necessary to give the same size of throat as is given in the drawing, nor the same outside sweep. This rule will suit any case or sized elbow as may be desired, and as one becomes familiar with the working of the rule, some of the other lines need not be drawn out, but are here given to make the drawing complete.

FIG. 3.



The above is given to get the complete data for side elevation which are necessary to develop the patterns for the different sections of an elbow. To develop the same I will give a quick snap rule, which comes so near right as to be practically almost correct. I will, however, first give a good snap rule for angles.

If Fig. 3 is examined, it shows the usual long and tedious geometrical method of obtaining miter lines for both a two-piece, and also a three-piece angle, both of the angles being of the same pitch. The solid lines are for a three-piece angle, and the dotted lines are for a two-piece angle.

Now, to do away with all this drawing, and to get a quick and very nearly correct method to obtain the desired result, suppose an angle is wanted as is given by the lines *a b* and *a* to *c*, Fig. 3, the diameter to be as full drawing requires, proceed as follows: First measure off the distance which is the size of diameter wanted, from *a* to *b;* do the same from *a* to *c*, and from points thus obtained, which are *c* and *b*, draw the line *d* from *c* to *b*. Then from either line, *a c* or line *a b*, draw at right angles the line *a* to *x*, as shown, the line *a x* intersecting line *d* at *x*. This much gives the required elevation for miter line of a two-piece angle as called for; line *d* from *c* to *x* is miter line, *a* to *x* is height of rise, and *a* to *c*, base line, which is size of diameter called for. The line *x* to *a* divided into half gives the point *r* where the miter line intersects., of a three-piece angle; *r* to *a* is height, *a* to *c* is base line, and *c* to *r* is miter line, as will be seen by dotted line in drawing. Twice the length of distance of line from points *a* to is the width of outer curve of center section. You must, of course, allow for laps or burrs for joining same together when cutting pattern.

Compare this with the solid line center section of full side elevation, and see how much quicker this method is over the old way. When once accustomed to use this method, you will use no other. This rule is absolutely correct for a two-piece angle, and varies so little on a three-piece angle from

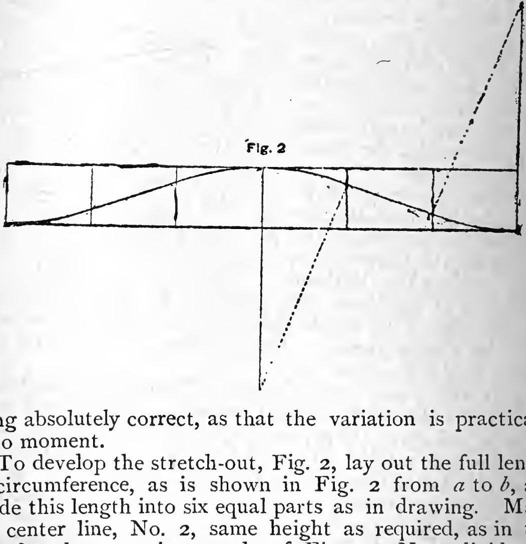


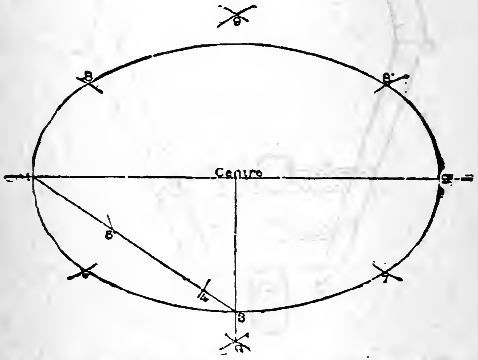
Fig. 2

being absolutely correct, as that the variation is practically of no moment.

To develop the stretch-out, Fig. 2, lay out the full length of circumference, as is shown in Fig. 2 from *a* to *b*, and divide this length into six equal parts as in drawing. Make the center line, No. 2, same height as required, as in this case for the two-piece angle of Fig. 3. Next divide the right and left lines nearest to the center line, into four equal parts, and mark of one off these parts nearest to the top of each line; and do the same as to spacing to the lines nearest to the end of stretch-out, as lines No. 4 and *r*, but with the difference that you mark off one space at the bottom of each line as the drawing fully shows. Continue the center line indefinitely downward, and with dividers strike the arc 1, 2 and 3, cutting lines at points 1, 2 and 3. Draw line *b* indefinitely upward, reverse the dividers, and with line *b* as center line, draw the arc from point 5 to point 4, cutting points 5 and 4; do the same on the other end. Then draw a straight line from point 3 to 4, and same from 1 to *r*. This completes the pattern. Allow for locks or laps on both ends, and miter lines, of course.

The method given above is an old one, but not so universally known among tinners as its merits deserve. This method is also applicable to develop the pattern for elbow as given in Fig. 1. I use it for all kinds of elbows.

TO DRAW ANY OVAL WITH SQUARE AND CIRCLE.



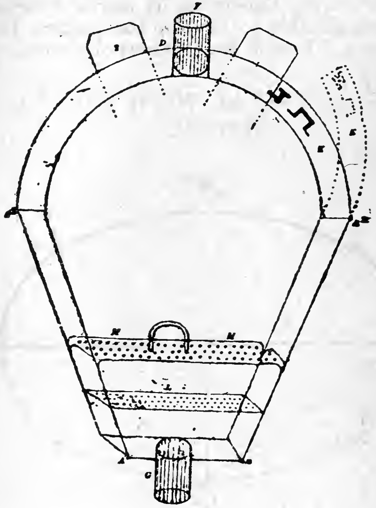
The following is a correct rule to draw any size or oval used in the tin shop, with square and circle:

Draw the line from 1 to 2, which is the length of the oval. Draw line from center to 3, which is one-half the width, and draw a line from 1 to 3. Set compass from 1 to center; leave one point on 1, and mark 4. Set compass from center to 3. Leave one end (of compass) in center and mark 5. Set compass from 4 to 5, and from 6 draw head lines of circles 7 and 8, and dot 7 and 8 from points 1 and 2. Set compass from 7 to 7, and mark 9 from 7 7 and 8 8. Complete oval from 9.

RAIN WATER STRAINER.

I hand you a sketch of a rain water strainer which I have put up and which gives good results. It is eighteen inches high, twelve inches in diameter at the half-circle, five and a half inches length of bottom, and five inches deep. Allow for all seams.

A, A^2, *D*, B^2, *B*, represents the outside of finished

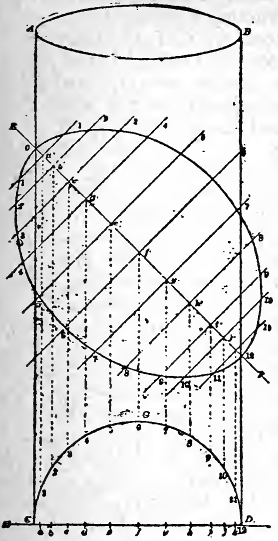


strainer. *K* is a section of circular top hinged at B^2 and fastened with a turn button. The dotted lines at *E* show the section of circular top, *K*, partly open; *m* is a galvanized strainer with three-eighth inch holes. The strainer rests upon supports at the ends, and may be removed at will. *L* is a tin strainer with one-eighth inch holes, and is soldered in place. *F* and *G* are three-inch inlet and outlet. 2 2 are straps on back side, by which the strainer is fastened to the building.

As will be seen, the top strainer catches the refuse which is washed from the roof and gutters, and is easily taken out; the finer particles are caught below and may be removed when the top strainer is out.

OVAL DAMPER.

Enclosed please find method of obtaining an oval damper, that when closed in, the pipe will be at an angle of 45°.



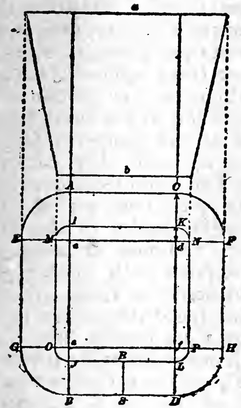
Let A B C D represent the pipe, and E F the line through the pipe at an angle of 45°, which will be the position of the damper when closed. Divide the semi-circle into any even number of equal parts, as, 1, 2, 3, 4, etc. (even numbers, because in doing so you obtain the center line of the short diameter of the damper). Carry lines up until they cut the line E F as dotted lines, then draw solid lines across, and at right angles to the line E F, and number them to correspond with spaces in semi-circle, as 1, 2, 3, 4, etc. With the dividers step from a to 1 on dotted line, and with one point of the dividers at a′; cut the solid line 1 each side of the line E. F. Step from b to 2, and with one point of the dividers on b′, cut the solid line to both sides of the line E F, and so on until all the spaces have been transferred. Now set the dividers so as to draw an arc through the points 5, 6, 7, both sides of the line E F, and then set them to draw the two end circles, as 11, 12, 11, and 1, 0, 1. Draw a′ line free hand through the points from 1 to 5, and from 7 to 11, both sides of line E F, and you have the required damper.

The same method is used to obtain the shape of a hole in piece of sheet metal that a pipe is to pass through on an angle. For instance, let A B C D represent a pipe, and E F a roof through which the pipe passes; we want a piece of iron or tin laid on the roof for the pipe to pass through; we want to know how to get the shape of the opening. Employ this method and it will give you the required article every time.

A TAPERING ROUND-CORNERED SQUARE RESERVOIR.

Not long since, there was an inquiry in your columns for a pattern for a tapering, round-cornered square reservoir. I give herewith diagrams for constructing such a pattern:

Fig. 1 is the size, top and bottom (A C F H D B G E is the top, and I K N P L J O M is the bottom), and Fig. 1 the upright height. Take the perpendicular height a d, Fig. 1, and mark it off from h to k, Fig. 3. Take the radius for the corners d C, Fig. 1, and mark it off from h to i, Fig. 3, also the radius dK; mark off from K to l, drawing a line from i l to cut the line h K, which gives the slanting height and the radius required for striking the corners. Draw the lines I K and A C, Fig. 4, the same length as I K, Fig. 2, and the same distance apart as l to i, Fig. 3; prolong the lines A I and C K, Fig. 4, till A c and C d equals to i m, Fig. 3. With radius d C, Fig. 4, using d and c as centers, strike the curves C F and A E, and, with a radius d K, Fig. 4, using the same centers, strike the curves K N and I M. Take the length of the large quar-



1

2

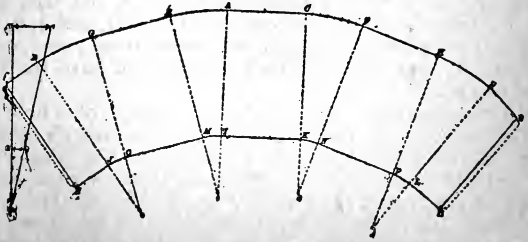


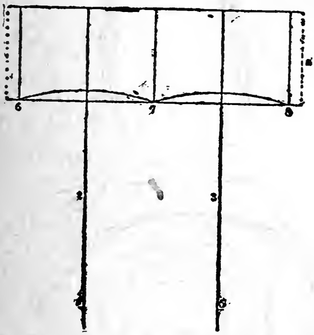
Fig. 3. Fig. 4.

ter-circle D H, Fig. 2, and dot off the same distance from C to F, Fig. 4; make A E equal to C F, and draw lines from E and F to the centers c and d; draw E G and M O at right angles with E c. Take the distance from A to C, and make the same distance from E to G and M to O, Fig. 3. Draw G e parallel to E c. From G mark off point e, the same length as E to c, then, using e as center, strike the curves G B and O J, making the curve G B equal to A E; draw line from B to center c, draw B T and J R at right angles to B e, taking the distance from B to S, Fig. 2, mark off the same distance from B to S and J to R, draw S R parallel with B e, and proceed in the same manner with the other end; adding on the laps, as shown, will make the pattern complete in one piece, being joined together at R S.

PATTERN FOR T JOINTS.

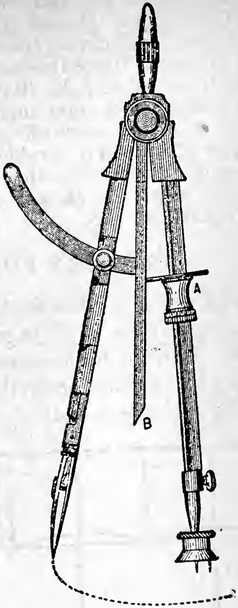
The following rule is a short and explicit method of obtaining a pattern for T joints where different diameters are required. Suppose, for instance, a T is required whose diameters are 3 and 8 inches respectively.

Divide the stretch-out, *a a* (which must be the exact length required to form up 3 inches, allowing for locks as shown by dotted lines) in center as shown in the figure. Then divide each half equally between 6-7 and 7-8 as shown by indefinite lines 2 and 3. Now spread the compass to 8 inches, which is the diameter of the large pipe, set one point at 4, and the other at 6; strike a circle to 7; then set compass on the other line at 5 and draw circle 7 to 8. Cut out the circles, and you have your pattern. The same rule applies to any diameter by spreading compass to the larger diameter and striking the circle on the stretch-out required for smaller diameter as shown above.

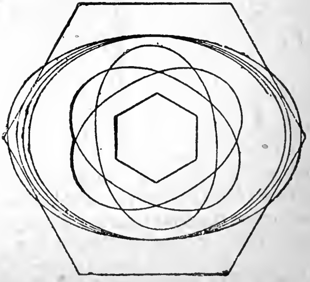


Ireland has seventy-six collieries — nine in Ulster, seven in Connaught, thirty-one in Leinster, and twenty-nine in Munster. Very few of these are being worked.

NOVEL DRAWING INSTRUMENT.



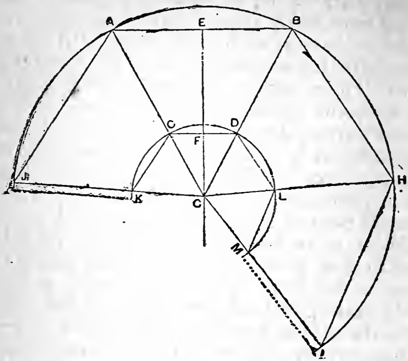
A pair of dividers, or compasses, which will describe any figure is shown herewith. It is of English origin and very simple. The former, or template A, is affixed to one leg, and beats against the mid-leg B, around which, of course, revolves the working leg. By this means the drawing pen or pencil is moved in and out in an obvious manner. Specimens of the work are shown in Fig. 2.



The quality of wood is determined by the number of spirals. The best has about thirty " crinkles " in an inch.

TO DESCRIBE A PATTERN FOR A TAPERING SQUARE ARTICLE.

Erect the perpendicular line G E; draw the line A B at right angle to G E; make E F equal to the slant height, and draw the line C D parallel to A B; make A B equal in length to one side of the base; make C D equal in length to one side of the top or smallest end, draw the lines A G and B G, cutting the points A C and B D, G as a center with the radii G C and G A. Describe the arcs K M and J I; set off on the arc J I, J A, B H and H I equal in length to A B, and draw the lines J G, H G, and I G, also the lines J A, B H, H I, and K C, D L, L M.



Edges to be allowed.

THE PAINTING OF IRON.

Cast and wrought iron behave very differently under atmospheric influences, and require somewhat different treatment. The decay of iron becomes very marked in certain situations, and weakens the metal in direct proportion to the depth to which it has penetrated, and, although where the metal is in a quantity this is not appreciable, it really becomes so when the metal is under three-fourths of an inch in thickness. The natural surface of cast iron is very much harder than the interior, occasioned by its becoming chilled, or by its containing a large quantity of silica, and affords an excellent natural protection, but, should this surface be broken, rust attacks the metal and soon destroys it. It is very desirable that the casting be protected as soon after it leaves the mold as possible, and a priming coat of paint should be applied for this purpose; the other coats thought requisite can be given at leisure. In considering the painting of wrought iron, it must be noticed that, when iron is oxidized by contact with the atmosphere, two or three distinct layers of scale form on the surface, which, unlike the skin upon cast iron, can be readily detached by bending or hammering the metal. It will be seen that the iron has a tendency to rust from the moment it leaves the hammer or rolls, and the scale above described must come away. One of the plans to preserve iron has been to coat it with paint when still hot at the mill, and, although this answers for a while, it is a very troublesome method, which iron masters cannot be persuaded to adopt, and the subsequent cutting processes to which it is submitted leave many parts of the iron bare. Besides, a good deal of the scale remains, and, until this has fallen off or been removed, any painting over it will be of little value. The only effectual way of protecting wrought iron is to effect a thorough and chemical cleansing of the surface of the metal upon which the paint is to be applied; that is, it must be immersed for three or four hours in water containing from one to two per cent. of sulphuric acid. The metal is afterward rinsed in cold water, and, if necessary, scoured with sand, put again into the pickle, and then well rinsed. If it is desired to keep iron already cleansed for a short time before painting, it is necessary to preserve it in a bath rendered alkaline by caustic lime, potash, soda, or their carbonates. Treatment with caustic lime water is, however, the cheapest and most easy method, and iron which has remained in it some hours will not rust by a slight exposure to dampness. Having obtained a clean surface, the question arises, what paint should be used upon iron? Bituminous paints, as well as those containing variable quantities of lard, were formerly considered solely available, but their failure was made apparent when the structure to which they were applied happened to be of magnitude, subjected to great inclemency of weather or to constant vibration. Recourse has, therefore, been had to iron oxide itself, and with satisfactory results. A pound of iron oxide paint, when mixed ready for use in the proportion of two-thirds oxide to one-third linseed oil, with careful work, should cover twenty-one square yards of sheet-iron, which is more than is obtained with lead compound.

INVENTOR OF THE SCREW-AUGER.

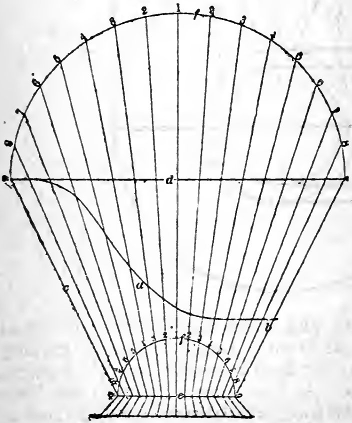
The screw-auger was invented by Thomas Garrett about 100 years ago. He lived near Oxford, Chester County, Pa. The single screw-auger was invented by a Philadelphian, and it is said to be the only one used with any satisfaction in very hard woods, where the double screw-augers become clogged

RUST PROOF WRAPPING PAPER.

This is made by sifting on the sheet of pulp, in process of manufacture, a metallic zinc powder (blue powder), about to the extent of the weight of the dried paper, the pulp sheet is afterward pressed and dried by running through the rolls and over the drying cylinders as usual. The zinc powder adheres to the paper, and is partly incorporated with it, the amount varying with the thickness and wetness of the pulp sheet. The paper may be sized with glue or starch and then dusted with the zinc powder, or the powder may be stirred into the size and then applied to the surface of the paper. If silver, brass or iron articles are wrapped in paper thus prepared, the affinity of the zinc for the sulphureted hydrogen (always present in the air), chlorine or acid vapors, will prevent those substances from attacking the articles inclosed in the paper.

HIP-BATH IN TWO PIECES.

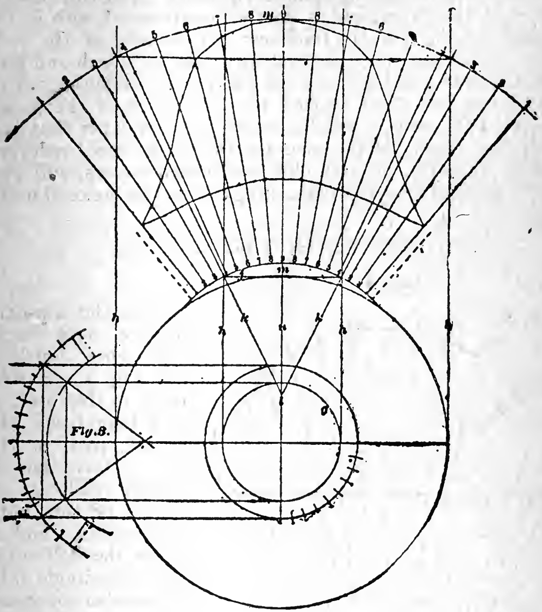
Fig. 1.



Draw the hip-bath full size, as it would look when finished, as in Fig. 1. Extend line *b*, or the front, to same height as *c*, the highest part of the tub. Draw line *d* parallel with *e*, or bottom of tub, until it intersects *c* and *b*. Strike the half-circle *f f*, and divide into any number of equal parts, as 1, 2, 3, 4, etc. (the more lines the better). For the points draw lines as shown in profile.

Set dividers same as when the circles in Fig. 1 were described, and strike the circles *g g*, and with a T square draw the perpendicular lines *h h h h*. Draw the line *i* parallel with the lines *h*. Take the height, same as from *d* to *e*, in Fig. 1, and mark the line *j*, Fig. : Draw lines *k k* until they intersect at *l*. Set dividers at *l*, and strike the circles *m m*. Draw line *n*, and, taking it as the center line, step each way one-fourth of the circumference, in as many parts as in profile, 1, 2, 3, 4, etc., and draw lines same as in Fig. 1.

Fig. 2.



Take a pair of dividers, and from the bottom of tub in profile step on the lines, as from 9 to 9, 8 to 8, etc., making the line in Fig. 2 equal to the lines in profile, stopping where the curved line *a* crosses. A line traced through the dots will give the pattern, is the foot, which is drawn the same as the other, with the exception of drawing the lines through.

A VERY durable black paint for out-of-door work, and for many other purposes, is made by grinding powdered charcoal in linseed oil, with sufficient litharge or drier. Thin for use with boiled linseed oil.

ROPE TRANSMISSION IN ENGLAND.

According to the London *Engineer*, a fly-rope apparently was first used in England in 1863, by Mr. Ramsbottom, for driving cranes at Crewe. These ropes were ⅝ inch in diameter when new, of cotton, and weighing 1½ ounces per foot. They lasted about eight months, and ran at 5,000 per minute. The total lengths of the rope were 800 feet, 320 feet and 560 feet. The grooves in the pulley were V-shaped, at an angle of 30°. The cord was supported every 12 feet or 14 feet by flat pieces of chilled cast iron. The actual power strain on the rope was about 17 pounds, and the ropes were kept tight by a pull of 109 pounds put on by a jockey pulley. Rope-gearing is now superseding belting and gearing in cotton mills. It has long been used in South Wales for driving helve hammers in tin-plate mills. The ropes are usually about 5¼ inches to 6¼ inches in circumference, of hemp. The diameter of the pulleys should be at least 30 times that of the rope, and the shafts should not be less than 20 feet apart. A 6½-inch rope is about equivalent to a leather belt 4 inches wide, running at the same speed—3,000 feet per minute. Such a rope will transmit 25 horse-power. The coefficient of resistance to slipping of a rope in a groove is about four times that of an equivalent belt.

HEAT-PROOF PAINTS.

Steam pipes, steam chests, boiler fronts, smoke connections and iron chimneys are often so highly heated that the paint upon them burns, changes color, blisters and often flakes off. After long protracted use, under varying circumstances, it has been found that a silica-graphite paint is well adapted to overcome these evils. Nothing but *boiled linseed oil* is required to thin the paint to the desired consistency for application, no dryer being necessary. This paint is applied in the usual manner with an ordinary brush. The color, of course, is black. But another paint, which admits of some variety in color, is mixed by making soapstone, in a state of fine powder, with a quick drying varnish of great tenacity and hardness. This will give the painted object a seemingly enameled surface, which is durable, and not affected by heat, acids, or the action of the atmosphere. When applied to wood it prevents rotting, and it arrests disintegration when applied to stone. It is well known that the inside of an iron ship is much more severely affected by corrosion than the outside, and this paint has proven itself to be a most efficient protection from inside corrosion. It is light, of fine grain, can be tinted with suitable pigments, spreads easily, and takes hold of the fiber of the iron or steel quickly and tenaciously.

A cheap and effective battery can be made by dissolving common soap in boiling water and adding to it small amounts of bran and caustic potash or soda. This mixture, while warm, is poured in a jar containing a large carbon pole and an amalgamated zinc rod. When cold the battery "sets" after the manner of a jelly, and consequently will not readily evaporate or spill over.

NEW PROCESS FOR WIRE MANUFACTURE.

A machine for cheapening and improving steel or iron wire has been invented, which is calculated to make a change in many branches of industry in which iron, steel, copper and brass wire are used. The invention, which has just been patented, consists of a series of rolls in a continuous train, geared with a common driver, each pair of rolls having a greater speed than the pair preceding it, with an intervening friction clutch adapted to graduate the speed of the rolls to the speed of the wire in process of rolling. The entire process of manufacturing the smallest-sized wires from rods of one-half inch is done cold. The new process obviates the danger of unequal annealing, and of burning in the furnaces, and the wire is claimed to be more flexible and homogeneous than that produced by the common processes, and capable of sustaining greater longitudinal strain. It is, therefore, specially adapted for screws, nails, cables, pianofortes, and many other uses, and copper wire made by this process is claimed to be possessed of greatly increased electrical conductivity.

SLEEPERS USED BY THE WORLD'S RAILROADS.

According to the *Moniteur Industriel*, the six principal railways of France use more than 10,000 wooden sleepers per day, or 3,650,000 per annum. As a tree of ordinary dimensions will only yield ten sleepers, it will be necessary to cut down 1,000 trees per day. In the United States the consumption is much greater, amounting to about 15,000,000 sleepers per year, which is equivalent to the destruction of 170,000 acres of forest. The annual consumption of sleepers by the railways of the world is estimated at 40,000,000. From these figures the rapid progress of disforestation will be understood, and it is certain that the natural growth cannot keep pace with it.

WEIGHTS OF CAST IRON PIPES.

Weights, per foot, of Cast Iron Pipes in general use, including Socket and Spigot ends.

Diameter.	Thickness.	Weight per foot.	Diameter.	Thickness.	Weight per foot.
2 inches.	¼+ inch.	6¼ lbs.	14 inches	⅜ inch.	138 lbs.
2 "	⅜ "	9¼ "	16 "	½ "	85 "
2 "	½ "	14 "	16 "	⅝ "	108 "
3 "	¼+ "	11 "	16 "	¾ "	129 "
3 "	⅜ "	13½ "	16 "	⅞ "	152 "
3 "	½ "	18 "	16 "	1 "	175 "
3 "	⅝ "	23 "	18 "	⅝ "	114 "
4 "	⅜+ "	16½ "	18 "	¾ "	137 "
4 "	½ "	23 "	18 "	⅞ "	161 "
4 "	⅝ "	31 "	20 "	⅝ "	132 "
6 "	⅜ "	25 "	20 "	¾ "	160 "
6 "	½ "	33 "	20 "	⅞ "	197 "
6 "	⅝ "	42½ "	20 "	1 "	215 "
6 "	¾ "	52 "	24 "	⅝ "	159 "
8 "	⅜ "	40 "	24 "	¾ "	190 "
8 "	½ "	43½ "	24 "	⅞ "	224 "
8 "	⅝ "	56 "	24 "	1 "	257 "
8 "	¾ "	68 "	30 "	¾ "	237 "
10 "	7/16+ "	50 "	30 "	⅞ "	277 "
10 "	½ "	54 "	30 "	1 "	319 "
10 "	⅝ "	68 "	30 "	1⅛ "	360 "
10 "	¾ "	80 "	36 "	⅞ "	332 "
12 "	½ "	67 "	36 "	1 "	381 "
12 "	⅝ "	82 "	36 "	1⅛ "	429 "
12 "	¾ "	99 "	36 "	1¼ "	479 "
12 "	⅞ "	117 "	48 "	1 "	512 "
14 "	½ "	74 "	48 "	1⅛ "	584 "
14 "	⅝ "	94 "	48 "	1¼ "	685 "
14 "	¾ "	113 "	48 "	1½ "	775 "

POINTS FOR BUILDERS.

BY STEEL SQUARE.

Never compete with a "botch" if you know he is favored by the person about to build. He will undercut and beat you every time.

Favor the man who employs an architect. Under an honest architect you will have less friction, make more money, be better satisfied with your work, and give greater satisfaction to the owner than in working from plans furnished by a nondescript.

In tearing down old work, be as careful as putting up new.

Old material should never be destroyed simply because it is old.

When putting away old stuff, see that it is protected from rain and the atmosphere.

It costs about fifteen per cent. extra to work up old material, and this fact should be borne in mind, as I have known several contractors who paid dearly for their "whistle" in estimating on working up second-hand material.

These remarks apply to woodwork only. In using old brick, stone, slate and other miscellaneous materials, it is as well to add double price for working up.

Workmen do not care to handle old material, and justly so. It is ruinous to tools, painful to handle, and very destructive to clothing.

In my experience I always found it pay to advance the wages of workmen — skilled mechanics — while working up old material. This encouraged the men and spurred them to better efforts.

Sash frames, with sash weights, locks and trim complete, may be taken out of old buildings that are being taken down and preserved just as good as new by screwing slats and braces on them, which not only keep the frame square, but prevent the glass from being broken.

Doors, frames and trims may also be kept in good order until used, by taking the same precautions as in window frames.

Old scantlings and joists should have all nails drawn or hammered in before piling away.

Counters, shelving, draws and other store-fittings should be kindly dealt with. They will all be called for sooner or later.

Take care of the locks, hinges, bolts, keys, and other hardware. Each individual piece represents money in a greater or less sum.

Old flooring can seldom be utilized, though I have seen it used for temporary purposes, such as fencing, covering of veranda floors, while finishing work on plastering, etc. As a rule, however, it does not pay to take it up carefully and preserve it.

Conductor pipes, metallic cornices, and sheet metal work generally can seldom be made available a second time, though all is worth caring for, as some parties may use it in repairs.

Sinks, wash-basins, bath-tubs, traps, heating appliances, grates, mantels and hearth-stones should be moved with care. They are always worth money and may be used in many places as substitutes for more inferior fixings.

Marble mantels require the most careful handling.

Perhaps the most difficult fixtures about a house to adapt a second time are the stairs. Yet, I have known where a shrewd contractor has so managed to put up new buildings that the old stairs taken from another building just suited. This may have been a "favorable accident," but the initiated reader will understand him. Seldom such accidents can occur.

Rails, balusters and newels may be utilized much readier than stairs, as the rail may be lengthened or shortened to suit variable conditions.

Gas fixtures should be cared for and stowed away in some dry place. They can often be made available, and are easily renovated if soiled or tarnished.

It is not wise to employ men to take down buildings who who have no other qualities to recommend them than their strength. As a rule they are like bears—have more strength than knowledge, and the lack of the latter is often an expensive desideratum. Employ for taking down the work good, careful mechanics, and do not have the work "rushed through." Rushers of this sort are expensive.

Never send old material to a mill to be sawed or planed. No matter how carefully nails, pebbles and sand have been hunted for, the saw or planer knives will most assuredly find some you overlooked; then there will be trouble at the mill.

Have some mercy for the workman's tools. If it can be avoided, do not work up old stuff into fine work. If not avoidable, pay the workman something extra because of injury to tools.

Don't grumble if you do not get as good results from the use of old material as from new. The workman has much to contend with while working up old, nail-speckled, sand-covered material.

RULES FOR ESTIMATING COST OF PLASTERING AND STUCCO WORK.

PLASTERING.

Plastering is always measured by the square yard for all plain work, and by the foot superficial for all cornices of plain members, and by foot lineal for enriched or carved moldings in cornices.

By plain work is meant straight surfaces (like ordinary walls and ceilings), without regard to the style or quantity of finish put upon the job. Any paneled work, whether on walls or ceilings, run with a mold, would be rated by the foot superficial.

Different methods of valuing plastering find favor in different portions of the country. The following general rules are believed to be equitable and just to all parties:

Rule 1.—Measure on walls and ceilings the surface actually plastered without deducting any grounds or any openings of less extent than seven superficial yards.

Rule 2.—Returns of chimney breasts, pilasters and all strips of plastering, less than 12 inches in width, measure as 12 inches wide; and where the plastering is finished down upon the wash-board, surbase or wainscoting, add 6 inches to height of wall.

Rule 3.—In closets, add one-half to the measurement; or, if shelves are put up before plastering, charge double measurement. Raking ceilings and soffits of stairs, add one-half to the measurement. Circular or elliptical work, charge two prices; domes or groined ceilings, three prices.

Rule 4.—For each 12 feet interior work is done further from the ground than the first 12 feet, add five per cent. For outside work, add one per cent. for each foot the work is done above the first 12 feet.

STUCCO WORK.

Rule 1.—All moldings, less than one foot girt, to be rated as one foot; over one foot, to be taken superficial. When work requires two molds to run same cornice, add one-fifth.

Rule 2.—For each internal angle or miter, add one foot to length of cornice; and each external angle add two feet. All small sections of cornice less than 12 inches long measure as 12 inches. For raking cornices add one-half. Circular or elliptical work, double price; domes and groins, three prices.

Rule 3.—For enrichments of all kinds, charge an agreed price.

Rule 4.—For each 12 feet above the first 12 feet from the ground, add five per cent.

CHINESE CASH.

A large number are engaged in molding, casting and finishing the "cash" used as coin all over China, Mexican dollars and Sycee silver being used in large transactions. The cash are made from an alloy of copper and zinc, nearly the same as the well-known Munn metal, and it takes about 1,000 of them to answer as change for a dollar, so minute and low do prices run in this country, of which I will only give one instance. The fare for crossing the ferry on the Peiho was only two cash, or one-fifth of a cent.

DEEP SOUNDINGS NEAR THE FRIENDLY ISLANDS.

Her Majesty's surveying ship Egeria, under the command of Captain P. Aldrich, R. N., has, during a recent sounding cruise and search for reported banks to the south of the Friendly Islands, obtained two very deep soundings of 4,295 fathoms and 4,430 fathoms, equal to five English miles respectively, the latter in latitude 24 deg. 37 min. S., longitude 175 deg. 8 min. W., the other about twelve miles to the southward. These depths are more than 1,000 fathoms greater than any before obtained in the Southern Hemisphere, and are only surpassed, as far as is yet known, in three spots in the the world—one of 4,655 fathoms off the northeast coast of Japan, found by the United States steamship Tuscarora; one of 4,475 fathoms south of the Ladrone Islands by the Challenger; and one of 4,561 north of Porto Rico, by the United States ship Blake. Captain Aldrich's soundings were obtained with a Lucas sounding machine and galvanized wire. The deeper one occupied three hours, and was obtained in a considerably confused sea, a specimen of the bottom being successfully recovered. Temperature of the bottom, 33.7 deg. Fahr.

SIZE AND WEIGHT OF FLAT-TOP CANS.

The following table gives the size of the flat top cans and the amount of material required when galvanized iron is used in their construction. The table shows the net weight per can with iron from No. 27 gauge to No. 20 gauge. No allowance is made for seams, hoops, or solder.

SIZE CANS.			WEIGHT PER CAN.															
			No. 27 G.		No. 26 G.		No. 25 G.		No. 24 G.		No. 23 G.		No. 22 G.		No. 21 G.		No. 20 G.	
No. Gal.	Diam. Inches.	Height Inches.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
1	6¾	6¾	1	6	1	7												
2	8½	8¾	2	2	2	4												
3	9	11½	2	13	3	0												
5	10½	13¾	3	13	4	2	4	6	4	14	5	7	5	15	6	9	7	6
5	11½	11½	3	13	4	2	4	6	4	14	5	7	5	15	6	9	7	6
6	11½	13½	4	3	4	8	4	12	5	6	5	15	6	9	7	2	8	1
8	13½	13½	5	4	5	10	6	0	6	12	7	8	8	9	9		10	1
10	13½	16½	6	0	6	7	6	14	7	12	8	9	9	7	10	5	11	9
15	15½	9	7	15	8	8	9	1	10	3	11	5	12	7	13	9	15	4
20	17½	19½	9	8	10	2	10	13	12	3	13	8	14	4	16	3	18	4
20	16	23	9	8	10	2	10	13	12	3	13	8	14	4	16	3	18	4
25	18	23	11	0	11	12	12	8	14	1	15	11	17	4	18	13	21	2
30	18½	26½	12	10	13	8	14	7	16	4	18	0	19	13	21	10	23	11
35	18½	30½	14	0	15	0	16	0	18	0	20	0	22	0	24	0	27	0
40	18¾	34	15	9	16	10	17	11	19	15	22	2	24	6	26	9	29	14
45	19½	35	16	10	17	13	19	0	21	6	23	12	26	2	28	8	32	1
50	20½	35	17	11	18	15	20	3	22	12	25	4	27	13	30	5	34	2
55	21¼	36	18	14	20	6	21	10	24	3	26	7	29	12	32	7	36	8
60	22	37	20	3	21	10	23	0	25	15	28	12	31	10	34	8	38	13
65	22½	38	21	3	22	9	24	3	27	4	30	5	33	6	36	5	40	14
70	23	40	22	10	24	4	25	13	29	1	32	5	35	8	38	12	43	9
75	23½	40	23	3	24	14	26	9	29	13	33	2	36	7	39	13	44	13
80	24½	40	24	7	26	3	27	15	31	7	34	15	38	6	41	15	47	3
85	25	40	25	1	26	14	28	10	32	7	35	13	39	6	43	0	48	5
90	24½	45	26	13	28	11	30	10	34	7	38	4	42	1	45	15	51	11
95	25	45	27	7	29	6	31	5	35	4	39	3	43	1	47	0	52	14
100	26	45	28	13	30	14	32	14	37	0	41	2	45	4	49	6	55	9
125	27½	50	33	8	35	15	38	5	43	2	47	14	52	11	57	7	64	10
150	29	52½	37	1	39	12	42	6	47	11	52	15	58	4	63	9	71	9
175	30	57½	41	9	44	8	47	7	53	6	59	5	65	3	71	3	80	1
200	30¾	64	46	6	49	12	53	3	59	14	66	6	73	0	79	10	89	10

Mexican coal has been successfully used for making coke at Pittsburg.

THE CHICAGO AUDITORIUM.

At a meeting of the Chicago Auditorium Association the president submitted his report, from which we take the following:

To the Stockholders of the Chicago Auditorium Association — Your great undertaking has progressed to a point when a recital of the condition of affairs, together with a brief history of the project, will be of especial interest to you.

Ground was broken and the work of tearing down buildings was begun in January, 1887. The construction has been vigorously prosecuted from that time, the only delay occurring from difficulty in procuring granite, which necessitated the association taking possession of the quarries, the result of which was satisfactory. From the date of completion of the granite work, comprising the two stories of the sub-structure, all contracts have been thus far satisfactorily and promptly carried forward, and we feel that we have been exceptionally fortunate in the selection of all the contractors, especially so of the architects, who have faced most difficult and unprecedented problems.

This enterprise, like all large projects, has been a matter ot growth and development from its inception, both in magnitude and cost, and, in the judgment of your board, it has been in every instance wise. It was originally contemplated by the projectors that a great public hall and a hotel should be built on a site not including the corner of Wabash avenue and Congress street and the north lot of the Michigan avenue frontage, which were not then obtainable. From that your building has grown to cover the entire site now occupied — 710 feet frontage, or an area of one and five-eighths acres. Strict fire-proof construction of the most approved kind was always contemplated, and it prevails throughout the entire structure; so that under no circumstances can your building sustain more than slight superficial injury from fire. The tenth story has recently been changed to make it one foot higher, and one story has been added to the plans of the tower this summer.

With the grandeur of the rising building developed the necessity of absolutely first-class treatment in details and interior finish. The hotel rooms will be finished in hardwood throughout; mosaic floors will be laid in the vestibule and lobby in the Auditorium and hotel. The grand stairway will be marble, with bronze sides. An extra elevator was recently decided upon, making twelve in all, nine passenger and three freight.

A grand organ, costing about $50,000, was contracted for, and is being built probably at a loss to the contractor, the contract for which calls for the most complete and grandest instrument ever constructed, and which your board believes will do much for musical education in this city, and add largely to the earnings of your Auditorium—more than ordinary interest on its cost.

It was also determined to adopt the most approved and modern stage, with appointments similar to one at Buda-Pesth, Hungary, for which purpose Architect Adler was sent to Europe, and Mr. Bairstow, chief stage carpenter for McVicker's theater for many years, was employed, and accompanied him abroad. This will cost much more than the ordinary stage, but will be unequaled on either continent in its effects and operating economies, and it is regarded a judicious step by your board, as it constitutes, in theatre parlance, a permanent attraction.

Then there are the devices of heavy ironwork for shutting off the galleries and part of the main balcony, lessening the cubic contents of our hall, thereby adapting it for many purposes for which otherwise it could not well be used. This has added considerably to cost of ironwork.

A few statistics respecting your structure, about which so many questions are asked, may be of interest to you. It comprises five principal features — the auditorium, with its grand organ and stage; the hotel; the business front on Wabash avenue, containing seven stories and nine floors of rooms; the little auditorium, or rehearsal hall; and the public observatory. To which might be added the *café* on the main floor on Congress street. The main building will be ten stories high, or 145 feet, the auditorium proper reaching the seventh story. The tower will be seventeen stories high, or 240 feet. The foundations under your buildings have been carefully and scientifically considered. Every square yard of the ground was first tested by heavy water-tanks, then horizontal timbers of varying lengths, one square, were laid permanently below the water-line, covering which is a heavy bed of concrete, in which from one to four layers of 67-pound steel rails are imbedded. These, if placed in line, would reach ten miles in length. Where the rails were insufficient in strength, steel I-beams were substituted for them. Upon these rails and beams the piers were constructed. The tower rests on a solid foundation, 100x67 feet, thus distributing the weight over a larger surface. The auditorium will contain 5,000 seats, including forty-two boxes. This capacity can be largely increased for conventions by utilizing the stage space. The hotel will occupy the entire Michigan avenue and Congress street fronts, and forty feet of Wabash avenue front, and will contain nearly 400 rooms. The main dining-room will be on the tenth floor of the east front, 175 feet long, overlooking the lake. There will be twelve elevators in all. The cost of the iron in the building is nearly $350,000, no portion of which will be visible. The number of bricks in the building is 15,000,000.

The number of electric lights in the auditorium proper is 4,000; in the hotel and balance of the building, 4,600; making 8,600 in all. The electric current is generated by eleven dynamos and nine engines; there will be eleven boilers, having a capacity of 1,800 horse-power; and twenty-one pumping engines to supply water for the elevators and other purposes, with a total hourly capacity of 400,000 gallons. There are two distinct heating and lighting plants for the hotel and balance of building. The tower weighs 30,000,000 pounds, or 15,000 tons. There are over twenty-five miles of gas and water pipes.

To calculate number of shingles for a roof, ascertain number of square feet and multiply by 4; if 2 inches to weather, 8 for 4½ inches, and 7 1-5 if 5 inches are exposed. The length of rafter of one-third pitch is equal to three-fifths of width of building, adding projection.

PAINTWORK.

It may be useful to know that a gallon of paint will cover from 450 to 630 superficial feet of wood. On a well-painted surface of iron the gallon will cover 720 feet. In estimating painting to old work, the first thing to do is to find out the nature of the surface, whether it is porous, rough or smooth, hard or soft. The surface of stucco, for example, will take a great deal more paint than on of wood, much depending on the circumstance whether it has been painted, and what state the surface is in. We have known prices tendered for outside painting that have been seriously wrong, owing to the want of knowing the condition of the stucco work. A correct estimate of repainting woodwork cannot be made from the quantities only; a personal examination ought to be made in every case where there is much work to be done. A great many painters trust to the quantity; the consequence is, nothing is allowed to remove old paint, or for scouring, and the stopping of cracks.

Then, there is painting and painting. It can be done well and artistically, or indifferently, and few trades allow of greater scamping. In first-class work, after the first two coats have been put on, the paint, when dry, should be rubbed down with pumice-stone before the finishing coats are put on. Inferior painting is so common that it has a demoralizing effect on painters of the day. The quality of the material, especially the white lead, has much to do with the permanency. We find painting done on old work without any cleaning, stopping or even pumicing. A slovenly and inartistic class of grainers are also met with, who repaint and regrain on work that ought to be well rubbed with pumice-stone or sand-paper before the first new coat is laid.

For painting three coats, the following materials are given for 100 superficial feet of new work: Paint, eight pounds; boiled linseed oil, three pints; spirits of turpentine, one pint; the work taking three men for one day. According to Saxton, forty-five yards of first coat, including stopping, will require five pounds of white lead, five pounds of putty, one quart of oil. The same quantity of each succeeding coat will require the same allowance of white lead and oil. The best materials will last for seven years, but the ordinary painting seldom lasts three.

THE ANNUAL RING IN TREES.

The annual rings in trees exist as such in all timber grown in the temperate zone. Their structure is so different in different groups of timber that, from their appearance alone, the quality of the timber may be judged to some extent. For this purpose the absolute width of the rings, the regularity in width from year to year and the proportion of spring wood to autumn wood must be taken into account. Spring wood is characterized by less substantial elements, the vessels of thin-walled cells being in greater abundance, while autumn wood is formed of cells with thicker walls, which appear darker in color. In conifers and deciduous trees the annual rings are very distinct, while in trees like the birch, linden and maple the distinction is not so marked, because the vessels are more evenly distributed. Sometimes the gradual change in appearance of the annual ring from spring to autumn wood, which is due to the difference in its component elements, is interrupted in such a manner that a more or less pronounced layer of autumn wood can apparently be recognized, which again gradually changes to spring or summer wood, and then gradually finishes with the regular autumn wood. This irregularity may occur even more than once in the same ring, and this has led to the notion that the annual rings are not a true indication of age; but the double or counterfeit rings can be distinguished by a practiced eye with the aid of a magnifying glass. These irregularities are due to some interruptions of the functions of the tree, caused by defoliation, extreme climatic condition or sudden changes of temperature. The breadth of the ring depends on the length of the period of vegetation; also when the soil is deep and rich, and light has much influence on the tree, the rings will be broader. The amount of light, and the consequent development of foliage, is perhaps the most powerful factor in wood formations, and it is upon the proper use of this that the forester depends for his means of regulating the development and quantity of his crop.

POINTERS FOR ARCHITECTS, BUILDERS AND WOOD-WORKERS.

A box of window-glass contains fifty feet of glass, regardless of size of sheets.

African teak-wood outlasts any other kind of wood. It is the only wood found preserved in Egyptian tombs 4,000 years old. It shrinks only "on end."

It is a common practice in France to coat the beams, the joists and the under side of the flooring of buildings with a thick coating of lime-wash as a safeguard against fire. It is a preventive of prime ignition, although it will not check a fire when once under headway.

Any beam, whether of wood or iron, is as much stronger when placed on its edge as when on its side, as the width is greater than the thickness. Thus a stick or bar of iron one inch by three inches when used as a beam is three times as strong when placed on its edge as when on its side. This is true only within limits. It would not be true of a piece of boiler-plate, on account of the flexibility.

Mortar made in the following manner will stand if used in almost all sorts of weather: One bushel of unslaked lime, three bushels of sharp sand; mix 1 lb. of alum with one pint of linseed oil, and thoroughly mix this with the mortar when making it, and use hot. The alum will counteract the action of the frost on the mortar.

A new system of building houses of steel plates is being introduced by M. Danly, manager of the Société des Forges de Chateleneau. It has been found that corrugated sheets only a millimetre in thickness are sufficiently strong for building houses several stories high, and the material used allows of architectural ornamentation. The plates used are of the finest quality, and as they are galvanized after they have been cut to the sizes and shapes required, no portion is left exposed to the action of the atmosphere. Houses so constructed are very sanitary, and the necessary ventilating and heating arrangements can readily be carried out.

Moisture-proof glue is made by dissolving 16 ounces of glue in 3 pints of skim milk. If a still stronger glue be wanted, add powdered lime.

Shellac and borax boiled in water produces a good stain for floors.

Don't inclose the sink — no place in a kitchen is so much neglected.

Porch floors should be of narrow stuff and the joints laid in white lead.

Lime-water is fire-proof protection for shingles or any light wood-work.

Common brick absorb a pint of water each, and make a very damp house.

The lowest-priced builder is not always the cheapest, as poor work will testify.

A closet finished with red cedar shelves and drawers is death to moths and insects.

Do not locate a furnace register next to a mantel — that is, if you wish to utilize the heat.

Terra-cotta flue linings are a great improvement over the old, roughly plastered chimney.

For basement flooring, oak is preferred to maple because it will stand dampness better.

To properly select the colors applicable to the proper place, consult an educated painter.

A ventilating flue from the kitchen into the chimney often does away with atmospheric meals.

Stops to doors and windows should be fastened with roundhead screws, so as to be easily moved.

It is better to oil floors than to paint them — a monthly rubbing will make them as good as new.

Do not use one chimney-flue for two stove pipes — the draft of one will counteract that of the other.

Do not finish windows to the floor — the circulation across the floor is one of the causes of cold houses.

Ash-pits in cellars under fire-places and mantels save taking up ashes, for they may be raked down through a hopper.

Do not construct solid doors of two kinds of hardwood — the action of the atmosphere on one or the other will cause the door to warp.

HINTS ON VENTILATION.

In ventilating — say, a bed-room — by means of the window, what you may principally want is an upward-blowing current. Well, there are several methods of securing this without danger of a draught.

1. Holes may be bored in the lower part of the upper sash of the window, admitting the outside air.

2. Right across one foot of the lower sash, but attached to the immovable frame of the window, may be hung or tacked a piece of strong Willesden paper — prettily painted with flowers or birds, if you please. The window may then be raised to the extent of the breadth of this paper, and the air rushes upward between the two sashes.

3. The same effect is got from simply having a board about six inches wide and the exact size of the sash's breadth. Use this to hold the window up.

4. This same board may have two bent or elbow tubes in it, opening upward and into the room, so that the air coming through does not blow directly in. The inside openings may be protected by valves, and thus the amount of incoming current can be regulated. We thus get a circulating movement of the air, as, the window being raised, there is an opening between the sashes.

5. In summer a frame half as big as the lower sash may be made of perforated zinc or wire gauze and placed in so as to keep the window up. There is no draught; and, if kept in position all night, then, as a rule, the inmate will enjoy refreshing sleep.

6. In addition to these plans, the door of every bedroom should possess, at the top thereof, a ventilating panel, the simplest of all being that formed of wire gauze.

In conclusion, let me again beg of you to value fresh air as you value life and health itself; while taking care not to sleep directly in an appreciable draught, to abjure curtains all round the bed. A curtained bed is only a stable for nightmares and an hotel for a hundred wonder-ills and ailments.

INVENTION OF THE SCREW AUGER.

The screw auger was invented by Thomas Garrett about 100 years ago. He lived near Oxford, Chester County, Pennsylvania. The single screw auger was invented by a Philadelphian, and it is said to be the only one used with any satisfaction in very hard woods where the double screw augers become clogged.

THE FORESTS OF THE UNITED STATES.

The total area of forest lands in the United States and Territories, according to the annual report of the Division of Forestry of the Department of Agriculture, is 465,795,000 acres. The State which has the largest share is Texas, which is credited with 40,000,000 acres. Minnesota comes next with 30,000,000, then Arkansas with 28,000,000; and Florida, Oregon, California and Washington Territory are put down at 20,000,000 each. Georgia and North Carolina have each 18,000,000; Wisconsin and Alabama, each 17,000,000; Tennessee, 16,000,000; Michigan, 14,000,000; and Maine, 12,000,000 acres. Taking the States in groups, the six New England States have, in round numbers, 19,000,000 acres; four Middle States, 18,000,000; nine Western States, 80,000,000; four Pacific States, 53,000,000; seven Territories, 63,000,000; and fourteen Southern States, 233,000,000 acres, or almost precisely half of the whole forest area of the country.

Reviewing the figures given by the department, the *Tradesman*, of Chattanooga, Tenn., makes the following instructive comment: "These statistics show that, while the process of denudation has been carried on to an unhealthy extreme in the Eastern, Middle and a few of the Western States, the forest area still remaining in this country is a magnificent one. If the estimates of the department are approximately correct, the timber lands of the country, exclusive of Alaska, cover an area equal to fifteen States the size of Pennsylvania. If proper measures are taken to prevent the rapid and unnecessary destruction of what is left of our forest domain, it should be equal to all requirements for an indefinite period. It is not yet a case of locking the stable after the horse is stolen, and never should be allowed to become so. With the adoption the policy of judicious tree planting in the prairie States, and a system of State or government reservations in the mountainous districts, which are the sources of the chief rivers of the country, the evil effects which have followed forest denudation in Europe and some portions of Asia would never exist here."

TO FIND THE WEIGHT OF GRINDSTONES.

.06363 times square of inches diameter, times thickness in inches = weight of grindstone in lbs.

3.1415926 = ratio of diameter to circumference of circle.

ALTITUDE ABOVE THE SEA-LEVEL OF VARIOUS PLACES IN THE UNITED STATES.

Portland, Me.	185	Knoxville, Tenn	1,000
Concord, N. H	375	Louisville, Ky	449
Cleveland, O	645	Cincinnati, O	480
Detroit, Mich	595	Upper portion of city	588
Mt. Washington	6,293	San Francisco, Cal	130
Ann Arbor, Mich	890	Indianapolis, Ind	700
Boston, Mass	82	Chicago, Ill	581
Albany, N. Y	75	Milwaukee, Wis	590
New York, N. Y	60	St. Anthony Falls, Minn	822
Buffalo, N. Y	580	Dubuque, Ia	1,400
Philadelphia, Penn	60	St. Louis, Mo	480
Pittsburg, Penn	935	Omaha, Neb	1,300
Baltimore, Md.	275	Lawrence, Kan	803
Washington, D. C	92	Fort Phil Kearney, Wy	6,000
Charleston, S. C	27	Yankton, Dak	1,900
Vicksburg, Miss	352	Fort Garland, Colo	8,365
New Orleans, La.	10	Salt Lake City, Utah	4,322
El Paso, Texas	3,831	Sacramento, Cal	22

TABLE OF PRINCIPAL ALLOYS.

A combination of zinc and copper makes bell metal.
A combination of copper and tin makes bronze metal.
A combination of antimony, tin, copper and bismuth, makes britannia metal.
A combination of copper and tin makes cannon metal.
A combination of copper and zinc makes Dutch gold.
A combination of copper, nickel and zinc, with sometimes a little iron and tin, makes German silver.
A combination of gold and copper makes standard gold.
A combination of gold, copper and silver, makes old standard gold.
A combination of tin and copper makes gun metal.
A combination of copper and zinc makes mosaic gold.
A combination of tin and lead makes pewter.
A combination of lead and a little arsenic, makes sheet metal.
A combination of silver and copper makes standard silver.
A combination of tin and lead makes solder.
A combination of lead and antimony makes type metal.
A combination of copper and arsenic makes white copper.

HOW TO POLISH ZINC.

We have been successful in polishing zinc with the following solution: To 2 quarts of rainwater add 3 oz. powdered rotten stone, 2 oz. pumice stone, and 4 oz. oxalic acid. Mix thoroughly, and let it stand a day or two before using. Stir or shake it up when using, and, after using, polish the zinc with a dry woolen cloth or chamois skin. The more thoroughly the zinc is rubbed the longer it will stay bright.

HOW TO MAKE A GOOD FLOOR.

Nothing attracts the attention of a person wishing to rent or purchase a dwelling, store or office, so quickly as a handsome, well-laid floor, and a few suggestions on the subject, though not new, may not be out of place.

The best floor for the least money can be made of yellow pine, if the material is carefully selected and properly laid.

First, select edge-grain yellow pine, not too "fat," clear of pitch, knots, sap and splits. See that it is thoroughly seasoned, and that the tongues and grooves exactly match, so that, when laid, the upper surfaces of each board are on a level. This is an important feature often overlooked, and planing-mill operatives frequently get careless in adjusting the tonguing and grooving bits. If the edge of a flooring board, especially the grooved edge, is higher than the edge of the next board, no amount of mechanical ingenuity can make a neat floor of them. The upper part of the groove will continue to curl upward as long as the floor lasts.

Supposing, of course, the sleepers, or joists, are properly placed the right distance apart, and their upper edges precisely on a level, and securely braced, the most important part of the job is to "lay" the flooring correctly. This part of the work is never, or very rarely ever, done nowadays. The system in vogue with carpenters of this day, of laying one board at a time, and "blind nailing," is the most glaring fraud practiced in any trade. They drive the tongue of the board into the groove of the preceding one, by pounding on the grooved edge with a naked hammer, making indentations that let in the cold air or noxious gases, if it is a bottom floor, and then nail it in place by driving a six-penny nail at an angle of about 50° in the groove. An awkward blow or two chips off the upper part of the groove, and the last blow, designed to sink the nail-head out of the way of the next tongue, splits the lower part of the groove to splinters, leaving an unsightly opening. Such nailing does not fasten the flooring to the sleepers, and the slanting nails very often wedge the board up so that it does not bear on the sleeper. We would rather have our flooring in the tree standing in the woods than put down that way.

The proper plan is to begin on one side of the room, lay one course of boards with the tongue next to, and neatly fitted to, the wall (or studding, if a frame house), and be sure the boards are laid perfectly straight from end to end of the room and square with the wall. Then nail this course firmly to the sleepers, through and through, one nail near each edge of the board on every sleeper, and you are ready to begin to lay a floor. Next, fit the ends and lay down four or six courses of boards (owing to their width). If the boards differ widely in color, as is often the case in pine, do not lay two of a widely different color side by side, but arrange them so that the deep colors will tone off into the lighter ones gradually. Push the tongues into the grooves as close as possible, without pounding with a hammer, or, if pounding is necessary, take a narrow, short piece of flooring, put the tongue in the groove of the outer board, and pound gently on the piece, never on the flooring board. Next, adjust your clamps on every third sleeper and at every end joint, and drive the floor firmly together by means of wedges. Drive the wedges gently at the start, and each one equally till the joints all fill up snugly, and then stop, for, if driven too tight, the floor will spring up. Never wedge directly against the edge of the flooring board, but have a short strip with a tongue on it between the wedge and the board, so as to leave no bruises. Then fasten the floor to the sleepers by driving a flat-headed steel wire nail of suitable size, one inch from either edge of every board, straight down into each sleeper. At the end-joints smaller nails may be used, two nails in board near the edges, and as far from the ends as the thickness of the sleeper will permit. Proceed in this manner until the floor is completed, and you will have a floor that will remain tight and look well until worn out.

Such minute directions, for so common and simple a job, sound silly, but are justifiable from the fact that there are so many alleged carpenters who either do not know how or are too lazy to lay a floor properly.

GLUE FOR DAMP PLACES.

For a strong glue, which will hold in a damp place, the following recipe works well: Take of the best and strongest glue enough to make a pint when melted. Soak this until soft. Pour off the water, as in ordinary glue-making, and add a little water if the glue is likely to be too thick. When melted, add three table-spoonfuls of boiled linseed oil. Stir frequently, and keep up the heat till the oil disappears, which may take the whole day, and perhaps more. If necessary, add water to make up for that lost by evaporation. When no more oil is seen, a tablespoonful of whiting is added and thoroughly incorporated with the glue.

MORTAR MAKING.

Much depends on having mortar made on correct, if not scientific, principles. The durability, if not the actual safety, of a building is more or less affected by the kind of mortar that is put into it. We have seen brick buildings, and not very old ones either, from which the dry and hardened mortar could easily be picked in cakes from between the bricks. The advantage of using such mortar is, that, when the building tumbles down, there will be no trouble in picking from it the old bricks, preparatory to rebuilding. A brick wall, if put up with the right kind of mortar, will be solid and almost homogeneous, as likely to break through the middle of the bricks as at the joints. Such a building will never tumble down, except under great strain, and will withstand a pretty severe earthquake shock.

An old builder, of nearly forty years' experience in making mortar, writing upon the subject to a contemporary, very justly says: "The mere matter of slacking lime does not make mortar out of it. Lime and water alone will not make any better mortar than sand and water." He suggests the use of plenty of water in slacking the lime, so that, when it is run out of the box into the bed, it will not bake or burn, as it is liable to do, if not well watered. The mortar bed should be large and tight, so there will be no leakage of the lime water. The proportion should be about fifty yards of good sand to twenty-five barrels of lime, for the first mixing, which should be thoroughly done. The hair should be put into the lime before mixing in the sand. After the mortar has been mixed in the above proportions for ten days or more, if the amount of materials given have been used, twenty-five to fifty loads of sand may be added and worked in. It is said that the water that rises on a bushel of slaked lime, and where plenty of water has been used, if removed and put on a sharp sand, will make better stone than lime and sand mixed, showing that the water should be retained in the sand and lime while it is fresh, and that the mortar should be tempered in its own liquor. Of course, where smaller quantities are used, the proportion should be retained, both at the first mixing and in the sand added subsequently.

A pound of ten-penny cut nails will do as much work as two pounds of wire nails. Taking the average of all cut nails, they are worth nearly double as much as wire nails, from tests made at the Watertown Government Arsenal.

COST OF EXCAVATING AND HANDLING ROCK.

The average weight of a cubic yard of sandstone or conglomerate, in place, is given as 1.8 tons, and of compact granite, gneiss, limestone or marble, 2 tons, or an average of 1.9 tons, or 4,256 pounds. A cubic yard, when broken up ready for removal, increases about four-fifths in bulk, and $\frac{1}{14}$ of a cubic yard, 177 pounds, is a wheelbarrow load. Experience shows that, with wages at $1 per day of 10 hours, 45 cents per cubic yard is a sufficient allowance for loosening hard rock. Soft shales and allied rocks may be loosened by pick and plow at a cost of 20 cents to 30 cents per cubic yard. The quarrying of ordinary hard rock requires from ¼ pound to ⅓ pound and sometimes ½ pound of powder per cubic yard. Drilling with a churn driller costs from 12 to 18 cents per foot of hole bored. Upon these data, Mr. Rigly estimates the total cost, per cubic yard of rock in place, for loosening and removing by wheelbarrow (labor assumed at $1 per day of 10 hours), as follows: When distance removed is 25 feet, total cost=$0.537; when 50 feet, $0.549; when 100 feet, $0.573; when 200 feet, $0.622; when 500 feet, $0.768; when 1,000 feet, $1.011; and when 1,800 feet, $1.401. This is exclusive of contractor's profit.

When labor is $1.25 per day, add 25 per cent. to the cost prices given; when $1.50 per day, add 50 per cent. and so on. In hauling by cart, the cost of loading, which will be about 8 cents per cubic yard of rock in place, and the additional expense of maintaining the road must be added. Allowing, then, 851 pounds as a cart-load, the total cost per cubic yard is estimated, when removed 25 feet, at $0.596; when 50 feet, $0.599; when 100 feet, $0.605; when 200 feet, $0.617; when 500 feet, $0.655; when 1,000 feet, $0.717; and when 1,800 feet, $0.94.

IRON BRICK.

It is reported that the German Government testing laboratory for building materials has reported favorably on a new paving-block called iron brick. This brick is made by mixing equal parts of finely-ground clay, and adding 5 per cent. of iron ore. This mixture is moistened with a solution of 25 per cent. sulphate of iron, to which fine iron ore is added until it shows a consistency of 38 degrees Baume. It is then formed in a press, dried, dipped once more in a nearly concentrated solution of sulphate of iron and finely ground iron ore, and is baked in an oven for 48 hours in an oxidizing flame, and 24 hours in a reducing flame.

DRY ROT IN TIMBER.

No wood which is liable to damp, or has at any time absorbed moisture, and is in contact with stagnant air, so that the moisture cannot evaporate, can be considered safe from the attack of dry rot.

Any impervious substance applied to wood, which is not thoroughly dry, tends to engender decay; floors covered with kamptulicon and laid over brick arching before the latter was dry; cement dado to wood partition, the water expelled from dado in setting, and absorbed by the wood, had no means of evaporation.

Woodwork coated with paint or tar before thoroughly dry and well seasoned, is liable to decay, as the moisture is imprisoned.

Skirtings and wall paneling very subject to dry rot, and especially window backs, for the space between woodwork and the wall is occupied by stagnant air; the former absorbs moisture from the wall (especially if it has been fixed before the wall was dry after building), and the paint or varnish prevents the moisture from evaporating into the room. Skirting, etc., thus form excellent channels for the spread of the fungus.

Plaster seems to be sufficiently porous to allow the evaporation of water through it; hence, probably, the space between ceiling and floor is not so frequently attacked, if also the floor boards do not fit very accurately and no oil cloth covers the floor.

Plowed and tongue floors are disadvantageous in certain circumstances, as when placed over a space occupied by damp air, as they allow no air to pass between the boards, and so dry them.

Beams may appear sound externally and be rotten within, for the outside, being in contact with the air, becomes dryer than the interior. It is well, therefore, to saw and reverse all large scantling.

The ends of all timber, and especially of large beams, should be free (for it is through the ends that moisture chiefly evaporates). They should on no account be imbedded in mortar.

Inferior and ill-seasoned timber is evidently to be avoided.

Whatever insures dampness and lack of evaporation is conducive to dry-rot, that is to say, dampness arising from the soil; dampness arising from walls, especially if the damp-proof course has been omitted; dampness arising from use of salt sand ; dampness arising from drying of mortar and cement.

Stagnation of air resulting from air grids getting blocked with dirt or being purposely blocked through ignorance. Stagnation may exist under a floor although there are grids in the opposite walls, for it is difficult to induce the air to move in a horizontal direction without some special means of suction. Corners of stagnant air are to be guarded against.

Darkness assists the development of fungus; whatever increases the temperature of the wood and stagnant air (within limits) also assists.

PAINTING FLOORS.

Colors containing white lead are injurious to wood floors, rendering them softer, and more liable to be worn away. Paints containing mineral colors only, without white lead, such as yellow ochre, sienna or venetian or Indian red, have no such tendency to act upon the floor, and may be used with safety. This quite agrees with the practice common in this country, of painting floors with yellow ochre or raw umber or sienna. Although these colors have little body, compared with the white-lead paint, and need several coats, they form an excellent and very durable covering for the floor. Where a floor is to be varnished, it is found that varnish made by drying lead salts is nearly as injurious as lead paint. Instead of this, the borate of manganese should be used to dispose the varnish to dry, and a recipe for a good floor varnish is given. According to this, two pounds of pure white borate of manganese, pounded very fine, are to be added, little by little, to a saucepan containing ten pounds of linseed oil, which is to be well stirred, and gradually raised to a temperature of three hundred and sixty degrees Fahrenheit. Meanwhile, heat one hundred pounds linseed oil in a boiler until bubbles form; then add to it slowly the first liquid, increase the fire, and allow the whole to cook for twenty minutes, and finally remove from the fire, and filter while warm through cotton cloth The varnish is then ready, and can be used immediately. Two coats should be used, and a more brilliant surface may be obtained by a final coat of shellac.

The railroads consume half of the coal used in this country.

COLD WATER SUPPLY PIPES.

The following matter, in catechetical form, illustrates the teachings of the New York Trades Schools in this connection:

1.—What size should the pipe from the street main to the house be?

A.—The supply pipes of New York average about 1¼ to 1½ inches in diameter.

2.—What material is used for this pipe in New York?

A.—Mostly lead pipes.

3.—What other materials, besides lead, are used for supply pipes?

A.—Galvanized iron, brass, and tin-lined lead pipes.

4.—How is iron used?

A.—Plain, galvanized, and lined with tin or glass.

5.—What are the advantages and disadvantages of lead pipes?

A.—Advantages are its ductility, strength, and easiness of working, also its durability. Disadvantages are danger of poisoning the water, and of being eaten by rats.

6.—What are the advantages and disadvantages of plain iron pipe?

A.—Advantages are cheapness, easiness of putting together, and freedom from poisoning. Disadvantages are rusting, and filling up of pipes.

7.—What are the advantages and disadvantages of tin-lined pipes?

A.—Advantage is in its freedom from poisoning water. Disadvantage in not being durable for hot-water pipes.

8.—What are the advantages and disadvantages of glass-lined pipe?

A.—Glass-lined pipe makes an excellent water pipe, but is liable to break in working and putting up.

9.—What are the advantages and disadvantages of galvanized iron pipe?

A.—Galvanized iron pipe is cheap and free from rust, but some water decomposes zinc, and its salts are poisonous.

10.—What are the advantages and disadvantages of brass pipe?

A.—When brass pipe is lined with tin it is very light and strong; but, when the tin wears off, there is danger of poisoning the water.

11.—What are the advantages and disadvantages of block-tin pipe?

A.—They are not durable for hot water, and are very expensive.

12.—What are the advantages and disadvantages of tin-lined lead pipe ?

A.—They are not durable.

13.—In using tin-lined lead pipe, what must be guarded against?

A.—The lining must not be disturbed or the tin melted out.

14.—How should the supply pipe be connected with street mains?

A.—By a brass tap and coupling.

15.—How should a lead pipe be joined to an iron pipe?

A.—By a brass spud or soldering nipple.

16.—Should the supply pipe be so arranged that it can be emptied? and why?

A.—Yes. To prevent freezing, and the water from stagnating in the pipe.

17.—What precaution can be taken against freezing if the main is within three feet of surface?

A.—By bending the pipe a few feet lower at the main, and continuing the pipe at the lower level.

18.—In crossing an area with a supply pipe, what precaution should be taken?

A.—Cover the pipe with felt, or put it in a box filled with saw-dust, to prevent freezing?

19.—What is gained by putting a supply pipe from street main to house in a larger iron pipe?

A.—The air in a larger iron pipe protects the supply, and steam can be injected to thaw pipe if it freezes.

20.—How can water supply be increased after service pipe enters house?

A.—The flow of water can be greatly assisted by using a larger pipe after entering the house.

21.—Is there any way to arrange a pipe so that drawing water from a lower floor will not stop or retard the flow from upper floors ?

A.—The best way would be to proportion branches on different floors according to pressure ; the smaller the pressure the larger the outlet.

22.—Suppose a three-story house had a ⅝ tap from main to house, and connected from this tap to top of boiler with a 1¼ inch pipe ; what size should the branch pipes to basement fixtures be ?

A.—One-half to five-eighths should be large enough.

23.—The parlor floor contains a pantry sink, a wash-basin and a water-closet; how large should the supply pipe from basement to parlor floor be?

A.—About 1 inch in diameter.

24.—How large the branch pipes to fixtures?

A.– ½ to ⅝ in diameter.

25.—The second floor contains a bath, two water-closets and five wash-basins; how large should the pipe from parlor to second floor be?

A.—About 1 inch in diameter.

26.—How large should the pipe from basement to tank be?

A.—About 1¼ inch in diameter.

27.—In a building of six or more stories in height with cold water supply drawn from tank on upper floors, does any difficulty occur?

A.—Yes. On the lower floors the pressure is too great.

28.—How can it be remedied?

A.—By diminishing branch pipes to give a proportional supply.

29.—Can supply pipe be so arranged that water can be drawn from the main or from tank?

A.—Yes. By using a special stop-cock for the purpose.

30.—What precautions should be taken to prevent pipes freezing?

A.—By placing as far from frost as possible, and by proper boxing and felting.

31.—Why are pipes liable to burst when they freeze?

A.—The expansion expands the pipes, and, consequently, they burst.

32.—What is the expanding pressure of freezing water?

A.—Thirty thousand pounds to the square inch.

33.—What means are taken to thaw out a service-pipe?

A.—The application of heat externally or steam and hot water internally is about the best means.

34.—Is the external application of heat objectionable with iron pipes?

A.—Yes; as the sudden contraction is as dangerous as the expansion.

35.—In carrying supply pipes across a floor, what precaution can be taken to protect ceiling below from a leak?

A.—By putting pipes in a box lined with lead, and having a waste, or tell-tale, pipe at lowest point.

36.—Does fresh mortar injure lead pipes?

A.—As the lime in fresh mortar is corrosive and forms a soluble compound, it is an injury to lead pipes.

PRESSURES ON TANKS.

Q.—In a full cubical tank, what is the pressure on any vertical side ?

A.—One-half the weight of the contents.

Q.—In a full conical vessel standing on its base, what is the pressure on the base ?

A.—Three times the weight of the contents.

Q.—In a hollow sphere, full of liquid, what is the pressure on the surface of the lower half ?

A.—Three times the weight of contents.

TINNING BY SIMPLE IMMERSION.

Argentine is a name given to tin precipitated by galvanic action from its solution. This material is usually obtained by immersing plates of zinc in a solution of tin, containing 6 grammes (about 90 grains) of the metal to the litre (0.88). In this way tin scrap can be utilized. To apply the argentine according to M. P. Marino's process, a bath is prepared from argentine and acid tartrate of potash, rendered soluble by boric acid. Pyrophosphate of soda, chloride of ammonium, or caustic soda may be substituted for the acid tartrate. The bath being prepared, the objects to be coated are plunged therein, first having been suitably pickled and scoured, and they may be subjected to the action of an electric current. But a simple immersion is enough. The bath for this must be brought to ebullition, and the objects of copper or brass, or coated therewith, may be immersed in it.

HOW TO FIND THE AMOUNT OF STEAM-PIPE REQUIRED TO HEAT A BUILDING WITH STEAM.

Rule for finding the superficial feet of steam-pipe required to heat any building with steam : One superficial foot of steam-pipe to six superficial feet of glass in the windows, or one superficial foot of steam-pipe for every hundred square feet of wall, roof or ceiling, or one square foot of steam-pipe to eighty cubic feet of space. One cubic foot of boiler is required for every fifteen hundred cubic feet of space to be warmed. One horse-power boiler is sufficient for forty thousand cubic feet of space Five cubic feet of steam, at seventy-five pounds pressure to the square inch, weighs one pound avoirdupois.

SEASONING TIMBER.

Timber, when freshly cut, contains from thirty-seven to forty-eight per cent. of water, the kind, the age, and the season of vegetation governing the percentage. Older wood is generally heavier than young wood, and the weight of wood cut in the active season is greater than that of wood cut in the dormant season. Water in wood is not chemically combined with the fiber, and, when exposed to the atmosphere, the moisture evaporates. The wood becomes lighter until a certain point is reached in the drying-out process, after which it gains or loses in the weight according to the variations in the moisture and temperature of the atmosphere. Following is a table showing the percentage in weight of water in round woods from young trees at different lengths of time after cutting:

Kind of Wood.	6 mos.	12 mos.	18 mos.	24 mos.
Beech	30.44	23.46	18.60	19.95
Oak	32.71	26.74	23.25	20.28
Hornbeam	27.19	23.08	20.60	18.59
Birch	39.72	29.01	22.73	19.52
Poplar	40.45	26.22	17.77	17.92
Fir	33.78	16.87	15.21	18.00
Pine	41.70	18.67	15.63	17.42

According to these figures, taken from actual trials, there is nothing gained by keeping wood longer than eighteen months, so far as drying or seasoning is concerned. In the woods mentioned, there appears to be an actual loss in some, and only a slow gain in others after that length of time. The pine, fir, and beech gained moisture, and the others in the list lost only very slightly after the eighteen months had passed.

PROPOSED GREAT ENGINEERING FEAT.

A gigantic scheme has been proposed, by which the cañons of the Rocky Mountains are to be dammed up from the Canadian boundary to Mexico, in order to form vast reservoirs of water to be used in the irrigation of arid lands, and so prevent floods in the lower Mississippi. Major Powell, director of the national survey, estimates that at least 150,000 square miles of land might thus be reclaimed — a territory exceeding in extent one-half of the land now cultivated in the United States. The plan is to build dams across all the cañons in the mountains large enough and strong enough to hold back the floods from heavy rains and melting snows, and then let the water down as it may be needed upon the land to be reclaimed.

ON THE USE OF GLUE.

In order to use glue successfully, says a writer of experience, a great deal of experience is required, and it is useless for the amateur to try it; he will only spoil the work. So, unless the workman is well experienced in the treatment and the application of the glue, he had better leave it alone entirely. To render the operation successful, two considerations must be taken into account: First, to do good gluing requires that the timber be well seasoned and thoroughly dry, taking care that the joints to be glued are well fitted. Second, in preparing the parts to be glued, each piece should be scratched with a sharp file or piece of a fine saw, to make the glue hold better. The shop should be kept at a proper temperature, and the material heated so that the glue may flow quite freely. Having the glue properly prepared, spread it evenly upon the parts so as to fill up the pores and grain of the wood, then put the pieces together as rapidly as possible, using clamps and thumb-screws to draw the joints tightly together; all superfluous glue should be washed off, taking great care not to use too much water, or allowing any to remain on the pieces put together. The greatest cause of bad gluing is in using inferior glue and in laying it on unevenly. Before using a new brand of glue it is safer to test it by gluing a piece of whitewood and ash together, clamping it with a thumb-screw, and, when dry, insert a chisel where it is put together, and, if the joint separates where it is glued, it is not fit to use, and should be rejected at once. The wood should split or give way rather than the substance promoting adhesion. This is a practical and severe test, but it will pay to apply it, in the stability of the work.

GLUE PAINT FOR KITCHEN FLOOR.

For a kitchen floor, especially one that is rough and uneven, the following glue paint is recommended: To three pounds of spruce yellow add one pound, or two pounds if desired, of dry white lead, and mix well together. Dissolve two ounces of glue in one quart of water, stirring often until smooth and nearly boiling. Thicken the glue water after the manner of mush, until it will spread smoothly upon the floor. Use a common paint brush and apply hot. This will fill all crevices of a rough floor. It will dry soon, and when dry apply boiled linseed oil with a clean brush. In a few hours it will be found dry enough to use by laying papers or mats to step on for a few days. When it needs cleaning, use hot suds.

EFFECT OF THE ATMOSPHERE ON BRICKS.

Atmospheric influence upon bricks, tiles and other building materials obtained by the burning of plastic clays, depends very much on the chemical composition of the clays and on the degree of burning. Thus, any distinct portions of limestone present in them would be converted into quicklime in the kiln, and, when the bricks were thoroughly wetted, would expand in such a manner as to disintegrate the mass. If the clay used is too poor — that is to say, if it contains an excess of sand — the bricks will not become sufficiently fused, and, upon exposure to the weather, their constituent parts will separate. It is to be observed that in bricks, as in stones, decomposition does not take place with the greatest rapidity where constant moisture exists, but rather where, from the absence of capillarity, variable according to the moisture furnished by the atmosphere, either directly or indirectly, a series of alternations of dryness and humidity prevail.

The foundation walls of buildings do not in fact suffer so much in the parts immediately upon the ground as they do in those at a height of from one to three feet, according to the permeability of the materials employed. When bricks made of clay containing free silica are laid in mortar, and moisture can pass freely from either one or the other, it may be observed that the edges in contact become harder than the body of the bricks. No doubt this arises from the formation of a silicate of lime and alumina, the lime being furnished by the passage of the water through the bed of the mortar.

THE GREAT EIFFEL TOWER.

One of the principal features of interest at the Paris Exposition is the Eiffel tower. It is constructed of iron, and rises to a height of 984 feet. As the greatest height yet reached in any structure is that of the Washington monument, 550 feet, some idea can be formed of the great distance upward that this tower will go. This tower weighs 7,000 tons, and cost 4,500,000 francs. One object of its construction is to light the Exposition grounds. The tower will be supplied with elevators, which will land passengers 971 feet from the earth. There is talk of supplying it with electric lights of 19,000,000 candle power. Four such towers, with a capacity of 50,000,000 each, it is thought, would light the whole city of Paris. Perhaps this tower will decide the question whether or not it is possible to light an entire city from a few points, if not from one.

ROT IN TIMBER.

The principal cause of the lack of proper durability of timber in buildings is the porosity of the lumber used and the consequent liability to absorb moisture. Coarse-grained woods of quick growth are more liable to this defect than those of tough fiber and slow growth. When timber becomes repeatedly wet and dry, it becomes brittle and weakened, or "its nature is gone," as the workmen say. Rot is of two kinds, wet and dry, and moisture is the essential element in both cases, the only difference being that in the first the moisture is quickly evaporated by exposure to the air, and in the latter, when there is no exposure, it produces a species of fungus and minute worms which eat in between the fibers, and gradually produce disintegration. Sap wood is more perishable than heart wood, for the former contains more of the saccharine principle, and renders the wood liable to a fermentive action.

The prevalent practice of confining unseasoned timber by building it close into walls, thus preventing the ready evaporation of whatever moisture happens to get to it, is a bad one. The ends of the wood, especially, should be surrounded by an open-air space, however small, as it is the ends where the dampness is most liable to penetrate into the structure of the wood. It is a well-known fact that a log of green timber, when kept immersed, will become water-logged and sink, and, of course, become unfit for use afterward. The same process, only slower, applies when it is exposed to damp with no facilities for rapid evaporation. Quicklime, when assisted by moisture, is a powerful aid in hastening decomposition, in consequence of its affinity for carbon. Mild lime has not this effect, but mortar, as used in buildings, requires a considerable length of time to become inert in its action as a corroding agent; therefore bedding timber in damp mortar is very injurious, and often the cause of unaccountable decay. Wood, in a dry state, does not seem to be injured by contact with dry lime, it being rather a preservative. An example of this is shown in lathing covered with plaster, which often retains its original strength when surrounding timbers are completely rotted away.

Anything that will hinder the absorbing process will extend the life of a wood, such as a coating of tar, paint, or a charring of the surface. The latter method will prove the most effective, if sufficiently deep, as the charred coating is practically indestructible, closes the pores of the wood, and will prevent the bursting into flame in case of a fire. If all joists, girders and inside beams of every kind were treated to a superficial charring process, it would tend, in conjunction with fire-proof paint applied to outside finishing work, to make a building as nearly fire-proof as wood in any condition will allow.

NUMBER OF BRICKS REQUIRED TO CONSTRUCT A BUILDING.

Superficial feet of **Wall.**	Number of Bricks to Thickness of					
	4 Inch	8 Inch	12 Inch	16 Inch	20 Inch	24 Inch
1.......	7	15	22	29	37	45
2.......	15	30	45	60	75	90
3.......	23	45	68	90	113	135
4.......	30	60	90	120	150	180
5.......	38	75	113	150	188	225
6.......	45	90	135	180	225	270
7.......	53	105	158	210	263	315
8.......	60	120	180	240	300	360
9.......	68	135	203	270	338	405
10.......	75	150	225	300	375	450
20.......	150	300	450	600	750	900
30.......	225	450	675	900	1,125	1,350
40.......	300	600	900	1,200	1,500	1,800
50.......	375	750	1,125	1,500	1,875	2,250
60.......	450	900	1,350	1,800	2,250	2,700
70.......	525	1,050	1,575	2,100	2,625	3,150
80.......	600	1,200	1,800	2,400	3,000	3,600
90.......	675	1,350	2,025	2,700	3,375	4,050
100.......	750	1,500	2,250	3,000	3,750	4,500
200.......	1,500	3,000	4,500	6,000	7,500	9,000
300.......	2,250	4,500	6,750	9,000	11,250	13,500
400.......	3,000	6,000	9,000	12,000	15,000	18,000

Sycamore is being introduced quite extensively for interior finish. When properly selected it makes a very handsome finish. Care should be taken in securing it, as it is nearly as bad to warp as elm. It should be well backed with pine, spruce or hemlock.

A door of the right construction to resist fire should be made of good pine, and should be of two or more thicknesses of matched boards nailed across each other, either at right angles or at forty-five degrees. If the doorway be more than seven feet by four feet, it would be better to use three thicknesses of same stuff; in other words, the door should be of a thickness proportioned to its area. Such a door should always be made to shut into a rabbet, or flush with the wall when practicable; or, if it is a slide door, then it should be made to shut into or behind a jamb, which would press it up against the wall. Both sides of the door and its jambs, if of wood, should then be sheathed with tin, the plates being locked at joints, and securely nailed under the locking with nails at least one inch long. No air spaces should be left in a door by paneling or otherwise, as the door will resist best that has the most solid material in it. In most places it is much better to fit the door upon inclined metal sliders than upon hinges.

This kind of door may be fitted with automatic appliances, so that it will close of itself when subjected to the heat of a fire; but these appliances do not interfere with the ordinary methods of opening and shutting the door. They only constitute a safegard against negligence. The construction of shutters varies from that of doors only in the use of thinner wood.

Under this heading may be classed all the doors of iron, whether sheet, plate, cast or rolled, single, double or hollow, plain or corrugated, none of which are capable of resisting fire for any length of time; also wooden doors covered with tin on one side only, or covered with zinc, which melts at 700 degrees Fahrenheit,

The wooden door covered with tin only serves its purpose when the wood is wholly encased in tin, put on in such a way that no air, or the minimum of air, can reach the wood when it is exposed to the heat of a fire. Under these conditions, the surface of the wood is converted into charcoal; charcoal being a non-conductor of heat, itself tends to retard the further combustion of the wood. But, if air penetrates the tin casing in any measure, the charcoal first made, and then the wood itself, are both consumed, and the door is destroyed. In like manner, if a door is tinned only only on one side, as soon as the heat suffices to convert the surface of the wood under the tin and next to the fire into charcoal, the oxygen reaches it from the outside, and the door is of little more value than a thin door of iron, or plain wooden door.

DIMENSIONS OF THE MOST IMPORTANT OF THE GREAT CATHEDRALS.

	Length, feet.	Breadth, feet.	Height, feet.
St. Peter's	613	450	438
St. Paul's	500	248	404
Duomo	555	240	375
Notre Dame	416	153	298
Cologne	444	283	...
Toledo	395	178	...
Rheims	480	163	117
Rouen	469	146	465
Chartres	430	150	373
Antwerp	384	171	402
Strasbourg	525	195	465
Milan	477	186	360
Canterbury	530	154	235
York	524	261	...
Winchester	554	208	...
Durham	411	170	214
Ely	617	178	...
Salisbury	473	229	279

SUGGESTIONS FOR COLORS.

In forms, tints, and colors the ocean depths supply valuable decorative suggestions. On silverware the iridescent hues of tropical shells are skillfully reproduced, and on ceramic ware their fascinating combinations of tints and the gradations of these shells have been too much hidden away in cabinets, instead of being studied by designers for their elegant curvatures and attractive colors. The delicate and varied hues of the sea anemone, and the curves, volutes and flowing lines of the univalves and bivalves are worthy of patient study with reference to graceful and fanciful ornamentation.

REMOVAL OF OLD VARNISH.

A Mr. Myer has just patented, in Germany, a composition for removing old varnish from objects. It is obtained by mixing five parts of 36 per cent. silicate of potash, one of 40 per cent. soda lye, and one of sal ammoniac (hydrochlorate of ammonia).

DECIMAL EQUIVALENTS OF INCHES, FEET AND YARDS.

Frac. of an Inch.	Dec. of an Inch.	Dec. of a Foot.
1-16	.0625	.00521
1/8	.125	.01041
3-16	.1875	.01562
1/4	.25	.02083
5-16	.3125	.02604
3/8	.375	.03125
7-16	.4375	.03645
1/2	.5	.04166
9-16	.5625	.04688
5/8	.625	.05208
11-16	.6875	.05729
3/4	.75	.06250
13-16	.8125	.06771
7/8	.875	.07291

Ins.	Feet.	Yds.
1	.0833	.0277
2	.1666	.0555
3	.25	.0833
4	.3333	.1111
5	.4166	.1389
6	.5	.1666
7	.5833	.1944
8	.666	.2222
9	.75	.25
10	.8333	.2778
11	.9166	.3055
12	1.	.3333

DECIMAL EQUIVALENTS OF OUNCES AND POUNDS.

Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.
1/4	.015625	4	.25	8 1/2	.5313
1/2	.03125	4 1/2	.2813	9	.5625
3/4	.046875	5	.3125	10	.625
1	.0625	5 1/2	.3438	11	.6875
1 1/2	.09375	6	.375	12	.75
2	.125	6 1/2	.4063	13	.8125
2 1/2	.15625	7	.4375	14	.875
3	.1875	7 1/2	.4688	15	.9375
3 1/2	.21875	8	.5	16	1.

NOTES ON THE LAW AFFECTING ARCHITECTS.

A person following the occupation of forming plans, drawings and specifications for building purposes, representing himself as an architect, is presumed in law not only as being such, but to be learned in the profession.

If there is any obscurity in the drawings and specifications, the contractor should apply to the architect for directions, or be liable for the consequences.

There is no fixed rule as to compensation of architects in the United States law.

The architect's contract does not survive to his representative. So, if there is a contract to complete certain work for a certain sum, the representative of a deceased architect cannot recover for the part performance.

In competitions it should always be made clearly understood that the drawings, etc., are subject to approval, for otherwise the party receiving them will be liable for their value, whether used or not.

An architect has not the right to substitute another person in his stead.

If the architect fraudulently or capriciously refuses to give proper certificates when required, the builder may maintain an action for specific performance or against the architect for damages.

PRESERVATION OF WOOD BY LIME.

I have for many years been in the habit of preparing home-grown timber of the inferior sort of fir — Scotch spruce and silver — by steeping it in a tank (that is, a hole dug in clay or peat, which was fairly water-tight) in a saturated solution of lime. Its effect on the sap-wood is to so harden it and fill it with pores that it perfectly resists the attacks of the little wood-boring beetle, and makes it, in fact, equally as durable as the made wood. I had a mill which was lofted with Scotch fir prepared in this way in 1850, and it is in perfect preservation. The timber is packed as closely as it will lie in the tank, water is let in, and unslacked lime is thrown on the top and well stirred about. There is no danger that the solution will not find its way to everything in the tank. I leave the wood in the solution for two or three months, by the end of which time an inch board will be fully permeated by it. Joists and beams would, of course, take a longer time for saturation ; but, in practice, we find that the protection afforded by two or three months' steeping is sufficient, if the scantlings are cut to the sizes at which they are to be used.

A VERY DURABLE WOOD.

The interesting fact is stated that so indestructible by wear or decay is the African teak wood that vessels built of it have lasted one hundred years, to be then only broken up because of their poor sailing qualities from faulty models. The wood, in fact, is one of the most remarkable known, on account of its very great weight, hardness and durability, its weight varying from forty-two to fifty-two pounds per cubic foot. It works easily, but, on account of the large quantity of silex contained in it, the tools employed are quickly worn away. It also contains oil, which prevents spikes and other iron work, with which it comes in contact, from rusting.

HOW TO BUILD AN ICE HOUSE.

1. The ice house floor should be above the level of the ground, or, at least, should be above some neighboring area to give an outfall for a drain, put in such a way as to keep the floor clear of standing water.

2. The walls should be hollow. A four inch lining-wall, tied to the outer wall with hoop iron, and with a three-inch air space, would answer ; but it would be better, if the air space is thoroughly drained, to fill it with mineral wool, or some similar substance, to prevent the movement of the air entangled in the fibers, and thus check the transference by convection of heat from the outside of the lining wall.

3. A roof of thick plank will keep out heat far better than one of thin boards with an air space under it.

4. Shingles will be much better for roofing than slate.

5. It is best to ventilate the upper portion of the building. If no ventilation is provided, the confined air under the roof becomes intensely heated in summer ; and outlets should be provided, at the highest part, with inlets at convenient points, to keep the temperature of the air over the ice at least down to that of the exterior atmosphere.

TESTING EXTERIOR STAINS.

Since the use of stains for exterior work became so general, several stains, some good and some bad, have appeared on the market, so that a few points on estimating their comparative values may not be amiss.

The nose, and, to a less degree, the eye, are admirable allies for this work, but, unassisted, are not infallible. The following is about the simplest method of testing :

1. Search for kerosene by warming, and then noting the smell. Also, note the thinness and lack of covering power which kerosene causes. Kerosene is simply a cheapener.

2. See how fine it brushes out on a smooth shingle. There should not be the slightest grit or any perceptible grains of pigment, the presence of which will prove that the coloring was mixed dry with the vehicle, and was never ground fine.

3. Pour out some of the stain in a tumbler. If it begins to settle at once, except in the case of a chrome yellow or green, it is made as above stated, by mixing a dry paint with the vehicle, and therefore should be avoided.

A well-ground oil stain tested in this way held up a whole day, and a creosote stain a day and a half.

Of course, when debating between two stains, it is best to try them side by side. In such case the comparative color-strength may be determined by diluting equal quantities of both stains at about the same shade, with equal quantities of turpentine, and then applying the diluted colors to wood, and noting the depth of the color. One part of stain to ten parts of turpentine is a good strength.

HOW TO PREPARE CALCIMINE.

Soak one pound of white glue over night; then dissolve it in boiling water, and add twenty pounds of Paris white, diluting with water until the mixture is of the consistency of rich milk. To this any tint can be given that is desired.

Lilac — Add to the calcimine two parts of Prussian blue and one of vermilion, stirring thoroughly, and taking care to avoid too high a color.

Gray — Raw umber, with a trifling amount of lamp-black.

Rose — Three parts of vermilion and one of red lead, added in very small quantities until a delicate shade is produced.

Lavender — Mix a light blue, and tint it slightly with vermilion.

Straw — Chrome yellow, with a touch of Spanish brown.

Buff — Two parts spruce, or Indian yellow, and one part burnt sienna.

HOW BASSWOOD MOLDINGS ARE MADE.

Basswood may be enormously compressed, after which it may be steamed and expanded to its original volume. Advantage has been taken of this principle in the manufacture of certain kinds of moldings. The portions of the wood to be left in relief are first compressed or pushed down by suitable dies below the general level of the board, then the board is planed down to a level surface, and afterward steamed. The compressed portions of the board are expanded by the steam, so that they stand out in relief.

BUILDING BLOCKS MADE OF CORNCOBS.

Building blocks made of corncobs form the object of a new Italian patent. The cobs are pressed by machinery into forms similar to bricks, and held together by wire. They are made water-tight by soaking with tar. These molds are very hard and strong. Their weight is less than one-third of that of hollow brick, and they can never get damp.

REDWOOD FINISH.

The following formula and directions have been highly recommended.

Take one quart spirits turpentine.
Add one pound corn starch.
Add ¼ " burnt sienna.
Add one tablespoonful raw linseed oil.
Add " " brown Japan.

Mix thoroughly, apply with a brush, let it stand say fifteen minutes; rub off all you can with fine shavings or a soft rag, then let it stand *at least twenty-four hours*, that it may sink into and *harden* the fibers of the wood; afterward apply two coats of white shellac, rub down well with fine flint paper, then put on from two to five coats best polishing varnish; after it is well dried, rub with water and pumice-stone ground very fine, stand a day to dry; after being washed clean with chamois, rub with water and rotten-stone; dry, wash as before clean, and rub with olive oil until dry.

Some use cork for sand-papering and polishing, but a smooth block of hard wood, like maple, is better. When treated in this way, redwood will be found the peer of any wood for real beauty and life as a house trim or finish.

A NEW WALL PLASTER.

A new material for use instead of common plaster is now prepared, which offers many advantages, as it can be applied more quickly, and dries in less than twenty-four hours. It is impervious to dampness, and there is no possibility of the window and door casings contracting or swelling and causing cracks, as very little water is required in the mixing. It is known as "Adamant" wall-plaster, and deserves its name, as, when once dry, it is very hard to break. From a sanitary point of view, it is also valuable, as it is non-absorbent.

A RELIABLE CEMENT.

A reliable cement, one that will resist the action of water and acids, especially acetic acid, is: Finely powdered litharge, fine, dry white sand and plaster of Paris—each three quarts by measure—finely pulverized resin one part. Mix and make into a paste with boiled linseed oil, to which a little dryer has been added, and let it stand for four or five hours before using. After fifteen hours' standing, it loses strength. The cement is said to have been successfully used in Zoological Gardens, London.

PAVEMENTS.

Bricks, impregnated at a warm temperature with asphaltum, have been successfully used in Berlin, for street pavement. After driving out the water with heat, bricks will take up from fifteen to thirty per centum of bitumen, and the porous, brittle material becomes durable and elastic under pressure, the bricks are then put endwise on a *beton* bed, and set with hot tar. It is said that the rough usage which the pavement made of these bricks will stand is astonishing. A few years ago, in California, a pavement was laid of bricks, those that were soft-burned being selected, which were saturated with boiling coal tar. They were placed endwise on a bed of concrete, and the interstices filled with the hot tar, sand being scattered to the depth of about one-half (½) inch upon the pavement, and afterward swept off. And now we learn from an exchange that bricks impregnated with creosote or bitumen have been adopted for paving purposes in Nashville, Tenn., and with very satisfactory results. The wear is very uniform, as the softer and more porous bricks absorb more bitumen, which has the effect of hardening them, at the same time making them absolutely impervious, and thus protecting them from the disintegrating effect of frost. It is stated that pavement of this type, exposed for three and a half (3½) years to the wear of fairly heavy traffic, was, at the end of that period, found to be in excellent condition. The process of bitumenizing, however, rather more than doubles the cost of the brick.

A POLISH FOR WOOD.

The wooden parts of tools, such as the stocks of planes and handles of chisels, are often made to have a nice appearance by French polishing; but this adds nothing to their durability. A much better plan is to let them soak in linseed oil for a week, and rub with a new cloth for a few minutes every day for a week or two. This produces a beautiful surface, and has a solidifying effect on the wood.

TO CALCULATE THE NUMBER OF SHINGLES FOR A ROOF.

To calculate number of shingles for a roof, ascertain number of square feet, and multiply by four, if two inches to weather, 8 for 4½ inches; and 7 1-5 if 5 inches are exposed. The length of a rafter of one-third pitch is equal to three-fifths of width of building, adding projection.

VALUABLE FIGURES.

The following figures are worth remembering, as they will save a good deal of calculation and give approximately accurate results with a minimum of labor :

A cord of stone, three bushels of lime and a cubic yard of sand, will lay one hundred cubic feet of wall.

Five courses of brick will lay a foot in height on a chimney.

Nine bricks in a course will make a flue eight inches wide and twenty inches long, and eight bricks in a course will make a flue eight inches wide and sixteen inches long.

Eight bushels of good lime, sixteen bushels of sand and one bushel of hair, will make enough mortar to plaster one hundred square yards.

One-fifth more siding and flooring is needed than the number of square feet of surface to be covered, because of the lap in the siding and matching of the floor.

One thousand laths will cover seventy yards of surface, and eleven pounds of lath nails will nail them on.

One thousand shingles laid four inches to the weather, will cover one hundred square feet of surface, and five pounds of shingle nails will fasten them on.

FROSTED GLASS.

Verre Givre, or hoar frost glass, is an article now made in Paris, so called from the pattern upon it, which resembles the feathery forms traced by frost on the inside of the windows in cold weather. The process of making the glass is simple.

The surface is first ground, either by the sand blast or the ordinary method, and is then covered with a sort of varnish. On being dried, either in the sun or by artificial heat, the varnish contracts strongly, taking with it the particles of glass to which it adheres ; and, as the contraction takes place along definite lines, the pattern produced by the removal of the particles of glass resembles very closely the branching crystals of frostwork.

A single coat gives a small, delicate effect, while a thick film, formed by putting on two, three or more coats, contracts so strongly as to produce a large and bold design. By using colored glass, a pattern in half-tint may be made on the color ed ground, and, after decorating white glass, the back may be silvered or gilded.

PERFECT MITERING.

BY OWEN B. MAGINNIS.

The many awkward ways in which so many woodworking mechanics endeavor to mark and cut in soft and hard wood moldings, and the botching results of their efforts, has induced the writer to give the following simple and successful methods which are perfect in their accuracy.

The different conditions which exist through the carelessness of those who precede him, when an operator commences to set in his molding, often cause him much trouble and loss of patience, as for instance, a molding being run standing on the little rebated lip or a raised molding being out of square, or an obtuse angle, instead of a little *under*, or an acute angle. This will of course necessitate, either the re-rebating of the molding by hand, or taking the arris of the corner of the panel sinkage as shown at *A*. Fig. 1. Then the molding

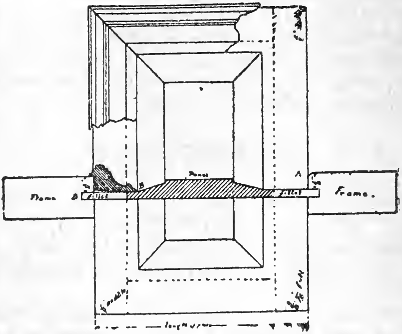


FIG. 1.

is often stuck too thin for sinkage, as will be clearly seen on the left hand side of the panel at *B*, and again the surface of the door, on account of the inequalities of the thickness of the pieces, especially on the back side, often varies as much as $\frac{1}{16}$ of an inch. This difficulty is easily overcome by the following sure process.

Take a small strip, and, placing the end of it down in the corner, mark the arrises with a sharp pocket knife. Measure these depths; in the case shown here they will be, for example, respectively, ½-inch, ½-inch, $\frac{1}{16}$-inch, full, ½-inch full, and ½-inch, scant. Having done this, make 4 strips, or saddles, equal in width to the different depths of the sinkage, as ½-inch wide, ½–$\frac{1}{16}$ wide, and so on, each being about ⅜-inch thick and long enough to go into the miter box between the saw cuts.

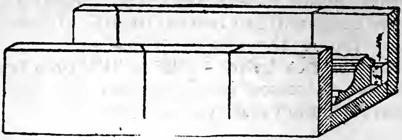


FIG. 2.

Place it in the box as represented at Fig. 2, with the lip of the molding resting on the saddle as it will rest on the door frame, at the miter and saw the left-hand end (say on the ½ scant saddle): To get the neat and exact length without gauging on the door. From the point where the saw crosses the saddle at Fig. 3, square across the bottom of the box with the pen-knife. These lines are the neat and exact lengths for either end, so if the thin edge—*B*, Figs. 1 and 3, of the molding, be marked at the opposite arris, holding the already mitered end close into its corners—and then this mark be placed at the asterisk or intersection, and the molding sawn on the saddle necessary for the opposite corner (say ½ full saddle), and so on all around the panel, it will, if cut out of one piece, perfectly utersect in its profile, the lip will come to a close joint on the frame, and the thin edge close to the panel. The dotted line in Fig. 3 shows how the molding should be held down in the box. The best way is to try a pair of pattern pieces as shown at Fig. 1 (on the necessary saddle), trying the patterns in each corner.

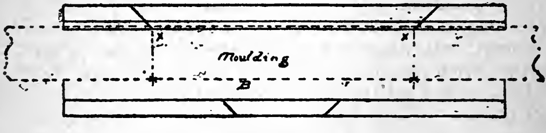
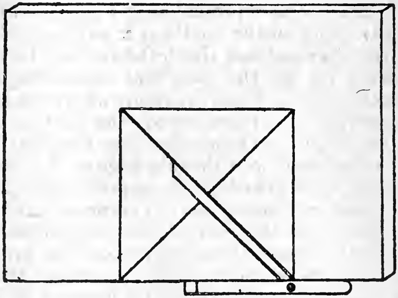


Fig. 3.

By this means it will be easy to find the exact saddle which will bring a good miter. Be sure they will come right before commencing to cut the molding all round. If it be too thick for the sinkage, of course it must be planed down on the back until it is a shaving thin, so that it will not strike the fillet, but press closely on the panel.

Great care should be exercised in cutting the miter box, as perfect mitering is almost reliant on a good box, cut exactly on the angle of forty-five degrees. To set the level, lay out a square on a drawing-board about four inches wide. Join the opposite angles like at Fig. 4 (be certain it is exact to a hair, or the bevel will not reverse itself). Place the bevel on to the lines joining the angles as it lies on the board and mark the miter box by it. This is the only perfect way to miter and cut in raised moldings, and will always, without error, assure accuracy and good mitering.

Fig. 4.



Mitering flush molding or molding which does not rise above the surface of the frame is comparatively simple, and is usually done with a jack, except in the case of large molding. All that is necessary is to first miter the left-hand end and mark the right hand.

The handiest way is to commence at the right-hand corner next to you, and work to the farthest corner, and soon all round, returning to the one started from. Should the lengths, when placed in the panel before drawing down, be too long, take a rebate plane, shaving off until they be a snug, tight fit.

THE VENTILATION OF BUILDINGS.

Perhaps no single feature of modern architectural construction is likely to secure such immediate regard in the near future, and is already so conspicuously engaging the attention of the foremost men in the profession, as that of proper ventilation. Nor can it be denied that no feature is more important for health considerations in private homes, office buildings and public institutions, than the securing of a steady supply of pure air and the coincident and corresponding removal of the vitiated air, so that the atmosphere in the rooms is, at all times, fresh and pure. The two points covered in the last sentence constitute what is known as, and is technically termed, "ventilation."

The expedients for obtaining a supply of fresh air to the room, so that there is a constant dilution and consequent bettering of the atmosphere, are comparatively simple. They merely imply that the air warmed by the hot-air furnace or steam coils in the cellar be taken from a place where it is pure (not, for instance, above a cesspool), that the ducts in cellar, through which the air travels, be air-tight (preferably be constructed of No. 22 or No. 24 galvanized iron, rather than of wood), and that some automatic means be adopted to regulate the temperature of the air supplied to the rooms, without shutting off such air supply. Or, when steam radiators are in rooms, that they be placed below windows, and air pass by means of proper orifices from outside through the radiators.

Furthermore, in large structures, a fan driven by electric or steam power is often instituted for forcing in a larger amount of fresh air than could be secured by the natural suction of the warmed air.

But the mere supply of warmed fresh air to the rooms is not enough. For note, if the air in the room has no escape, it does not take long, whatever the fresh air supply, before the vitiated air contaminates and makes foul the air as it enters the apartment. To open the windows is the remedy which the uninitiated at once suggest, and, in fact, in most houses this is the only palliative at hand.

It is, however, one of the first principles of ventilation, that the windows must not enter as an expedient. In a properly ventilated building the windows should never be open when people are in the rooms, at least in the winter months. For, opening the windows secures the admission of cold air in bulk, but does not remove the foul air, and more especially causes pneumonia-giving draughts, and chills the room, and in this way more damage is done than by even the presence itself of vitiated air in the rooms.

A warm or hot room does not necessarily signify an impure atmosphere; while we may have a room cold and the atmosphere still terribly impure. The unthinking never take this into account, and are apt to confuse the term warm with impure, and the term cold with pure atmosphere, as far as the rooms they are in are concerned.

The proper way to remove the vitiated air is by means of vent-ducts, or vertical flues leading from the rooms to the roof of the building. These flues should have an aggregate cross-sectional area at least equal to, and preferably about ten per cent. greater than, the cross-sectional area of the fresh air inlets; and should be situated on the opposite (preferably diagonally opposite) side of the room.

These vent-ducts should have openings controlled by registers, near the floor and near the ceilings of the rooms, but the two registers should not be opened at the same time. The cross-sectional area of the registers should bc twenty-five per cent. more than that of the vent-ducts.

The bottom register is the one ordinarily to be used; for the heavy, vitiated air sinks to the floor, while the fresher, unpolluted air rises. When the people in the room are smoking profusely, it is better to close the bottom and open the top registers of the vent-ducts, for the smoke rises to the top, and is then more speedily removed.

These vent-ducts cause a gentle draught in the same way that a chimney of a steam boiler or hot-air furnace does. The temperature in the room being higher than that of the external air, the temperature in the vent-ducts is also higher, and consequently a draught or removal of the vitiated air is secured, the amount depending on the area and height of the duct, and the difference of temperature between the external air and the air in the room. This system is known as that of natural ventilation.

To make this removal of vitiated air still more rapid than is secured by the natural draught just mentioned and explained, one of several expedients may be adopted. An exhaust-fan, driven by steam or electric power, may be placed near the top of vent-duct, and the air exhausted from duct by means of this fan, thus increasing the fresh air supply through fresh air inlet. This is frequently adopted in public buildings, where the rooms are, at times, full of people. Or the temperature of the air in the vent-ducts, and consequently the drabght and the removal of vitiated air, may be increased by any of the following means:

1. Gas jets may be burned in the vent-flues near the bottom.

2. Steam risers, through which steam of high or low pressure circulates, may run through the vent-ducts.

3. Such steam risers may have a large coil near top, or right above vent-flues proper.

For private homes and dwellings; natural ventilation suffices. For public buildings and large halls, either the fan or the steam system should be preferably adopted. The gas jets give out a comparatively little additional heat, but are inexpensive in first cost, and in running expense.

In a paper "On the Relative Economy of Ventilation by Heated Chimneys and Ventilation by Fans," read by Prof. Wm. P. Trowbridge, of the School of Mines, Columbia College, before the American Society of Mechanical Engineers, Prof. Trowbridge decides that in all cases of moderate ventilation of rooms or buildings, where, as a condition of health or comfort, the air must be heated before it enters the rooms, and spontaneous ventilation is produced by the passage of this heated air upward through vertical flues, such ventilation, if sufficient, is faultless as far as cost is concerned. He consideres this a condition of things which may be realized in most dwelling houses, and in many halls, school-rooms and public buildings, inlet and outlet flues of ample cross-section being provided, and the heated air being properly distributed.

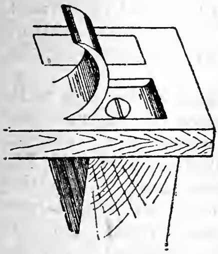
If, however, starting from this condition of things, a more active ventilation is demanded, the question of relative economy of fan and heated chimney is not so simple a problem. Prof. Trowbridge points out that ventilation by chimneys is disadvantageous under one point of view in any case, viz: the difficulty of accelerating the ventilation at will when larger quantities of air are needed in emergencies; while the fan or blower possesses the advantage in this respect, that by increasing the number of revolutions of the fan the head or pressure is increased. This latter fact makes the fan preferable for the ventilation of hospitals or public buildings of considerable magnitude, whenever, as is customary, the activity of the ventilation must be varied occasionally.

Where the power required is only a small fraction of a horse-power, as in ventilating single large rooms or small buildings, Prof. Trowbridge concludes it to be evident that as regards cost of fuel and the care and attention required, ventilation by heated chimneys is preferable, except, of course, for cases where a fan is driven by machinery employed for other purposes than ventilation, the cost of attendance chargeable to ventilation being then trifling and the fan evidently being more appropriate.

The construction of the building, of course, enters as an important factor, and often precludes the adoption of the exhaust-fan system. In large structures it is always important to take into account, and decide upon, the system of ventilation before the plans of the building proper are finished or finally adopted.

BURYING A SCREW HEAD OUT OF SIGHT.

To get the heads of nails and screws out of sight, where glue can be used without any objection, just raise up a chip with a thin paring chisel, as shown in the drawing, and then set the nail in solid. This "leaf" can be covered with a coating of glue and laid back again in place, where it must fit on all sides to perfection. A dead weight will hold everything in place till the glue dries, and a few moments with the scraper makes the job complete. It will add to the nicety of the work to draw lengthwise with the grain two deep cuts with a thin case-knife just the width of the chisel, and this keeps the sides of the chips from splitting. The chisel should be set at a steep angle at first till the proper depth is reached,



and then made to turn out a cut of even thickness until there is room to drive a nail. If too sharp a curve is given, the leaf is likely to break apart in being straightened out again. In blind nailing a narrow chip is taken with a tool made especially for this purpose, that lifts the cut just high enough to let in the nail on the slant, a set slightly concaved, being used to keep it from ever slipping off the head, and the upraised cut driven down again with the hammer.

HIP AND VALLEY ROOF FRAMING.

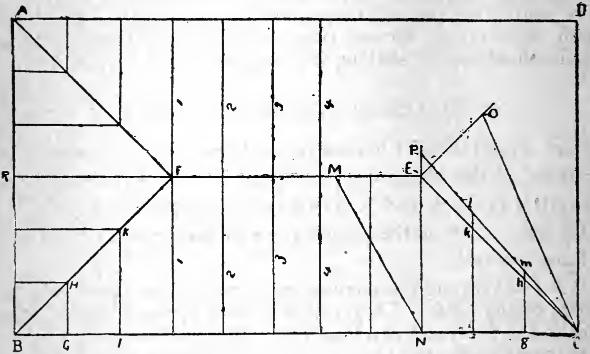
A simple way of laying out a hip or valley roof and finding the length of jack rafters, cuts and bevels, is shown in the accompanying sketch. The method followed is comparatively simple and easily understood.

Lay down the plan of the building *A*, *B*, *C*, *D*, find the center line of the ridge *E F*, and show the plan of hips *A F* and *B F*, also the jacks *G H* and *I K*.

To find the length of the common or straight side rafters, lay off on the ridge line *E F* the height of the pitch *E M*. From the point *N*, which is the outside edge of the wall plate, join *N M*. This will give *N M* as the extreme length, on the upper edge, of the common rafter which is to stand over the seat *E N*.

In order to find the length of the hip rafters which will stand over the seats *C E* or *B F*, draw the line *O E* square with the line *E C*, and make *O E*=*M E* the height of the pitch. Join the point *C* with the point *O*, thus obtained, which will give the length to the hip rafter on its upper edge.

The length of the jack rafters is generally obtained by direct measurement, but the following method will be found correct. Produce the line *N E*, and make *N P* equal to the length of the common rafter, so that *N P*=*M N*, join *P C*, which will equal *C O;* produce the seat of the jack



rafters *k i* and *g h*, until they intersect *P C* in *l* and *m*, and then *i l* and *g m* will be the correct lengths for the jack rafters.

In raising a roof of this description, it is usual to cut the ridge *E F* and the common rafters which abut against it at each end as at *R F*. In placing them in position they are fastened plumb over their seats by braces, and the side rafters are placed each against its mate, as *1* against *1*, *2* against 2, *3* against *3*, and so on.

When all the side rafters are in position, the hips are inserted, and their accompanying jacks.

PAINTING AND VARNISHING FLOORS.

A French writer observes that painting floors with any color containing white lead is injurious, as it renders the wood soft and less capable of wear. Other paints without white lead, such as ochre, raw umber or sienna, are not injurious and can be used with advantage. Varnish made of drying lead salts is also said to be destructive, and it is reccommended that the borate of manganese should be used to dispose the varnish to dry. A recipe for a good floor varnish is given as follows: Take two pounds of pure white borate of manganese, finely powdered, and add it little by little to a saucepan containing ten pounds of linseed oil, which is to be well stirred and raised to a temperature of 360° Fahr. Heat 100 pounds of linseed oil in a boiler till ebullition takes place; then add to it the first liquid, increase the heat and allow it to boil for twenty minutes. Then remove from the fire and filter the solution through cotton cloth. The varnish is then ready for use, two coats of which may be used, with a final coat of shellac, if a brilliant polish is required.

A COLOSSAL STICK OF TIMBER.

A colosal stick of lumber from Puget Sound has been contributed to the Mechanics Exhibition at San Francisco. Its length is 151 feet, and it is twenty by twenty inches through. It is believed to be the longest piece of timber ever turned out of any saw mill.

A few years ago mechanics cared very little about winter work of any kind. They rather looked forward with pleasure to the prospects of a long rest. Things have been changing recently, and the tendency now is to secure all the winter work possible: One reason is, there are more building and loan associations, more insurance societies, more lodges and more organizations of one kind and another, all of which must be kept up. Besides, there is an increasing amount of work that has heretofore been done in summer. The cost of labor in a good many vocations is less in winter than it is in summer, owing to the small amount to be done and the greater number seeking it.

PLASTER FOR MOLDINGS.

Where walls and ceilings are to be molded whilst yet in a plastic state, some decorators are using a fibrous plaster, with the object of securing greater firmness and tenacity. The idea itself is not new, animal hair having formerly been intermixed with lime, but this is a new application. In England and France a fine wire netting is at times inserted between two courses of plaster, to afford greater firmness in holding picture frames. The tenacity of some of the old moldings in old New York houses, whilom aristocratic, is very remarkable, retaining as they do their original sharpness of outline.

THE SWEATING OF CHIMNEYS.

The sweating of chimneys is now believed to be due to condensation of the moisture in the air that is confined in a poorly ventilated chimney flue. The trouble, as our correspondent indicates, is chiefly to be found occurring in small chimneys, and in such chimneys whose flues start from the second or third story of a building. The sweating is the most copious when a fire is started in a place that has been for some time in disuse, or, in other words, when the flue is cold. The humidity of the air is a large factor in the phenomena of sweating. If the air be charged with moisture, the flue cold, and a fire newly kindled, the conditions are favorable for sweating. It is only under these favorable conditions that a well-ventilated chimney will begin to sweat, but the sweating will not continue. If sweating should continue in a chimney after a fire is fairly under way, it can be safely concluded that the chimney needs an opening near the ground to provide a better circulation of air within the flue. It may be, as our correspondent suggests, that rain may beat in and cause the same effect as sweating, especially where the rain has continued for several days together, and in that case a cowl, such as has been lately described in "Building, in House and Stable Fittings," would cure the disease by excluding the rain; but such occurrences are exceedingly rare, and we have seen chimneys guilty of sweating that were provided with the most approved form of cowl, and the remedy applied has been to insert an air-brick at the base of the chimney to secure better ventilation, so as to lessen condensation, and the device has proved successful. Cowls prove useful only so far as they promote ventilation by increasing the circulation within the chimney flue. A cowl may be so improperly applied to a flue as to promote, instead of abolishing, sweating. The main point is to provide an ingress of air sufficient to tax the extractive capacity of the cowl that is used.

ELECTRIC LIGHTS IN GERMANY.

According to Dr. Schilling, the number of electric light installations in the 13 principal towns of Germany has increased during the last two years from 121 to 604; the number of arc lamps has increased from 591 to 3,280, and the number of incandescents from 10,403 to 50,469. The number of gas lamps in these 13 towns is 1,221,882, and therefore, lamp for lamp, electricity furnishes about four per cent. of the total illumination.

SMOKY CHIMNEYS AND HOW TO CURE THEM.

A smoky chimney is a complaint we are often called upon to deal with, and the best way of building chimneys which should not smoke into the rooms, and of remedying existing chimneys which are liable to do so, is a matter of great importance to estate clerks of works. There are many small matters in building new chimneys which, together, may be a means of preventing them from smoking at the wrong end; but my intention at present is to deal only with the shaft or stack, or portion outside the roof, and my object is not to give ornamental elevations of chimney heads, which are unnecessary for the purpose of this article, but to explain a way of forming them which I have many times found to give relief to inveterate smokers. A common shaft, such a one as would be adapted for existing old cottages, is 2½ bricks or 1 ft. 10½ in. in width, and in my opinion none should be less than this, with a 9-inch earthenware flue-pipe built in solid; this I usually commence on the damp course, which should be just above the flashings of roof. As the area of the round pipe is smaller than the 14-inch by 9-inch brick flue on which it is placed, a quicker current of air or draught is thereby generated, and in windy weather a check is given to sudden down-draughts. Another advantage in a flue-lined stack is that there is no danger of the brickwork cracking when the soot in the flue is on fire, and which, owing to the scarcity of chimney-sweeps, is often the case in country places. Stoneware drain pipes, however, are quite unfit, as they are liable to split with the heat; but the tubes made of fire-clay or terra-cotta, only should be used. Another help is to keep the stack dry; a damp flue is generally a smoky one, and if a fire is lighted in the fire-place, say, of a disused bed-room, it is a common occurrence to see the smoke puff down violently and the chimney is said to have a down-draught, and by many people is assumed to be badly constructed, whereas, perhaps, it may be built in the best possible manner except that it will not keep out rain and damp. The rain may come through the sides of the stack, or it may come downward through the head; at any rate the chimney for some distance from the top is, in wet weather, cold and soppy. I roof the chimney top with plain tiles, with the object of protecting the head and permitting the rain to drop off at the eaves instead of running down the stack and making the flue cold, and the stack outwardly black and soot stained. I bed the tiles in cement, using copper nails driven into the latter through the pin holes—or a plain, cemented weathering looks fairly well. But by forming the covering with tiles a good drip is obtained, which is not so readily done with cement. Another point is not to make the slope or pitch of a suitable angle, and this, in my opinion, should be about 45 degrees, as I find that inclination most effectual; when the wind strikes the slope it takes an upward direction, and, as a matter of course, carries the smoke with it.

Some time since a gentleman living by the seaside was much troubled with smoky chimneys, and asked me what was the best thing to do ; I told him near about what I have just now written, and a short time afterward I received a letter (which I must confess somewhat scared me) saying he had decided to pull down his chimneys and rebuild them on my principle, and desired me to order for him two truck loads of George Jennings' flue pipes at once. This I did, and waited anxiously for the result; at last I was gratified by hearing "Chimneys are a great success," but it was summer time, and I was not so sure how they would act in cold, boisterous weather by the seaside, where every patented smoke-curer had apparently been tried by some one or other ; but eventually I was glad to learn that they continued to draw well.

I have proved this system of chimney stack building to be good in a large number of cases ; for instance, my office chimney is directly under the branches of a large tree, and the fire is on the hearth, yet I am never troubled with smoke.

For economizing heat in single houses or detached cottages, we all know it is the best plan to get the chimney on the inside, and not forming a portion of the outer walls, as in the latter case they are much more likely to smoke, and we also know that register grates, or grates with doors a few inches above the fire, generally make the fire draw ; they not only draw the smoke, but a greater portion of the heat as well, and necessitate getting very close to the fire to obtain a portion of the heat going up the chimney. To my mind, there is nothing to equal a fire on the hearth, and wood, if you can get it, in preference to coals.

There is much might be said about set-offs in flues, and I know they are objected to as a rule, but I believe a chimney with one or two set-offs is all the better for it. I also believe chimney heads built in cement mortar true economy ; the latter makes good work and looks well, long after chimney heads built with lime mortar, which soon show startling mortar joints and crumbly bricks. How often do we find old chimney heads want repointing, for the weather loosens the mortar and the birds carry it away.

The summary of my experience is briefly this.

1. Put a damp course to new chimneys, or insert one in old chimneys.

2. Line the chimneys with flue pipes above the damp course.

3. Roof the chimney tops carefully.

4. Don't forget a good projecting eaves-drip to the chimney head.

4. Build the heads with cement mortar

FACTS ABOUT FURNACES.

In February, 1881, the committee of hygiene of the Medical Society of Kings County rendered a report, which is published in full in the proceedings of that society, upon catarrh, and whether that disease was aggravated by residence in cities. The opinions of a large number of physicians of long experience were obtained, and their testimony showed "that, though climatic and city influences have much to do with the creation of catarrh, yet defective heating, lighting, airing, sunning and drainage of houses, with improper views as to air, clothing, bathing and exercise, are the main causes." Individual physicians laid special stress upon individual influences, as "dry and irritating air from villainous furnaces, increased furnace heat and artificial methods of living."

Furnace air *per se* is not so unwholesome, but it is the absence of ventilation which makes it so. If a furnace is of sufficient size to warm a building without opening every draft and heating the fire-pot red-hot, and if the fresh air supply is taken from a proper source and not from a damp area or unclean cellar; and, furthermore, if there are sufficient openings at the top of the house to allow the impure air which rises to that point to escape and thus cause a constant circulation of sufficiently warmed but not overheated air through the house, under these conditions a furnace is not objectionable.

Furnaces are often badly located. It is easier to force warm air through a furnace flue fifty feet away from the prevalent wind than ten feet in the opposite direction. Hence the furnace should be placed nearest the northern side of the building, or two should be provided Hot-air flues should not be carried for any distance through cold cellars, halls or basements, as they will become chilled, and will not draw without being cased with some non-conducting material, as mineral wool.

Don't set a furnace in a pit, especially in a wet soil where water will collect after every rain storm, but stand it on brick arches, so as to raise it above the ground; also cement the pit. It is unfortunately very common to find such depressions filled with water; this causes rusting of the furnace itself and damp in the cellar. In very many houses occupied by persons of means, the furnaces are no longer used, but have been replaced by open fires. This is costly comfort, but it is a commendable plan, as it furnishes ample ventilation to the living rooms. It is desirable that one room should at least be thus supplied with a careful and sanitary fire.

Where fresh-air inlets are carried from the house drain to the front of a house at the yard level, they should not be located near to the cold-air supply, as there is a chance that during heavy states of the atmosphere a down-draft may be created, and the foul air sucked into the air box and thence upward into the house. Registers should never be placed at the floor level, as they will collect dust and sweepings, which are liable to take fire.

Furnaces with heavy castings heat slowly and are less easily cracked or warped, and they cool more slowly, so that the heat evolved is more uniform. It is well to retain the air close to the fire-pot, and thus keep it longer in contact with he fire-heating surface.

Water pans are often badly arranged so that they admit ust, and as they are seldom cleaned that may become offenive. They should always be supplied by a ball-cock so as to e automatic, rather than by a stop-cock which has to be opened by a servant, who may be neglectful.

Attempts have been made to filter the air before entering the furnace, but they usually fail. A screen of galvanized iron wire of 1-16 mesh will exclude most floating material from the air. The air supply is sometimes taken from the attic, but it is apt to be dusty and impure. Others take it from vestibules of halls or piazzas, which are not bad places.

STEAM VS. HOT-WATER HEATING.

Hot water as a heating agent is one of the oldest in use, and has a number of advantages in its favor. For mild climates it answers very well. For northern latitudes, however, and in countries such as Canada and most of our northern States, having long, severe winters, hot-water heating is not in general use on account of the following objections:

High First Cost—Hot water, as generally used, only gives off two-thirds the amount of heat per square foot of radiating surface which steam will give under similar circumstances. To get the same results as from steam it therefor requires about fifty per cent. more of radiators, and a corresponding increase of piping.

Added to the expense of this extra material is that of labor, which increases in the same proportion, thus makin the entire first cost of hot water about one-third higher than steam.

Leakage—As all the pipes are continually full of water, any leakage will rapidly flood the house, causing trouble and damage. With steam, the flow-pipes contain no water whatever, and the return drip-pipes but very little, so that in event of a leakage the water would be discovered and stopped long before it could do any damage.

No Way to Shut Off—We have never yet seen a hot-water radiator which can be turned off and yet allow the water within it to flow back to the boiler; the construction of the radiator being such that all the water must circulate up and down between divisions connected alternately at the top and bottom.

When the radiator is turned off, these divisions still remain full of water which has no chance to run off. It is therefore necessary to keep all the radiators in the house running all the time, or else take the chances of their freezing and giving trouble if they are turned off. Now there are certain rooms in almost every house, such as guest-rooms, which are only occupied occasionally, and it would be a useless expense and inconvenience to keep them constantly warmed. The advantage of steam over hot water in this respect is evident. With steam you can entirely shut off any radiator you please, and keep every room in your house at the exact temperature desired, without inconvenience or waste of heat.

Freezing and Bursting—It is a curious fact that hot water will cool down and freeze much quicker than ordinary water under the same circumstances. The first effect in boiling water is to drive off all its air, hence, becoming more solid and condensed, it is very susceptible to cold and will freeze very easily. If the fire in the boiler from any reason goes out, the water, of course, soon stops circulating, and in cold weather the pipes will rapidly freeze and burst. Many instances are on record where immense damage has been done from this cause. The use of steam, on the other hand, entirely precludes this cause.

Difficulty of Regulation—In zero weather it is difficult to keep warm by hot water, unless there is a great amount of heating surface, and then in mild weather you are liable at any time to have too much heat. This is especially noticeable in any sudden change of temperature.

Hot water, being slow in acquiring heat and slow in parting with it, is consequently difficult to regulate with any degree of satisfaction.

This feature is seen in greenhouse heating particularly. When the sun is shining, on account of the great amount of natural heating glass surface, the temperature soon runs up above the normal, causing a necessity for opening the ventilators and so wasting the heat. And should the temperature once get down, it takes a long time to get it up again.
The advantage of steam in this case is apparent, as it is capable of being handled and regulated rapidly, and therefore is superior to any other method wherever an even and uniform temperature is desired either for a greenhouse or a dwelling.

Comparative Economy—Careful experiments have recently been made by parties owning many greenhouses — some of which are warmed by steam and others by the most approved of hot-water heaters — for the purpose of accurately determining the relative cost of fuel in each case. They had nothing to gain by such experiments except the truth, as, with all florists, coal is a very heavy item and one of the principal expenses attending the running of a greenhouse.

Without entering into details, it has been demonstrated that greenhouses may be heated by steam on two-thirds the quantity of coal required for a hot-water apparatus. This fact has become so well established, that to-day steam is very rapidly taking the place of every other method for warming greenhouses.

The objections to hot water for this class of buildings is, moreover, much less than for residences, on nearly all the receding five points. For instance, a leakage of a pipe can o no harm, as in a house, and there is, of course, no occaon to shut off any portion of the system, as is sometimes esired in a house.

Although the expense of a change from hot water to steam is heavy, yet the advantages secured are so great and apparent that it will not be long before hot water as a heating agent will be practically abandoned in every kind of building.

INTERESTING FACTS ABOUT ISINGLASS.

Isinglass consists of the dried swimming bladder of fishes. The bladders vary in shape, according to their origin, and they are prepared for the market in various ways. Some are simply dried while slightly distended, forming pipe isinglass. When there are natural openings in these tubes they are called pursers. When the swimming bladders are slit open, flattened, and dried, they are known as leaf isinglass. Other things being equal, the value of a sample is determined by the amount of impurities present. These impurities are ordinary dirt, mucus naturally present inside the bladder technically called grease, and blood stains. If the bladders, were hung up to dry with the orifice downward, the mucus could be drained off; but usually the fishermen fear the reduction in weight, and take care to retain all they can. It is necessary to insist on having the bladders slit up and rinsed clean as soon as they are removed from the fish. This would so much increase the value of the product that the extra labor would be very profitable. Blood stains cannot be removed without injuring the quality. If any process could be devised effectual for this purpose, a valuable discovery would be made.

The uses of isinglass are not very varied. The largest quantity is used by brewers and wine merchants for clarifying. This property is extraordinary, for gelatin, which seems chemically the same thing as isinglass, does not possess it.

For clarifying purposes the isinglass is "cut" or dissolved in acid, sulphurous acid being used by brewers, as it tends to preserve the beer. When reduced to the right consistence, a little is placed in each cask before sending it out for consumption.

There seems to be only six isinglass cutters in England, all being in London. The sorted isinglass is very hard and difficult to manipulate. It is soaked till it becomes a little pliable, and is then trimmed. Sometimes it is just pressed by hand on a board with a rounded surface; at others it is run once between strong rollers to flatten it a little. The next process is that of rolling. Very hard steel rollers, powerful and accurately adjusted, are used. They are capable of exerting a pressure of 100 tons. Two are employed, the first to bring the isinglass to a uniform thickness, and the smaller ones, kept cool by a current of water running through them to reduce it to little more than the thickness of writing paper. From the finer rollers it comes in a beautifully transparent ribbon, many yards to the pound, "shot" like watered silk in parallel lines about an inch broad. It is now hung up to dry in a separate room, the drying being an operation of considerable nicety. When sufficiently dried, it is stored till wanted for cutting, or it is sold as ribbon isinglass to all who prefer this form.

MODERN USES OF TIN.

The uses of tin have greatly increased during the last few centuries of our era. Salmon, in his splendid work on casting tin (1788), describes the methods of work, and mentions the objects manufactured from this metal. We see from the plates of his atlas that table services (spoons and forks) pitchers, jugs, candelabra, lamps, surgical instruments, chemical apparatus, boilers for dyeing scarlet, etc., were being put upon the market in the most varied forms of that epoch.

Griffith, between 1840 and 1850, perfected the manufacture of tin utensils in a single piece. This industry became especially developed in France from 1850 to 1860.

In 1860 America began manufacturing impermeable boxes, without soldering, from single pieces of metal.

To-day tin is being used in the manufacture of bronzes for guns, money and medals, and in the alloys used for making measures of capacity for liquids. Its unalterability in the air, and the harmlessness of its salts when they exist in small quantity, cause it to be employed in our day in the manufacture of culinary vessels and utensils. Advantage is taken of its malleability to form from it those thin sheets that are used as wrappers for chocolate, tea, etc.

In the various bronzes that it forms with copper, we have evidence of the influence that relative proportions of the two metals have upon the properties of the alloy. Thus gun bronze, which contains ten parts of tin to ninety of copper, is remarkable for tenacity. The bronze of tom-toms and bells, which differs from the last named only in its larger proportion of tin (twenty to eighty of copper) is, on the contrary, very brittle, although it fortunately possesses greater sonorousness than gun metal does. On still further increasing the proportion of tin to thirty-three parts per sixty-seven of copper, we obtain a white alloy capable of taking a polish that causes it to be used for the manufacture of telescope mirrors. Upon uniting with tin, copper loses its ductility. The alloys of these two metals increase in density through being hardened, as they do also by being hammered.

A mixture of twenty parts of tin with eighty of copper gives an alloy which is brittle at a bright red heat and when cold, but which is malleable at a dark red heat.

When alloyed with lead, the tin forms plumbers' solder. Associated with mercury, it gives the silvering of looking-glasses. Besides this, it enters into a host of fusible alloys or compositions, known under the general name of white metal. One of these alloys, composed of tin, antimony and copper, is very much used as a bushing for engine bearings. For this purpose the following are very good proportions: Tin, 100; antimony, 10; copper, 10. It is also alloyed with antimony alone, or with bismuth. It serves for tinning copper and iron kitchen utensils. To this effect the wrought-iron utensils are cleaned with sand and then wiped, and afterward immersed in a bath of molten tin, and finally rubbed with tow saturated with sal-ammoniac. Food cooked in tin vessels has a slight fishy taste, because it dissolves a little of the tin, just as food prepared in iron contracts a slight taste of ink.

Tin is used in enormous quantities also in the manufacture of tinplate. In order to prepare this, the sheet iron designed for the manufacture of it is cleansed by plunging into diluted sulphuric acid, which dissolves the pellicles of oxide. Then it is rubbed with sand and immersed in melted tallow, and afterward in a bath of tin covered with tallow. When taken out it is tinned, there having formed upon the surface of the sheet iron a true alloy of iron and tin covered with pure tin. Tin plate is as unalterable as tin itself, because the iron does not come into contact with the air at any point; but if, upon cutting it, we expose the iron, oxidation proceeds more rapidly than it would if the iron had not been tinned.

Upon washing the surface of the tinplate with a mixture of hydrochloric and nitric acids, we remove the superficial layer, and render visible the crystallized surface of the tin and iron alloy. We thus obtain what is called moire metallic or crystallized tinplate.

It now remains for us to say a few words about the new and important use of tin for the preparation of phosphor bronze.

In the melting of bronze the absorption of oxygen is very detrimental, the formation of an oxide of tin rendering the metal brittle. In former times an endeavor was made to prevent this oxidation by stirring the mass with wood, or by adding a little zinc to it; but for the last fifteen years greater success has been obtained by the addition of a little phosphorus. This substance extraordinarily increases the compactness, toughness and elasticity of the product, and gives it, in addition, a beautiful golden color. Guns, statues, ornaments and bearings are now cast from phosphor bronze with the greatest success.

Kunzel, of Dresden, has taken out a patent for an alloy composed one-half to three parts, by weight, of phosphorus, from four to fifteen of lead, from four to fifteen of tin, and for the rest, copper up to 100.

Schiller & Sewald, of Graupen, prepare two kinds of phosphor bronze; one with 2½ and the other 5 per cent. of phosphorus. The demand for this article is daily becoming more extensive.

The most important uses of tin are, in Asia, for tinning copper, and in Europe and America, for the manufacture of objects from tinplate. The manufacture of bronze and white metal likewise consumes a large quantity.

USES OF MICA.

The peculiar physical characteristics of mica, its resistance to heat, transparency, capacity of flexure and high electric resistance, adapt it to applications for which there does not appear to be any perfect substitute. Its use in windows, in the peep-holes on the furnaces used in metallurgical processes, as well as the ordinary use in stoves for domestic purposes, are examples of its adaptability to specific purposes which it does not seem to share with any other material. Its fitness for use in physical apparatus is represented by its application for the vanes on the Coulomb meter, recently invented by Prof. George Forbes, F. R. S. For electrical purposes mica has proved useful, acting as an insulator between the segments of commutators of dynamos and safety fuses in lighting circuits, also as the base part of switches handling heavy currents, to obviate the dangers of ignition by the arc formed when the switch is changed. For this latter purpose it shares the field with sheets of slate. Both of these uses were first suggested a number of years ago by an insurance expert in America in the course of regulations governing the safe installation of electric-light plants. As a lubricator, mica answers a very peculiar purpose for classes of heavy bearing, where the powdered mica serves a useful office in keeping the surface separate, thereby permitting the free ingress of oil. It is used in roof-covering mixtures in a powdered condition in combination with coal tar, ground steatite and other materials, its foliated structure tending to bond the material together. Not affected by ordinary chemicals which are corrosive to many other substances, it has been applied in the valves to sensitive automatic sprinklers, where a sheet of mica placed over a leather disk has proved to be non-corrosive, and without possibility of adhering to the seat, while the leather packing rendered the whole sufficiently elastic to provide a tight joint.

IMPROVED PROCESS OF TINNING.

An improved process of coating metals with tin, by Borthel and Holler, of Hamburg, is said (by a metropolitan contemporary) to possess the advantage of preventing, or at least delaying, oxidation. The process can be employed with special advantage for tinning cast-iron cooking utensils, household and other implements of cast iron, as the employment of poisonous enamel is avoided and a much higher degree of polish attained. The process can also be employed for protecting architectural or other iron decorations from rusting by the coating of tin or other metal, without detriment to the sharpness of the form, as is the case with the customary oil or bronze paints. In order to produce a perfectly even coating of tin on cast iron, the same is first provided with a thin coating of chemically pure iron, regardless of the form of casting. This coating is produced in galvanic manner in a bath composed as follows: Six hundred grammes of sulphate of iron, $FeSO_4$, are dissolved in five liters of water, to which add a solution of about 2,400 grammes of carbonate of soda, Na_2CO_3, in five liters of water. The precipitate of ferro-carbonate ($FeCo_3$) resulting is dissolved in small quantities in so much concentrated sulphuric acid until the fluid has a green color. The bath is then rendered aqueous by adding about twenty liters of water. Blue litmus paper dipped in the bath must assume a deep claret color, and red litmus paper remains unchanged.

The objects to be provided with a coating of chemically pure iron are placed in the bath opposite to the abode of cast or wrought iron or iron ore, and both parts connected to the corresponding poles of a dynamo machine, electric battery, or other appropriate source of electricity. In a very short time the objects placed in the bath are covered with a coating of iron, the thickness of which depended on the duration of the action of the bath or the strength of electric current. The coated objects are then well rinsed in clear water, dried, then painted with, or immersed in, a solution of ammonia in chloride of zinc alone, and then immersed in a vessel containing molten tin. The tin adheres with great tenacity to the prepared surface, and the surplus of tin can be readily removed by a brush, or any other manner. If the object to be tinned is of such size, or so complicated in form, that it cannot be readily immersed in molten tin, it can be placed in a galvanic tin bath, which can be readily made in any desired size, and be provided with a layer of tin of desired thickness, which, after having been painted either with a solution of chloride of zinc or ammonia in chloride of zinc, can be heated to such a degree that the tin is equally melted on the object.

In like manner objects cast or made of lead or other readily melting metal, which would lose their form by melting when immersed in molten tin, are, previous to tinning, provided with a coating of pure iron, and are then provided with a coating of tin in a galvanic bath, as mentioned above, without being subjected to heat for melting the layer of tin deposited on the same. With objects of wrought or rolled iron, or which do not require the before described treatment —*id est*, the production of a coating of chemically pure iron — it will be sufficient to carefully clean the same and paint them with a solution of ammonia or chloride of zinc or a concentrated solution of chloride of zinc. This tinning process combines the advantage of simple manipulation and the great durability of the coating with cheapness of manufacture, which is partially attained in the saving of tin.

SOLDERING.

The term soldering is generally applied when fusible alloys of lead and tin are employed for uniting metals. When hard metals which melt only above a red heat, such as copper, brass or silver, are used, the term brazing is sometimes used. Hard-soldering is the art of soldering or uniting two metals or two pieces of the same metal together by means of a solder that is almost as hard and infusible as the metals to be united. In some cases the metals to be united are heated, and their surface united without solder by fluxing the surfaces of the metals. This process is then termed burning together. Some of the hard-soldering processes are often termed brazing. Both brazing and hard-soldering is usually done in the open fire on the brazier's hearth. A soldered joint is more perfect and more tenacious as the point of the fusion of the solder rises. Thus, tin, which greatly increases the fusibility of its alloys, should not be used for solders, except when a very easy-running solder is wanted. Solders made with tin are not so malleable and tenacious as those prepared without it. The Egyptians soldered with lead as long ago as B. C. 1490, the time of Moses.

Pliny refers to the art, and says it requires the addition of tin to use as a solder. The tin came mainly from the Cassiterides (Cornwall). Plumbers use solder composed of two parts of lead and one of tin, and a very slight variation in the quantities makes a very considerable difference in the working and also in the soundness of the joint. If a slight excess over the above proportion of lead is used, the solder is more difficult to work, and the joint when made frequently leaks, the water passing through the small cellules or pores in the metal, and the joint is then said to "sweat." If an excess of tin is used, the solder melts too easily, and considerable difficulty is found in keeping it on the joint, and it cools so suddenly that the joints always look rough and ragged at the ends. They sometimes require trimming up to make them look better; this solder also keeps running, and then congealing, in such a way as to be difficult to keep it at a workable heat. Small portions of the metal also keep sticking to the cloth used for molding (technically called wiping) the joint or seam as the case may be.

Plumbers' solder, with the above proportions, on being melted, and then allowed to cool, will generally exhibit several bright spots on its surface, due to the two metals partly separating. These bright spots are generally a very sure guide as to the proper quantities of each metal used. If none are seen, it is too coarse; and if too many are seen, it contains too much tin and is said to be too fine. If the spots are small the metal may not be good, although it may have beyond its proper quantity of tin; but if the spots are about the size of a threepenny piece the solder very rarely fails to work well. In uniting tin, copper, brass, etc., with any of the soft solders a copper soldering-bit is generally used. This tool and the manner of using it are well known. In many cases the work may be done more neatly without the soldering-bit by filing or turning the joints so that they fit closely, moistening them with the soldering fluid described hereafter, placing a piece of smooth tin foil between them, tying them together with binding wire, and heating the whole in a lamp or fire till the tin foil melts. Pieces of brass are often joined in this way so that the joints are invisible. With good soft solder almost any work may be done over a spirit lamp, or even a candle, without the use of a soldering-bit. Advantage may be taken of the varying degrees of fusibility of solders to make several joints in the same piece of work. Thus, if the first joint has been made with the fine tinners' solder, there would be no danger of melting it in making a joint near it with bismuth solder. The fusibility of soft solder is increased by adding bismuth to the composition. An alloy of lead 4 parts, tin 4 parts, and bismuth 1 part, is easily melted; but this alloy may itself be soldered with an alloy of lead 2 parts, bismuth 2 parts, and tin 1 part. By adding mercury a still more fusible solder can be made. Equal parts of lead, bismuth and mercury, with two parts of tin, will make a composition which melts at 122 degrees Fahr.; or an alloy of tin 5 parts, lead 3 parts, and bismuth 3 parts, will melt in boiling water. In melting these solders melt the least fusible metal first in an iron ladle, then add the others in accordance with their infusibility. It is convenient —and in fact, often necessary—to have solders which will melt at different degrees of temperature, to avoid the risk of spoiling the work by subjecting it to too great a heat, when, with a little easy-flowing solder, there would be no danger.

POINTS ON SOLDERING.

For tinning soldering coppers nothing is better than a soft-burned brick to contain the tin and solder. Dig a cavity on the side two or three inches long, and wide enough to receive the soldering tool. Melt some solder in the cavity thus formed, and throw in some pieces of sal-ammoniac and rosin. See that the copper bits are hot enough to melt solder; a great heat will not tin as well as a low one. Rub the tool on the brick, melting the solder, ammoniac and rosin. The brick scours the copper bright, and the flux causes the solder to adhere very easily. One of the worst things ever attempted is to solder a dirty job with a dirty, untinned copper.

See that the surfaces to be soldered are clean. If not, make them so by filing or scraping; then protect the surfaces from oxidation by an application of flux or muriatic acid in which zinc has been dissolved. Have the soldering copper hot. Hold it two inches from your face, and the right degree of heat will soon be learned. When all of these conditions exist, the melted solder will flow along the seam with the greatest ease, leaving a smooth, well-finished surface behind it.

To do work in the best manner and the easiest, a flux should be provided for each metal to be soldered. The hydrochloric (muriatic) acid and zinc flux is worthless when rust is to be avoided, for in some cases the acid continues to act after the soldering is done, and in a few months may eat far enough to separate the solder from the work. In this case, of course, the joint falls apart.

In soldering zinc some use muriatic acid diluted with water for a flux, and the rusting action is to be feared in this instance, but may be lessened by adding soda carbonate (washing soda) to the acid. There are few pieces that cannot be soldered without the use of an acid flux, and rosin will do nearly as well if a little oil be added, or if the soldering copper be dipped in acid and then into oil before applying it to the seam with rosin on it.

Sal-ammoniac is the proper flux for copper, and this agent works well with tin, but it is not necessary, for rosin is all that is needed. Lead is perfectly fluxed by tallow (the plumbers call it "touch"), but may be soldered with either of the other fluxes.

NEW METHOD OF BRONZING IRON.

The following method is successful in producing a bronze-like surface which practically prevents rust. All the methods as yet known for producing a bronze-like surface, by rubbing over the surface of the iron an acid solution of copper or an iron solution, letting it dry in the air, brushing off the rust produced in this way, and an abundant repetition of this method, give a more or less reddish-brown crust or rust on the iron body. Objects formed of iron can easily be covered with copper or brass by dipping them in the requisite solution, or by submitting them to the galvanic method. The surface so prepared, however, peels off in a short time, by exposure to moist air in particular. By the method given below it is possible to cover iron objects, especially such as have an artistic aim, with a fine bronze-like surface; it resists pretty satisfactorily the influence of moisture, and one is, moreover, enabled to apply it to any object with great ease. The clean, polished objects are to be exposed to the action of the vapors of a heated mixture of hydrochloric acid and nitric acid, in equal portions, for from two to five minutes; they are not to be shifted, and the temperature may range from 300° to 350° C. The heating is continued so long that the bronze-like surface is well developed on the surface of the objects. After the objects have cooled they should be well rubbed down with vaseline and again heated until the vaseline begins to decompose. When again cold they should be a second time treated with vaseline in the same way. If the vapor of a mixture of the two concentrated acids is allowed to act on an iron object in this manner, a light reddish-brown tone is developed. If some acetic acid be mixed with the two acids, and the vapor of all the acids together be allowed to act on the metallic surface, a fine bronze yellow color can be obtained. By using different mixtures of these acids every tint, from a dull red-brown to a light brown, and from a dull brownish yellow to light brown yellow, can be produced on the surface of the iron. In this way some T-rods for iron boxes were covered with a bronze-like surface, and at the end of ten months, although exposed during the whole time to the action of the acid fumes of a laboratory, they had undergone no trace of any change.

MANUFACTURE OF RUSSIAN SHEET IRON.

There appears to be much misunderstanding in reference to the manufacture of sheet iron in Russia, and questions are frequently asked the writer: "What are the secrets connected with it?" "How is it made?" "Could admission be obtained to the iron works in the Urals, where the iron is made?" It is difficult to understand why such questions should be asked by persons versed in the literature of iron and steel, for Dr. Percy wrote a very excellent and accurate monograph on the subject a number of years ago.

Not having had the opportunity of personally visiting the Russian iron works in the Urals, Dr. Percy's paper was compiled from data furnished him by a number of persons who had actually visited these sheet iron works. Since it has been my good fortune to have the opportunity of seeing some of these works in the Urals, but a short time ago, I will, at the risk of telling an old story, briefly describe the process of manufacture as I saw it.

The ores used for the manufacture of this iron are mostly from the celebrated mines of Maloblagodatj, and average about the following chemical composition: Metallic iron, 60 per cent.; silica, 5 per cent.; phosphorus from 0.15 to 0.06 per cent. The ore is generally smelted into charcoal pig iron, and then converted into malleable iron by puddling or by a Franche-Comte hearth. Frequently, however, the malleable iron is made directly from the ore to various kinds of bloomaries.

The blooms or billets thus obtained are rolled into bars 6 inches wide, ¼ inch thick and 30 inches in length. These bars are assorted, the inferior ones "piled" and re-rolled, while the others are carefully heated to redness and cross-rolled into sheets about thirty inches square, requiring from eight to ten passes through the rolls. These sheets are twice again heated to redness, and rolled in sets of three each, care being taken that every sheet before being passed through the rolls is brushed off with a wet broom made of fir, and at the same time that powdered charcoal is dextrously sprinkled between the sheets. Ten passes are thus made, and the resulting sheets trimmed to a standard size of twenty-five to fifty-six inches. After being sorted and the defective ones thrown out, each sheet is wetted with water, dusted with charcoal powder and dried. They are then made into packets containing from sixty to one hundred, and bound up with waste sheets.

The packets are placed one at a time, with a log of wood at each of the four sides, in a nearly air-tight chamber, and carefully annealed for five or six hours. When this has been completed the packet is removed and hammered with a trip-hammer weighing about a ton, the area of its striking surface being about six to fourteen inches. The face of the hammer is made of this somewhat unusual shape in order to secure a wavy appearance on the surface of the packet. After the packet has received ninety blows, equally distributed over its surface, it is reheated and the hammering repeated in the same manner. Sometime after the first hammering the packet is broken and the sheets wetted with a mop, to harden the surface. After the second hammering the packet is broken, the sheets examined, to ascertain if any are welded together, and completely finished cold sheets are placed alternately between those of the packet, thus making a large packet of from 140 to 200 sheets. It is supposed that the interposition of these cold sheets produces the peculiar greenish color that the finished sheets possess on cooling.

This large packet is then given what is known as the finishing or polishing hammering. For this purpose the trip-hammer used has a larger face than the others, having an area of about 17 to 21 inches. When the hammering has been properly done the packet has received 60 blows, equally distributed, and the sheets should have a perfectly smooth, mirror-like surface. The packet is now broken before cooling, each sheet cleaned with a wet fir broom to remove the remaining charcoal powder, carefully inspected, and the good sheets stood on their edges in vertical racks, to cool. These sheets are trimmed to regulation size (28 by 56 inches) and assorted into Nos. 1, 2 and 3, according to their appearance, and again assorted according to weight, which varies from 10 to 12 lbs. per sheet. The quality varies according to color and freedom from flaws or spots. A first-class sheet must be without the slightest flaw, and have a peculiar metallic gray color, and on bending a number of times with the fingers, very little or no scale is separated, as in the case of ordinary sheet iron. The peculiar property of Russian sheet iron is the beautiful polished coating of oxides ('glanz") which it possesses. If there is any secret in the process, it probably lies in the "trick" of giving this polish. As far as I was able to judge, from personal observation and conversation with the Russian iron masters, the excellence of this sheet iron appeared to be due to no secret, but to a variety of conditions peculiar to and nearly always present in the Russian iron works of the Urals. Besides the few particulars already noted in the above description of this process, it should be borne in mind that the iron ores of the Urals are particularly pure, and that the fuel used is exclusively charcoal and wood. Another and equally important consideration lies in the fact that this same process of manufacturing sheet iron has been carried on in the Urals for the last hundred years. As a consequence, the workmen have acquired a peculiar skill, the want of which has made attempts to manufacture equally as good iron outside of Russia generally unsuccessful. It is difficult to understand what effect the use of charcoal powder between the sheets, as they are rolled and hammered, has upon the quality. It is equally as difficult to understand the effect of the interposition of the cold-finished sheets upon the production of the polished coating of oxide. The Russian iron-masters seem to attribute the excellence of their product more to this peculiar treatment than to any other cause. One thing is quite certain, there is no secret about the process, and if the Russian sheet iron is so much superior to any other, it is due to the combination of causes already indicated.

THE LARGEST ELECTRIC LIGHT IN THE WORLD.

The largest electric light in the world is on St. Catharine's Point lighthouse, Isle of Wight. Some idea of the power of this light will be conveyed when it is known that the carbons employed in electric arc lamps commonly used for street lighting are about ⅜ inch in thickness, while these have a diameter of nearly 2½ inches.

There are two dynamos, and if both worked in conjunction it is computed that the concentrated light from the lantern would equal six millions of candles. The induction arrangement of each machine consists of sixty permanent magnets, and each magnet is made up of eight steel plates. The armature, 2 ft. 6 in. in diameter, is composed of five rings with twenty-four bobbins in each, arranged in groups of four in tension and six in quantity.

LUMBER MEASUREMENT TABLE.

LENGTH		LENGTH		LENGTH		LENGTH		LENGTH		LENGTH	
2x4		2x6		2x8		2x10		3x6		3x8	
12	8	12	12	12	16	12	20	12	18	12	24
14	9	14	14	14	19	14	23	14	21	14	28
16	11	16	16	16	21	16	27	16	24	16	32
18	12	18	18	18	24	18	30	18	27	18	36
20	13	20	20	20	27	20	33	20	30	20	40
22	15	22	22	22	29	22	37	22	33	22	44
24	16	24	24	24	32	24	40	24	36	24	48
26	17	26	26	26	35	26	43	26	39	26	52

3x10		3x12		4x4		4x6		4x8		6x6	
12	30	12	36	12	16	12	24	12	32	12	36
14	35	14	42	14	19	14	28	14	37	14	42
16	40	16	48	16	21	16	32	16	43	16	48
18	45	18	54	18	24	18	36	18	48	18	54
20	50	20	60	20	27	20	40	20	53	20	60
22	55	22	66	22	29	22	44	22	59	22	66
24	60	24	72	24	32	24	48	24	64	24	72
26	65	26	78	26	35	26	52	26	69	26	78

6x8		8x8		8x10		10x10		10x12		12x12	
12	48	12	64	12	80	12	100	12	120	12	144
14	56	14	75	14	93	14	117	14	140	14	168
16	64	16	85	16	107	16	133	16	160	16	192
18	72	18	96	18	120	18	150	18	180	18	216
20	80	20	107	20	133	20	167	20	200	20	240
22	88	22	117	22	147	22	183	22	220	22	264
24	96	24	128	24	160	24	200	24	240	24	288
26	104	26	139	26	173	26	217	26	260	26	312

A blast at 800 degrees temperature will ignite charcoal; 900 degrees will ignite coke, and 1,300 degrees will ignite anthracite.

HOUSE BUILDING DEPARTMENT.

PLANS AND SPECIFICATIONS.

HINTS TO BUILDERS.

It seems to be a natural instinct with every one to desire to own his own home. There is a charm in the word "home" that can be felt only by those who do own their own houses. No matter how poor a man may be, if he can go *home* at night after his day's work is finished, there is a feeling of rest and security that amply repays any privations that may have been suffered in order to secure and pay for a home. In the succeeding pages we present designs for a large number of houses that will be found in every way suitable for any part of the country. They have been most carefully selected with a view to suiting all classes and tastes. For the handsome designs Nos. 4, 9, 17, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, we are indebted to the kindness of *The National Builder*. Full detail working plans of these houses may be obtained from The National Builder Company, No. 116 LaSalle street, Chicago, Ill., by remitting the small sum of 25 cents each. We desire that all who purchase this book should understand why we do not give the price of each house. Some books on architecture advertise to do this. We have left out the cost of the different houses for the reason that the cost of lumber, material and labor, differs so greatly in different parts of the country, that a sum which would be the cost price of any particular house in Illinois, would differ very greatly from the cost of the same house in Missouri. It will be an easy matter to take the specifications we supply, to any lumber merchant, and get an estimate on the quantity required, according to the quality. We shall now proceed to give a few valuable hints to those contemplating building, and to those owning and living in their own homes. As "brevity is the soul of wit," we shall make these 'hints' as brief as possible and to the point.

Build within your means. It is better to build a plain house *and pay for it*, than one that will keep you in hot water till it is paid for. It is an easy matter to add improvements to a house as they appear necessary and you can afford it.

Do not copy your neighbor's house. It will almost surely cause unpleasantness, and you will always find it more agreeable to be on good terms with your neighbor. See to it that your house is built so that you get plenty of ventilation and sunshine. Nothing is more important. Be sure and arrange to have the living-rooms on the sunny side. It is both pleasanter and healthier. Do not have stationary wash-bowls in sleeping-rooms.

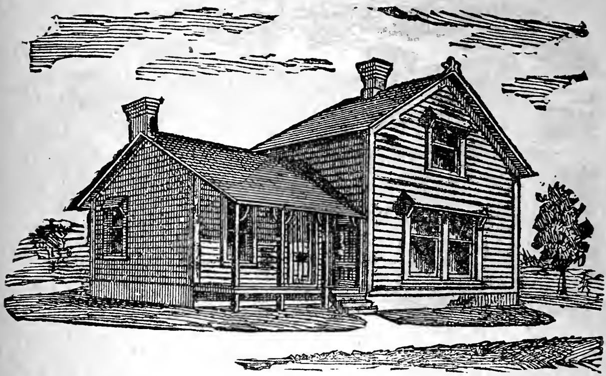
Be sure and arrange your house so that at any future time it may be readily enlarged with additions at the least expense. This is an important item.

Do not fail to have a legal contract, covering every detail, drawn up and signed by your contractor and builder, and properly witnessed. A proper observance of this may save you a great deal of trouble and many dollars. Do not attempt to vie with rich neighbors. Do not sacrifice comfort for the sake of appearances. You will certainly suffer for it in the long run.

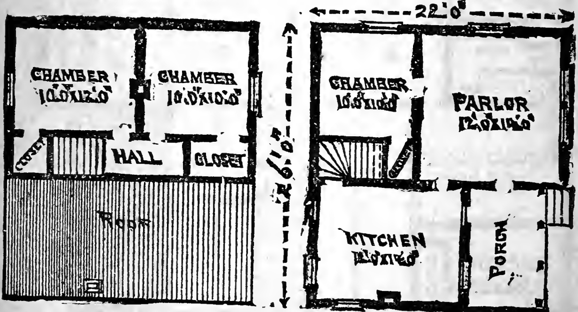
Do not have gingerbread work in or upon the house, nor allow poor work or shams of any kind to enter into its construction.

Arrange to have large rooms. They will give much better satisfaction than small rooms and more of them.

DESIGN No. 1.

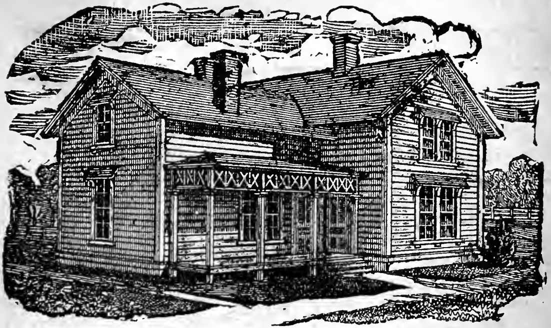


Five Room Cottage.

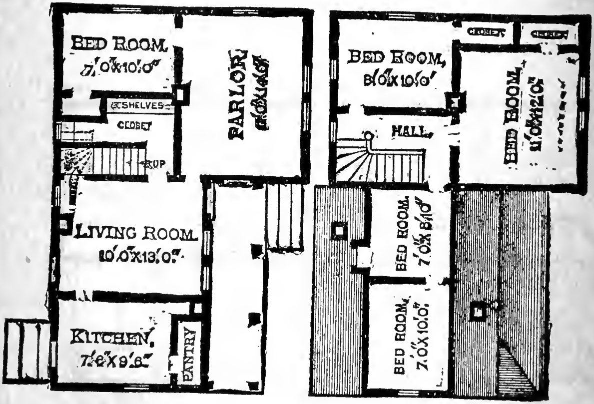


Very Cheap and Comfortable.

DESIGN No. 2.

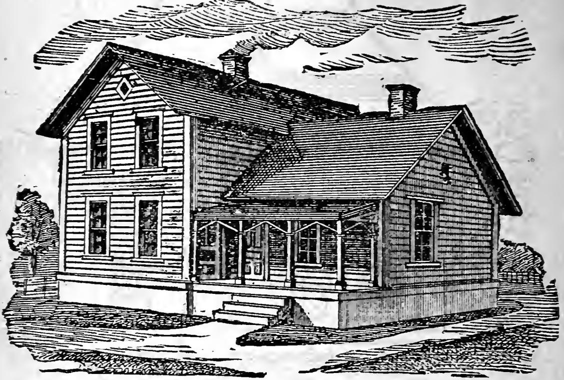


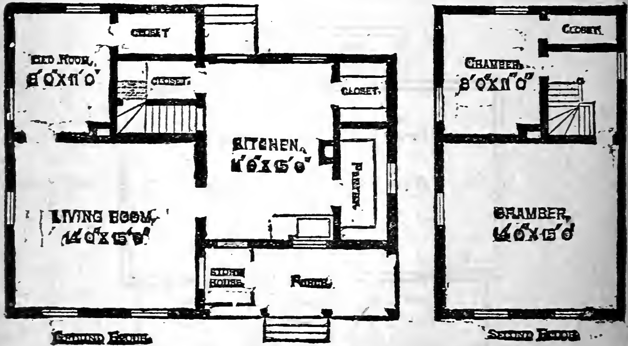
Eight Room Dwelling,



Suitable for Farm or Village.

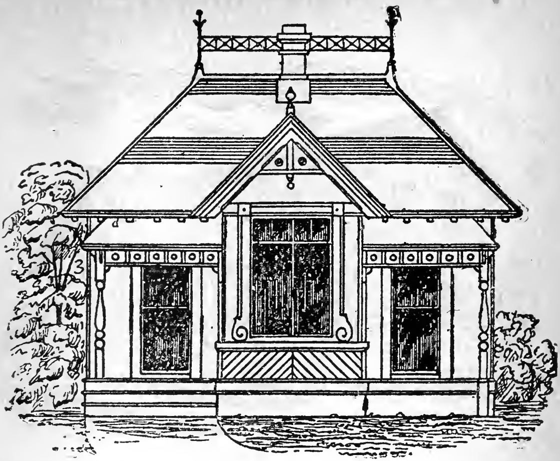
DESIGN No. 3.



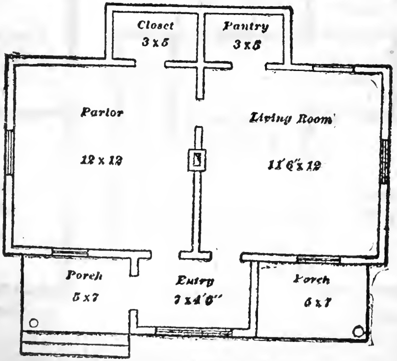


A very convenient Five Room Cottage.

DESIGN No. 4.



FRONT ELEVATION.

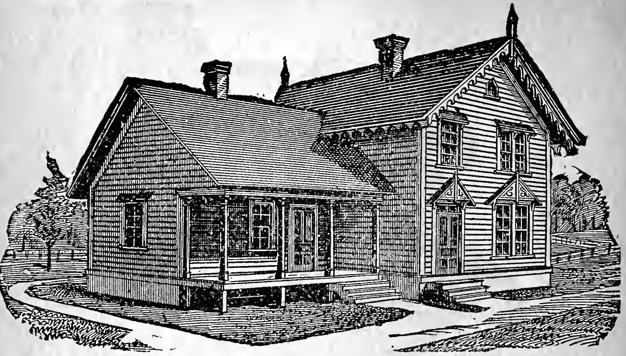


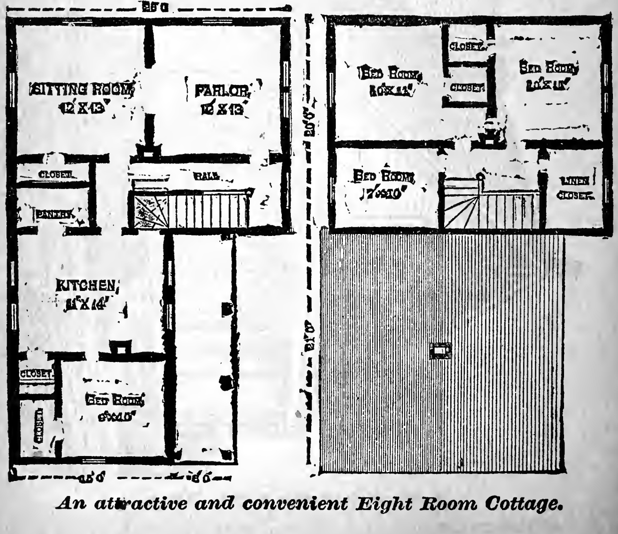
FLOOR PLAN.

A Convenient and Cheap Cottage.

Size — 21½ feet deep, 25 feet wide.

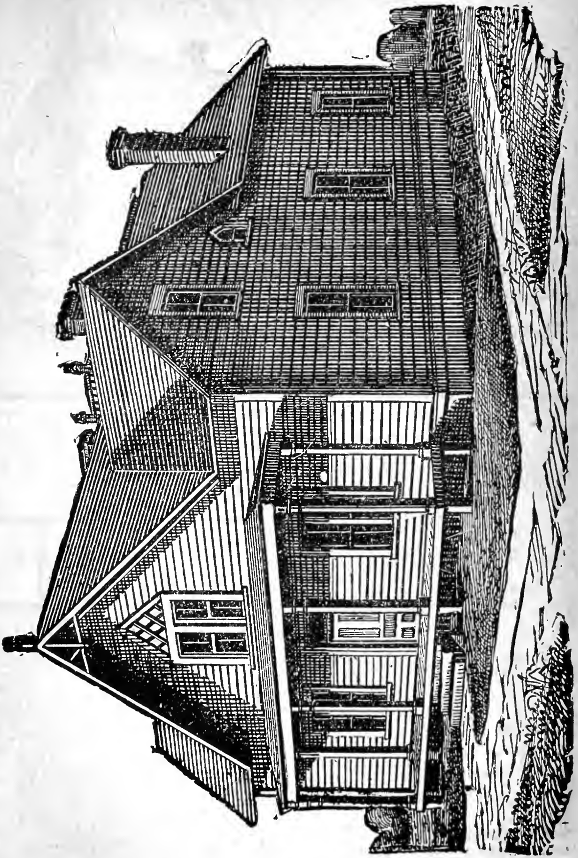
DESIGN No. 5.





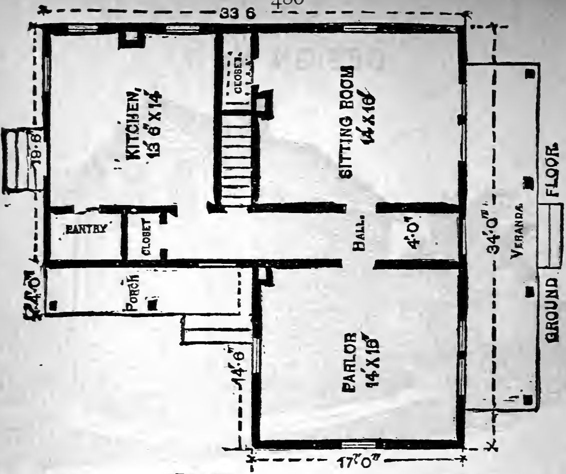
An attractive and convenient Eight Room Cottage.

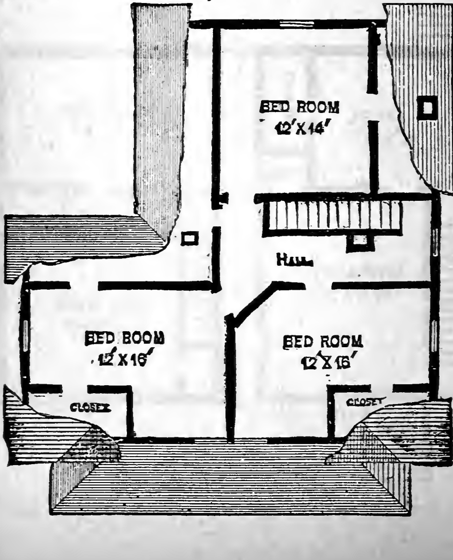
DESIGN No. 6.



A convenient Six Room House.

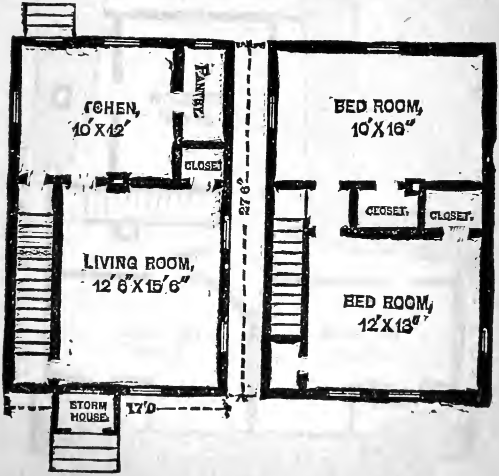
(See Plans on next page.)





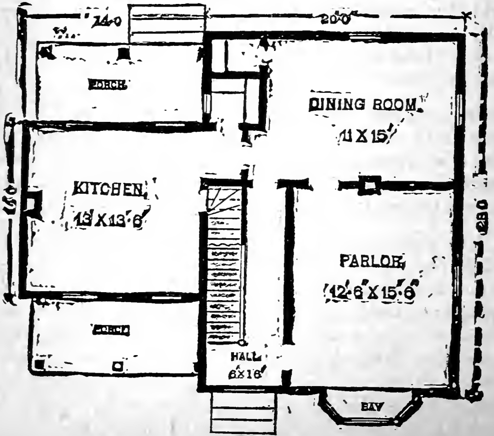
Plan for Design No 6.

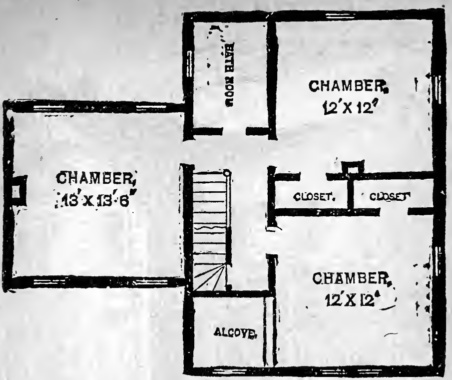
DESIGN No. 7.



A very Cheap House for small Farm or Village Tenement.

DESIGN No. 8.


24·0
20·0
PORCH
DINING ROOM
11 X 15
KITCHEN
13 X 13·6
PARLOR
12·6 X 15·6
PORCH
HALL
6 X 16
BAY
28·0



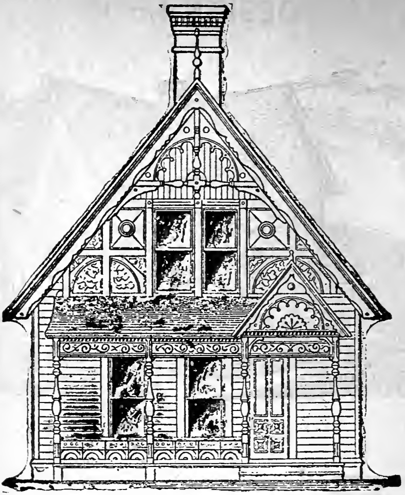
Second Story, Design No. 8.

To find the number of bricks required in a building: Rule—Multiply the number of cubic feet by 22½. The number of cubic feet is found by multiplying the length, height and thickness (in feet) together. Bricks are usually made 8 inches long, 4 inches wide and 2 inches thick; hence it requires 27 bricks to make a cubic foot without mortar, but it is generally assumed that the mortar fills 1-6 of the space.

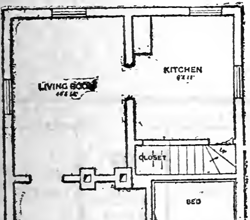
Partitions unsupported from underneath the floors should be supported from the walls by means of a simple truss. This can be made by setting two pieces of scantling into the walls on either side, at the floor, to abutt against each other at the ceiling or against a collar-beam over the doors. This plan will obviate the sinking of floors so often seen under partitions.

Putty, for plastering, is a very fine cement made of lime only. It is thus prepared: Dissolve in a small quantity of water, as two or three gallons, an equal quantity of fresh lime, constantly stirring it with a stick until the lime be entirely slaked, and the whole becomes of a suitable consistency, so that when the stick is taken out of it, it will but just drop therefrom; this, being sifted or run through a hair sieve, to take out the gross parts of the lime, is fit for use. Putty differs from fine stuff in the manner of preparing it, and its being used without hair.

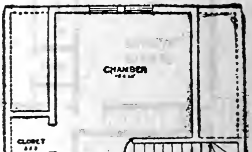
DESIGN No. 9.



FRONT ELEVATION.



FIRST FLOOR.

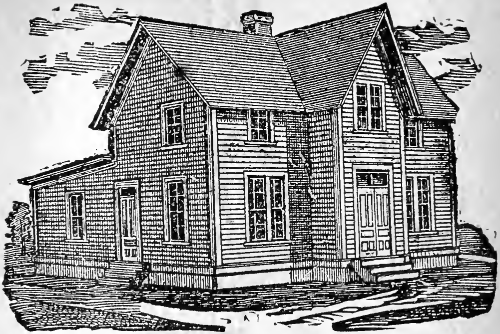


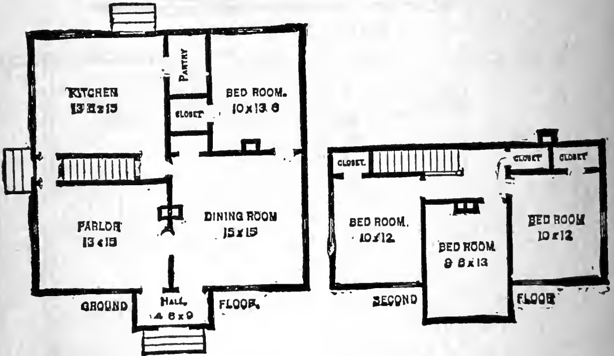
SECOND FLOOR.

Size—30 ft. deep, 21 ft. wide.

A MODEL COTTAGE.

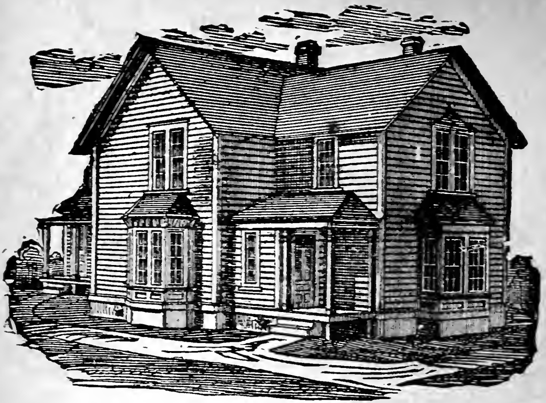
DESIGN No. 10.

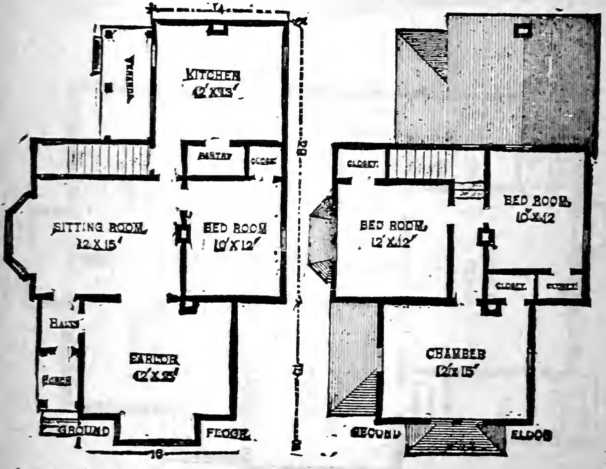




This can easily be made larger by making it all two stories high, which would give quite a large house.

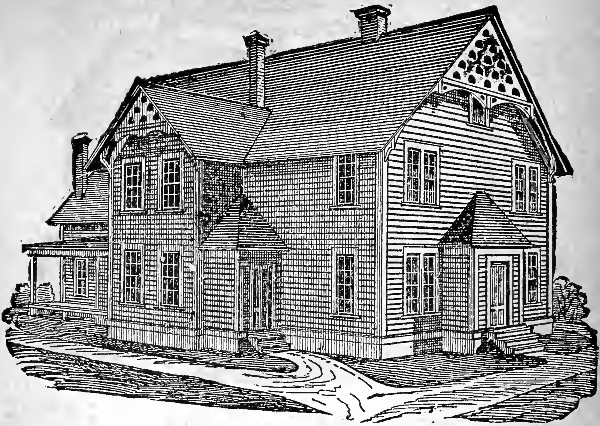
DESIGN No. 11.

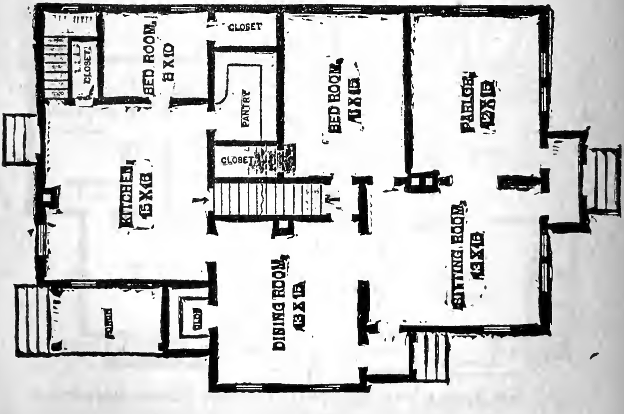


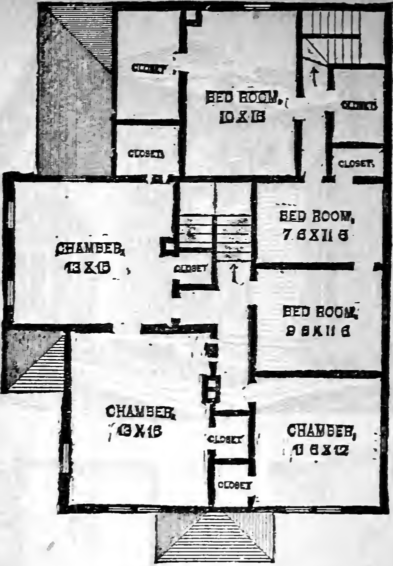


A very handsome and convenient Seven Room Residence.

DESIGN No. 12.




CLOSET
BED ROOM
CLOSET
PANTRY
BED ROOM
PARLOR
KITCHEN
CLOSET
SITTING ROOM
DINING ROOM



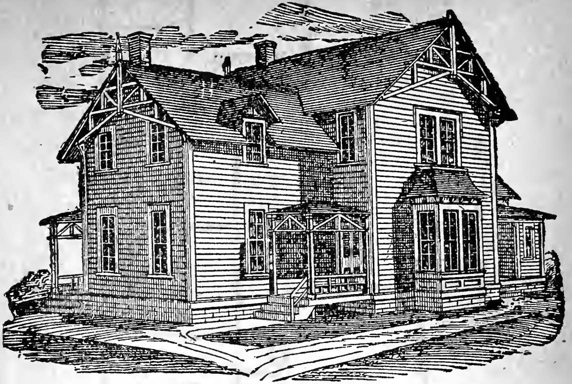
Design 12 is a very well arranged, large House, capable of accommodating a large family, thoroughly provided with closets, etc.

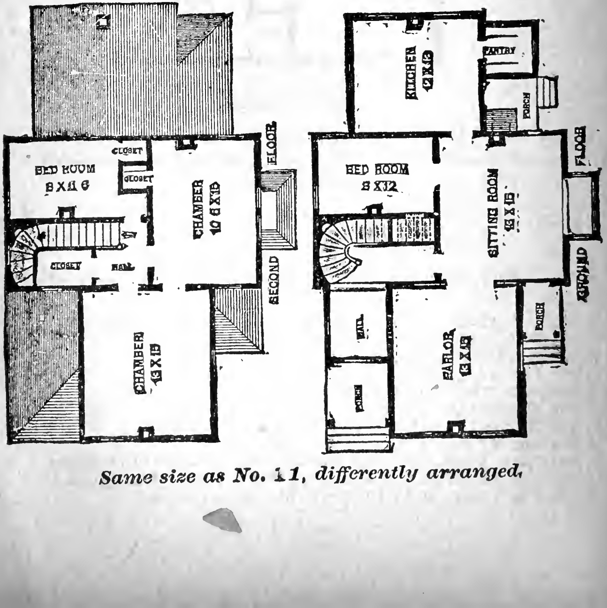
MEASURES OF CAPACITY.

The following table will often be found convenient, taking inside dimensions:

A box 24 in.x24 in. x 14.7 will contain a barrel of 31½ gallons.
A box 15 in. x 14 in. x 11 in. will contain 10 gallons.
A box 8¼ in. x 7 in. x 4 in. will contain a gallon.
A box 4 in. x 4 in x 3.6 in. will contain a quart.
A box 24 in. x 28 in. x 16 in. will contain 5 bushels.
A box 16 in. x 12 in. x 11.2 in. will contain a bushel.
A box 12 in. x 11.2 in 8 in. will contain a half bushel.
A box 7 in. x 6.4 in. x 12 in. will contain a peck.
A box 8.4 in. x 8 in.x4 in. will contain a half peck, or 4 dry quarts.
A box 6 in. x 5 3-5 in., and 4 in. deep, will contain a half gallon.
A box 4 in. x 4 in., and 2 1-10 deep, will contain a pint.

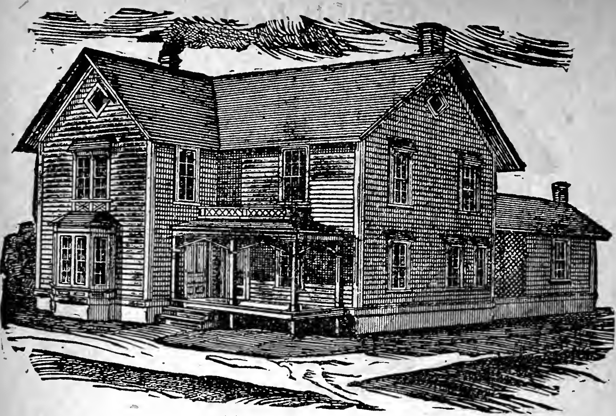
DESIGN No. 13.





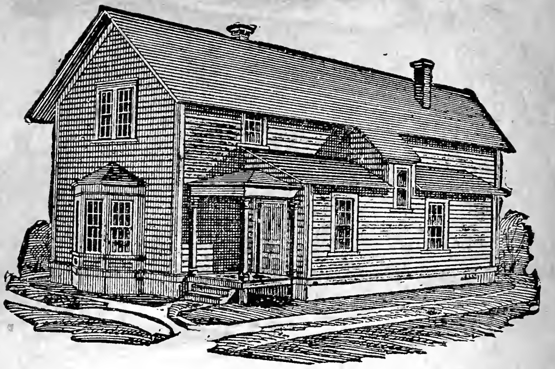
Same size as No. 11, differently arranged.

DESIGN No. 14.

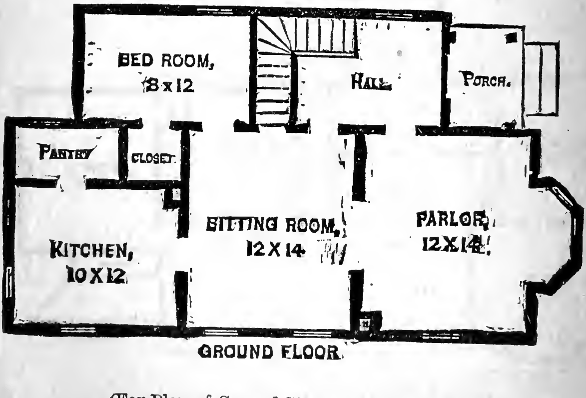


Convenient Eight Room Dwelling,

DESIGN No. 15.

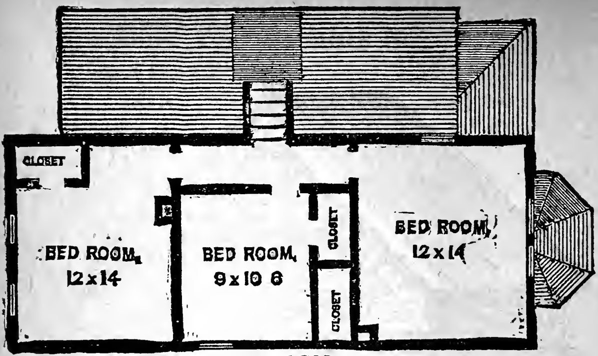


A Cheap Village or City House where ground is limited.



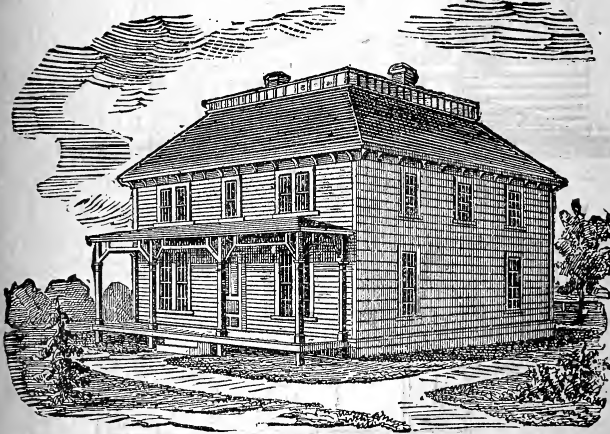
GROUND FLOOR.

(For Plan of Second Story see opposite Page.)



SECOND FLOOR

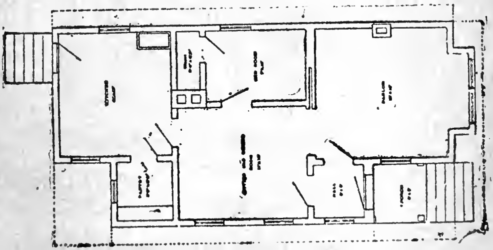
DESIGN No. 16.



A good Farm or Village House, with room well utilized.

DESIGN No. 17.

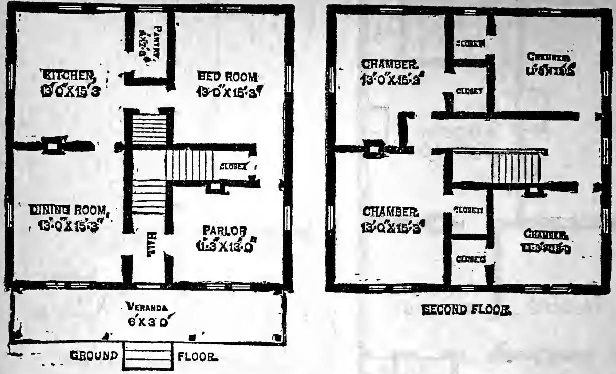
FRONT ELEVATION.



FLOOR PLAN.

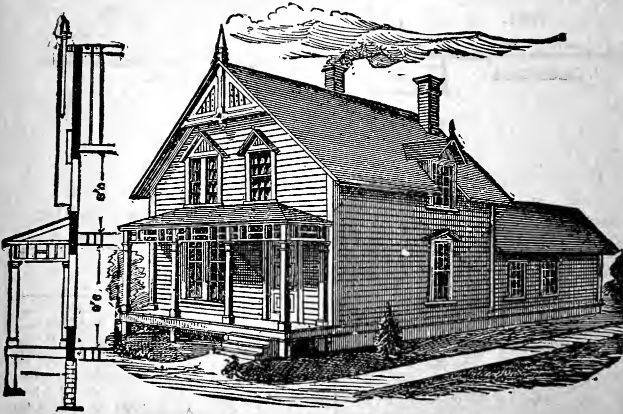
A Beautiful and Convenient Cottage.

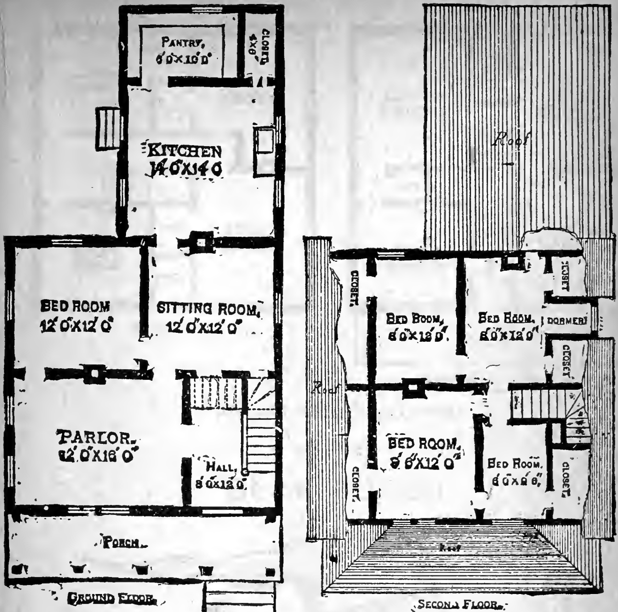
Size — 42 feet deep, 20 feet wide.



Plans of Design No. 16.

DESIGN No. 18





Plans for Design No. 18.

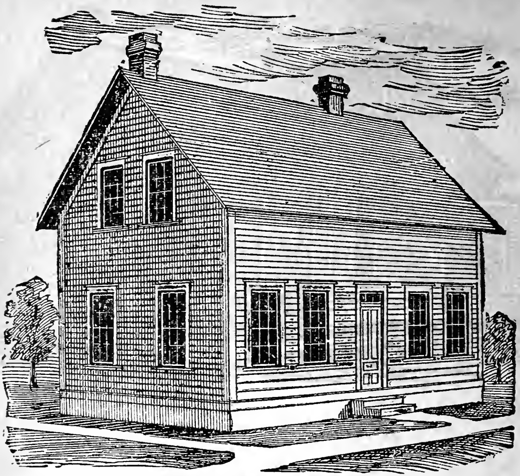
DIMENSIONS OF ONE ACRE.

A square, whose sides are 12,649 rods, or 69.57 rods, or 208.71 feet long, contains one acre. Table of dimensions of rectangle containing one acre:

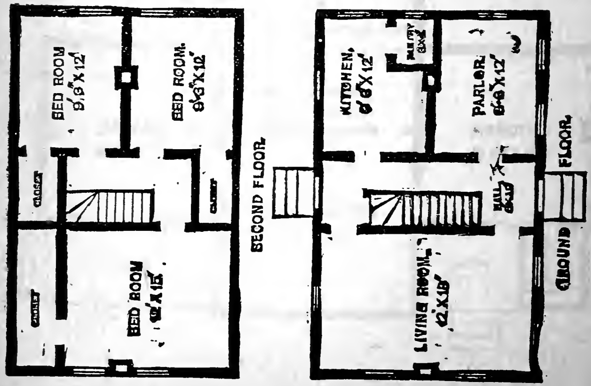
RODS.

1 × 160	1½ × 106⅔	2 × 80	2½ × 64
3 × 53⅓	3½ × 45 5-7	4 × 40	4½ × 35 5-9
5 × 32	5½ × 29 1-11	6 × 26⅔	6½ × 24 8-13
7 × 22 6-7	7½ × 21⅓	8 × 20	8½ × 18 14-17
9 × 17 7-9	9½ × 16 16-19	10 × 16	10½ × 15 5-21
11 × 14 6-11	11½ × 13 21-33	12 × 13⅓	12½ × 12 4-5
			12 13-20 × 12 13-20

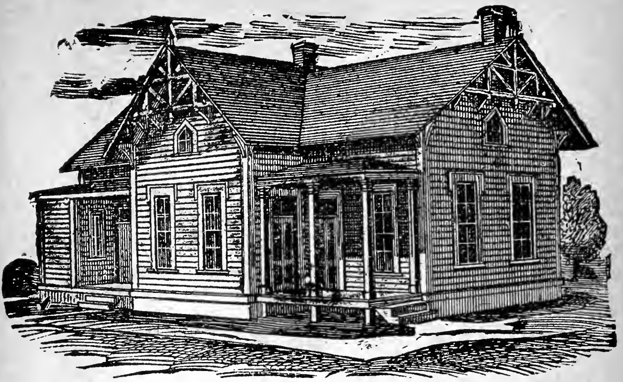
DESIGN No. 19.



A very Cheap and convenient House.

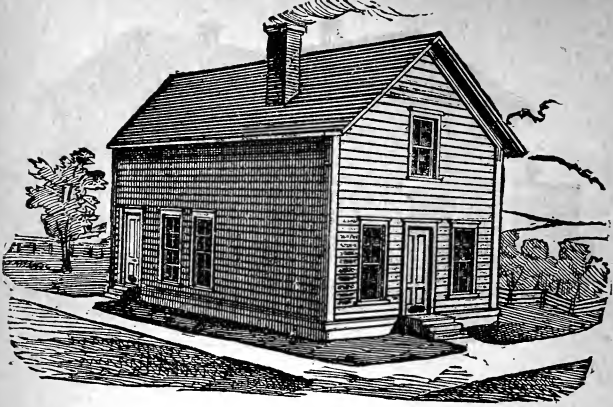


DESIGN No. 20.

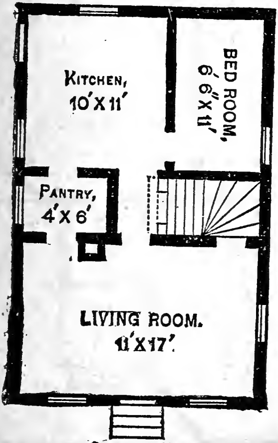


A Model One Story House.

DESIGN No. 21.



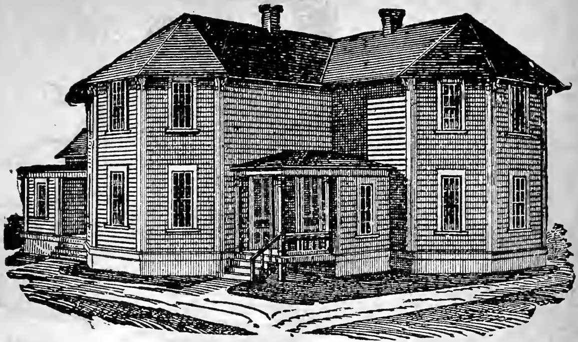
A very Cheap Tenement.



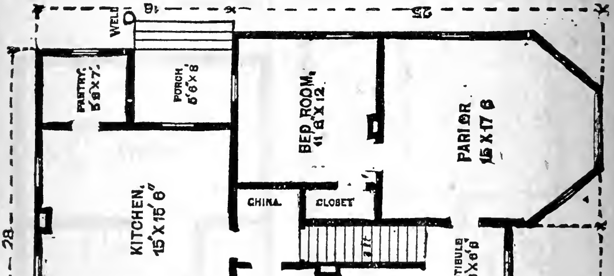
GROUND FLOOR.

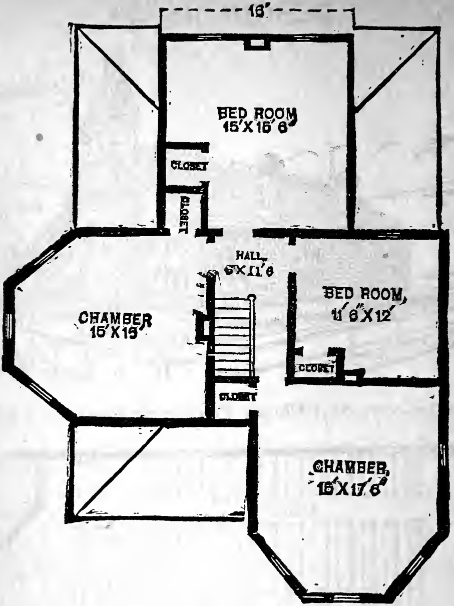
SECOND FLOOR.

DESIGN No. 22.



A beautiful Village Residence.





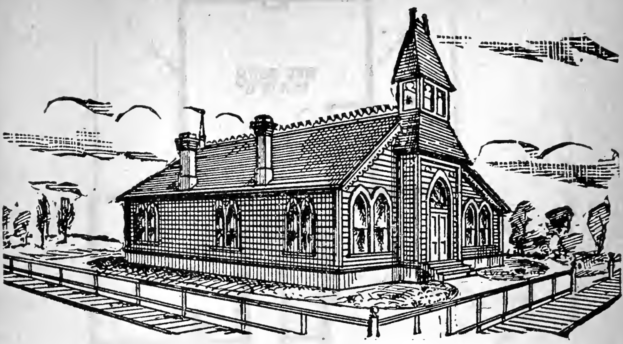
Second Story Plan Design No. 22.

NUMBER OF TREES REQUIRED PER ACRE.

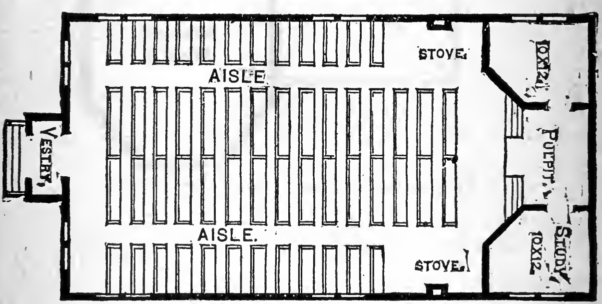
4 feet apart each way	2,720	15 feet apart each way	200
5 " "	1,742	18 " "	135
6 " "	1,200	20 " "	110
8 " "	680	25 " "	70
10 " "	430	30 " "	50
12 " "	325	33 " "	40

Hay Measure.—About 500 cubic feet of well-settled hay, or about 700 of new mown hay, will make a ton. To estimate amount of hay in mow—Ten cubic yards of meadow hay weigh a ton. When the hay is taken out of old stacks, 8 or 9 yards will make a ton. Eleven or 12 cubic yards of clover, when dry, make a ton. (*Note.*—The only accurate method to measure hay is to weigh it, since two quantities equal in bulk will never weigh alike. Any rule is simply an approximation.)

DESIGN No. 23.

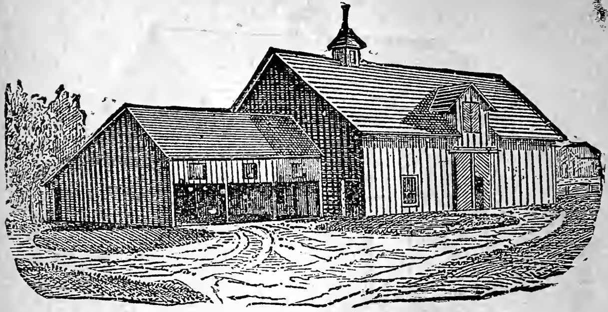


An attractive and Cheap Village or Country Church.

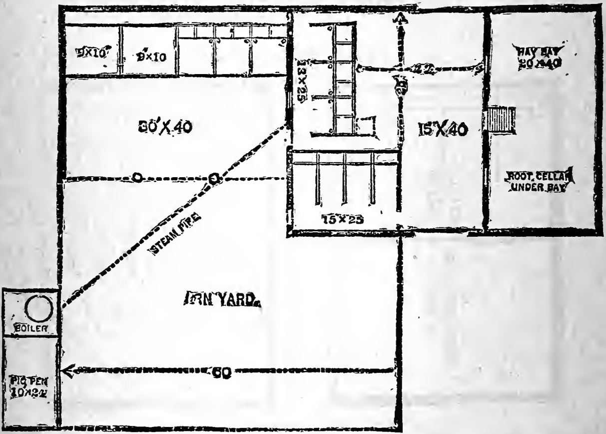


Building contracts, as all other business arrangements, should be written. A few moments' time spent in stating, clearly and concisely, what is expected of each party will often save delays and annoyances during the progress of the work and endless litigation after it. The mechanic's lien laws are a sufficient protection to the contractor or material-man, but their enforcement is much more simple and prompt if action can be based on a written contract.

DESIGN No. 24.

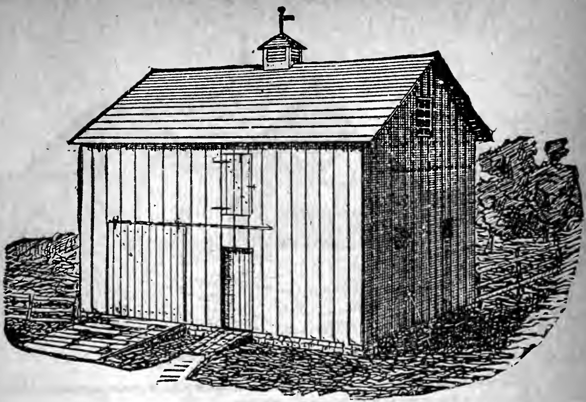


A very commodious Barn.

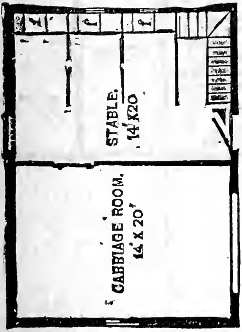


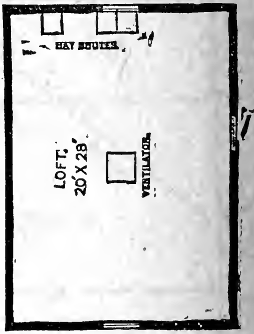
FLOOR, WALL AND ROOF MEASURE.—To find the number of square yards in a floor or wall: *Rule*—Multiply the length by the width or height (in feet), and divide the product by 9; the result will be square yards.

DESIGN No. 25.



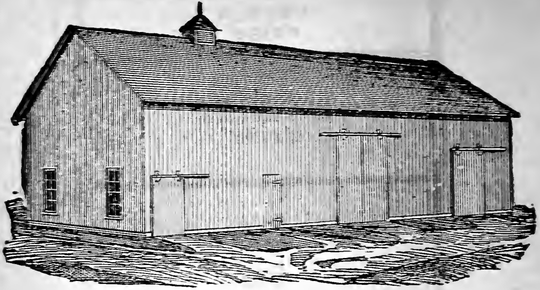
Cheap Horse Barn.





To find the contents of a corn crib: Rule—Multiply the number of cubic feet by 4½ and point off one decimal place—the result will be the answer in bushels. How many bushels will a crib hold that is 48 feet long, 7½ feet wide and 8½ feet high?—48×7½×8½=3,060 cubic feet; 3,060×4½=12,240; 12,240+1530=1377. bushels, answer.

DESIGN No. 26.



A Finely Arranged Combination Barn.

(For Plan see opposite Page.)

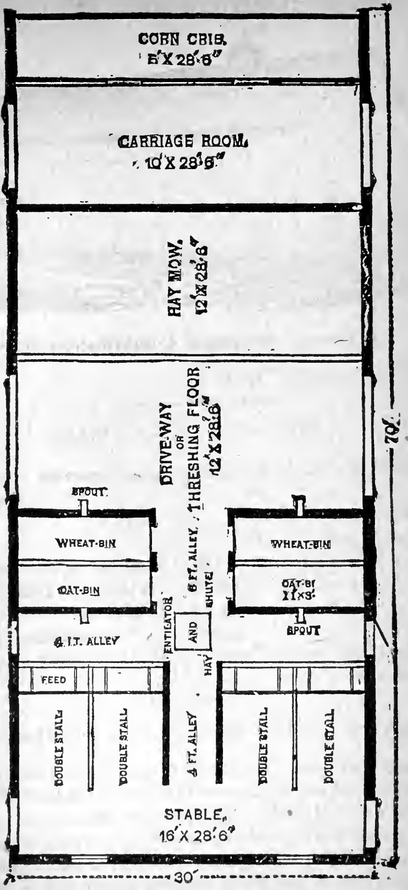
ESTIMATES OF MATERIALS.

3½ barrels of lime will do 100 square yards plastering, two coats.
2 " " " 100 " " one coat.
1½ bushels of hair " 100 " "
1¼ yards good sand " 100 " "
⅓ barrel of plaster (stucco), will hard-finish 100 square yards plastering.
1 barrel of lime will lay 1,000 brick. (It takes good lime to do it.)
2 " " 1 cord rubble stone.
½ " " 1 perch " (estimating ¼ c'd to perch.)

To every barrel of lime estimate about ⅝ yards of good sand for plastering and brick work.

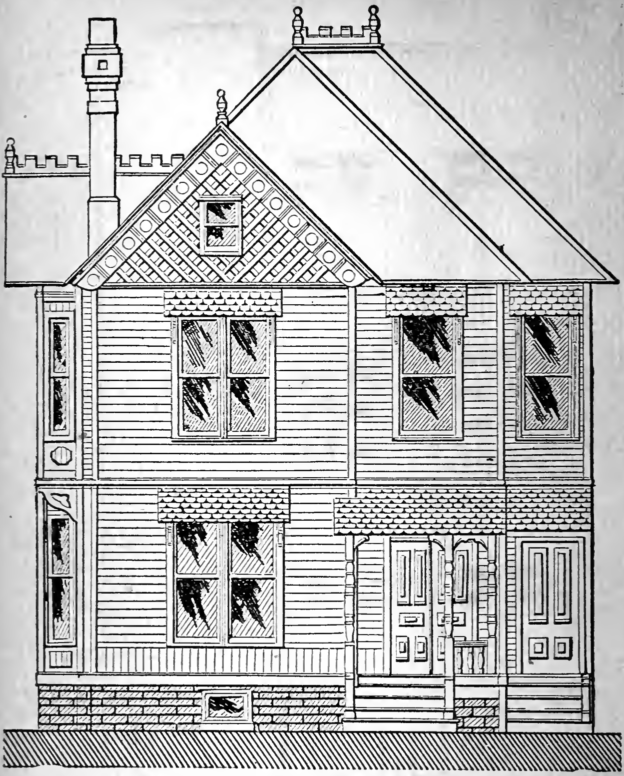
AMOUNT OF PAINT REQUIRED FOR A GIVEN SURFACE.

It is impossible to give a rule that will apply in all cases, as the amount varies with the kind and thickness of the paint, the kind of wood or other material to which it is applied, the age of the surface, etc. The following is an approximate rule: Divide the number of square feet of surface by 200. The result will be the number of gallons of liquid paint required to give two coats; or, divide by 18 and the result will be the number of pounds of pure ground white lead required to give three coats.



Plan of Barn—Design No. 26.

DESIGN No. 27.



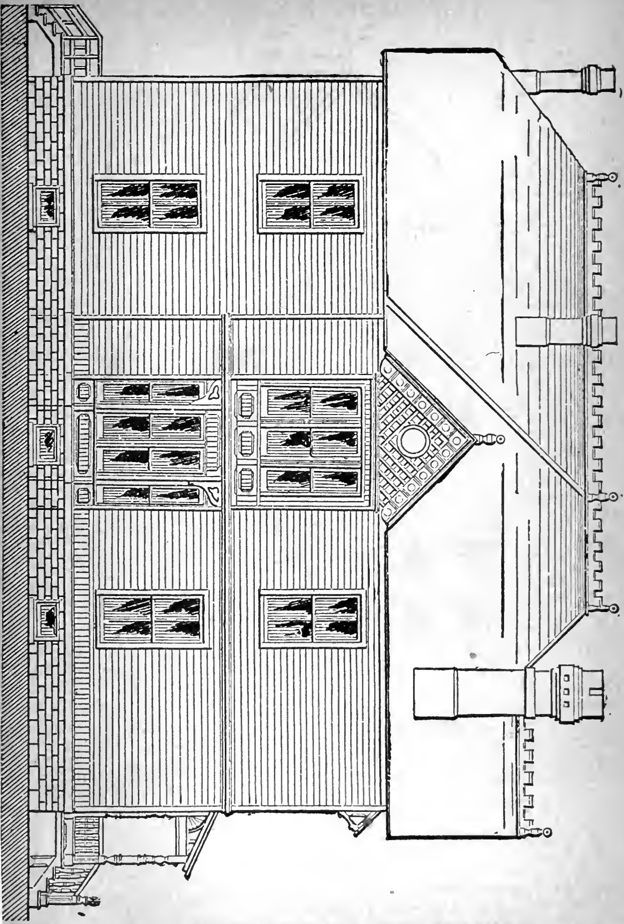
A Model Residence. (Front Elevation.)

WOOD MEASURE.

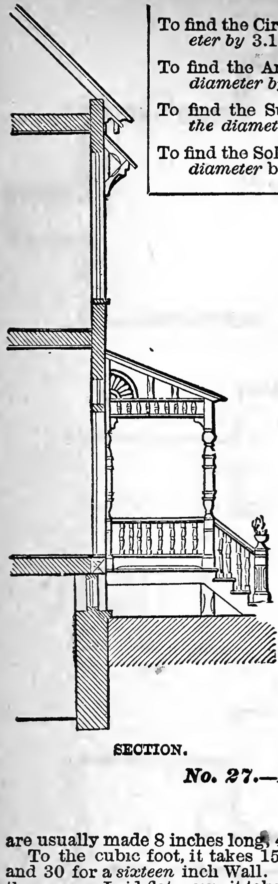
To find the contents of Cord Wood; *multiply the length, width and height together and divide the product by* 128.

How many Cords in a pile of Wood 4 ft. wide, 5 ft. high and 24 ft. long?

$4 \times 5 \times 24 = 480$ (cu. ft.) $\div 128 = 3\frac{3}{4}$ cords.



No. 27.—Model Residence. (Side Elevation.)

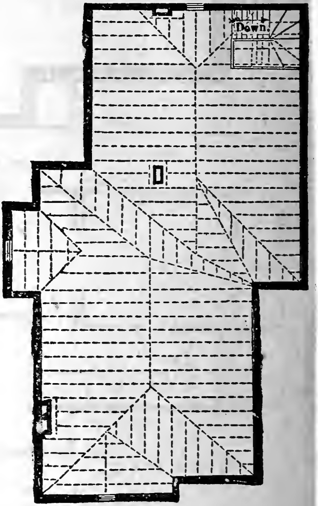


To find the Circumference of a Circle; *multiply the diameter by* 3.1416.

To find the Area of a Circle; *multiply the square of the diameter by* .7854.

To find the Surface of a Globe; *multiply the square of the diameter by* 3.1416.

To find the Solidity of a Globe; *multiply the cube of the diameter* by .5236.



SECTION. ROOF AND ATTIC PLAN.

No. 27.—Model Residence.

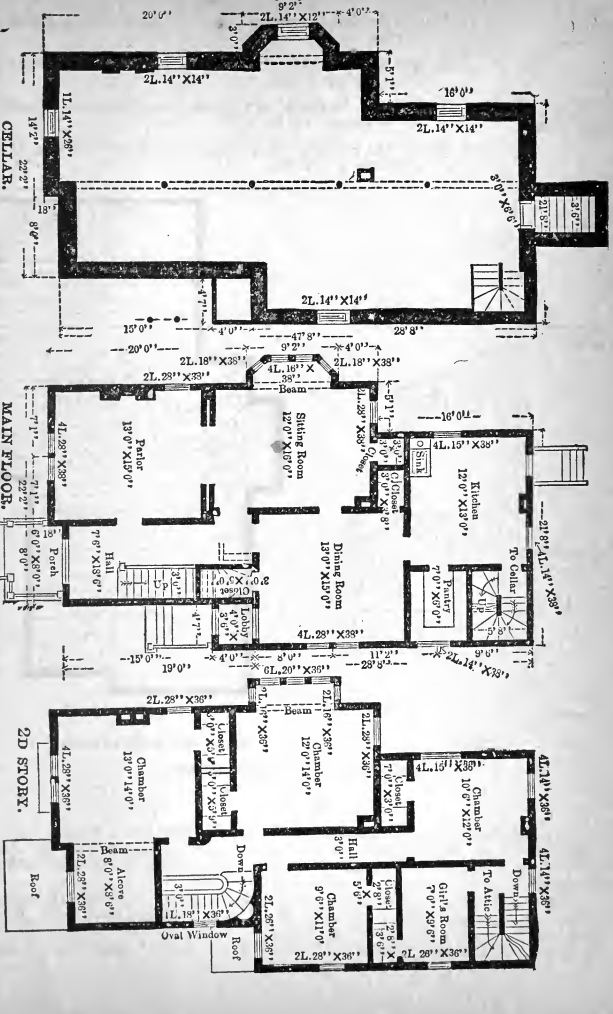
BRICK

are usually made 8 inches long, 4 inches wide, and 2 inches thick.

To the cubic foot, it takes 15 for an *eight* inch, $22\frac{1}{2}$ for a *twelve* inch, and 30 for a *sixteen* inch Wall. The mortar filling up about *one-sixth* of the space. Laid flat ways, it takes $4\frac{1}{2}$ to the sq. ft.

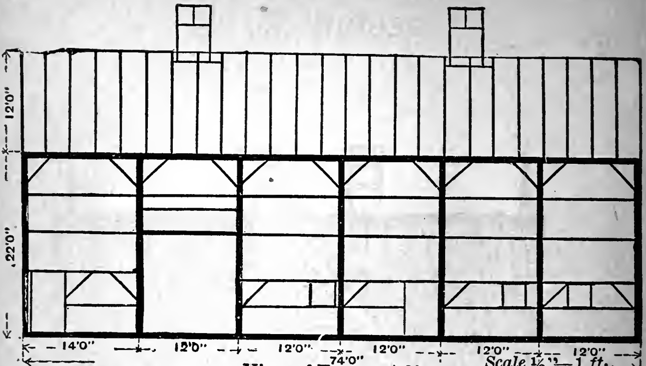
How many Brick will it take to build a house, whose walls are 156 ft. long, 20 ft. high and 16 inches ($1\frac{1}{3}$ ft.) thick; deducting 640 cu. ft. for doors and windows?

$156 \times 20 \times 1\frac{1}{3} = 4160$ cu. ft.
Less $640 = 3520$ "
$22\frac{1}{2}$
Ans. 79200 brick.

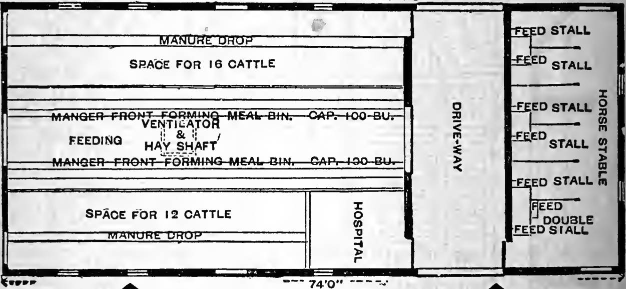


No. 27.—Model Residence.

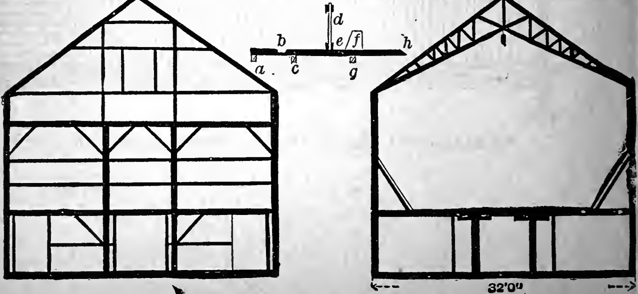
DESIGN No. 28.



View of Frame at Side Scale 1/8" = 1 ft.

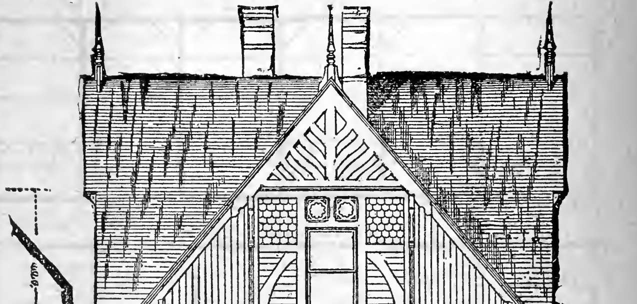


Scale 1/8" = 1 ft.-32'0" Plan of Barn

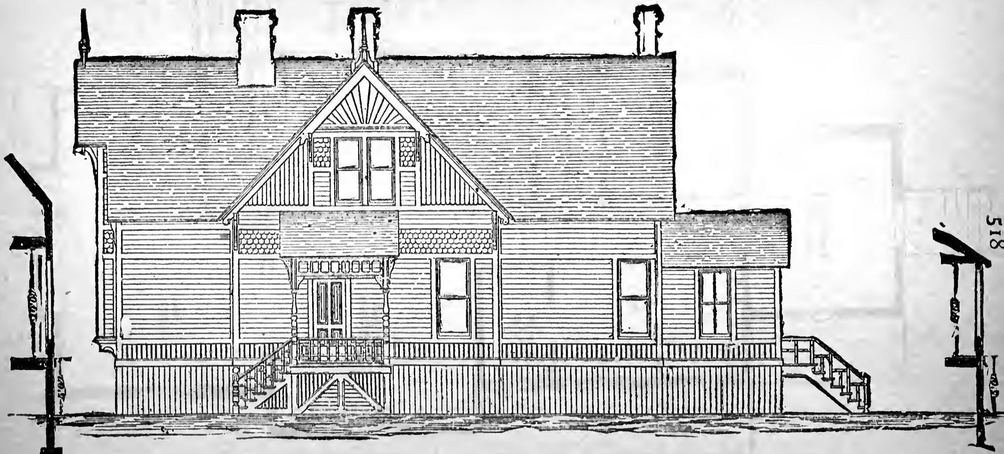


Model Combination Barn.

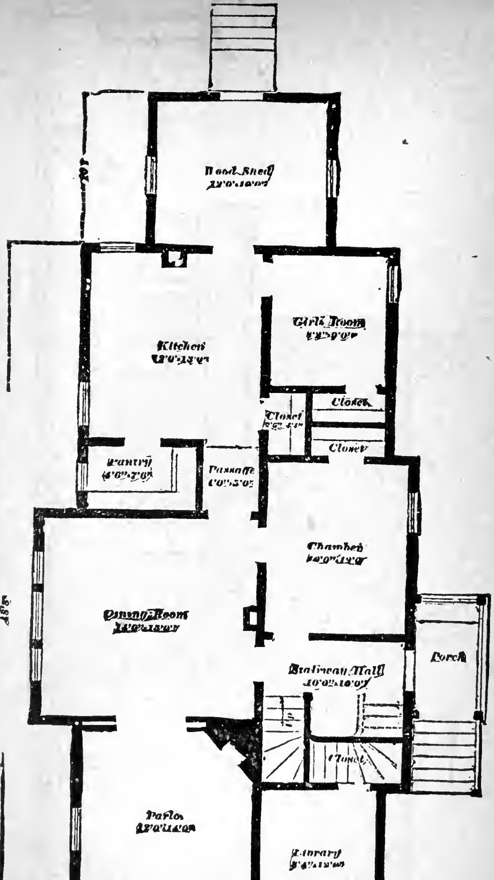
DESIGN No. 29.



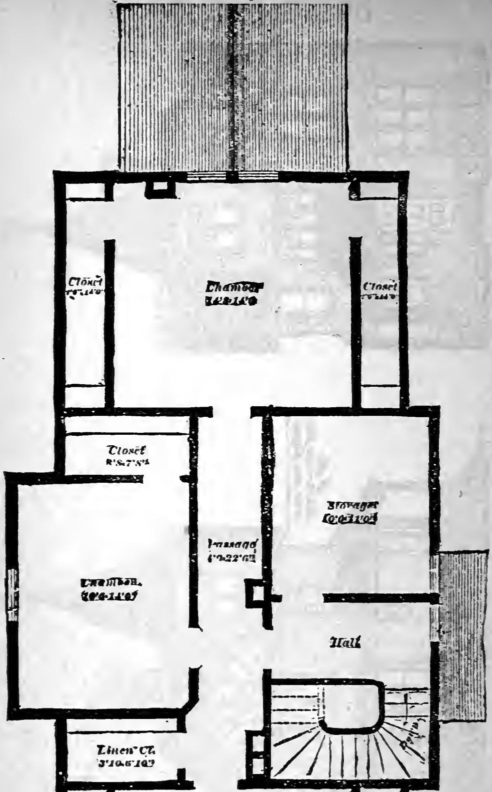
"CHICAGO COTTAGE"—Front Elevation.



No. 29.—"CHICAGO COTTAGE"—Side Elevation.



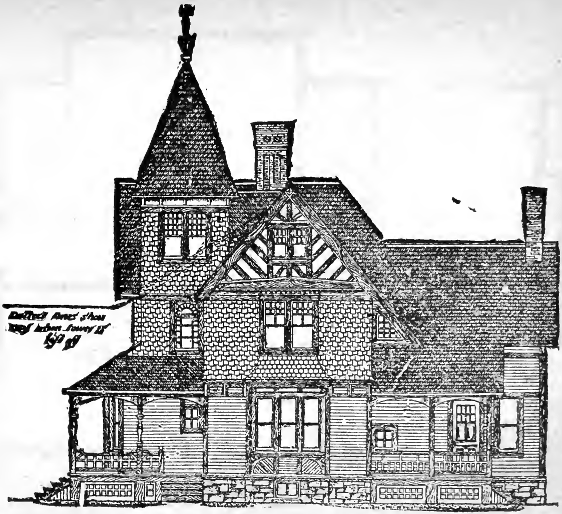
No. 29.—"CHICAGO COTTAGE"—Ground Floor Plan.



No. 29.—"CHICAGO" COTTAGE—Second Floor Plan.

DESIGN No. 30.

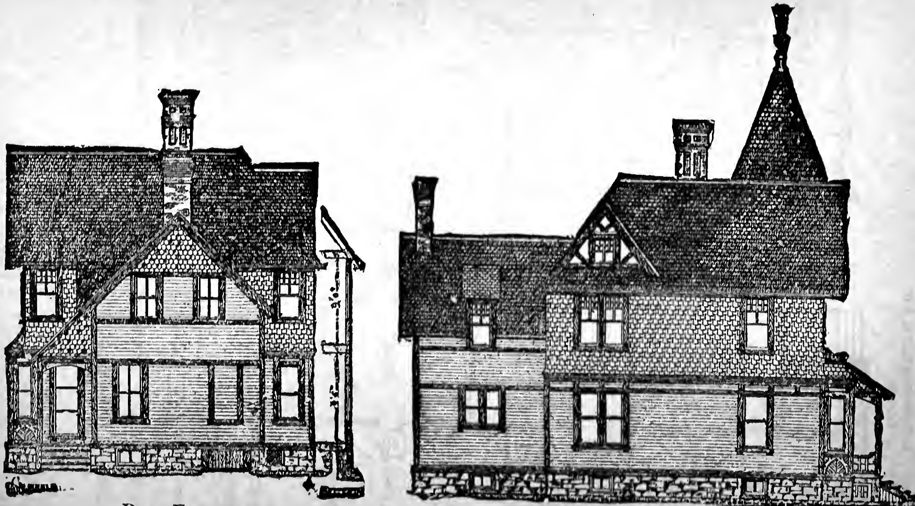
FRONT ELEVATION.



SIDE ELEVATION.

No. 30.—Elevations of Modern Eight Room Cottage.

Plans of this Cottage furnished by Palliser, Palliser & Co., Architects, Bridgeport, Conn.



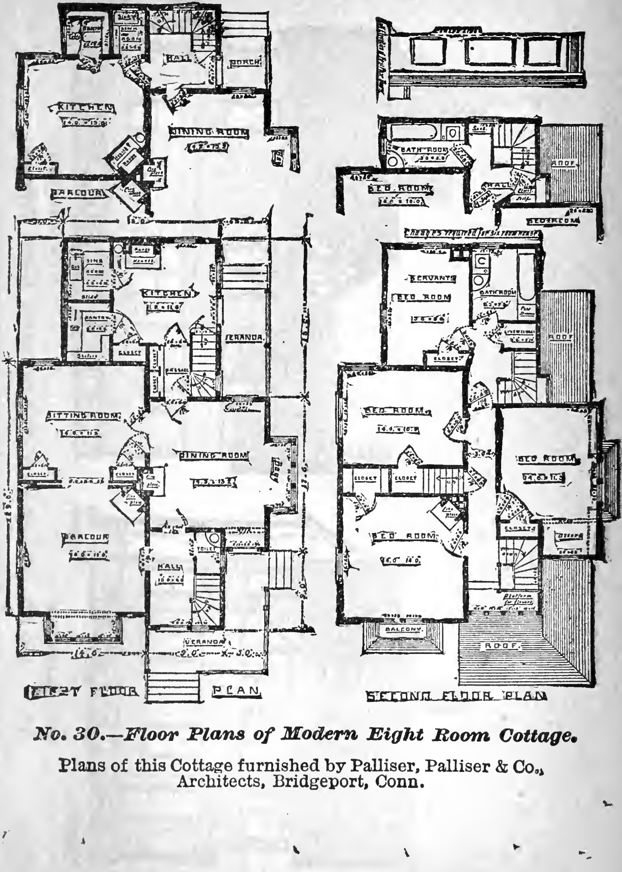
REAR ELEVATION.

SIDE ELEVATION.

No. 30.—Elevation of Modern Eight Room Cottage.

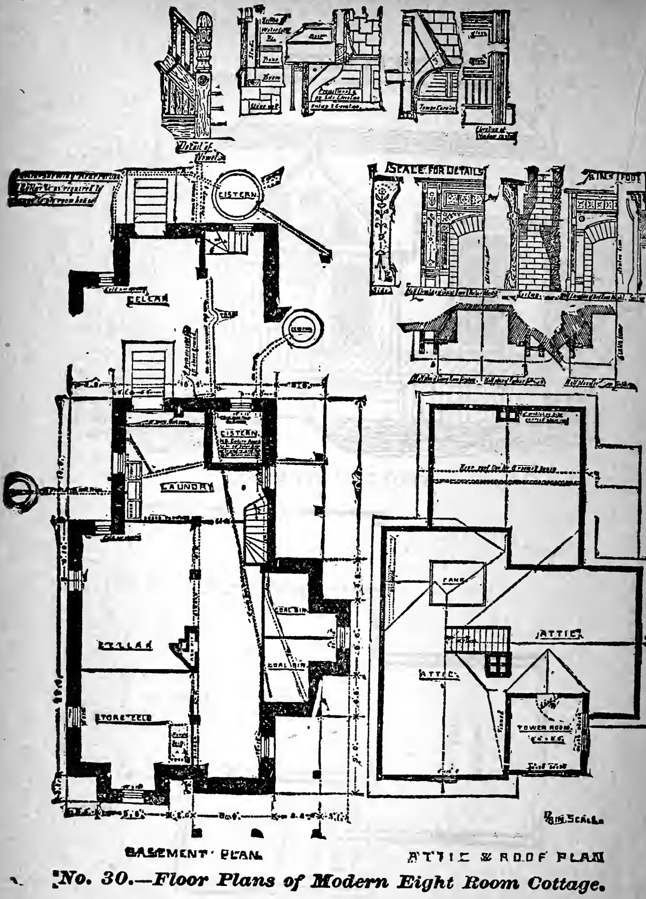
Plans of this Cottage furnished by Palliser, Palliser & Co., Architects, Bridgeport, Conn.

Plan showing changes required for six-room house.



No. 30.—Floor Plans of Modern Eight Room Cottage.

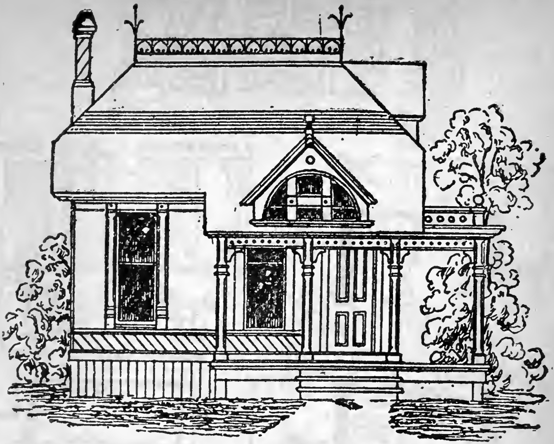
Plans of this Cottage furnished by Palliser, Palliser & Co., Architects, Bridgeport, Conn.



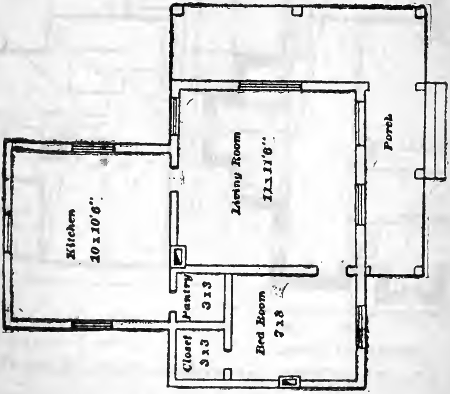
No. 30.—Floor Plans of Modern Eight Room Cottage.

Plans of this Cottage furnished by Palliser, Palliser & Co., Architects, Bridgeport, Conn.

DESIGN No. 31.



FRONT ELEVATION.

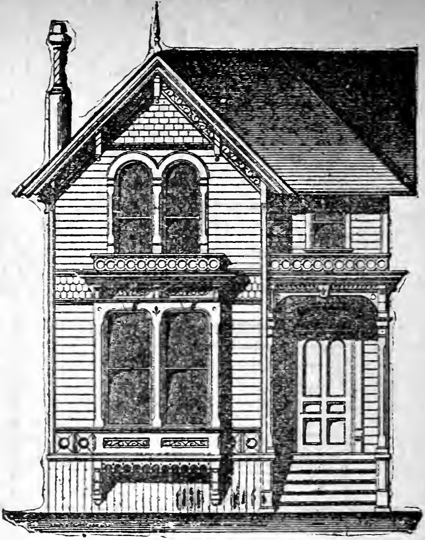


FLOOR PLAN.

MULTUM IN PARVO COTTAGE.

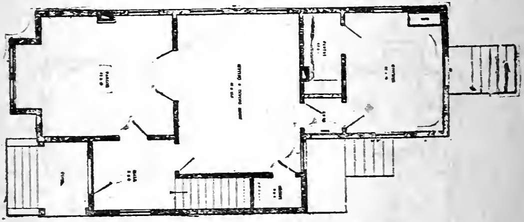
Size — 23 feet deep, 20 feet wide.

DESIGN No. 32.

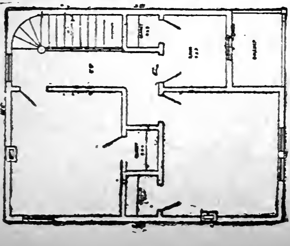


FRONT ELEVATION.

FIRST FL.



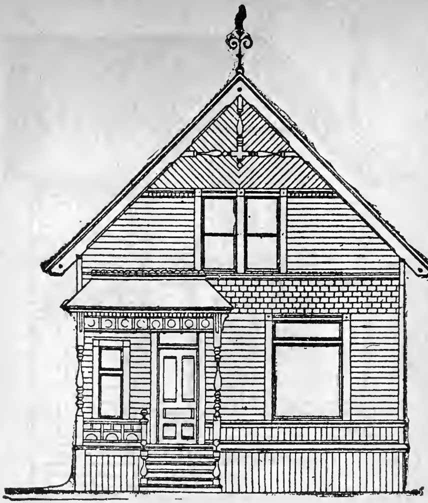
SECOND FLOOR.



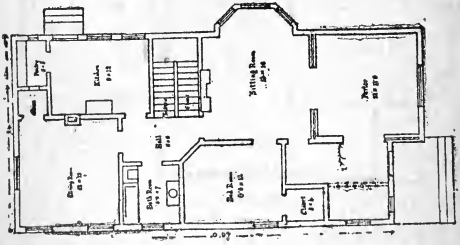
A Handsome and Commodious Residence.

Size—43 feet deep, 20 feet wide.

DESIGN No. 33.



FRONT ELEVATION.

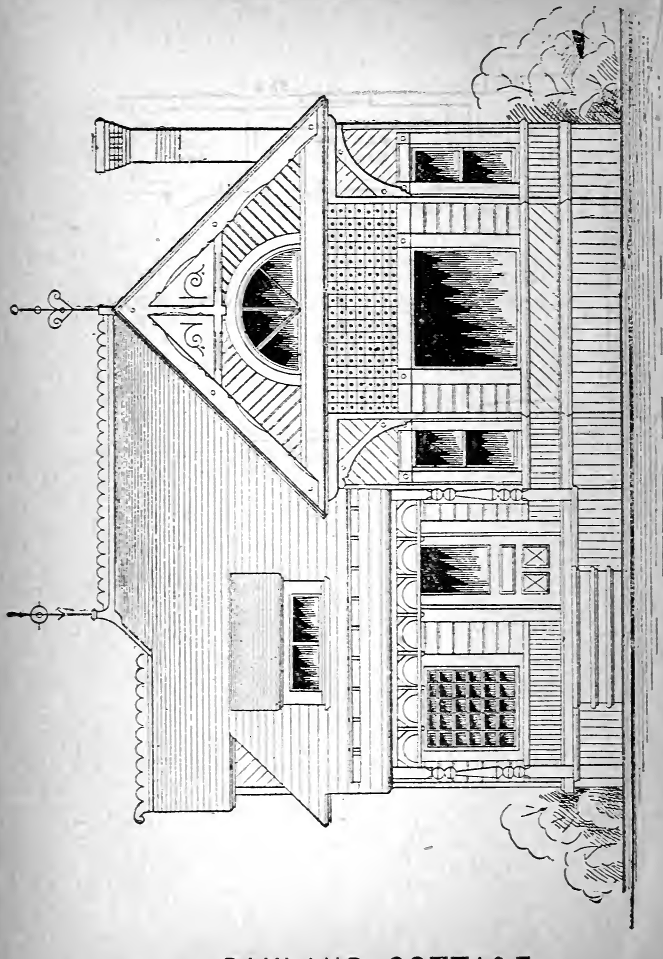


FLOOR PLAN.

A Very Handsome Cottage with no Waste of Room.

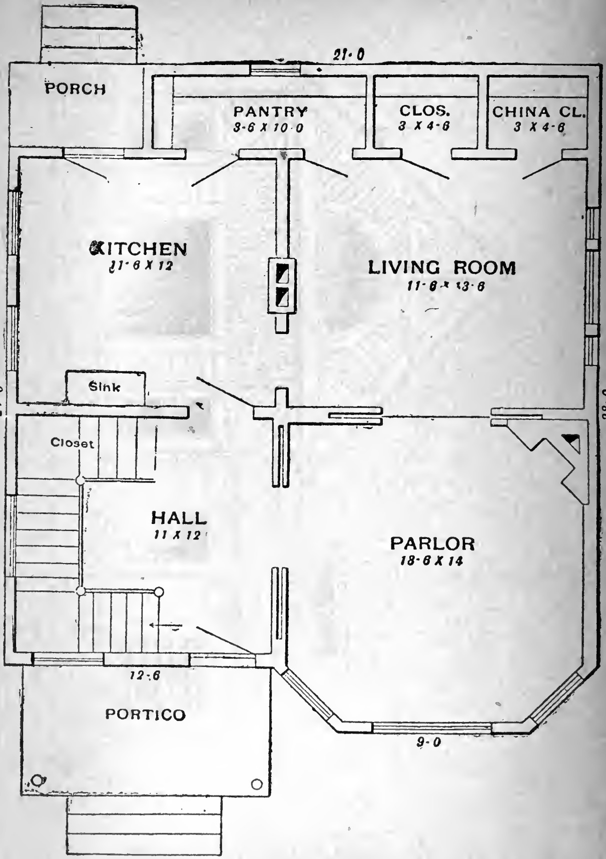
Size—46 feet deep, 24 feet wide.

DESIGN No. 34.



OAKLAND COTTAGE.

DESIGN No. 34.

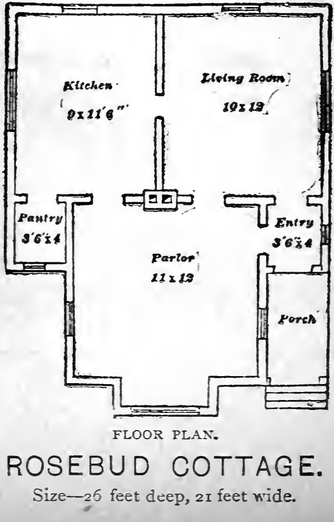


FLOOR PLAN.

OAKLAND COTTAGE.

DESIGN No. 35.

FRONT ELEVATION.

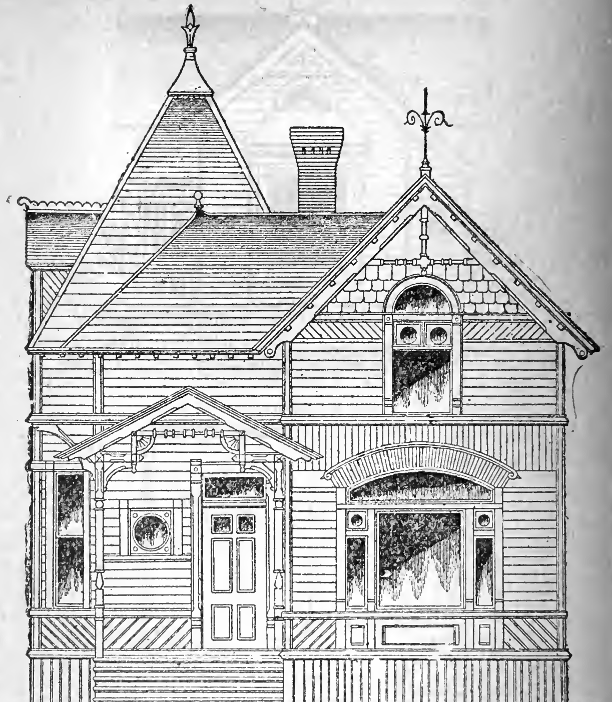


FLOOR PLAN.

ROSEBUD COTTAGE.

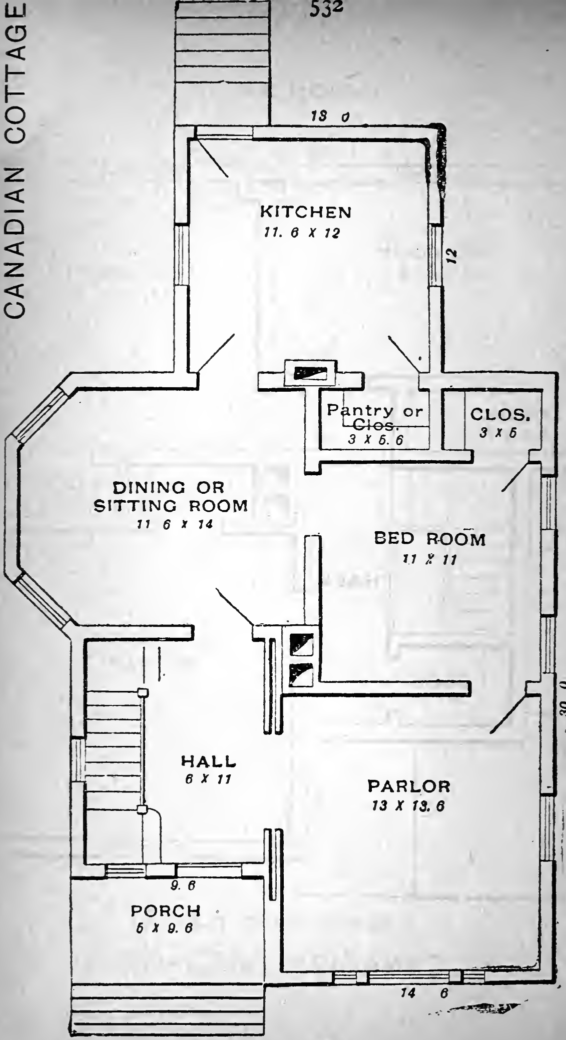
Size—26 feet deep, 21 feet wide.

DESIGN No. 36.



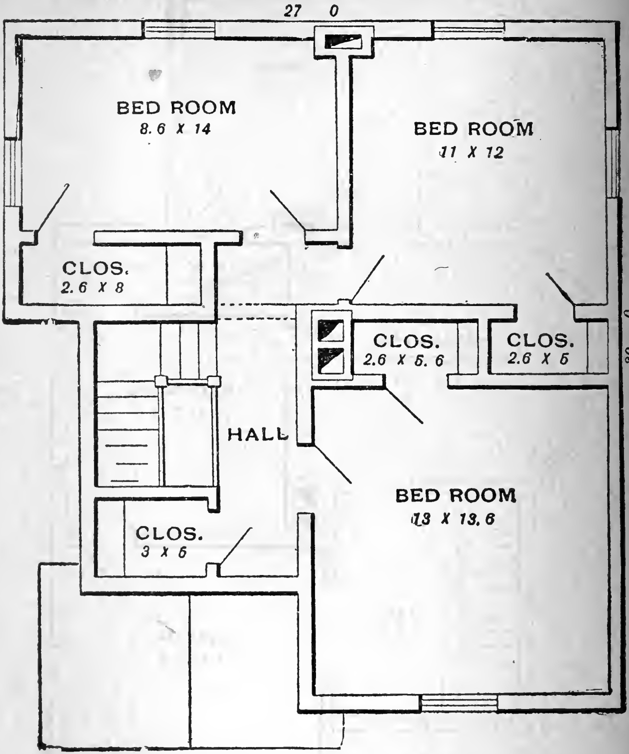
CANADIAN COTTAGE

CANADIAN COTTAGE



First Floor

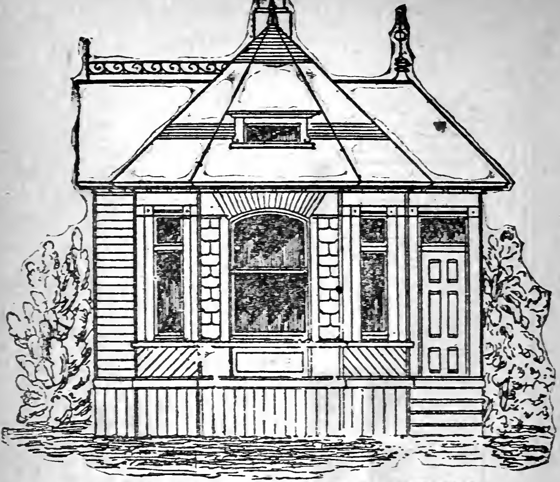
DESIGN No. 36.

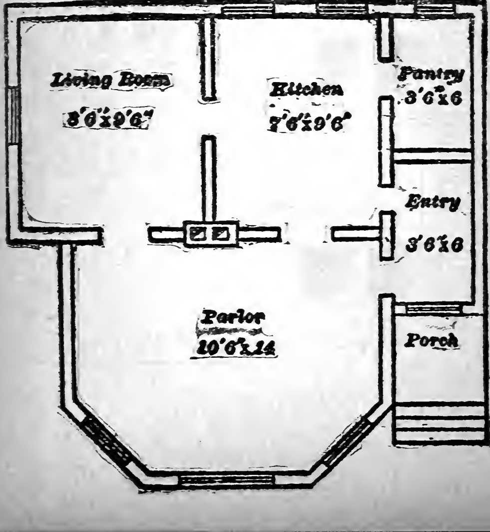


SECOND FLOOR PLAN.

CANADIAN COTTAGE.

DESIGN No. 37.

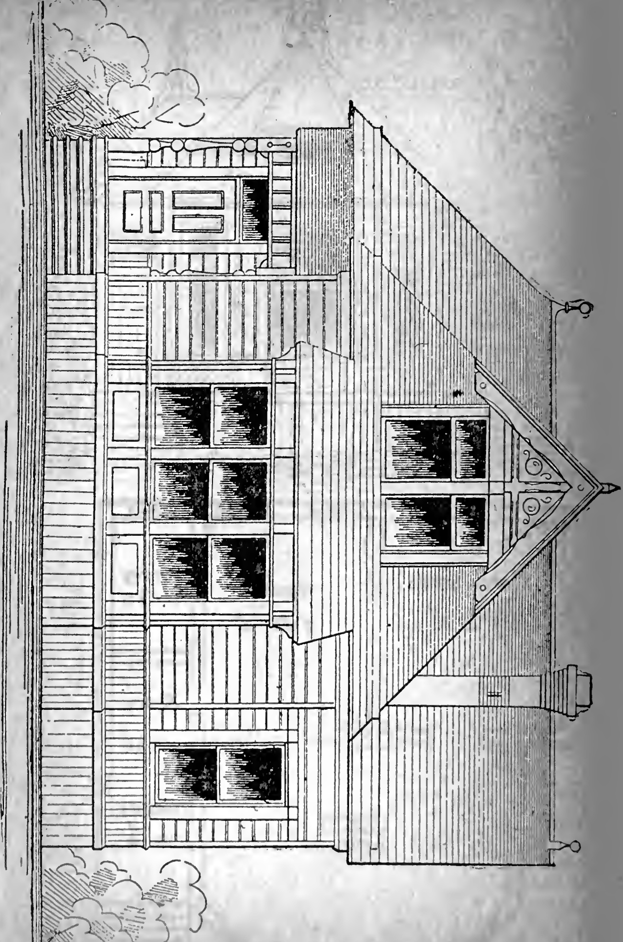




LAWNDALE COTTAGE.

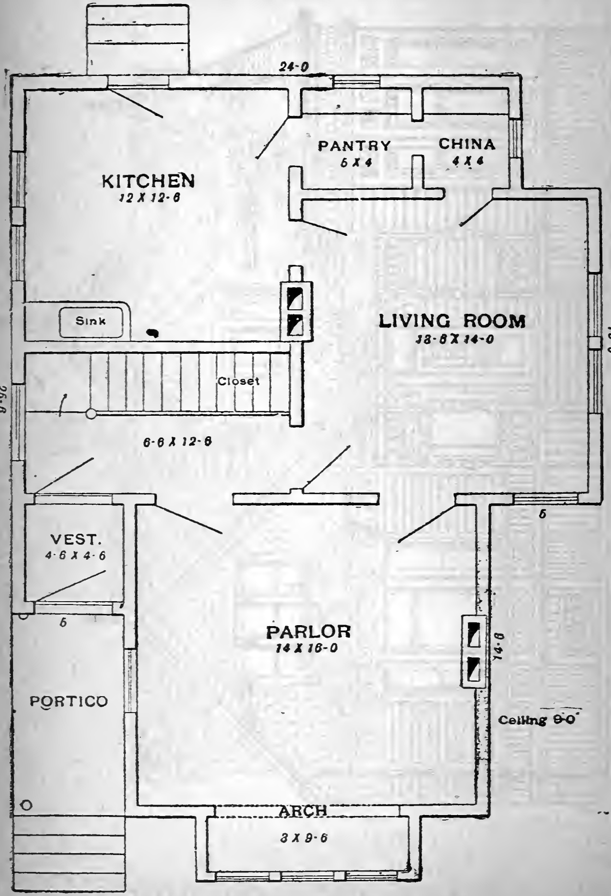
Size—22 feet deep, 22 feet wide.

DESIGN No. 38.



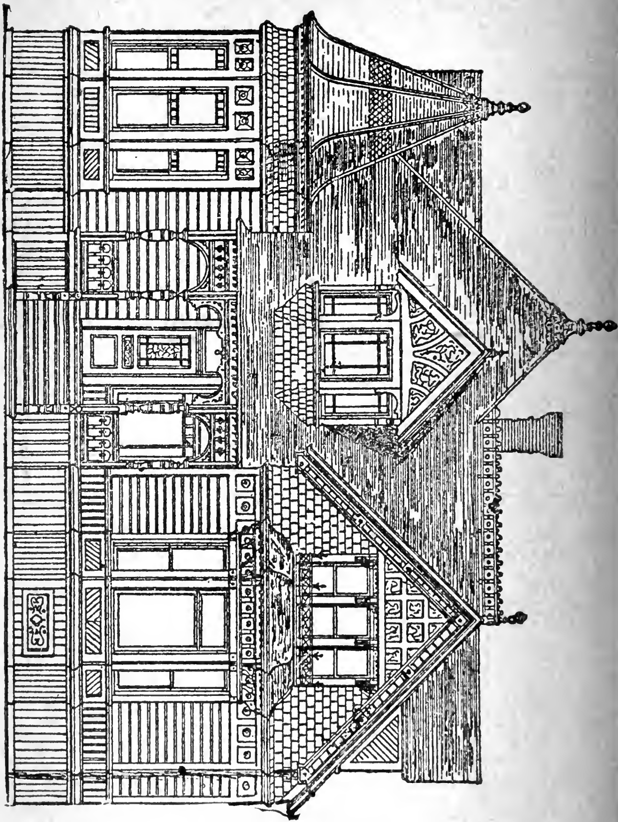
FERNWOOD COTTAGE.

FERNWOOD COTTAGE.



FLOOR PLAN.

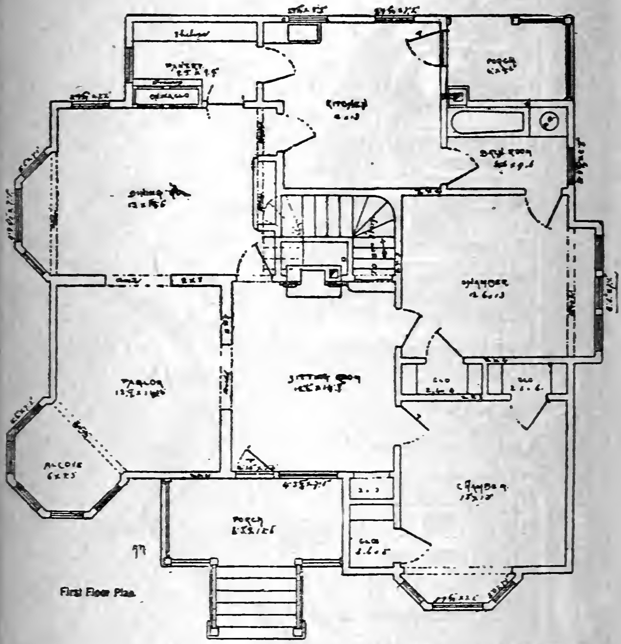
DESIGN No. 39.



FRONT ELEVATION.

BUENA VISTA COTTAGE.

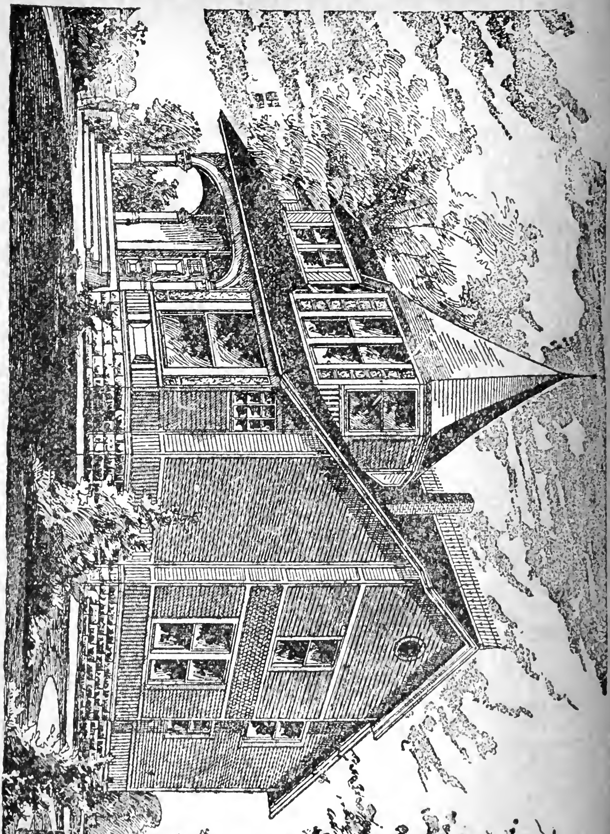
DESIGN No. 39.



Buena Vista Cottage

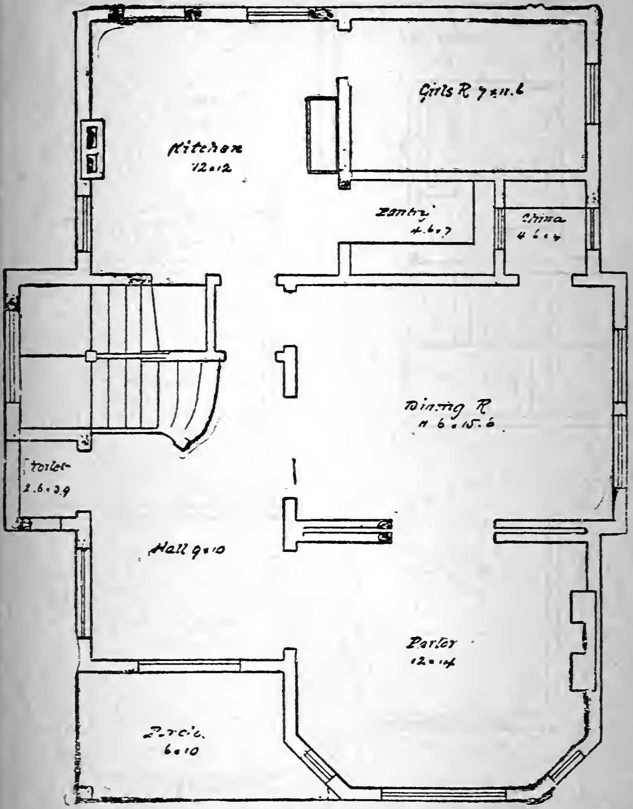
BUENA VISTA COTTAGE.

DESIGN No. 40.



KENWOOD VILLA.

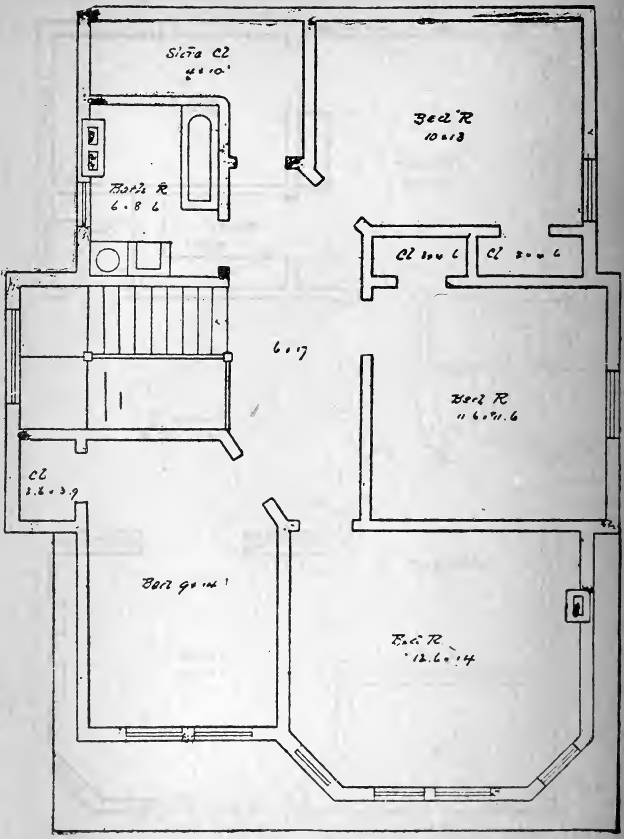
DESIGN No. 40.



KENWOOD VILLA.

GROUND PLAN.

DESIGN No. 40.



FIRST FOOR-PLAN.

KENWOOD VILLA.

SPECIFICATIONS.

We present in the following pages a list of specifications for the houses, etc., illustrated from page 480 to page 542 of this book. They will be found a complete list of materials, and any one who may desire to build according to the following plans may feel perfectly secure in buying the materials according to these specifications. For the very handsome designs illustrated on pages 490, 499, 525, 526, 527, 528, 530, 531, 534, 535, 537, and 539, we are indebted to the kindness of *The National Builder*, published at 116 La Salle street, Chicago. *The National Builder* is devoted to the interests of those who contemplate building homes, and to internal decorations. We have also made arrangements with the above paper whereby any one of our readers who may wish to build from any of the designs illustrated on the above specified pages can obtain, by remitting *the very small sum of twenty-five cents* to *The National Builder*, *full detail working plans and complete specifications* of any one of these twelve beautiful designs. When it is known that the usual cost of an architect's plans will average at least $50. we feel sure that this grand offer will be appreciated. *In sending for these detail working plans it will be necessary for you to state that you have purchased a copy of this book.*

DESIGN No. 1.

2 ps. 6x8 22; 3 ps. 6x8 14; 2 ps. 6x8 12; 16 ps. 2x8 14; 17 ps. 2x6 14; 1 ps. 2x6 18; 3 ps. 2x6 12; 52 ps. 2x4 16; 32 ps. 2x4 14; 53 ps. 2x4 12; 25 ps. 2x4 10; 900 ft. rough sheathing; 1,200 ft. sheathing d 1 s; 1,400 ft. siding; 900 ft. flooring; 7,000 shingles; 800 ft. finishing; 150 ft. wainscoting; 60 ft. 3/8 ceiling; 4,700 laths; 3 doors, 2 8x6 8, 1 3/8, No. 1; 8 doors, 2 6x6 6, 1 3/8 No. 1; 7 windows 12x28 4 lt.; 2 windows 12x24 4 lt.; 4 ps. 2x8 18, d and b; 220 ft. O G base; 500 ft. O G casing; 130 lbs. pl. paper; 120 lbs. tar paper; 2 cellar windows, 8x10 3 lt.: 2 ps. 4x4 16; 150 ft. 3½ in. O G crown molding; 150 ft. 1⅛x1¾ in. Scotia; 48 ft. large drip; 48 ft. 1¼x2½ in. nosing; 130 ft. blind stop; 130 ft. parting strip; 130 ft. 1 3/8 O G stop; 170 ft. 1¾ O G stop; 48 ft. 1⅛x2½ in. cap; 58 ft. ¾x1 in. Scotia; 48 ft. ¾ in. quarter-round; 1 cord stone, 12-in. wall; 800 brick; 15 gal. paint; 9 bbls. lime; 1 bbl. stucco; 3 bu. hair; 1 bbl. cement; nails, 50 lbs. 20d, 100 lbs. 10d, 50 lbs. 8d, 20 lbs. 6d, 25 lbs. 3d com., 30 lbs. 3d fine, 25 lbs. 10d casing; 11 mortise locks; 11 pair butts; 2¼ doz. window springs; 2 doz. wardrobe hooks; 5 6-in. thimbles. Main part 14x22, 12 ft.; ell, 12x14, 8 ft. with porch.

DESIGN No. 2.

2 ps. 6x8 22; 2 ps. 6x8 18; 3 ps. 6x8 14; 4 ps. 2x8 18; 60 ps. 2x8 14; [illegible] ps. 4x4 16; 83 ps. 2x4 10; 37 ps. 2x4 12; 40 ps. 2x4 14; 43 ps. 2x4 16;

39 ps. 2x4 18; 1,500 ft. sheathing, d 1 s; 940 ft. rough sheathing; 1,700 ft. siding; 1,600 ft. flooring; 8,000 shingles; 1,000 ft. finishing; 120 ft. wainscoting; 120 ft. 3/8 ceiling; 8,000 lath; 4 doors, 2 8x6 8, 1 3/8, No. 1; 13 doors, 2 6x6 6, 1 3/8 No. 1; 6 windows 12x24 4 lt.; 9 windows 12x28 4 lt.; 5 ps. 2x8 18 d and b; 400 ft. O G base; 750 ft. O G casing; 165 lbs. pl. paper; 125 lbs. tar paper; 2 cellar sash, 8x10 3 lt.; 170 ft. 4 1/2 in. O G crown molding; 170 ft. 2 1/2 in. O G crown molding; 80 ft. large drip; 80 ft. 1 1/4x2 1/2 in. nosing; 220 ft. parting strip; 220 ft. 1 3/8 O G stop; 220 ft. blind stop; 300 ft. 1 3/4 O G stop; 40 ft. 1 1/8x2 1/2 in. cap; 40 ft. 3/4x1 in. Scotia; 40 ft. 3/4 in. quarter-round; 1 cord stone, 12 in. high; 1,300 brick; 25 gal. paint; 16 bbls. lime; 1 bbl. stucco; 4 bu. hair; 1 bbl. cement; nails, 60 lbs. 20d; 140 lbs. 10d; 35 lbs. 3d; 25 lbs. 6d; 50 lbs. 8d com., 60 lbs. 3d fine; 25 lbs. 10d casing; 17 mortise locks; 17 pr. butts and screws; 3 3/4 doz. window springs; 3 doz. wardrobe hooks; 4 6-in. thimbles. Main part 14x22, 14 ft. high; ell part 14x18 12 ft. high, with porch.

DESIGN No. 3.

2 ps. 6x8 26; 5 ps. 6x8 16; 54 ps. 2x8 16; 13 ps. 2x6 16; 2 ps. 4x4 18; 17 ps. 2x4 20; 47 ps. 2x4 18; 62 ps. 2x4 16; 28 ps. 2x4 14; 83 ps. 2x4 12; 1,800 ft. sheathing, d 1 s; 1,200 ft. sheathing; 2,100 ft. siding; 1,600 ft. flooring; 10,000 shingles; 1,260 ft. finishing; 160 ft. wainscoting; 120 ft. 3/8 ceiling; 7,600 lath; 3 doors 2 8x6 8, 1 3/8 No. 1; 10 doors 2 6x6 6, 1 3/8 No. 1; 8 windows 12x28, 4 lt.; 4 1/2 window 12x24 4 lt.; 4 ps. 2x8 18 d and b; 380 ft. O G base; 600 ft. O G casing; 200 lbs. pl. paper; 165 lbs. tar paper; 2 cellar sash, 8x10 3 lt.; 200 ft. 4 1/2 in. O G crown molding; 190 ft. 2 1/2 in. O G crown molding; 48 ft. large drip; 48 ft. 1 1/4x2 1/2 in. nosing; 48 ft. 1 1/8x2 1/2 in. cap; 48 ft. 3/4x1 in. Scotia; 48 ft. 3/4 in. quarter-round, 200 ft. blind stop; 180 ft. parting strip; 180 ft. 1 3/8 O G stop; 230 ft. 1 3/4 O G stop; 1 1/2 cords stone 15 in. high; 900 brick; 23 gal. paint; 15 bbls. lime; 1 bbl. stucco; 4 bus. hair; 1 bbl. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 60 lbs. 8d, 30 lbs. 6d, 30 lbs. 10d casing, 40 lbs. 3d com., 60 lbs. 3d fine; 13 mortise locks; 13 pr. butts; 3 doz. window spring bolts; 3 doz. wardrobe hooks; 5 thimbles 6-in. Main part 16x26, 16 ft. high; ell part 16x16, 9 ft. high, porch on the front of kitchen.

DESIGN No. 5.

2 ps. 6x8 26; 2 ps. 6x8 22; 2 ps. 6x8 20; 1 ps. 6x8 16; 22 ps. 2x8 20; 11 ps. 2x8 16; 17 ps. 2x6 16; 2 ps. 4x4 18; 15 ps. 2x4 20; 88 ps. 2x4 18; 94 ps. 2x4 16; 45 ps. 2x4 14; 34 ps. 2x4 12; 10 ps. 2x4 10; 2,150 ft. sheathing, d 1 s; 1,600 ft. rough sheathing; 2,500 ft. siding; 1,830 ft. flooring; 13,000 shingles; 1,250 ft. finishing; 180 ft. wainscoting; 150 ft. 3/8 ceiling; 10,000 lath; 1 door 2 10x6 10, glazed and transom; 2 doors 2 8x6 8, 1 3/8 No. 1; 18 doors 2 6x6 6, 1 3/8 No. 1; 8 windows, 12x28 4 lt; 5 windows, 12x24, 4 lt.; 4 ps. 2x8 18 d and b; 540 ft. O G base; 900 ft. O G casing; 240 lbs. pl. paper; 220 lbs. tar paper; 2 cellar sash, 8x10 3 lt.; 200 ft. 4 1/2 in. O. G. crown molding; 200 ft. 2 1/2 in. O G crown molding; 44 ft. 1 1/8x2 1/2 in. cap; 44 ft. 3/4x1 in. Scotia; 44 ft. 3/4 in quarter-round; 64 ft. large drip; 64 ft. 1 1/4x2 1/2 in. nosing; 180 ft. 1 3/8 O G stop; 180 ft. parting strip; 200 ft. blind stop; 380 ft. 1 3/4 O G stop; newel stair rail and balusters; 1 1/2 cords stone, 12 in. high; 900 brick; 27 gals. paint; 21 bbls. lime; 2 bbls. stucco; 5 bu. hair; 2 bbls. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 60 lbs. 8d, 40 lbs. 6d, 50 lbs.

3d com., 40 lbs. 10d casing, 75 lbs. 3d fine; 19 mortise locks; 21 pairs hinges; 3¼ doz. window springs; 4 doz. wardrobe hooks; 5 thimbles, 6-in. Main part 20x26 ft. high; ell, 16x22 9 ft. high, with porch.

DESIGN No. 6.

3 ps. 6x8 20; 4 ps. 6x8 16; 2 ps. 6x8 18; 50 ps. 2x8 18; 24 ps. 2x8 20; 5 ps. 2x8 16; 4 ps. 4x4 18; 10 ps. 2x8 14; 4 ps. 4x6 20; 27 ps. 2x4 18; 136 ps. 2x4 16; 20 ps. 2x4 14; 71 ps. 2x4 12; 82 ps. 2x4 10; 1,750 ft. sheathing, d 1 s; 1,800 ft. rough sheathing; 2,000 ft. siding; 2,500 ft. flooring; 15,000 shingles; 1,300 ft. finishing; 180 ft. ⅞ wainscoting; 320 ft. ⅜ ceiling; 9,000 lath; 1 glazed door and transom; 2 doors, 2 8x6 8, 1⅜; 10 doors, 2 6x6, 1⅜; 5 doors, 2 0x5 0, in. batten; 11 win. 12x28, 4 lt.; 6 win. 12x24, 4 lt.; 5 ps. 2x8 18 d and b; 450 ft. O G base; 720 ft. O G casing; 200 lbs. pl. paper; 250 lbs. tar paper; 2 cel. sash, 8x10, 3 lt.; 200 ft. 4½ in. O G crown molding; 200 ft. 2½ in. O G crown molding; 80 ft. large drip; 80 ft. 1¼x2½ in. nosing; 250 ft. blind stop; 240 ft. parting strip; 240 ft. 1⅜ O G stop; 288 ft. 1¾ O G stop; 50 ft. 1⅛x2½ in. cap; 50 ft. ¾x1 in. Scotia; 50 ft. ¾ in. quarter-round; 1¼ cords stone, 12 in.; 1,300 brick; 25 gal. paint; 16 bbls. lime; 1 bbl. stucco; 5 bu. hair; 1 bbl. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 60 lbs. 8d, 40 lbs. 6d, 50 lbs. 3d com., 30 lbs. 10d casing, 70 lbs. 3d fine; 13 mortise locks; 13 pair 3½x3½ butts; 5 rim latches; 5 rim 2x2 butts; 4¼ win. spring bolts; 3 doz. wardrobe hooks; 4 thimbles. Main part 17-6x34; ell part 16x15-6, 10 ft. high, ½ pitch roof, with porch, 4 ft., 4 gables and front veranda.

DESIGN No. 7.

2 ps. 6x8 28; 2 ps. 6x8 18; 42 ps. 2x8 18; 8 ps. 2x4 18; 42 ps. 2x4 16; 16 ps. 2x4 14; 96 ps. 2x4 12; 22 ps. 2x4 10; 1,280 ft. sheathing, d 1 s; 750 ft. rough sheathing; 1,500 ft. siding; 1,370 ft. flooring; 6,000 shingles; 680 ft. finishing; 140 ft. ⅞ wainscoting; 5,700 lath; 2 doors, 2 8x6 8, 1⅜ No. 1; 11 doors, 2 6x6 6, 1⅜ No. 1; 6 win. 12x28, 4 lt.; 4 win. 12x24, 4 lt.; 3 ps. 2x8 18 d and b; 280 ft. O G base; 600 ft. O G casing; 140 lbs. pl. paper; 100 lbs. tar paper; 2 cel. sash 8x10, 3 lt.; 120 ft. 3½ in. O G crown molding; 110 ft. 1⅛x1¾ in. Scotia; 52 ft. large drip; 52 ft. 1¼x2½ in. nosing; 150 ft. blind stop; 150 ft. parting strip; 150 ft. 1⅜ O G stop; 220 ft. 1¾ O G stop; 36 ft. 1⅛x2½ in. cap; 36 ft. ¾x1 in. Scotia; 36 ft. ¾ in. quarter-round; 1 cord stone; 450 brick; 15 gal. paint; 11 bbls. lime; 1 bbl. stucco; 1 bbl. cement; 3 bu. hair; nails 50 lbs. 20d, 100 lbs. 10d, 30 lbs. 8d, 25 lbs. 6d, 20 lbs. 3d com., 20 lbs. 10d casing, 40 lbs. 3d fine; 13 mortise locks; 13 pair butts; 2¾ doz. win bolts; 2 doz. wardrobe hooks; 3 thimbles. Estimated for 18x28 12 ft. high, with storm house over door.

DESIGN No. 8.

2 ps. 6x8 28; 2 ps. 6x8 20; 3 ps. 6x8 14; 42 ps. 2x8 20; 28 ps. 2x8 14, 3 ps. 4x4 18; 43 ps. 2x4 20; 32 ps. 2x4 18; 117 ps. 2x4 16; 66 ps. 2x4 14; 11 ps. 2x4 12; 2,500 ft. sheathing d 1 s; 1,200 ft. rough sheathing, 3,000 ft. siding; 2,240 ft. flooring; 9,500 shingles; 1,300 ft. finishing; 180 ft. ⅞ wainscoting; 200 ft. 3x8 ceiling; 9,000 lath; 1 door glazed and

transom; 2 doors 2 8x6 8, 1⅜ No. 1; 13 doors 2 6x6 1⅜ No. 1; 7 win. 12x28 4 lt.; 2 win. 12x28 2 lt.; 11 win. 12x24 4 lt.; 6 ps. 2x8 18, d and b; 400 ft. O G base; 800 ft. O G casing; 260 lbs. pl. paper; 160 lbs. tar paper; 2 cel. sash 8x10 3 lt.; 200 ft. 4½ in. O G crown molding; 200 ft. 2½ in. O G crown molding; 290 ft. 1¾ O G stop; 280 ft. 1⅜ O G stop; 280 ft. parting strips; 280 ft. blind stops; 90 ft. large drip; 90 ft. 1¼x2½ in. nosing; 48 ft. 1⅛x2½ in. cap; 48 ft. ¾x1 in. Scotia; 48 ft. ¾ in. quarter round; 2 cords stone 18 in high; 1,000 bricks; 28 gals. paint; 17 bbls. lime; 1 bbl. stucco; 4 bu. hair; 1 bbl. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 60 lbs. 8d, 50 lbs. 6d, 40 lbs. 3d com., 70 lbs. 3d fine, 40 lbs. 10d casing; 16 mortise locks; 16 pr. butts and screws; 2½ doz. window spring bolts; 3 doz. wardrobe hooks; 5 flue thimbles; stair rail and balusters. Main part 20x28 ft.; ell part 14x14, 16 ft. high, with two porches and bay window.

DESIGN No. 10.

3 ps. 6x8 32; 2 ps. 6x8 30; 1 ps. 6x8 20; 48 ps. 2x8 16; 24 ps. 2x8 14; 5 ps. 2x8 10; 16 ps. 2x4 20; 42 ps. 2x4 18; 126 ps. 2x4 16; 54 ps. 2x4 14; 60 ps. 2x4 12; 2,000 ft. sheathing, d 1 s; 1,600 ft. rough sheathing; 2,400 ft. siding; 1,800 ft. flooring; 12,000 shingles; 1,000 ft. finishing; 180 feet wainscoting; 9,000 lath; 1 pair doors, 4 0x7 0, 1¾, and transom; 2 doors, 2 8x6 8, 1⅜, No. 1; 14 doors, 2 6x6 6, 1⅜, No. 1; 9 win. 12x28 4 lt.; 6 win. 12x24 4 lt.; 5 ps. 2x8 18 d and b; 450 ft. O G base; 760 ft. O G casing; 220 lbs. pl. paper; 210 lbs. tar paper; 2 cel. sash, 8x10, 3 lt.; 170 ft. 3½ in. O G crown molding; 170 ft. 1⅛x1¾ in. Scotia; 72 ft. large drips; 72 ft. 1¼x2½ in. nosing; 200 ft. blind stop; 200 ft. parting strip; 200 ft. 1⅜ O G stops; 300 ft. 1¾ O G stops; 50 ft. 1⅛x2½ in. cap, 50 ft. ¾x1 in. Scotia; 50 ft. ¾ in. quarter-round 1½ cords stone, 12 in. high; 1,000 brick; 21 gal. paint; 17 bbls. lime; 1 bbl. stucco; 4 bu. hair; 1 bbl. cement; nail, 60 lbs. 20d, 205 lbs. 10d, 60 lbs. 8d, 40 lbs. 6d, 50 lbs. 3d com., 70 lbs. 3d fine, 25 lbs. 10d casing; 16 mortise locks; 18 pair butts and screws; 3¾ doz. win. bolts; 3 doz. wardrobe hooks; 4 flue thimbles. Main part, 16x32, 16 ft. high. Lean-to on side, 14x32, 8 ft. on side. Vestibule in front, with gable.

DESIGN No. 11.

2 ps. 6x8 26; 4 ps. 6x8 16; 2 ps. 6x8 14; 4 ps. 6x8 12; 60 ps. 2x8 16; 9 ps. 2x8 14; 20 ps. 2x6 14; 24 ps. 2x4 20; 56 ps. 2x4 18; 90 ps. 2x4 16; 36 ps. 2x4 14; 100 ps. 2x4 12; 20 ps. 2x4 10; 2,100 ft. sheathing, d 1 s; 1,600 ft. rough sheathing; 2,400 ft. siding; 1,750 ft. flooring; 15,000 shingles; 1,400 ft. finishing; 160 ft. ⅞ wainscoting; 140 ft. ⅜ ceiling; 10,000 lath; 3 doors 2 8x6 8, 1⅜, No. 1; 15 doors 2 6x6, 1⅜, No. 1; 12 win. 12x28, 4 lt.; 7 win. 12x21, 4 lt.; 6 ps. 2x8 18 d and b; 500 ft. O G base; 860 ft. O G casing; 230 lbs. pl. paper; 220 lbs. tar paper; 2 cel. sash 8x10 3 lt.; 250 ft. 4½ in. O G crown molding; 250 ft. 2½ in. O G crown molding; 90 ft. large drip; 90 ft. 1¼ x2½ in. nosing; 260 ft. blind stop; 260 ft. parting strip; 260 ft. 1⅜ O G stops; 320 ft. 1¾ O G stops; 48 ft. 1⅛x2½ in. cap; 48 ft. ¾x1 in. Scotia; 48 ft. ¾ in. quarter-round; 2 cords stone 15 in. high; 1,500 brick; 28 gal. paint; 18 bbls. lime; 2 bbls. stucco; 5 bu. hair; 1 bbl. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 100 lbs. 8d, 40 lbs. 6d, 60 lbs. 3d com., 70 lbs. 3d fine, 50 lbs. 10d casing. 18 mortise locks; 18 pair butts and screws; 5 doz. win. springs;

4 doz. wardrobe hooks; 7 thimbles for flues. Main house 16x26, 16 ft. high; ell for parlor 12x16, 16 ft. high; ell for kitchen 12x14, 9 ft. high. Two bay windows; two porches with hall.

DESIGN No. 12.

2 ps. 6x8 30; 1 p. 6x8 24; 2 ps. 6x8 20; 6 ps. 6x8 16; 90 ps. 2x8 14; 44 ps. 2x8 16; 45 ps. 2x6 14; 1 p. 4x4 18; 200 ps. 2x4 18; 116 ps. 2x4 16; 54 ps. 2x4 12; 3,150 ft. sheathing, d 1 s; 2,100 ft. rough sheathing; 3,600 ft. siding; 3,360 ft. flooring; 17,000 shingles; 2,000 ft. finishing; 200 ft. 7/8 wainscoting; 100 ft. 3/8 ceiling; 16,000 lath; 2 doors glazed and transoms; 2 doors 2 8x6 8, 1 3/8, No. 1; 27 doors 2 6x6 6, 1 3/8 No. 1; 13 win. 12x28, 4 lt.; 11 win. 12x24, 1 lt.; 7 ps. 2x8 18 d and b; 900 ft. O G base; 1,500 ft. O G casing; 350 lbs. pl. paper; 300 lbs. tar paper, 2 cel. sash 8x10, 3 lt.; 290 ft. 4 1/2 in. O G crown molding; 280 ft. 2 1/2 in. O G crown molding; 110 ft. large drip; 110 ft. 1 1/4x2 1/2 in. nosing; 336 ft. blind stop; 336 ft. 1 3/8 O G stops; 620 ft. 1 3/4 O G stops; 336 parting strips; 60 ft. 1 1/8x2 1/2 in. cap; 60 ft. 3/4x1 in. Scotia; 60 ft. 3/4 in. quarter-round; 2 cords stone 12 in. high; 2,000 brick; 40 gal. paint; 30 bbls. lime; 3 bbls. stucco; 1 bbl. cement; 8 bu. hair; nails, 200 lbs. 20d, 300 lbs. 10d, 100 lbs. 8d, 60 lbs. 6d, 60 lbs. 3d com.; 100 lbs. 10d casing; 125 lbs. 3d fine; 31 mortise locks; 4 rim locks; 35 pair butts and screws; 6 doz. win. spring bolts; 4 doz. wardrobe hooks; 7 thimbles, 6 in. Main part, 28x30, 18 ft. high; front projection 6x14, 18 ft. high; back part 16x 24, 12 ft. high; outside closet with one porch and one vestibule in front.

DESIGN No. 13.

6 ps. 6x8 16; 2 ps. 6x8 14; 2 ps. 6x8 12; 46 ps. 2x8 16; 32 ps. 2x8 14; 7 ps. 2x8 12; 20 ps. 2x6 16; 10 ps. 2x6 14; 3 ps. 4x4 18; 54 ps. 2x4 20; 81 ps. 2x4 18; 60 ps. 2x4 16; 4 ps. 2x4 14; 69 ps. 2x4 12; 2,500 ft. sheathing, d 1 s; 1,400 ft. rough sheathing; 2,800 ft. siding; 2,100 ft. flooring; 11,000 shingles; 1,500 ft. finishing; 180 ft. 7/8 wainscoting; 160 ft. 3/8 ceiling; 9,000 lath; 1 glazed door and transom; 2 doors, 2 8x6 8 1 3/8 No. 1; 9 doors, 2 6x6 6, 1 3/8 No. 1; 15 win. 12x28 4 lt.; 9 win. 12x24, 4 lt., 7 ps. 2x8 18 d and b; 450 ft. O G base; 750 ft. O G casing; 280 lbs. pl. paper; 175 lbs. tar paper; 2 cel. sash 8x10; 270 ft. 4 1/2 in. O G crown molding; 270 ft. 2 1/2 in. O G crown molding; 100 ft. large drip; 100 ft. 1 1/4x2 1/2 in. nosing; 340 ft. blind stop; 340 ft. parting strip; 340 ft. 1 3/8 O G stop; 250 ft. 1 3/4 O G stop; 44 ft. 1 1/8x2 1/2 in. cap; 44 ft. 3/4x1 in. Scotia; 44 ft. 3/4 in. quarter-round; stair rail, balusters and newel; 2 cords stone 15 in. high; 2,000 brick; 28 gal. paint; 17 bbls. lime; 1 bbl. stucco; 1 bbl. cement; 4 bu. hair; nails, 100 lbs. 20d, 200 lbs. 10d, 50 lbs. 8d, 40 lbs. 6d, 40 lbs. 3d com., 70 lbs. 3d fine, 50 lbs. 10d casing; 12 mortise locks; 14 pair butts and screws; 6 doz. win. springs; 3 doz. wardrobe hooks, 7 thimbles. Main part 16x26, 18 ft. high; front wing 14x16 ft. high; back wing 12x14, 9 ft. high; 3 porches, 1 pantry, 1 hall and 1 bay window.

DESIGN No. 14.

2 ps. 6x8 30; 4 ps. 6x8 16; 1 p. 6x8 18; 2 ps, 6x6 20; 1 p. 6x6 12; 76 ps. 2x8 16; 38 ps. 2x6 16; 15 ps. 2x6 12; 2 ps. 4x4 18; 130 ps. 2x4 18; 67 ps. 2x4 16; 90 ps. 2x4 12; 2,800 ft. sheathing d 1 s; 1,600

ft. rough sheathing; 3,300 ft. siding; 2,440 ft. flooring; 13,000 shingles; 1,450 ft. finishing; 160 ft. 7/8 wainscoting; 140 ft. 3/8 ceiling; 9,500 lath; 5 doors, 2 8x6 8, 1 3/8 No. 1; 11 doors, 2 6x6 6, 1 3/8 No. 1; 13 win. 12x28, 4 lt.; 10 win. 12x24, 4 lt; 7 ps. 2x8 18 d and b; 500 ft. O G base; 800 ft. O. G casing; 300 lbs. pl. paper; 220 lbs. tar paper; 2 cel. sash, 8x10, 3 lt.; 400 ft. 1/2 in. batts for lattice; 250 ft. 4 1/2 in. O G crown molding; 250 ft. 2 1/2 in. O G crown molding; 110 ft. large drip; 110 ft. 1 1/4x2 1/2 in. nosing; 300 ft. blind stop; 300 ft. parting strips; 300 ft. 1 3/8 O G stop; 280 ft. 1 3/4 O G stop; 40 ft. 1 1/8x2 1/2 in. cap; 40 ft. 3/4x1 in. Scotia; 40 ft. 3/4 in. quarter-round; 2 cords stone 12 in. high. 1,500 brick; 30 gal. paint; 20 bbls. lime; 2 bbls. stucco; 5 bu. hair; 2 bbls. cement; nails, 100 lbs. 20d, 200 lbs. 10d, 100 lbs. 8d, 50 lbs. 6d, 45 lbs. 3d com., 70 lbs. 3d fine; 50 lbs. 10d casing; 16 mortise locks; 16 pr. butts and screws; 6 doz. win. springs; 3 doz. wardrobe hooks; 8 thimbles. Main part 16x30, 18 ft. high; wing on side 16x18, 18 ft. high; front porch and bay window; summer kitchen plastered; with back summer kitchen 12x20, 8 ft. high

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DESIGN No. 15.

1 p. 6x8 24; 4 ps. 6x8 20; 2 ps. 6x8 14; 1 p. 6x8 18; 56 ps. 2x8 14; 12 ps. 2x8 18; 2 ps. 4x4 16; 30 ps. 2x4 20; 42 ps. 2x4 18; 80 ps. 2x4 16; 15 ps. 2x4 12; 75 ps. 2x4 10; 1,900 ft. sheathing d 1 s; 1,100 ft. rough sheathing; 2,300 ft. siding; 1,650 ft. flooring; 9,000 shingles; 1,200 ft. finishing; 140 ft. 7/8 wainscoting; 60 ft. 3/8 ceiling; 9,500 lath; 1 glazed door and transom; 2 doors, 2 8x6 8, 1 3/8 No. 1; 14 doors, 2 6x6 6, 1 3/8 No. 1; 10 win. 12x28, 4 lt.; 7 win. 12x24, 4 lt.; 5 ps. 2x8 18 d and b; 500 ft. O G base; 780 ft. O G casing; 200 lbs. pl. paper; 150 lbs. tar paper; 2 cel. win. 8x10 3 lt.; 200 ft. 3 1/2 in. O G crown molding; 200 ft. 1 1/8x1 3/4 in. Scotia; 80 ft. large drip; 80 ft. 1 1/4x2 1/2 in. nosing; 240 ft. blind stop; 240 ft. parting strips; 240 ft. 1 3/8 O G stop; 300 ft. 1 3/4 O G stop; 40 ft. 1 1/8x2 1/2 in. cap; 40 ft. No. 3/4x1 in. Scotia; 40 ft. 3/4 in. quarter-round; newel post rail and balusters; 2 cords stone, 16 in. high; 1,000 brick; 24 gal. paint; 17 bbls. lime; 2 bbls. stucco; 1 bbl. cement; 5 bu. hair; nails, 100 lbs. 20d, 150 lbs. 10d, 60 lbs. 8d, 40 lbs. 6d, 30 lbs. 3d com., 50 lbs. 10d casing, 70 lbs. 3d fine; 17 mortise locks; 17 pair butts and screws; 4 1/4 doz. win. springs; 2 doz. wardrobe hooks; 7 thimbles 6 in. Main part 14x38, 16 ft. high. Side lean-to, 9x24, 9 ft. high. Porch and bay window.

DESIGN No. 16.

5 ps. 6x8 18; 5 ps. 6x8 16; 4 ps. 6x8 24; 50 ps. 2x8 18; 12 ps. 2x8 16; 50 ps. 2x8 14; 25 ps. 2x6 20; 30 ps. 2x6 16; 3 ps. 4x4 18; 10 ps. 2x4 20; 157 ps. 2x4 18; 96 ps. 2x4 16; 2,300 ft. sheathing, d 1s; 1,500 ft. rough sheathing; 2,700 ft. siding; 2,900 ft. flooring; 12,000 shingles; 1,400 ft. finishing; 170 ft. 7/8 wainscoting; 200 ft. No. 1 3/8 ceiling; 12,000 lath; 1 door glazed and transom; 1 door, 2 8x6 8, 1 3/8 No. 1; 16 doors, 2 6x6 6, 1 3/8 No. 1; 11 win. 12x28, 4 lt.; 13 win. 12x24, 4 lt.; 7 ps. 2x8 18 d and b; 600 ft. O G base; 940 ft. O G casing; 260 lbs. pl. paper; 200 lbs. tar paper; 2 cel. sash 8x10 3 lt.; 180 ft. 4 1/2 in. O G crown molding; 180 ft. 2 1/2 in. O G crown molding; 100 ft. large drip; 100 ft. 1 1/4x2 1/2 in. nosing; 340 ft.

blind stop; 340 ft. parting strip; 340 ft. 1⅜ O G stops; 320 ft. 1¾ O G stops; 50 ft. 1⅛x2½ in. cap; 50 ft. ¾x1 in. Scotia; 50 ft. ¾ in. quarter-round; 2 cords stone, 18 in. high; 1,300 brick; 30 gal. paint; 22 bbls. lime; 2 bbls. stucco; 2 bbls. cement; 5 bu. hair; nails, 100 lbs. 20d, 200 lbs. 10d, 100 lbs. 8, 40 lbs. 6d, 40 lbs. 3d com., 50 lbs. 10d casing, 90 lbs. 3d fine; 18 mortise locks; 18 pair butts and screws; 6 doz. window springs; 4 doz. wardrobe hooks; 6 thimbles 6 inch. House 32x32, 18 ft.; pavilion roof with veranda in front.

DESIGN No. 18.

5 ps. 6x8 24; 2 ps. 6x8 20; 1 p. 6x8 14; 8 ps. 2x8 16; 14 ps. 2x8 14; 72 ps. 2x8 12; 14 ps. 2x6 14; 4 ps. 4x4 16; 12 ps. 2x4 20; 28 ps. 2x4 18; 136 ps. 2x4 16; 8 ps. 2x4 14; 42 ps. 2x4 12; 22 ps. 2x4 10; 1,450 ft. sheathing, d 1 s; 1,360 ft. rough sheathing; 1,700 ft. siding, 2,000 ft. flooring; 11,000 shingles; 1,200 ft. finishing; 200 ft. ⅞ wainscoting; 160 ft. ⅜ ceiling: 8,000 lath; 1 door glazed and transom, 1 door, 2 8x6 8, 1⅜; 13 doors 2 6x6 6, 1⅜; 5 doors 2 0x6 0, 1⅛; 11 win. 12x28 4 lt.; 3 win. 12x24 4 lt.; 4 ps. 2x8 18 d and b; 450 ft. O G base; 680 ft. O G casing; 160 lbs. pl. paper; 185 lbs. tar paper; 2 cel. sash 8x10, 3 lt.; 220 ft. 3½ in. O G crown molding; 220 ft. 1⅛x1¾ in. Scotia; 64 ft. large drip; 64 ft. 1¼x2½ in. nosing; 200 ft. blind stop; 200 ft. parting strips; 200 ft. 1⅜ O G stop; 260 ft. 1¾ O G stops; 50 ft. 1⅛x2½ in. cap.; 50 ft. ¾x1 in. Scotia; 50 ft. ¾ in. quarter-round; 1½ cords stone 12 in. high; 1,000 brick; 22 gal. paint; 16 bbls. lime; 1 bbl. stucco; 1 bbl. cement; 3 bu. hair; nails, 100 lbs. 20d, 200 lbs. 10d, 60 lbs. 8d, 30 lbs. 6d, 40 lbs. 3d com., 50 lbs. 10d casing, 60 lbs. 3d fine; 15 mortise locks; 5 rim locks; 20 pair butts and screws; 3½ doz. window springs; 3 doz. wardrobe hooks; 7 thimbles, 6 in. Main part 24x24, 12 ft. high; ell part 14x20, 8 ft. high, with porch.

DESIGN No. 19.

2 ps. 6x8 30; 2 ps. 6x8 20; 44 ps. 2x8 20; 16 ps. 2x4 20; 30 ps. 2x4 18; 40 ps. 2x4 16; 98 ps. 2x4 14; 1,500 ft. sheathing, d 1 s; 900 ft. rough sheathing; 1,800 ft. siding; 1,400 ft. flooring; 7,500 shingles; 900 ft. finishing; 150 ft ⅞ wainscoting; 7,500 lath; 2 doors glazed and transoms; 10 doors, 2 6x6 6, 1⅜; 11 win., 12x28 4 lt.; 4 win. 12x24 4 lt.; 4 ps. 2x8 18, d and b; 170 lbs. pl. paper; 125 lbs. tar paper; 400 ft. O G base; 600 ft. O G casing; 2 cel. sash, 8x10 3 lt.; stair rail, newel post and balusters; 120 ft. 3½ in. O G crown molding; 120 ft. 1⅛x1¾ in. Scotia; 70 ft. large drip; 70 ft. 1¼x2½ in. nosing; 203 ft. blind stop; 200 ft. parting strip; 200 ft. 1⅜ O G stops; 200 ft. 1¾ O G stops: 40 ft. 1⅛x2½ in. cap; 40 ft. ¾x1 in. Scotia; 40 ft. ¾ in. quarter-round; 1 cord stone 12 in. high; 1,000 brick; 17 gal. paint; 14 bbls. lime; 1 bbl. stucco; 1 bbl. cement; 4 bu. hair; nails, 60 lbs. 20d, 100 lbs. 10d, 50 lbs. 8d, 30 lbs. 6d, 25 lbs. 3d com., 40 lbs. 10d casing, 60 lbs. 3d fine; 12 mortise locks; 12 pr. butts and screws; 3¾ doz. win. springs; 2 doz. wardrobe hooks; 6 thimbles, 6-in. House 20x30, 14 ft. high.

DESIGN No. 20.

2 ps. 6x8 32; 2 ps. 6x8 16; 6 ps. 6x8 14; 23 ps. 2x8 16; 18 ps. 2x8 14; 12 ps. 2x8 12; 25 ps. 2x6 16; 22 ps. 2x6 14; 2 ps. 4x4 16; 58 ps. 2x4 18; 16 ps. 2x4 16; 40 ps. 2x4 14; 50 ps. 2x4 12; 42 ps. 2x4 10; 1,460 ft. sheathing, d 1 s; 1,500 ft. rough sheathing; 1,800 ft. siding; 1,500 ft. flooring; 12,000 shingles; 1,000 ft. finishing; 180 ft. wainscoting; 160 ft. ⅜ ceiling; 5,000 lath; 4 doors, 2 8x6 8, 1⅜, No. 1; 7 doors, 2 6x6 6, 1⅜, No. 1; 13 win. 12x28 4 lt.; 4 ps. 2x8 18, d and b; 250 ft. O G base; 500 ft. O G casing; 160 lbs. pl. paper; 200 lbs. tar paper; 2 cel. sash, 8x10 3 lt.; 230 ft. 3½ in. O G crown molding; 230 ft. 1⅛x1¾ in. Scotia; 70 ft. large drip; 70 ft. 1¼x2½ in. nosing; 180 ft. blind stop; 180 ft. parting strip; 180 ft. 1⅜ O G stop; 200 ft. 1¾ O G stop; 148 ft. 1⅛x2½ in. cap; 48 ft. ¾ in. quarter-round; 48 ft. ¾x1 in. Scotia; 1½ cords stone, 12 in. high; 1,000 brick; 18 gal. paint; 11 bbls. lime; 1 bbl. stucco; 2 bu. hair; 1 bbl. cement; nails, 60 lbs. 20d, 140 lbs, 10d, 50 lbs. 8d, 30 lbs. 6d, 45 lbs. 3d com., 40 lbs. 3d fine, 50 lbs. 10d casing; 11 mortise locks; 11 pr. butts and screws; 3¼ doz. win. springs; 2 doz. wardrobe hooks; 3 thimbles. House 16x32, 2 wings, each 14x14, 9 ft. high; two porches and outside pantry.

DESIGN No. 21.

2 ps. 6x8 28; 2. ps. 6x8 18; 42 ps. 2x8 18; 8 ps. 2x4 20; 28 ps. 2x4 18; 22 ps. 2x4 16; 56 ps. 2x4 14; 66 ps. 2x4 12; 1,400 ft. sheathing, d 1 s; 800 ft. rough sheathing; 6,500 shingles; 1,600 ft. siding; 1,200 ft. flooring; 700 ft. finishing; 140 ft. ⅞ wainscoting; 6,500 lath; 2 doors 2 8x6 8, 1⅜, No. 1; 7 doors 2 6x6 6, 1⅜, No. 1; 7 win. 12x28 4 lt.; 2 win. 12x24 4 lt.; 3 ps. 2x8 18, d and b; 320 ft. O G base; 400 ft O G casing; 160 lbs. pl. paper; 110 lbs. tar paper; 2 cel. sash; molding, 110 ft. No. 2225, 110 ft. No. 2320 44 ft. large drip; molding, 44 ft. No. 2632; 120 ft. blind stop; 120 ft. parting strip; molding, 120 ft. No. 2374, 160 ft. No. 2380, 36 ft. No. 2450, 36 ft. No. 2319, 36 ft. ¼ round No. 2326; 1 cord stone 14 in. high; 500 brick; 16 gal. paint; 12 bbls. lime; 1 bbl. stucco; 1 bbl. cement; 3 bu. hair; nails, 50 lbs. 20 d., 100 lbs. 10 d., 40 lbs. 8d., 25 lbs. 6d., 25 lbs. 3d com., 50 lbs 3d fine, 40 lbs. 10d casing; 9 mortise locks; 9 pr. butts and screws; 2¼ doz. win. springs; 2 doz. wardrobe hooks; 4 thimbles, 6-in. House, 18x28, 14 ft. posts.

DESIGN No. 22.

2 ps. 6x8 22; 2 ps. 6x8 24; 6 ps. 6x8 16; 110 ps. 2x8 16; 36 ps. 2x6 16; 100 ps. 2x4 20; 48 ps. 2x4 18; 66 ps. 2x4 16; 128 ps. 2x4 12; 13 ps. 2x4 10; 3,100 ft. sheathing, d 1; 2,240 ft. rough sheathing; 3,600 ft. siding; 3,230 ft. flooring; 18,000 shingles; 1,800 ft. finishing; 210 ft. ⅞ wainscoting; 160 ft. ⅜ ceiling; 12,500 lath; 2 doors, glazed and transoms; 2 doors 2 8x6 8, 1⅜; 17 doors 2 6x6 6, 1⅜; 14 win. 12x32, 4 lt.; 11 win. 12x28, 4 lt.; 7 ps. 2x8 18 d and b; 650 ft. O G base; 1,000 ft. O G casing; 345 lbs. pl. paper; 310 lbs. tar paper; 2 cel. sash 8x10, 3 lt.; 280 ft. 4½ in. crown molding; 280 ft. 2½ in. O G crown molding; 120 ft. large drip; 120 ft. 1¼x2½ in. nosing; 350 ft. blind stop; 350 ft. parting strip; 350 ft. 1⅜ O G stop; 360 ft. 1¾ O G stop; 60 ft 1⅛x2½ in. cap; 60 ft. ¾ in. quarter-round; 60 ft. ¾x1 in. Scotia; 3 cords

stone 16 in. high; 25,000 brick; 37 gal. paint; 25 bbls. lime; 2 bbls. stucco; 5 bu. hair; 2 bbls. cement; nails, 150 lbs. 20d, 300 lbs. 10d, 100 lbs. 8d, 60 lbs. 6d, 70 lbs. 3d com., 100 lbs 3d fine, 100 lbs. 10d casing; 21 mortise locks; 21 pr. butts and screws; 6¼ doz. win. springs; 4 doz. wardrobe hooks, 8 thimbles. Main part 16x26; ell part 16x20, 20 ft. high; back part 16x16, 12 ft. high; three porches, vestibule, pantry and bath-room on the outside.

DESIGN No. 23.

200 ps. 2x4 20s for studding; 13 ps. 8x8 20s, for sills; 45 posts 8x8 6 ft.; 5 trusses 8x8, 35 ft. for span; 192 ps. 2x6 10s for rafters; 2,400 ft. rough sheathing for side; 2,000 ft. rough sheathing for roof; 3,000 ft. planed siding; 2,600 ft. planed flooring; 2,900 shingles; 200 ft. water table; 47 ps. joist, 2x10 18s; 250 ft. molding for outside; 60 ft. of cresting; 150 ft. corner boards; 650 yds. of lath and plaster; 8 double windows, complete; 2 sets double doors and 2 single, complete; 300 ft. of 10 in. base; pews extra; 2,000 brick for chimneys.

DESIGN No. 24.

2 ps. 6x8 32; 3 ps. 6x8 30; 6 ps. 6x8 22; 6 ps. 6x8 20; 6 ps. 6x6 12; 6 ps. 6x6 14; 8 ps. 6x6 16; 6 ps. 6x6 20; 62 ps. 2x6 26; 34 ps. 2x6 20; 8 ps. 2x6 18; 8 ps. 2x6 16; 66 ps. 2x6 14; 40 ps. 2x10 12; 76 ps. 2x10 14; 60 ps. 2x10 20; 25 ps. 4x4 16; 65 ps. 2x4 12; 52 ps. 2x4 16; 40 ps. 2x4 20; 4,800 ft. 2-in. plank; 8,100 ft. ship lap; 1,000 ft. stock, d 1 s; 8,800 ft. sheathing; 40,000 shingles; 4,600 ft. O G batts; 6 win. 8x10 12 lt. pl.; nails, 100 lbs. 30d, 200 lbs. 20d, 500 lbs. 10d, 25 lbs. 6d; 150 lbs. 3d, 25 lbs. 8d clinch; strap hinges, 5 pr. 8-in., 9 pr. 10-in; 12 hooks and staples; 5 hasps and staples; 1 cord stone for pillars; 28 gal. paint. Barn, main part 40x60; 14 ft. high; ell or shed, 30x40; 10 ft. high; open front.

DESIGN No. 25.

3 ps. 6x8 28; 2 ps. 6x8 20; 13 ps. 2x10 20; 15 ps. 2x8 20; 2 ps. 4x4 16; 10 ps. 2x4 20; 8 ps. 2x4 18; 16 ps. 2x4 16; 80 ps. 2x4 14; 1,120 ft. 2-in. plank; 2,300 ft. ship lap; 250 ft. stock, d 1 s; 1,300 ft. rough sheathing; 7,000 shingles; 1,500 ft. O G batts; 4 win. 10x12, 8 lt., pl.; ¼ cord stone; 1 pr. rollers and 16 ft. track; 3 pr. 10-in. strap hinges; 3 hooks and staples; 1 hasp and staple; nails, 60 lbs. 20d, 200 lbs 10d, 25 lbs. 6d, 25 lbs. 3d coarse, 15 lbs. 8d clinch; 10 gal. paint. Barn, 20x28, 14 ft.

DESIGN No. 26.

200 lineal ft. 8x10 for main sills; 150 lineal ft. 8x8 for cross sills; 150 lineal ft. 6x6 for cross girths; 16 ps. 8x8 16s for posts; 200 lineal ft. 6x8s for plates; 200 lineal ft. 6x8s for girths; 52 ps. 2x4 10s for studs for bins, stables, etc.; 20 ps. 2x8 12s for studs between carriage-room

and mow; 20 ps. 2x6 12s for studs between carriage-room and corn-crib; 20 ps. 2x6 16s for studs for end of corn-crib; 24 ps. 2x8 16s for floor joists for carriage-room and corn-crib; 24 ps. 2x8 12s for floor joists for drive-way; 24 ps. 2x8 8s (16s) for floor joists for bins; 24 ps. 2x8 20s for floor joists for stable; 2 ps. 4x4 16s, for stringer under stable; 2,800 ft. 2x8 joists under floor of loft, which is over stable, bins, carriage-room and corn-crib; 72 ps. 2x6 22s (or 20s) for rafters; 36 ps. 2x4 12s for collar beams; 3,200 ft. dressed dimension boards for siding; 800 ft. 3-in. O G battens; 540 ft. flooring for doors; 2,500 ft. common boards for roofing; 30,000 shingles; 3,000 ft. 2-in. plank; 1,150 ft. matched dimension boards for floor of loft; 600 ft. matched dimension boards for bins; 350 ft. 1½-in. plank for mangers, etc.; 360 ft. common boards for partition between carriage-room and hay mow; 270 ft. 3-in. battens between carriage-room and crib; 2 ps. 2x4 16s for ladder posts in front of mow; 136 lineal ft. 4x4s for braces; 135 ft. dressed dimension boards for ventilator shaft; 2 windows, 8-light, 8x12, 2 cellar sash, 3-light, 10x12, over small doors (not indicated in cuts).

DESIGN No. 27.

For sills: 2 ps. 8x10 34 0; 2 ps. 8x10 22 0; 1 ps. 8x10 16 0. For girders: 3 ps. 10x10 20 0; 2 posts 8x8 14 0. For joists: 46 ps. 2x10 22 0; 48 ps. 2x10 14 0; 12 ps. 2x10 18 0; 20 ps. 2x8 22 0; 24 ps. 2x8 14 0; 25 ps. 2x8 12 0; 120 ps. 2x4 22 0; 230 ps. 2x4 20 0;36 ps. 2x4 16 0; 16 ps. 2x4 14 0; 27 ps. 2x4 12 0; 6 ps. 2x10 20 0; 8 ps. 2x10 14 0. Six 6 in. x 6 ft. cedar posts; 5,300 ft. com. bds. d 1 s; 24,000 A shingles; 1,000 shingles, cut corners; 3,600 ft. siding; 335 yards No. 2 wool felt; 900 lineal ft. 2x2 bridging; 275 lineal ft. 1x6 ribbon bands; 23 ps. 14 and 23 ps. 16 ft. 1¼x5, beaded corner boards; 3,000 ft. 5⅓ in. flooring; 1,500 ft. 5½ in. fencing d & m; 14 ps. 6x16 0 ridge boards; 200 lin. ft. 5" crown mold, No. 2,201 Standard Molding Book; 200 lin. ft. 3" facie; 200 lin. ft. 2" bed mold No. 2,577 Standard Molding Book; 200 lin. ft. 12" soffeit; 200 lin. ft. 14" frieze; 160 lin. ft. 1¼x7 water table; 1 staircase, 22 ft. 3x4 rail; 32—2¼" turned balusters; 1—7" square newel post; 3 flights back stairs. Doors, 1¾" sunk mold, chamfered edges; 2—2 4x7 0; 1—2 8x7 6; 2—3 0x8 0; 3—2 8x7 6; 3—2 4x7 6; 2—2 8x7 6; 1—2 8x7 6. Doors, 1⅜ P G mold; 1—2 4x7 0; 1—2 6x7 0; 1—2 8x7 0; 4—2 8x7 0; 5—2 4x7 0; 1—2 8x7 0; 1—2 6x7 0; 1—3 0x6 6; 1 transom sash, 1¾", 1 light, 14x52; 4 transom sash, 1⅜", 4 lt. 12x28; 1 plank frame and sash, 1⅜", 1 lt. 14x26; 3 do. 6 lt. 14x14; 1 do. 2 lt. 12x14.

WINDOW FRAMES AND SASH 1⅜" THICK.

2 mullion, 2 lt. 28x38; 2 window 2 lt. 28x28; 2 window, 2 lt. 18x38; 1 mullion, 4 lt. 16x38; 1 window, 4 lt. 15x38; 1 window, 4 lt. 14x38; 1 window, 2 lt. 14x38; 1 mullion, 4 lt. 28x36; 4 window, 8 lt. 28x36; 2 window, 4 lt. 26x36; 2 window, 8 lt. 14x36; 1 window, 2 lt. 15x36; 2 window, 4 lt. 16x36; 3 window, 6 lt. 20x36; 1 oval, 1 lt. 18x36; 1 round, 1 lt. 20x20; 1 window, 4 lt. 12x24; 1 window, 2 lt. 18x20.

450 lin. ft. ⅞x5 O G casings; 600 lin. ft. 1 ⅛x6 door frames; 650 lin. ft. ⅞x5½ O G casings and moldings; 250 lin. ft. ⅞x8 carved plinth; 250 lin. ft. ⅞x2½ molding, No. 2,994 Standard Molding Book; 250 lin. ft. ¼" round molding; 350 lin. ft. ⅞x5½ pine, d m & b; 50 lin. ft, ⅞x1½ molding; 38 ps. 1⅛x5½x16 0 beaded and chamfered casings; 55 head blocks, 1⅜x5½x11 with turned rosettes; 38 plinth blocks, 1⅜x5½x10½ molded and beaded; 160 lin. ft. ⅞x5 O G plinths; 190

lin. ft. ⅞x8 coved, beaded plinths, No. 3,076 Standard Molding Book; 190 lin. ft. 2½" base mold, No. 3,075 Standard Molding Book; 190 lin. ft ¼" round molding, No. 2,324 Standard Molding Book; 24 lin. ft. ⅞x16 shelving; 18 lin. ft. ⅞x18 shelving; 100 lin. ft. ⅞x12 shelving; 100 lin. ft. ⅞x3 beaded strips; 120 lin. ft. 1⅛x6 molded stools, No. 2,423 Standard Molding Book; 120 lin. ft. of ⅞x5 O G apron, No. 2,455 Standard Molding Book; 120 lin. ft. of ⅞x2 O G apron mold, No. 2,397 Standard Molding Book; 2 sets of drawers, 2' 6" wide; 65 lin. ft. 1⅝x7 molded belt; 53 lin. ft. 1¾" roof cresting; 17 pairs of inside blinds 1⅛" thick; 11 pairs outside blinds 1⅛" thick; 38 ps. 1⅛x6x16 o outside beaded casings; 8 brackets for hoods; 4 brackets for bay window; 80 lin. ft. 1⅛x6; 6 brackets for porch; 850 lin. ft. ½x1⅜ O G stops, No. 2,381 Standard Molding Book; 3 ps. 1⅜x12x16 o beaded verge board; 35 turned rosettes; 6 ps. 1⅜x10x12 o; 20 turned balusters, 2x2x10 porch; 26 turned balusters, 3x3x18; 30 lin. ft. molded cornice; 4 7-inch turned posts; 3 molded and beaded newel posts, 8x8; 25 lin. ft. 3½x6 beaded rails; 80 lin. ft. ⅞x4 b w thresholds; 9 black walnut 1⅛" turned angle beads.

HARDWARE.

200 lbs. 6 penny common nails; 3 kegs 20 penny spikes; 1 keg 10 penny casing nails; 1 keg 6 penny casing nails; 2 kegs 10 penny common nails; 125 lbs. shingle nails; 116 sash weights: 10 hanks of Italian cable sash cord; 23 black walnut rubber tipped bennpers; 42 Berlin bronze sash lifts; 14 japanned sash lifts; 23 Morris' patent Berlin bronze sash locks; 5 japanned sash locks; 6 pair Berlin bronze drawer pulls; 4 Berlin bronze spring transom locks; 8 swivel springs; 22 pair blind hinges, catches and fastenings; 50 japanned hat and cloak hooks; 1 set Warner's sheaves and hardwood track; 1 Branford's mortise sliding door lock; 1 pr. Berlin bronze cups; 15 Branford's mortise locks; 9 Branford's mortise latches; 1 rim lock; 1 Branford's mortise 3-tumbler front door lock and night latch; 9 pair 2½ in. jet knobs and bronze trimmings; 16 pair 2¼ in. white porcelain knobs and plated trimmings, all locks to have brass face and striking plates; 1 2½ in. jet bell pull and bronze trimmings, 60 ft. copper wire and 4 cranks; 138 pair 2 in. butts and back flaps and screws; 1 flush bolt 12 in. long; 1 flush bolt 18 in. long; 2 mortise thumb latches; 1 pair trap door hinges and padlock; 27 pair 4½x4½ loose pin butts; 5 pair 3x3 butts; 5 3-in. barrel bolts; 1 6-in. barrel bolt; 1 pair 4x4 butts; 59 squares of 2 coat painting.

MASON WORK.

190 yards excavating; 14 cords rubble stone; 4,000 common brick; 1,867 yards plastering; 2,700 lath; 5 window sills, 4x8x3 4 (cut stone.)

DESIGN No. 28.

Lumber; 7 ps. 8x8 32; 8 ps. 8x8 26; 6 ps. 6x8 26; 2 ps. 8x8 24; 14 ps. 8x8 22; 100 ps. 2x6 22; 2 ps. 6x6 20; 5 ps. 4x6 20; 2 ps. 4x4 20; 7 ps. 2x8 20; 4 ps. 8x8 18; 2 ps. 6x8 18; 16 ps. 4x4 18; 4 ps. 8x8 16; 9 ps. 6x6 16; 11 ps. 4x6 16; 19 ps. 4x4 16; 14 ps. 2x8 16; 8 ps. 2x6 16; 28 ps. 2x4 16; 35 ps. 2x12 16; 3 ps. 6x6 14; 2 ps. 4x6 14; 10 ps. 4x4 14; 30 ps. 2x8 14; 2 ps. 2x6 14; 2 ps. 8x8 12; 4 ps. 6x6 12; 10 ps. 4x6 12; 3 ps. 4x4 12; 126 ps. 2x8 12; 14 ps. 2x6 12; 18 ps. 2x4 12; 7 ps. 2x14 12; 55 ps. 2x10 12; 28,000 shingles; 2,160 ft. 16 ft. com. boards; 1,400 ft. 14 ft. com. boards; 800 ft. 16 ft. fencing; 2,730 ft 16 ft. fencing flooring; 175 ft. 14 ft. fencing flooring; 350 ft. 12 ft. fencing flooring; 2,000 ft. 14 ft. D stock, s 1 s; 1,152 ft. 18 ft. D stock, s 1 s; 3,000 ft. 16 ft. D stock, s 1 s; 5,000 lineal ft. 2½ in. O G battens; 6 windows, 9x12, 12 lt., com. glazd.; 4 sash, 9x12, 5-lt., glazd. hardware; 10 rods 9 6x⅜; 50 lbs. 30d spikes; 100 lbs. 20d spikes; 25 lbs., 8d clinch nails; 125 lbs. 4d com. nails; 400 lbs. 10d com.; 4 pairs large door hangers, No. 2; 6 pairs small door hangers, No. 1; 8 pairs 10 in. strap hinges; 7 large hook hasps and staples; 12 pairs 6 in. T hinges with screws; 100 ft. iron track with screws; *a*—Outside sill; *b*—manure drop, cut in joists 4x18; *c*—4x6 supports for joists; *d*—stanchion; *e*—mangers; *f*—meal bin; *g*—cross sill; *h*—joist for floor.

DESIGN No. 34.

OAKLAND COTTAGE.

30 cedar posts 6 ft. long; 140 lineal ft. 8x8 sills; 28 joist 2x18, 16 ft long, first story; 15 joist 2x8, 16 feet long, first story; 13 joist 2x8, 12 ft. long, first story; 28 joist 2x8, 16 ft. long, first story; 15 joist 2x8, 16 ft. long, first story; 13 joist 2x8, 12 ft. long, first story; 16 collars 2x6, 18 ft. long, in attic; 140 studs 2x4, 12 ft. long, outside walls; 90 studs 2x4, 9 ft. long, partition studs; 92 rafters, 2x4, 12 ft. long; 1,900 ft. sheathing boards, 1x6; 1,100 ft. roof boards, common, 1 inch; 10,000 pine shingles and nails; 1,800 ft. 6 inch siding; 700 ft. 1x4 beaded and matched ceiling; 19 square ft. paper; 260 lineal ft. 1x8 molded base; 1,000 ft. 1x6 common flooring, pine; 800 ft. 1x6 fencing floor in attic; 11 windows, frames, sash, casings, etc.; 12 doors, frames, casings, hardware, etc.; 1 flight stairs to attic; front porch, etc.; sink, back steps, bells and tin work; 2 attic dormers, 1 half-circle window, water table, cornices, bells, corner boards, etc.; bridging, plates, braces, etc.; 1 fancy front gable; 2 chimneys, brick and mortar; 280 yards two-coat plastering; painting, glass, etc.

DESIGN No. 36.

CANADIAN COTTAGE.

133 lineal ft. 8x8 sills, 665 ft.; 50 8-inch cedar posts; 150 2x4 studs 16 ft. long, 1,650 ft.; 180 2x4 studs 12 ft. long; 95 2x4 rafters 12 ft. long; 60 2x10 joists 24 ft. long; 13 2x8 joists 12 ft. long; 32 2x4 ceiling joists 24 ft. long; 13 2x4 ceiling joists 12 ft. long; 2,000 fr. roof bo rds; 2,360 ft. sheathing boards; 700 ft. beaded and matched; 18,000 A shingles; 2,800 ft. 6-inch siding; 18 window frames, sash, casing and hardware; 17 doors, frames, jambs, casing and hardware; one flight stairs, front gable; outside steps; 2 chimneys, foundations and materials; 480 ft. base and mold; 145 ft. outside cornice; 135 feet water table and belt course; 6 closets, shelves and hooks; 2,000 feet 1x6-inch flooring; glass and painting; 628 yds. 2-coat plastering; fancy shingles, cresting and finials; 23 squares sheathing paper; plates, bridging blocks, etc.; hardware, nails, etc.

DESIGN No. 38.

FERNWOOD COTTAGE.

35 cedar posts 6 ft. long; 170 lineal ft. 8x8 sills; 44 2x8 joist 14 ft. long, first floor; 20 2x8 joist 16 ft. first floor; 44 2x8 joist 14 ft. long, second floor; 20 2x8 joist 16 ft. long, second floor; 20 2x4 collar beams 8 ft. long, attic; 138 2x4 outside studs 12 ft. long; 70 2x4 partition studs 9 ft. long; 100 2x4 rafters, 12 ft. long; 1,600 ft. com. boards for roof; 14,000 pine shingles, nails, etc.; 1,500 ft. 6 inch siding; 300 ft. 1x4 beaded and matched ceiling; 1,300 ft. 1x6 sheathing (fencing No. 2); 1,400 ft. paper and nails; 260 lineal ft. 1x8 molded base; 275 yards plastering; 1,000 ft. 1x6 pine flooring; 2 chimneys—brick and mortar; 12 windows, sash, casings, hardware, etc.; 9 doors, frames, hardware, etc.; 1 flight stairs to attic; 800 ft. fencing floor in attic; front porch: sink, back steps, bells and tin work; front dormer, water-table, corner boards, etc., painting, glass and glazing; main cornice; bridging, plates and braces.

DESIGN No. 39.

BUENA VISTA COTTAGE.

32,560 brick in foundation; 48 yards cubic excavation, 25 cts.; 5,040 brick in chimneys above footing; 190 ps. 2x4 studs, 16 ft. long, outside; 87 ps. 2x4 partition studs, 12 feet long; 20 ps. 2x8 partition studs, 12 ft. long; 48 ps. 2x3 partition studs, 12 feet long; 14 ps. 2x4 gable studs, 12 feet long; 24 ps. 2x10 joist, 16 ft. long; 25 ps. 2x10 joist, 18 ft. long; 22 ps. 2x10 joist, 14 ft. long; 16 ps. 2x10 joist, 12 ft. long; 16 ps. 2x10 joist, 20 ft. long; 10 ps. 2x10 joist, 10 ft. long; 92 lineal ft. 6x8 cross sills; 142 ps 2x10 attic joist, 14 ft. long; 90 ps. 2x6 rafters, 14 ft. long; 50 ps. 2x6 rafters, 22 ft. long; 12 ps. 2x6 rafters, 8 ft. long; 32 ps. 2x6 rafters, bay, 12 ft. long; 40 ps. 2x4 rafters, dormers, 8 ft. long; 16 ps. 2x4 rafters, porch, 8 ft. long; 20 ps. 2x6 rafters, deck, 12 ft. long; 8 ps. 2x6 rafters, deck, 6 ft. long; 30 ps. 2x6 collar beams, 16 ft. long; 20 ps. 2x6 collar beams, 18 ft. long; 10 ps. 6x8 sills on brick wall, 18 ft. long; 50 ps. 2x4 14 ft. long plates; 30,000 shingles, walls and roof; 2,000 ft. 1x6 surfaced roof-boards; 4,300 ft. 1x6 flooring (pine); 2,500 ft. 1x6 matched sheathing; 3,000 ft. 6-inch siding; 186 ft. water-table, molding and labor; 186 ft. sill course, molding and labor; 200 ft. main cornice, molding and labor; 1,200 ft. 1x6 beaded ceiling, outside; 55 lineal ft. of wood roof cresting; 260 ft. tin roofing on deck, 10 cts.; flashings, tin work, conductors, etc.; frames, sash, labor and lumber, three dormers; cornice, moldings, panels, etc., front gable; all work and material to front portico; cornice, panel work, labor and material of 3 bay windows and cresting on same; rear porch complete, front and rear steps; panels and labor on octagon tower; triple frame in front gable and finish; 6 interior fancy wood arches, complete; one flight stairs to attic, labor, etc.; 20 windows, frames, sash, labor, etc.; 13 doors, jambs, hardware, labor, etc.; fitting up sink and bath-room work; fitting up 6 closets, shelves and hooks, etc.; 400 ft. of molded 1x9 base; corner-boards, moldings, etc., not before estimated; 670 yards 2-coat plastering; 25 squares of felt wall paper; painting, glass and glazing; plumbing, gas and sewerage; bells, tubes, etc.

DESIGN No. 40.

KENWOOD COTTAGE.

217 yards excavation; 15,000 brick in cellar wall; 5,600 brick in chimneys above cellar wall; 858 yards of plastering, 2-coat; painting, glass, glazing, plumbing, gas, sewers, fixtures, etc.; rough cast work on front of building; 12 pieces 6x8 sills on brick walls, 12 ft. long; 15 pieces 2x10 joist, 1st floor, 14 ft. long; 32 pieces 2x10 joist, 1st floor, 8 ft. long; 20 pieces 2x10 joist, 1st floor, 12 ft. long; 26 pieces 2x10 joist, 1st floor. 13 ft. long; 26 pieces 2x10 joist, 2d floor, 14 ft. long; 6 pieces 2x10 joist, 2d floor, 15 ft. long; 8 pieces 2x10 joist, 2d floor, 10 ft. long; 16 pieces 2x10 joist, 2d floor, 14 ft. long; 16 pieces 2x4 joist, ceiling, 14 ft. long; 16 pieces 2x4 joist, ceiling, 10 ft. long; 14 pieces 2x4 joist, ceiling, 14 ft. long; 26 pieces 2x4 joist, ceiling, 14 ft. long; 12 pieces 2x4 joist, ceiling, 8 ft. long; 14 pieces 2x4 joist, ceiling, 8 ft. long; 16 pieces 2x4 joist, rafters, 30 ft. long; 16 pieces 2x4 joist, rafters, 26 ft. long; 6 pieces 2x4 joist, rafters, 12 ft. long; 24 pieces 2x4 joist, rafters, 14 ft. long; 10 pieces 2x4 joist, rafters, 7 ft. long; 16 pieces 2x4 collar beams, 16 ft. long; 30 pieces 2x4 plates, 14 ft. long; 343 studs for partitions, 2x4, 12 ft. long; 10 studs for outside walls, 2x4, 14 ft. long; 70 studs for outside walls, 2x4, 30 ft. average; 27 studs for outside walls, 2x4, 12 ft. long; 27 studs for outside walls, 2x4, 18 ft. long; 2,500 ft. of 1x6 fencing for sheathing, laid; 1,800 ft. of 1x6 fencing for roofing, laid; 17,000 pine, cedar or cypress shingles, laid; tin work, conductors, flashings, etc.; 3,000 ft. of 6 in. O.G. siding, laid; cornice, corner-boards, moldings, belts, water-tables, etc.; 300 ft. 1x4 beaded and matched ceiling; front porch, outside steps, etc.; 21 windows, sash, casings, etc.; 550 ft. base-board and mold; 24 doors, casings, hardware, etc.; one flight stairs, oak rail, balusters, etc.; 6 closets, shelves, hooks, strips, etc.; bath-room, store closet, kitchen sink, bells, cistern, etc.; 2,800 ft. 1x6 flooring, C quality; 2,500 ft. of building paper, outside.

HOW TO FIND THE POSITION OF THE SUN AT ANY TIME OF THE DAY.

A simple means of determining the position of the sun at any time of the day is by placing the point of a knife-blade or sharp lead pencil on the thumb nail, which will cast a shadow directly from the sun, no matter how thick the snow or fog is. Try it.

SHRINKAGE OF CASTINGS.

In making allowance for shrinkage in casting, pattern makers understand that different shapes will shrink differently. The standard table of allowance for shrinkage in use in the best shops in the country is as follows:

For Loam Castings	1-12	inch	per foot.
" Green Sand Castings	1-10	"	"
" Dry " "	1-10	"	"
" Brass Castings	3-16	"	"
" Copper "	3-16	"	"
" Bismuth "	5-32	"	"
" Tin "	1-4	"	"
" Zinc "	5-16	"	"
" Lead "	5-16	"	"

POINTERS ON SUCCESS IN BUSINESS.

Buy and sell for cash.

Don't try to start in a big way.

Morality is the basis of co-operation.

Require all employés who handle funds to give bonds.

Confidence in one another is the natural outgrowth of sound morality.

By doing a cash business every workingman's dollar is worth $1.10.

Co-operation will insure a good article, and honest weights and measures.

Beware of credit. He is the undertaker who buries all foolish co-operators.

Never imagine your work is done. Eternal vigilance is the price of success.

The primary object of co-operation is to improve the condition of producers.

Don't make your by-laws too long or technical, and compel their close observance.

The backbiter and slanderer is the most dangerous person you can get into a co-operative society.

See to it that your manager makes statements quarterly, or as the by-laws provide, and be on hand to hear them, instead of staying away and grumbling.

Keep clear of all political party manipulators; long before you fully understand the science of industrial co-operation, you will know how to co-operate at the ballot box.

Intelligence, sobriety, industry and economy are indispensable requisites of co-operators. Co-operation can do nothing for the lazy, immoral or reckless, unless they reform.

Put your enterprise, no matter what it is, in the hands of a man who understands the business. If you attempt to learn co-operation and educate a manager in the conduct of the business at the same time, you will fail.

When you select a manager let him run the business until he demonstrates his incapability. More enterprises fail through the meddling of a bad board in things they don't understand than from any other single cause.

Take the bold step of gradually reducing stock.

Seize the right time for modifying your business with advantage.

Push your trade with energy and spirit, and by judicious advertising.

Divide your risks as the insurance people do, so that in case of failure you will not be much hurt.

In stock-taking let nothing but real value appear in the balance sheet, and under rather than over value.

Let the benefit to accrue from vigorous use of the pruning knife sustain you. It will come out all right in the end.

As a rule you lose people and their custom when they get into your debt. If possible do a strictly cash business.

Strike off all customers who will not steadily pay monthly. Keep strictly to this rule and you will have a healthy trade.

The true limits of credit may be seen from the etymology of the word. It is a promise to pay something in the future.

When you have commenced a business go thoroughly into it. Do not be ashamed of an honest business that is supporting you. Make it honorable.

When an account is opened ask the parties to what extent they wish to go and keep them to the amount agreed upon, which, with their name, should be entered in the ledger.

VARIOUS LOCATIONS OF THE CAPITAL OF THE UNITED STATES.

The capital of the United States has been located at different times at the following places: At Philadelphia from September 5, 1774, until December, 1776; at Baltimore from December 20, 1776, to March, 1777; at Philadelphia from March 4, 1777, to September, 1777; at Lancaster, Pa., from September 27, 1777, to September 30, 1777; at York, Pa., from September 30, 1777, to July, 1778; at Philadelphia from July 2, 1778, to June 30, 1783; at Princeton, N. J., June 30, 1783, to November 20, 1783; Annapolis, Md., November 26, 1783, to November 30, 1784; Trenton from November, 1784, to January, 1785; New York from January 11, 1785, to 1790; then the seat of government was removed to Philadelphia, where it remained until 1800, since which time it has been at Washington.

GROWTH OF THE UNITED STATES.

The United States has a population of at least 62,000,000 at this moment. This makes it second in this particular among the great civilized nations of the world. Keeping in view the ratio of growth of the countries named between recent census periods, there are to-day about 88,000,000 inhabitants in European Russia, 47,000,000 in Germany, 40,000,000 in Austro-Hungary, 38,000,000 in France, 37,000,000 in Great Britain and Ireland, 30,000,000 in Italy, and 17,000,000 in Spain.

The population of none of the other countries in Europe reaches 10,000,000—Turkey's inhabitants outside of Asia aggregating scarcely half that figure. Russia alone of the great powers of Christendom exceeds the United States in population. Even Russia must soon be left far in the rear. July 1, 1890, when the next national enumeration takes place, the United States will have 67,000,000 inhabitants. It will have 96,000,000 in the year 1900, and 124,000,000 in 1910. This computation is based on the average growth of the country during the century. Employing a like basis for Russia, that nation before 1910 will have dropped to second place, the United States taking the first.

Forty years ago the United States stood sixth in point of population among civilized nations of the globe and twenty years ago it stood fifth. Twenty years hence it will stand first.

THE NEW FORTH BRIDGE.

The new railroad bridge over the Frith of Forth, in Scotland, to replace the one which went down with such appalling results a few years ago, is now near completion, and is described as one of the finest pieces of engineering in the world. The chief engineer of the structure gives the following "cold facts" regarding it: The total length of the viaduct will be 8,296 feet, or nearly 1⅝ miles, and there are two spans 1,710 feet, two of 680 feet, fifteen of 168 feet girders, four of 57 feet, and three of 25 feet, being masonry arches. The clear headway for navigation will not be less than 150 feet for 500 feet in the center of the 1,710 feet spans. The extreme height of the structure is 361 feet above, and the extreme depths of foundation 91 feet below the level of high water. There will be about 53,000 tons of steel in the superstructure of the viaduct, and the material used throughout is open-hearth of Siemens-Martin steel. That used for parts subject to tension is specified to withstand a tensile stress of 30 to 33 tons to the square inch with an elongation in eight inches of not less than 20 per cent.; that subject to compression only a tensile stress of 34 to 37 tons per square inch, with an elongation in eight inches of not less than 17 per cent.

Rochester, N. Y., has an electric-light plant which supplies 1,100 arc and 1,025 incandescent lamps. The plant is said to be the largest in the world run by water power.

"ANCIENT" WINTERS.

In 401 the Black Sea was entirely frozen over. In 763 not only the Black Sea, but the Straits of Dardanelle, were frozen over, the snow in some places rising 50 feet high. In 822 the great rivers of Europe, the Danube, the Elbe, etc., were so hard frozen as to bear heavy wagons for a month. In 860 the Adriatic was frozen. In 991 everything was frozen, the crops totally failed and famine and pestilence closed the year. In 1707 most of the travelers in Germany were frozen to death on the roads. In 1134 the Po was frozen from Cremona to the sea, the wine sacks were burst, and the trees split by the action of the frost with immense noise. In 1236 the Danube was frozen to the bottom, and remained long in that state. In 1316 the crops wholly failed in Germany. Wheat, which some years before sold in England at 6s. the quarter, rose to £2. In 1308 the crops failed in Scotland, and such famine ensued that the poor were reduced to feed on grass, and many perished miserably in the fields. In 1368 the wine distributed to the soldiers was cut with hatchets. The successive winters of 1432–3–4 were uncommonly severe. In 1663 it was excessively cold. Most of the hollies were killed. Coaches drove along the Thames, the ice of which was 11 inches thick. In 1709 occurred very clod weather; the frost penetrated three yards into the ground. In 1726 booths were erected on the Thames. In 1744 and 1745 the strongest ale in England, exposed to the air, was covered in less than 15 minutes with ice an eighth of an inch thick. In 1808 and again in 1812, the winters were remarkably cold. In 1814 there was a fair on the frozen Thames.

STRENGTH OF HORSES.

It is stated that, if one horse can draw a certain load over a level road on iron rails, it will take one and two-thirds horses to draw the same load on asphalt, three and one-third horses to draw it on the best Belgian block, five on the ordinary Belgian pavement, seven on good cobblestones, thirteen on bad cobblestones, twenty on an ordinary earth road, and forty on a sandy road.

THE LARGEST DAM IN THE WORLD.

The largest dam in the world is in California. It will be 700 feet long, 175 feet high, 175 feet thick at the base, 20 feet thick at the top, and the reservoir thus formed will have a capacity of 32,000,000 gallons.

THE LARGEST PONTOON BRIDGE IN THE WORLD.

The pontoon bridge over the Missouri River at Nebraska City is said to be the largest in the world. Its length across the navigable channel is 1,074 feet, while the back channel is traversed by a causeway 1,050 feet long, supported on cribs. The charter for this bridge has been held for twelve years, because of the difficulty of obtaining financial support for a project that appeared so impracticable. It is stated that the entire bridge was built in twenty-eight days, at a cost not exceeding $18,000, by Col. S. N. Stewart of Philadelphia, assisted by Gen. Lyman Banks, of Iowa. The draw is V-shaped, with the apex down stream. It is operated by the current and controlled by one man. The clear span is 528 feet, the largest in the world. The bridge was completed in August, and is doing good service. It will be removed during the ice season.

THE BANK OF ENGLAND DOORS.

The Bank of England doors are now so finely balanced that a clerk, by pressing a knob under his desk, can close the outer doors instantly, and they cannot be opened again except by special process. This is done to prevent the daring and ingenious unemployed of the metropolis from robbing the bank. The bullion departments of this and other banks are nightly submerged several feet in water by the action of the machinery. In some banks the bullion department is connected with the manager's sleeping room, and an entrance cannot be effected without shooting a bolt in the dormitory, which in turn sets in motion an alarm. If a visitor, during the day, should happen to knock off one from a pile of half sovereigns the whole pile would disappear, a pool of water taking its place.

NEW SUBSTITUTE FOR LEATHER.

Dr. George Thenius, in Vienna, has a process for the manufacture of artificial leather from red beechwood. The best wood for the purpose is taken from fifty to sixty years old trees, cut in the Spring, and must be worked up immediately, bark peeled off, steamed, treated with chemicals in a kettle under pressure, and then exposed to several more operations, which the inventor does not mention, as he wants to have them patented.

From the prepared wood strong and thin pieces are made by means of heavy pressure. The inventor states that a solid sole leather can be obtained, which he claims is superior to the animal leather in firmness and durability, and can be worked up in the same way as animal leather, nailed and sewed. We do not believe that the leather industry needs to fear the artificial product.

THE USELESSNESS OF LIGHTNING RODS.

The uselessness of the lightning rod is becoming so generally understood that the agents find their vocation a trying one. Fewer and fewer rods are manufactured each year, and "the day will come when a lightning rod on a house will be regarded in the same light as a horseshoe over a man's door.

THE WELLAND CANAL.

The enlarged Welland Canal is regarded as one of the grandest exhibitions of engineering skill in the world. The water level of Lake Erie is over 300 feet higher than that of Lake Ontario, and this canal has been built to allow loaded ships to pass from one lake to the other. For this passage 28 miles of canal and 26 locks are required. The small village of Port Colborne stands at the entrance of the canal. The first lock is built near the entrance, to keep back the swashing sea, after which comes a stretch of 14 miles through a farming country to the second lock, after which the locks are located about as thick as possible until Lake Ontario is reached. The greater part of the descent is in the upper half mile of the route, and it takes about 13 hours to get through the canal with no hindrances.

A VALUABLE POINT FOR PAPER-MAKERS.

Iron is apt to discolor paper by rusting after it has been abraded from the paper-making machinery. Magnetism has, therefore, been called in by a German manufacturer to clear away the iron specks. A series of magnets are arranged in the form of a comb and hung across the stream of pulp and water, which in passing the magnetic teeth of the comb, delivers up the iron particles.

HOW TO DRIVE A HOLE THROUGH GLASS.

In drilling glass, stick a piece of stiff clay or putty on the part where you wish to make the hole. Make a hole in the putty the size you want the hole, reaching to the glass, of course. Into this hole pour a little molten lead, when, unless it is very thick glass, the piece will immediately drop out.

THE LARGEST LOCK IN THE WORLD.

The Sault Ste. Marie canal has the second largest lock in the world. It is built of solid masonry, 560 feet long, 80 feet wide, with walls 40 feet high, the lift 18 feet, and the depth of the water in the basin 16 feet. This lock belongs to the United States Government and cost $3,000,000, and will accommodate four at a time of the largest vessels ever brought to these waters. A new and still larger lock, to cost $5,000,000, is now being constructed. The canal now has a larger daily traffic than the great Suez canal.

HOW GAMBOGE IS PREPARED.

Gamboge is a gum, and an average gamboge tree is said to yield annually sufficient to fill three bamboo cylinders, each about 18 to 20 inches long and 1½ inches in diameter. It takes about a month to fill a cylinder. When full the bamboo is rotated over a fire to allow the moisture to escape and the gum to harden sufficiently to admit of being removed.

A human hair is 10,000 times larger than a spider's thread.

The taxable valuation of New York city, real and personal property, for 1888, was $1,553,442,431.66.

At Erie, Pa., a well has been bored 3,500 feet. The Schladeback boring was down to 4,515 feet.

A hammer for a pile-driver, made at Jacksonville, recently, was the largest ever cast in Florida. It weighed 2,350 pounds.

Cavendish, in 1766, discovered hydrogen, and between 1774 and 1779 Priestley discovered oxygen, azote and nitrous gas.

A New York dealer says that 20,000,000 pounds of rubber comes to this country every year from Borneo, Africa, and Para, South America.

The Chinese language is spoken by 400,000,000 persons; Hindostani by upward of 100,000,000; English by more than 100,000,000; Russian by more than 70,000,000; German by 58,000,000; Spanish by 48,000,000, and French by only 40,000,000.

SEALS OF THE VARIOUS EXECUTIVE DEPARTMENTS OF THE UNITED STATES GOVERNMENT.

The great seal of the United States is nearly as old as the Union, being now in its 107th year as a device. When, on July 4, 1776, the continental Congress declared the English American colonies to be free and independent States, they appointed a committee to report a device for a seal, the emblem of sovereignty. That committee and others, from time to time, presented unsatisfactory devices. Finally, in the spring of 1782, Charles Thomson, the secretary of Congress, gave to that body a device largely suggested to John

FIRST GREAT SEAL OF THE UNITED STATES.

Adams, then United States minister to the court of Great Britain, by Sir John Prestwich, an eminent English antiquary. The suggestion was made the basis of a design adopted by Congress June 20, 1782, and which is still the device of the great seal of our republic. It is composed, as the sketch shows, of a spread-eagle, the emblem of strength, bearing on its breast an escutcheon with thirteen stripes, alternate red and white, like the national flag. In its right talon the eagle holds an olive branch, the emblem of peace, and in its left thirteen arrows, emblems of the thirteen States ready for war, should it be necessary.

In its beak is a ribbon bearing the legend "E Pluribus Unum" — "many in one" — many States make one Nation. Over the head of the eagle is a golden light breaking through a cloud surrounding thirteen stars, forming a constellation on a blue field.

At this time, and for many years after, there was a reverse seal used, old documents showing sides, the obverse above and the reverse as a pendant. The device of the latter showed an unfinished pyramid, emblematic of the unfinished republic, the building of which—the increase of States and Territories--is still going on. In the zenith is an all-seeing eye, surrounded by rays of light, and over this eye the words, "Annuit Ceptis." On the base of the pyramid, in

SEAL OF THE STATE DEPARTMENT.

Roman numerals, is the date 1776, and below the words "Novus Ordo Seclorum"—a new order for all ages.

Before the adoption of the great seal the continental Congress ordered a small one for the official use of their President for the time being. It was elliptical in shape and about an inch long by three-quarters of an inch wide. Within a raised border was a circlet of clouds, with a clear space within, in which were seen thirteen stars. At a point in the clouds was the national motto, "E Pluribus Unum."

Of all the cabinet bureaus that of the State Department is the oldest. On November 29, 1775, Congress resolved "that a committee of five be appointed for the sole purpose of corresponding with our friends in Great Britain, Ireland and other parts of the world, and that they lay their correspondence before Congress when directed, and that all expenses that might arise by carrying on such correspondence and for the payment of such agents as the committee might send on this service should be defrayed by this Congress." This was the germ of our State Department and the initial step in our foreign diplomacy. The members chosen were

SEAL OF THE TREASURY DEPARTMENT.

Benjamin Harrison, Dr. Franklin, Thomas Johnson, John Dickinson and John Jay. Following the committee of correspondence came the Department of Foreign Affairs in 1781, and then came the present State Department, or Department of State, as its official title reads, managed by the Secretary of State and two assistant secretaries.

The seal device embraces a spread-eagle, with oliv branch and sheaf of arrows in either claw, holding in its beak a scroll on which are the words "E Pluribus Unum," surrounded by an irregular constellation of thirteen stars, and bearing on its breast the national shield. The words "Department of State" occupy the upper two-thirds of the circle forming the seal, the lower third being taken up with an oak wreath.

The seal of the Treasury Department is richly emblematical. The central portion consists of a shield, the upper quarter bearing a pair of scales, and the lower quarter a key, divided by a bar on which are set the thirteen historical stars. Around this is a circle bearing the Latin inscription "Thesaur Amer Septent Sigil," divided by stars, and between the band and the shield are sprays of flowers. The wafer on which the seal is impressed is serrated at the edges with light projections. The department using this seal is in charge of the Secretary of the Treasury and two assistant secretaries.

The War Department is really the board of war, and is an institution that dates back to the days of the Revolution. On

SEAL OF THE BOARD OF WAR.

June 13, 1776, the Congress appointed John Adams, Roger Sherman, Benjamin Harrison, James Wilson and John Rutledge, commissioners constituting a "board of war and ordnance," and appointed Richard Peters their secretary. This was the germ of the war department of our government. It had a general supervision of all military affairs. The secretary and clerks were required to take an oath of secrecy before entering upon their duties, and the salaries, it may be interesting to add, were $800 a year for the secretary, and $226.66 for the clerks.

In 1778 another organization of the board occurred, when the seal of the department was fixed. It shows a military trophy of flags, armor and cannon, the central pike being surmounted by a cap of liberty, around which is coiled a rattlesnake, a reptile which is popularly supposed not to strke until it has given warning. At the foot of the trophy is the date in Roman figures, 1778, while the legend about the seal reads: "Board of War and Ordnance, United States of America." In the new organization of the government in 1781, the Congress resolved to create a Secretary of War, and General Lincoln was chosen, his salary being fixed at $5,000 a year. After that, military affairs were managed by

SEAL OF THE INTERIOR DEPARTMENT.

a board of war, until the organization of the government under the national constitution, when they were placed under the supreme control of a Secretary of War and one regular assistant.

The Navy Department was founded October 13, 1775, when Silas Deane, John Langdon and Christopher Glasden were appointed by the Congress as a committee to direct naval affairs. Stephen Hopkins, Joseph Hewes, Richard Henry Lee and John Adams were added, October 30, to the committee. The body was at first styled the "Marine Committee," and, on December 1, it was so modeled as to include one member from each colony represented in the Congress. Their lack of professional knowledge caused many and vexatious mistakes, and Congress finally resolved to select three persons, well skilled in marine affairs, to execute the business intrusted to the general committee. The experts constituted what was called "the continental navy board, or board of assistants of the marine committee," which remained in active operation until the autumn of 1779, when "a board of admiralty" was established, composed of three commissioners not members of Congress, and two members of that body.

SEAL OF THE POSTOFFICE DEPARTMENT.

In 1787 another change took place, when Gen. Alexander McDougall, of New York, was appointed secretary of the marine. A few months afterward Robert Morris, the distinguished financier of the Revolution, was appointed a general "agent of marine," and an admiralty seal was adopted composed of an escutcheon with a chevron of stripes alternate red and white, an anchor below and a ship under full sail as a crest. With the exception of the eagle, which has replaced the shield, the stamp is still the same. The present Navy Department, which was established in 1798, is in charge of the Secretary of the Navy, and its functions are discharged by the Secretary and one assistant secretary and eight bureaus.

The Interior Department was established in the spring of 1849, and was the first establishment of a new branch of the government since 1798, when, as has been shown, the Navy department as it now exists was organized. The chief of this department is called the Secretary of the Interior, and is a cabinet officer. The first incumbent of the office was Thomas Ewing, of Ohio, appointed by President Taylor. The device of the seal of the Interior Department is an eagle just ready to soar, resting on a sheaf of grain, with arrows and an olive branch in its talons and over it the words "Department of the Interior."

SEAL OF ATTORNEY-GENERAL'S DEPARTMENT.

The first parliamentary act for the establishment of a postoffice in the English American colonies was passed in April, 1692, when a royal patent was granted to Thomas Neale for that purpose. He was to transport letters and packets "at such rates as the planters should agree to give." Neale's patent expired in 1710, when parliament extended the English postal system to the colonies. The chief office was established in New York, to which letters were conveyed by regular packets across the Atlantic. The rates were fixed and the postriders had certain privileges of travel. In 1753 Dr. Franklin was appointed deputy postmaster general for the colonies It was a lucrative office, and he held it until 1774, when he was dismissed because of his active sympathy with the colonists.

Very soon after the commencement of the first session of the first National Congress, Ebenezer Hazard and the then Postmaster General, suggested (July 17, 1789) the importance of a reorganization of the postoffice department, and a bill for the temporary establishment of the general postoffice was soon afterward passed. The subject was brought up in Congress from time to time until 1792, when the present system in its general features was adopted. At present the department is under the direction and management of the Postmaster-General and three assistant postmasters-general. The seal presents the device of a pony-express at the conventional gallop.

The head of the Attorney-General's Department was first made a cabinet officer in 1849. The full title of the department is the Attorney-General's Department, or Department of Justice. The seal, which is the best designed of the whole group, in the judgment of the San Francisco *Chronicle*, is the last presented in the accompanying sketches.

HOW TO RENDER IRON OR STEEL INCORRODIBLE.

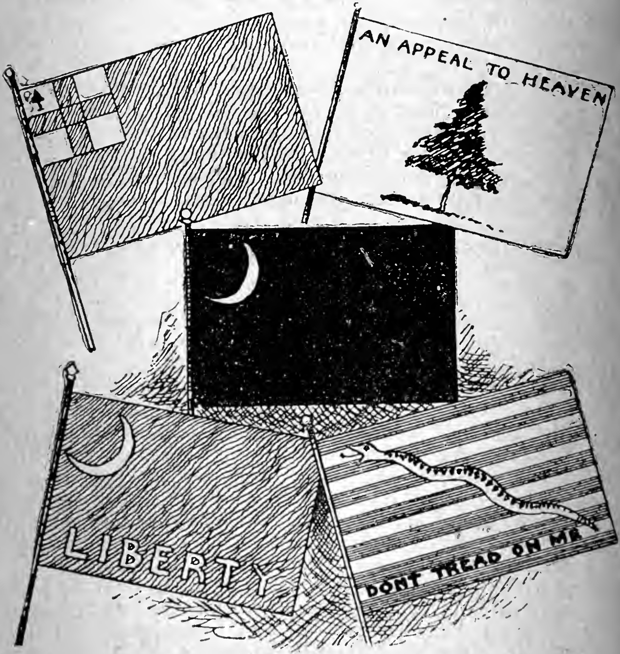
The following method for burnishing iron and steel by means of the electric current was communicated by A. de Meritens at a meeting of the International Electric Society in Paris. The layer of oxide on the surface of the metal is obtained by placing the same as anode in a bath of common or distilled water. The sides of the vessel holding the liquid, or a piece of iron, copper or carbon, are used as cathode. The temperature of the water is kept at 160 to 175 degrees F. The electromotive force must be just strong enough to decompose the water, as a current which is too strong gives a dusty layer which is not permanent. Under the action of the oxygen liberating at the anode, a layer of a black oxide (Fe_3O_4) forms on the metal. This layer can be easily polished, steel giving the best results, while on cast and rod iron a more dusty layer is obtained, though the use of distilled water makes the polish permanent.

To mark on tin boxes, a correspondent of the *New Idea* directs: "Rub the tin surface well with an ordinary lead-pencil rubber, and write directly on the box with good ink in your best style."

THE STARS AND STRIPES.

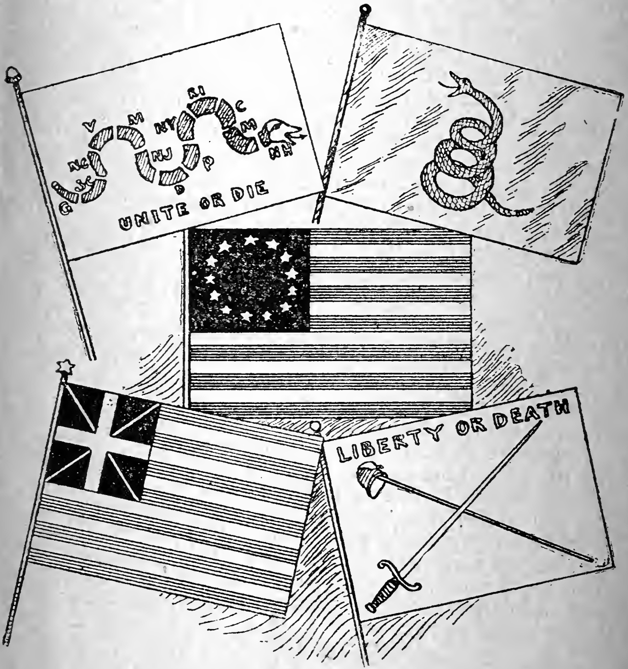
HOW THE NATIONAL EMBLEM WAS ADOPTED.

Before the inspiring words of Francis Scott Key were given to the world our American people carried various designs and colors of flags, banners and emblems. Now that the addition of four new States adds four stars to the national emblem, a word about the origin of the American stars and stripes will not be uninteresting reading. In June, 1777, the national ensign was adopted. That there was an emblem



carried at the battle of Bunker Hill we know not, says the Kansas City *Times*, except from what one writer says: "The banners carried were as varied as the troops were motley." In the rotunda at Washington there is a painting of the American flag by Trumbull. It is a red flag with a white canton bearing a green pine tree. One of the earlier banners bore the inscription, "He who brought us here will sustain us" on one side, while on the other was "An appeal to Heaven." Another design was a blue ground with one corner quartered by the red cross of St. George, in one section of which was a pine tree.

On July 18, 1775, Washington was presented with a standard bearing the motto: "An Appeal to Heaven." The



same year a similar design was used for a revolutionary flag, with the addition of a pine tree in the middle of a white ground. The Massachusetts government adopted this, and it became the emblem of the American ships. The different sections of the country had different designs; the first one that appeared in the south was that of Col. Moultrie. It was a blue flag with a white crescent in the upper left-hand corner. Early the following year a similar flag with the word "Liberty" inscribed upon it was raised above Fort Moultrie.

The colors of the American fleet in 1776 were the rattlesnake banner — thirteen stripes with a rattlesnake and the words "Don't tread on me." Some of the commanders on the sea adopted banners; that of Paul Jones consisted of thirteen stripes, alternate red and blue. The old banner of the French and Indian war was again used in 1775. This was a white flag with a rattlesnake cut into parts, representing the colonies, and the words "Unite or die." The next design was that of Col. Gadsen, which was presented to congress on February 8, 1776. It was a yellow flag with a rattlesnake in the middle, coiled ready to strike. This also bore the words of warning "Don't tread on me." Then came the union jack, the work of a committee appointed to prepare a design to be used on the ships of a fleet that was being fitted out. This was at the close of the year 1775. The new flag was hoisted at the Cambridge camp January 2. On August 27, 1776, at the battle of Long Island, the British captured a small red flag with the motto "Liberty." This was another of the many designs that had been originated and adopted. The whole country was anxious to be under the inspiring influences of a national banner, and it was only necessary for some design to be adopted as the emblem of the new world for all these various mottoes, etc., to at once give way. The last design before the present one was adopted was a white ground with a crossed sword and staff, the staff bearing a liberty cap and the motto: "Liberty or death." On June 14, 1777, congress resolved "That the flag of the thirteen United States be thirteen stripes of alternate red and white; that the union be thirteen stars, white in a blue field, representing a new constellation." At once this new flag was hoisted on land and sea, and the vast number of mottoes, banners, etc., disappeared and the remainder of the war was fought under the stars and stripes, and every loyal heart found inspiration in:

The red as of the rosy morn
When brightest, clearest days are born.
And of the lily fair and white
When dipped in dews of summer night.
The blue of clear and peaceful sky
When not a cloud goes floating by.
The stars of brightest glittering
All in that noble offering.
This emblem, then, shall ever be
The symbol of sweet liberty.

FUNNEL MARKS AND HOUSE FLAGS OF THE PRINCIPAL TRANSATLANTIC STEAMSHIP LINES.

STEAMERS.	FUNNEL MARKS.	HOUSE FLAGS.
ALLAN	Red, with white ring under black top.	Red, white and blue flag, with red pennant above.
AMERICAN	Red, with white keystone, black top.	Red swallowtail flag, with white keystone in centre.
ANCHOR	Black.	White swallowtail flag, with red anchor.
BORDEAUX	White, with black top.	White, red border, three red crescents in centre, blue letters C. B. N. V. in corners.
CUNARD	Red, with black top.	Red flag, with yellow lion in centre.
FRENCH	Red, with black top.	White flag, red ball in corner, and the name Cie. Gle. Transatlantique.
GREAT WESTERN	Black, with broad red band containing a blue and white ball.	Red flag, with blue and white ball in centre.
GUION	Black, with red band, black top.	Blue flag, with diamond in centre containing a black star.
HAMBURG-AMERICAN	Black.	White and blue flag, with an anchor and yellow shield bearing the letters H. A. P. A. G.
INMAN	Black, white band, black top.	Red flag, with square in upper corner containing black diamond.
NATIONAL	White, with black top.	Union-jack in sq., red field, blue and white cross in centre.
NORTH GERMAN LLOYD	Cream.	White flag, key and anchor crossed in centre of an oak leaf wreath, black.
RED STAR	Cream color, black top, with red star.	White swallowtail flag, with red star.
ROTTERDAM	Black, with green band.	One white, and two green stripes, N. A. S. M. in centre.
SLOMANS' (UNION)	Pea-green and black.	Blue, Hamburg towers and stars.
STATE	Blue, with red ring under black top.	Blue swallowtail flag, with red and white stripes at top and bottom, and letter S. in star and centre.
THINGVALLA	Yellow, with white band and 7 blue stars on each side.	White flag with purple star.
WHITE STAR	Cream, with black top.	Red swallowtail flag containing white star.

BELL TIME ON SHIPBOARD.

Time, A. M.		Time, A. M.		Time, A. M.	
1 Bell	12.30	1 Bell	4.30	1 Bell	8.30
2 Bells	1.00	2 Bells	5.00	2 Bells	9.00
3 "	1.30	3 "	5.30	3 "	9.30
4 "	2.00	4 "	6.00	4 "	10.00
5 "	2.30	5 "	6.30	5 "	10.30
6 "	3.00	6 "	7.00	6 "	11.00
7 "	3.30	7 "	7.30	7 "	11.30
8 "	4.00	8 "	8.00	8 "	Noon

Time, P. M.		Time, P. M.		Time, P. M.	
1 Bell	12.30	1 Bell	4.30	1 Bell	8.30
2 Bells	1.00	2 Bells	5.00	2 Bells	9.00
3 "	1.30	3 "	5.30	3 "	9.30
4 "	2.00	4 "	6.00	4 "	10.00
5 "	2.30	1 Bell	6.30	5 "	10.30
6 "	3.00	2 Bells	7.00	6 "	11.00
7 "	3.30	3 "	7.30	7 "	11.30
8 "	4.00	4 "	8.00	8 "	Midnight

HOW TO DETECT GAS LEAKAGE.

In order to detect gas leakage, Dr. Bunte, in the *Canadian Magazine of Science*, suggests the use of paper dipped in palladium chloride solution. Such paper changes its color in presence of gas coming from the leaks imperceptible by the odor, and which produce no effect upon the earth covering the pipes. Dr. Bunte suggests the following method of practically applying the test to street mains: Above the pipes are excavated, at intervals of two or three yards, holes twelve to sixteen inches deep, corresponding to the joints and sleeves. In each opening is placed an iron tube, half an inch in diameter, within which is a glass tube, containing a roll of the test paper. The air from about the main enters the iron tube, and the trace of gas which may be present reveals itself by coloring the paper brown or black, according to the quantity. If, after ten or twenty minutes, the paper is still white, it may be certainly concluded that at the point tested there is not the smallest escape of gas. Various authorities who have experimented with Bunte's method certify to its efficacy.