SHOP PROBLEMS
IN
SHEET METAL

EUGENE C. GRAHAM

EVANSVILLE, INDIANA
1918

SHOP PROBLEMS
IN SHEET METAL

FOR SECONDARY SCHOOLS
WITH NOTES ON EQUIPMENT, MATERIALS
AND SHOP METHODS

By
EUGENE C. GRAHAM
Director Vocational Education
Evansville, Indiana

PRINTED ON THE HIGH SCHOOL PRESS
EVANSVILLE, INDIANA
1918

THE TRADE OF THE SHEET METAL WORKER.

As an introduction to this little collection of notes and drawings the author wishes to call the attention of High School boys especially to the fact that this trade has not received the attention it deserves from the schools. In recent years several vocations such as printing, concrete construction, automobile repair and electrical work have found a place in the schools while others seem to be losing ground. It seems to be true that trades such as blacksmithing and molding which have been influenced by the introduction of new machinery which is more or less automatic, have become less attractive to boys.

Sheet metal work as a vocation has many attractive features. It is a large and growing industry represented both in the building trades and in modern automobile construction, furniture and boat building and in the construction of manufactured articles. The introduction of autogenous welding and electric welding has done much to make possible the use of sheet metal in new forms.

All well trained sheet metal workers can draft their own patterns. Boys who have been unable to see any use for intersections and developments in mchanical drawing can quickly see the relation between this branch of drawing and the drafting of patterns.

The working of metal in sheet form is light, interesting and instructive. The making of kitchen utensils, such as pans, sugar scoops, funnels, dustpans, canteens, bread boxes and other articles is attractive to most boys. A large number of hand operated machines are used and the training afforded by these machines is valuable. Boys like wood turning because they can run the machines for themselves. In the same way they become interested in the machines used to bend and shape sheet metal and can make a larger variety of useful products than in nearly any other school shop.

Boys who are interested in the trade will find that the wages paid are better than in some other related trades and that there is always a demand for competent men.

The author hopes to add to this collection of drawings from time to time and will welcome suggestions and criticisms. The notes are merely a bare outline of related facts and should be supplemented by outside reading and visits to shops where sheet metal is used.

Credit is due the Peck, Stow and Wilcox Co., of Southington, Conn., for the electrotypes used. The list of equipment is from their "Pexto" line, which has been used with satisfaction by many schools.

MATERIALS USED BY THE SHEET METAL WORKER.

Articles made of sheet metal are commonly made either of tin plate, sheet iron or galvanized iron. Other kinds of sheet metal sometimes used are sheet copper, sheet aluminum, sheet zinc or sheet brass. Each of these materials has some special advantages but it may be said that if we could neglect the item of first cost either sheet copper or sheet aluminum would take the place of most of the other materials. A short paragraph on the qualities of each of the above materials is given below.

Tin Plate.

It is often a surprise to a pupil to find that even good tin plate is not made of pure tin. Since it is covered with a metal so different from iron in appearance it is not easily discovered that it is made of sheets of iron covered on both sides with a coating of tin. The thickness of this coating varies somewhat with the quality but it is never very thick. It is put on by dipping plates of iron which have been carefully cleaned in acid and scrubbed with sand and water, into tanks of melted tin. The tin forms a kind of an alloy with the iron in the plate and after passing through the bath of tin one or more times and being carefully cleaned and inspected it becomes a sheet of tin plate. Sometimes lead is mixed with the tin and with this change "terne" plates are made for roofing buildings.

Tin plate is easily worked, is not easily affected by air or water, takes solder well and can be kept bright and clean without much trouble. It is the cheapest material used for kitchen ware.

Sheets of tin are usually 20x28 inches in size, but they may be had half that size or 14x20 inches and several other sizes are made. In thickness they run from 20 wire gauge to 30 and they may have from one to three coats of tin. Articles made of tin plate are often retinned after manufacture. This cannot be done with soldered work. Why?

Sheet Iron.

Plates of soft sheet iron are used for roasting pans, stove pipe and as a lining for ovens. When of nearly pure iron and treated with a process to prevent rust it becomes a good material for limited uses. It cannot be soldered and is easily affected by water and acids.

Galvanized Iron.

Galvanized iron is sheet iron or steel coated with zinc, somewhat as tin plate is coated with tin. The zinc coating makes it rust proof for a long time and gives it a pleasing appearance. However the zinc will not stand acids and is likely to peel off in flakes if the metal is hammered or bent. It does not polish well but can be kept clean by washing. It is not used in making kitchen ware but for dry measures, roofing, etc it is in common use.

Galvanized sheets are usually 30 inches wide and 96 inches long. Wider and longer sheets may be bought. The thickness runs from 16 wire gauge or thicker down to 30 wire gauge. Galvanized sheets from 24 to 30 gauge are most commonly used in schools.

Sheet Copper.

This metal comes in sheets nearly pure and can be had in many thicknesses and sizes. When used by the sheet metal worker it has many fine qualities and can be drawn, hammered, soldered, and pressed into many shapes. It is tough and stands working better than most metals. It can be annealed or made soft by heating and quenching in water. When made into utensils it is usually tinned and often nickel plated on the outside of the vessel. Pure copper is somewhat acted on by the air and by water and more by acids, so that tinning is necessary for some purposes. On account of the cost it is not much used, but is a very durable roofing material. Copper is used for many articles which are beaten into shape by hammering.

Sheet Zinc.

This metal has many valuable qualities and is used for roofing, tops for kitchen cabinets, ornamental vases, etc. It is very little acted on by the air after the first film of oxide forms on the surface. It may be soldered if care is taken to avoid burning through the metal with a copper which is too hot. Dilute muriatic acid is used as a flux in soldering zinc.

Sheet Brass.

Sheet brass has many of the qualities of copper. It is somewhat harder and requires more care in bending. By annealing it carefully it may be worked into many shapes. Borax may be used as a flux in soldering brass. Because of the increased cost it is not much used except in some manufactured articles such as automobile lamps.

Sheet Aluminum.

This metal is coming into very general use for kitchen utensils. It is very durable and easily kept clean. It is not much acted on by the air or by water and acids, but alkalies have some affect on it. Since its melting point is much lower than that of copper and iron it may be melted through on a hot range if the vessel boils dry. It is very easily worked and may be pressed and drawn into various shapes. Since it cannot be soldered with much success it must either be welded or riveted. Many articles are cast into shape. Aluminum rivets should be used for fastening handles and other attached parts.

The Folding Machine.

In order to turn a hem or lock on the edge of a piece of sheet metal some means must be found of holding the metal firmly while the edge is being turned. Or we may grip the edge and turn the fold by moving the piece itself. The ordinary folder does the latter. Other machines are used called open throat folders which use the former method.

These machines will also prepare the edge of sheet metal to receive a wire. All folders have adjustments to regulate the width of the fold and also the sharpness of bend, so that they may also be used to prepare the edge of sheets to receive a wire. It is always necessary to know just how the machine is adjusted before attempting to make a fold or to wire an edge.

The Grooving Machine.

After a lock seam has been folded on the folder it should be closed down with a grooved wheel on the grooving machine. Hand tools are also used for this but in all cases where it is possible to use the machine it is better to do so. The grooving rolls are made to fit several widths of seam and the proper roll should be used.

The Brake.

This machine, commonly called the cornice brake, has a wider range of usefulness than the folder. It may be used to turn hems or folds and also to make bends at all angles up to nearly 180 degrees, and at any distance from the edge. The brake also has attachments for forming molded shapes to almost any pattern. Lengths up to eight feet are in common use.

In using this machine it is necessary to plan the bends to be made if several are to be turned in the same piece. Otherwise the pupil will find it hard to decide what the order of operations should be.

It is advisable to mark the location of lines and bends with punch marks. A line may thus be transferred to the other side of the sheet accurately.

Foot levers are provided to hold the work temporarily, but it is quite important that the cam levers should be used to clamp the work in place. Pupils should never attempt to bend heavy metal or wire in this machine.

The Wiring Machine.

After the use of the turning machine the wire is fitted to its place and partly closed in with a mallet. Then the wiring machine is used to tuck in the edge of the metal neatly around the wire. Some judgment is needed to set the machine for different sizes of wire.

This machine may also be used to wire the edges of flat work. Pains should be taken to keep the surface of the flat work horizontal or to raise the outer edge a little in order to prevent a ridge being formed on the lower side of the work.

The Turning Machine.

Turning machines are used to prepare the edge of a can body or other similar work such as the edge of a funnel to receive a wire. When such work is ready it is placed on the lower grooved roll and against the guage. The screw is turned until the upper roll forms a slight groove in the work. After one revolution the work is tilted upward a little and the screw tightened until a deeper groove is formed. By repeating this operation and making several revolutions of the work the edge is prepared to receive the wire. To avoid some of the most common faults of beginners, try to turn slowly at first and to press the work firmly against the guage. After tilting the work upward do not allow it to drop back again. Do not force the rolls against the metal. Practice on some can bodies which have been cut down from discarded tomato cans to a height of about three inches. Serviceable tin cups may be made of these by wiring the top edge and soldering on a neat handle. Skill will come with practice.

The Burring Machine.

This machine is used for turning an edge on cylinders of metal or on discs such as can bottoms. In preparing vessels for double seaming a burr is first turned at a right angle on the body and then one of the same width on the edge of the bottom. This last operation is quite difficult and takes considerable practice. Bottoms can be made much better on a circular shear with a flanging attachment.

In using the burring machine remember that only a narrow burr about one-eighth of an inch wide can be turned. The burring machine is the hardest machine for beginners to use. The pupil should avoid spoiling good material until he has had careful instruction.

The Setting Down Machine.

This is used to close the seams left by the burring machine. It is very simple and may be turned in either direction. It has no adjustments except for thickness of material.

NOTES ON SOME OF THE MORE COMMON METALS AND ALLOYS

Iron is a very common metal. It is found in many countries and especially in the United States. The mines near lake Superior on what is called the Iron Range, and other mines near Birmingham, Alabama, produce great quantities of iron ore. These ores are melted with lime stone, coal and coke in blast furnaces which are about eighty feet high and twenty feet in diameter inside. These furnaces must be kept going night and day. The melted iron is cast into ingots called "pigs", or it may be made into steel in a Bessemer converter. Wrought iron is made from cast iron by removing impurities. Cast iron contains carbon, sulphur, silicon, phosphorus and other elements in varying proportions. These impurities make the cast iron brittle and weak as compared with steel and wrought iron.

Steel contains elements like carbon, manganese, nickel, etc., in quite definite proportions and by varying these proportions the manufacturer can produce steel fit for steel beams, razor blades or watch springs and a hundred other products, as he chooses.

Iron

Iron is a silvery metal with a density of 7.86, a melting point of 2754 degrees and a weight per cubic foot of 480 lbs.

It is ductile and malleable and almost as soft as aluminum. In the industries pure iron is seldom used. What is called mild steel is commonly used in its place.

Copper

Metallic copper has been known from the earliest times and was probably one of the first metals in use. It is a heavy metal of a reddish color with a density of about 8.93. It melts at 1948 degrees and weighs 552 lbs. per cubic foot. It is rather soft and is very ductile, malleable and flexible, yet tough and fairly strong. It is a very good conductor of heat and electricity. Copper is used for making alloys, for roofing, for electrical conductors and many other purposes. It can be rolled into sheets, hammered into shapes or drawn into wire.

Lead

Lead has been known from very early times. The Romans used it for water pipes, as we do now. It is a silvery metal of density 11.37, which melts at 588.6 degrees. One cubic foot of lead weighs 710 lbs. While it is heavier than most metals there are some, such as gold and platinum, which are much heavier. It is very little affected by air or hard water and is used for pipes, for alloys and in many kinds of paint. Sheet lead is often used for lining tanks and lead plates are used in storage batteries.

Tin

Tin is a silver white metal harder than lead and quite malleable. It has a density about 7:29 and a melting point of 418.5 degrees. It weighs 458 pounds per cubic foot. Tin is used in the manufacture of alloys and as a coating for sheet steel to make tin plate. Pure tin is used as tinfoil, but compared with other metals it is not often used in this form.

Zinc

Zinc is a bluish white metal. It has a density of 7.10 and a melting point of 754.9 degrees. It weighs about 436 pounds per cubic foot. At some temperatures it is brittle but between 250 and 300 degrees it may be rolled into sheets and is then of great use as a sheet metal. Since it is cheaper than copper and lighter than lead it is used for roofs, gutters and architectural ornaments. Its chief uses are in the manufacture of alloys and in the coating of steel pipes and plates. This process is called galvanizing. The oxide of zinc is used in making paints, and zinc rods and bars are used in batteries.

Aluminum

Aluminum resembles tin in appearance. It has a density of only 2.65 and is therefore only about one-third as heavy as iron. One cubic foot weighs 166.5 pounds. It melts at 1185.3 degrees. It is ductile and malleable except at low and high temperatures. It is fairly hard and strong. Sheet and cast aluminum are used for cooking utensils. Aluminum wire is used for conductors. Aluminum-zinc alloys are used in castings for automobile parts.

Alloys

An alloy is a mixture or combination of two or more metals to obtain certain desirable properties. These metals will in many cases unite in a great many different proportions, but to secure the desired properties only certain definite mixtures are commonly used. The advantages obtained are increases in strength, hardness, toughness or elasticity, a lower melting point or to facilitate the production of sound castings.

Some of the more important alloys are as follows:

Brass	Made of	Copper and zinc
Aluminum bronze	" "	Copper and aluminum
German Silver	" "	Copper, zinc and nickel
Manganese bronze	" "	Copper, zinc, iron and manganese
Bronze	" "	Copper and tin
Bell metal	" "	Copper and tin
Phosphor bronze	" "	Copper, tin and phosphorus
Solder	" "	Tin and lead
Pewter	" "	Tin, antimony, copper and bismuth

Only a few of these alloys are used by the sheet metal worker. Sheet brass may take the place of cheaper materials for some work. Soft solder, made of tin and lead, or hard solders made of copper and zinc, are of great importance.

SOLDERING FLUXES.

A flux is a material in any form, powder, paste or liquid, which helps to make the solder unite more easily with the metal. Most of these fluxes have some chemical action on the metals but some appear to do little but keep the solder flowing easily.

A good flux for one kind of metal may not work well on others. For instance rosin will not work well on anything but bright tin.

A list of the more commonly used fluxes follows:

Rosin—either powdered or dissolved in gasoline or turpentine. Used for new work on tin plate.

Zinc Chloride—made by cutting zinc with muriatic acid or by mixing the commercial zinc chloride with water. Used generally for all work.

Raw Muriatic Acid—also called hydrochloric acid, generally diluted with water, sometimes mixed with the zinc chloride flux. Used for zinc, also for galvanized iron.

Commercial soldering paste—containing various mixtures. Used for electrical work.

Borax—in powdered or dissolved form, used for brass.

RIVETING

Sheet metal may be fastened together firmly by riveting and many times where strength is necessary both rivets and solder are used. The size of the rivets used depends both on the thickness of the metal and on the strength required in the joint.

The tinner usually sets his rivets by what is called "blind riveting." He places the rivet under the sheets of metal and draws it through by driving a rivet "set" over it with a hammer. This process requires some practice but makes a very firm joint because the rivet always fits the hole and may be drawn up very tightly. On some light work the rivet sometimes spreads out and stretches the metal around it. For this reason and because it is easier to place them accurately, rivets may be set in holes already punched in the sheets of metal. This is always done in heavy work. This process is recommended for beginners and the holes should be carefully located and punched with a solid punch over a block of wood on end grain.

In heading a rivet a light hammer is used and light blows which form a head on the rivet slowly are necessary for good work. Use the rivet set to form a smooth head on the rivet.

Tinners' rivets, which are usually coated with tin are sold by the box and are numbered 8 oz. or 10 or 12 or 14 oz., which means that 1,000 rivets of one size weigh a certain number of ounces. Larger rivets from 1 lb. up to 16 lbs. are sold, which are rated in pounds or per thousand.

HOW TO SOLDER.

There are no secrets about the use of solder which may not be learned by the beginner, but the skill of the good mechanic does not come without many hours of practice. Thinking while you are working will shorten the learning of the process more than anything else you can do.

Ordinary soft solder is an alloy of tin and lead, usually about half and half. It melts at about 350 degrees and unites easily with tin, lead, zinc, copper and brass, but not easily with iron or steel.

There are four important principles to be remembered by any one who attempts to solder:—

1. The soldering copper must be kept clean and well tinned.
2. A good soldering flux must be used, and one which is suited to the metal.
3. The metals to be soldered must be clean.
4. The joint must be heated above the melting point of the solder.

Soldering requires heat. You may use gas, coal or charcoal or a gasoline torch to heat the coppers. If you use gas take care not to let the copper get smoked up in the yellow part of the flame. The blue flame is hotter,

To try if the copper is hot enough you may touch it to a lump of solder, oı hold it near your face to test the heat. Do not overheat the copper or the tin will be burned off.

When you are ready to solder a joint, see that the surfaces fit well and are clean. Apply the soldering flux to the joint with a small brush. Do not spread the flux over a wide surface. Touch the hot copper to the end of a bar of solder and then to the joint. See that only a narrow edge of the copper touches the joint. Try to have the solder flow along with the copper. Do not try to work fast as the heat must flow ahead of the solder and this takes time. Do not run back and forth over the joint but move in one direction. When the joint is soldered do not move it too soon but wait for the solder to set. Unnecessary solder may be wiped off with a cloth after heating a surface, but this should not be a common practice.

Re-tinning the Copper.

If for any reason the copper needs a new coat of tin you must remove the black surface with a file or grinding wheel. After you get it smooth heat it nearly to the point where it begins to show red. Rub on a soft brick or a block of sal-ammoniac to clean it and then put a little solder on the block and work the tin into each of the four surfaces. This makes the point look bright and shiny like new tin. Your soldering copper must be kept in this condition to work well.

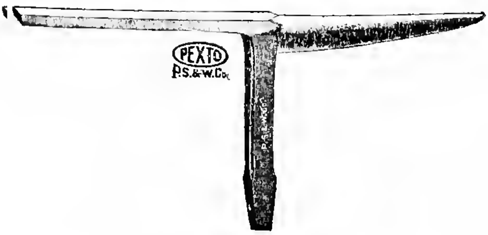
SHEET METAL PATTERN DRAFTING

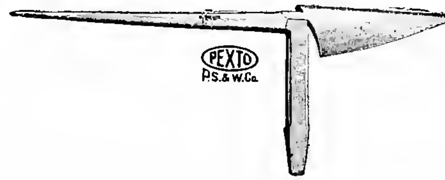
Sheet metal pattern drafting is mainly an application of the principles of developments and intersections as they are given in the usual courses in Mechanical Drawing in high schools. In addition the sheet metal worker uses a great many short cuts, some of which are not strictly according to the rules of projection. But the pupil who lays out his patterns according to rule will not go wrong providing he makes proper allowances for seams, folds, wiring, etc. Since most of the articles made of sheet metal are in the form of cylinders, prisms, cones or pyramids, or parts of these solids, it will be well for the pupil who expects to lay out his own patterns to study the forms of these solids and of their intersections with each other. So far as possible each pupil should learn to develop his patterns on paper and test them out in metal, but in order to save material the instructor should check all results with a master pattern. Since patterns made without proper allowances and without fixing the size, shape and location of notches are useless, particular attention must be paid to these details. Rules for these allowances are given in another paragraph.

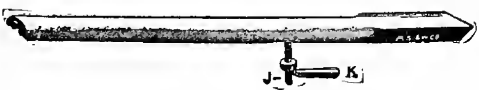
Allowances for Seams and Wiring.

In an ordinary lock seam three times the width of the seam must be added to the edges before folding. Little attention is paid to the amount added on account of the thickness of the metal but where heavy metal is used this has to be considered.

The allowance for wiring is usually twice the diameter of the wire plus twice the thickness of the metal, but experience in this case is a better guide than the rule, as it is hard to set the machines so that an exact amount will be turned on the edge of the material.


Beakhorn Stake

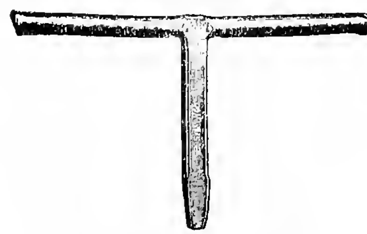

Blowhorn Stake



Hollow Mandrel Stake

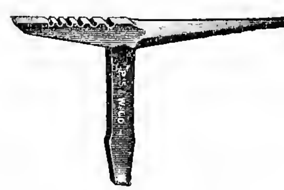

Candlemold Stake

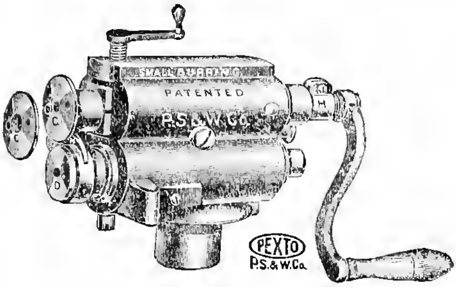

Conductor Stake


Double Seaming Stake

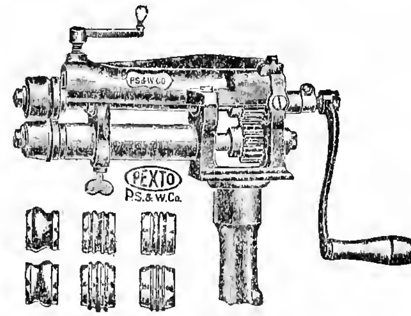

Square Stake


Hatchet Stake

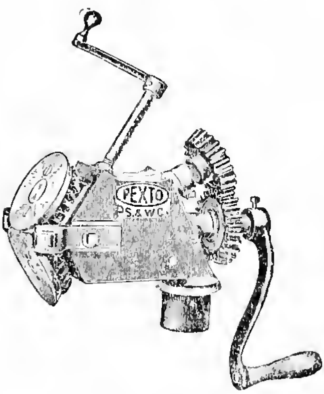

Creasing Stake



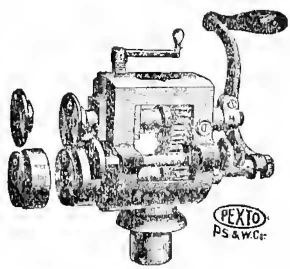
Burring Machine



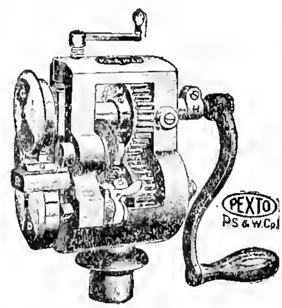
Beading Machine



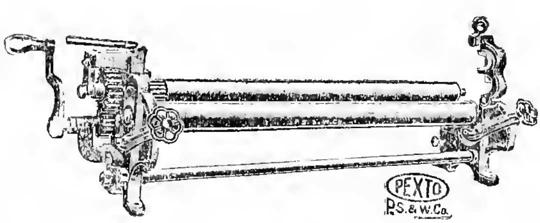
Setting Down Machine



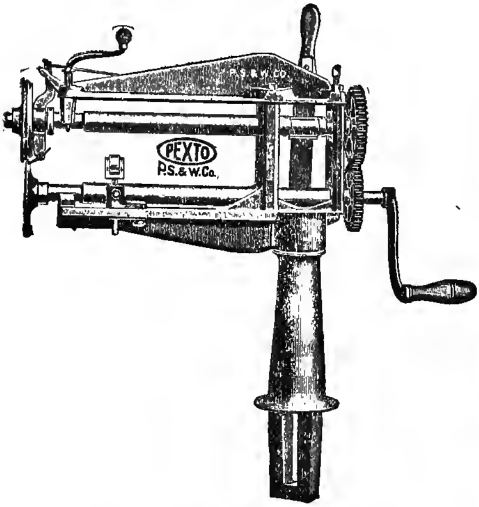
Turning Machine



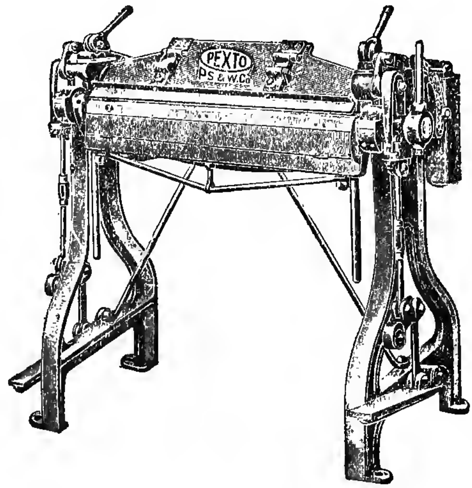
Wiring Machine



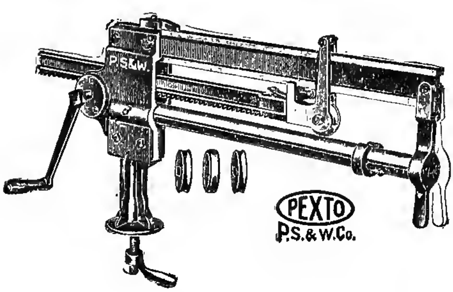
Forming Machine



Moores Double Seaming Machine

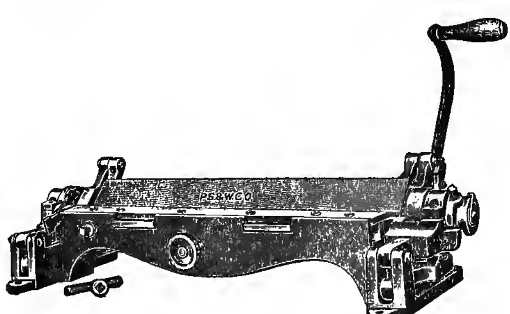


Cornice Brake

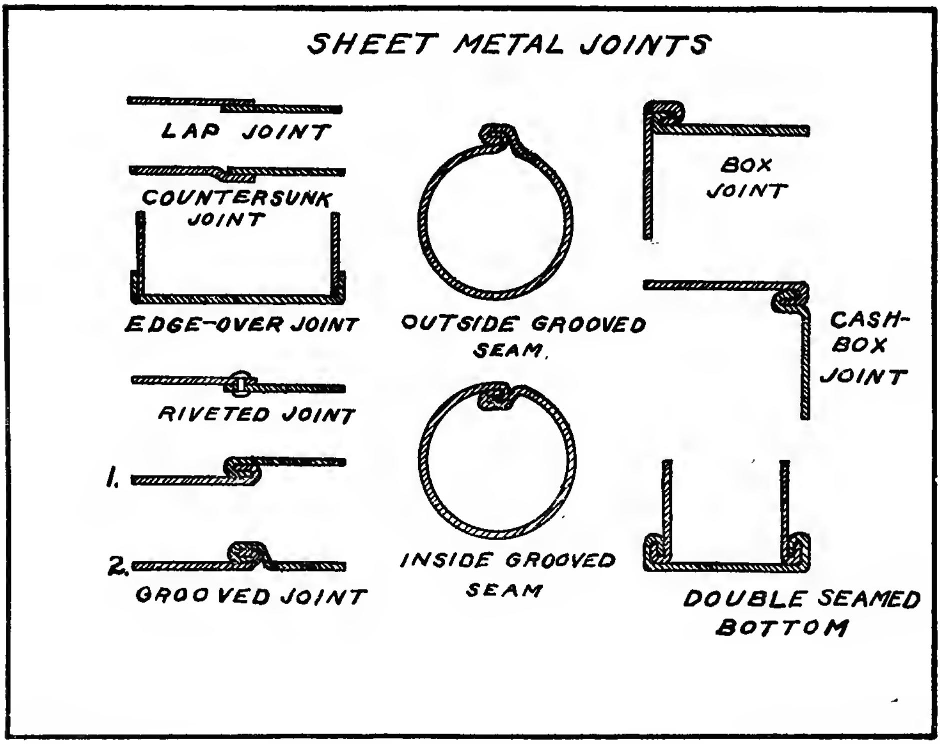


Groover

Squaring Machine



Folding Machine



INSTRUCTIONS AND OPERATIONS.

Plate I. Sheet Metal Joints and Seams.

1. Study these diagrams carefully. Learn the names of the joints and be able to describe each with a sketch.
2. Note that the proportions of these joints and seams must vary somewhat with the thickness of the metal. Note also that they may need solder to hold the pieces together.
3. Why is a grooved seam called a lock seam? What is the use of the hem and the double hem?

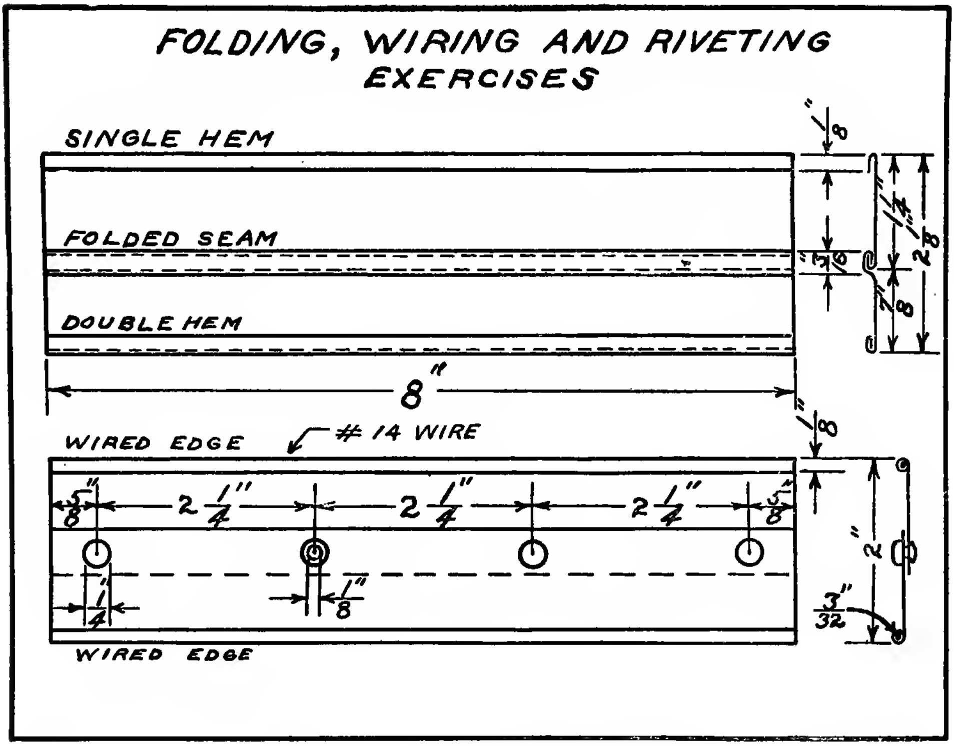


Plate II. Exercises in Folding, Grooving and Wiring.

(First Exercise.)

1. Cut two pieces of scrap tin 1½ by 8 inches in size.
2. With the folder set for a ⅛ inch sharp fold both edges of each piece. Carefully flatten down one edge of each piece with a mallet on a flat surface.
3. Hook the other two edges together and groove the seam with the proper grooving wheel on the machine.
4. Fold one edge of this exercise over a second time to make a double hem.

(Second Exercise.)

1. Cut two pieces of galvanized iron 1¾ by 8 inches.
2. Mark a line with the scriber ¼ inch from the edge of each piece and lay off four points as indicated, marking the points with the prick punch.
3. Punch these holes carefully using the machine or a solid punch on the end of a block of wood.
4. Using 12 oz. tinned rivets fasten these pieces together carefully. Use a light riveting hammer and try to form a rounded head on the rivet. Finish the heads with a rivet set.
5. Prepare the edges of this exercise for wiring by using the folder set to 3-16 inch with the table set for an open fold.
6. Cut two pieces of 14 guage wire eight inches long. Wire these in place as directed by the instructor.

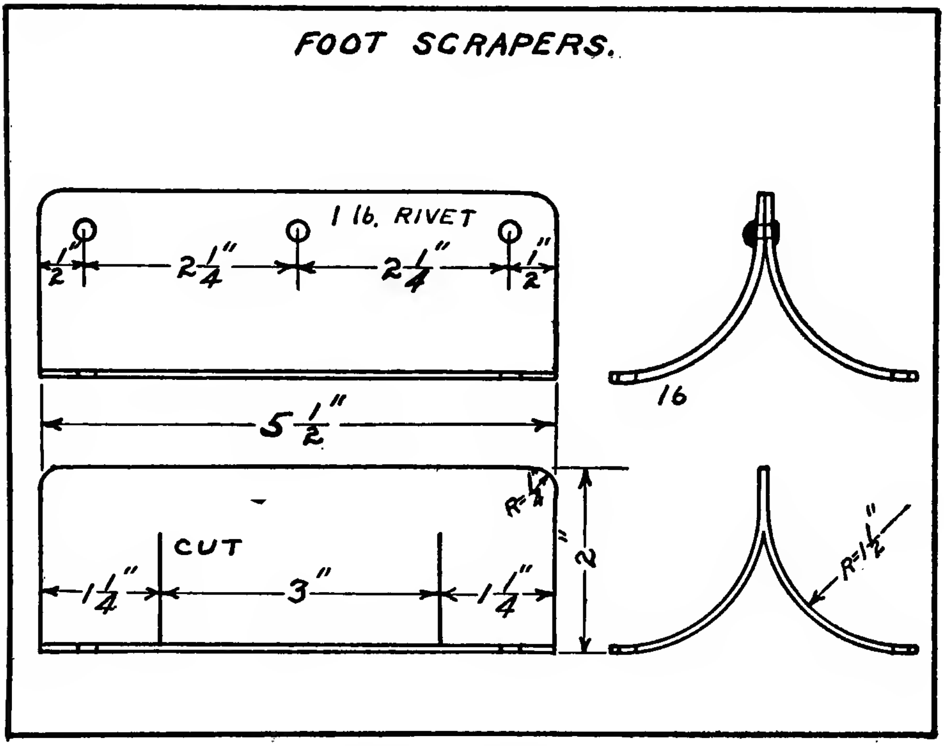


Plate III. Foot Scrapers.

1. Choose one of these designs. Cut stock from black iron, 20 gauge or thicker and $3\frac{1}{2}$ by $5\frac{1}{2}$ inches in size.
2. Round all corners by marking with chalk and laying off a radius with dividers. Cut and file to shape.
3. Punch $\frac{1}{8}$ inch holes for rivets on machine after carefully laying them off with steel rule. Bend pieces over a form in the cornice brake. Rivet with one-pound round head rivets.
4. Punch holes for screws $\frac{1}{2}$ inch from edge and fasten to doorstep.

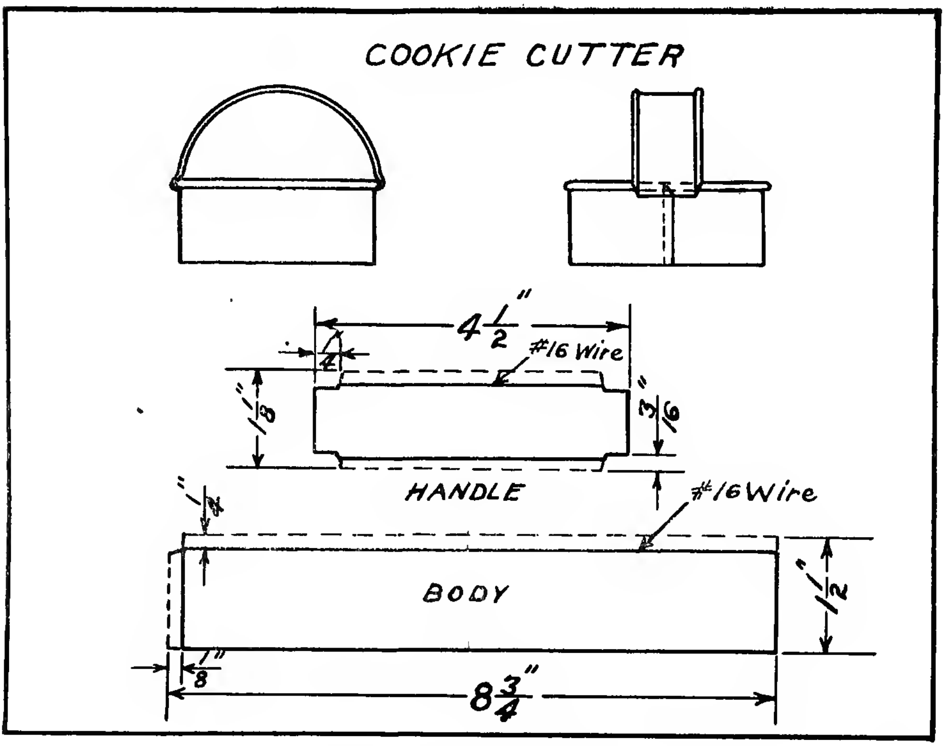


Plate IV. Cookie Cutter.

1. Cut stock of IC tin to dimensions given.
2. Mark off allowances for wiring on larger piece, cut corner and wire with 16 gauge wire.
3. Run the body through the forming machine with the wired side down.
4. Lap the ends just $\frac{1}{8}$ inch and hold with pliers while tacking with solder. Finish soldering after showing to the instructor.
5. Prepare handle by wiring in the flat and forming in the machine. Crease ends in the stake or by using the turning machine. Solder in place after carefully fitting each end to the body. Remember that no joint should be soldered until the surfaces fit closely together at all points.

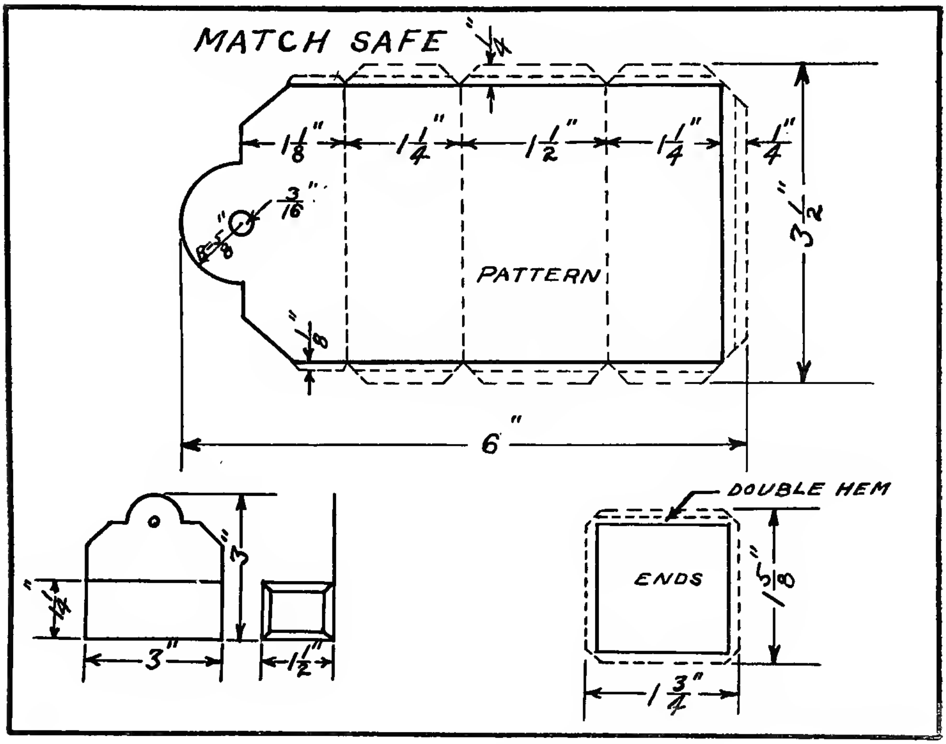


Plate V. Match Safe.

1. Cut three pieces to dimensions given. Scribe lines on edges 1/8 inch from edges and then 1/8 inch from these lines. Clip corners as indicated and lay off and cut design at the top.
2. Fold double hem where marked. Bend three edges of each end in folder at right angles. Fold two long edges of main pattern 1/8 inch from edge and place 1/8 inch strip of scrap metal under each.
3. Bend main pattern on first and second dotted lines. Remove strips of metal and slip ends in place. Double seam the ends over a stake or block of hard wood. Fold remaining edges toward the back with pliers.

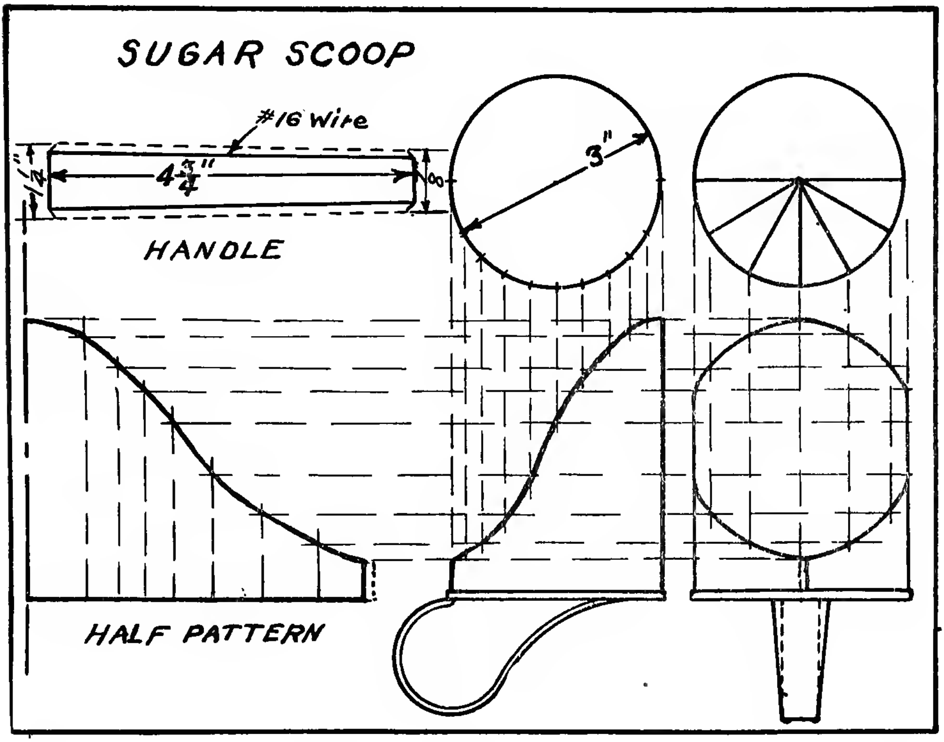


Plate VI. Sugar Scoop.

1. This scoop is to be made of 1C tin with back to be snapped on the body and soldered as indicated. The handle is to have wired edges.
2. Use pattern to lay out body of scoop. Cut a piece for the back on the circular shear and burr the edge 1/8 inch as indicated.
3. Form the body to the required shape and snap inside of back. Tack carefully in place with solder at several points, finally soldering 1/8 inch lap at the top. Solder back on the inside. Be careful not to overheat the joint at the lap.
4. Wire the edges of handle. Form to shape in machine using your hands to bend the handle around the roll. Solder handle on the back after carefully fitting in place.

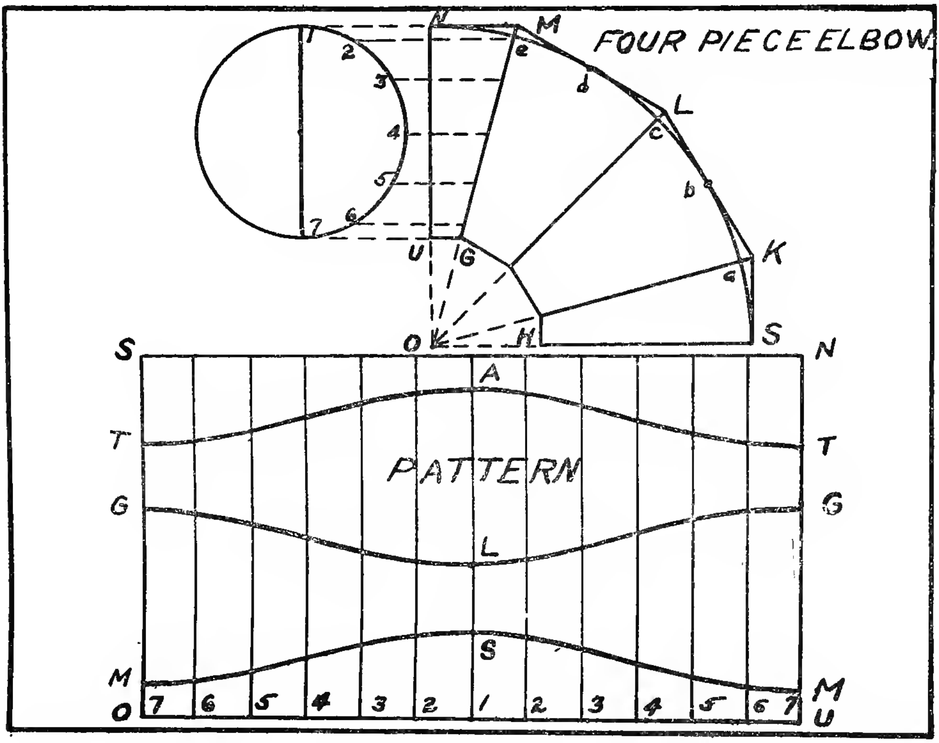


Plate VII. Four Piece Elbow.

1. Decide on the dimensions of the elbow wanted. Lay out a set of patterns and string them together with strips of metal. Use the standard method given to lay out this set. Be sure to add to each pattern the allowances for seams on all sides where necessary.
2. Use the elbow edging roll and the burring machine according to instructions. Slip parts in place and tack with solder. See that the elbow is not twisted before completing the soldering.
3. Use a similar method if an elbow with three or five or more parts is wanted. The throat, OH, is about one-half the diameter of the pipe, but may be increased.

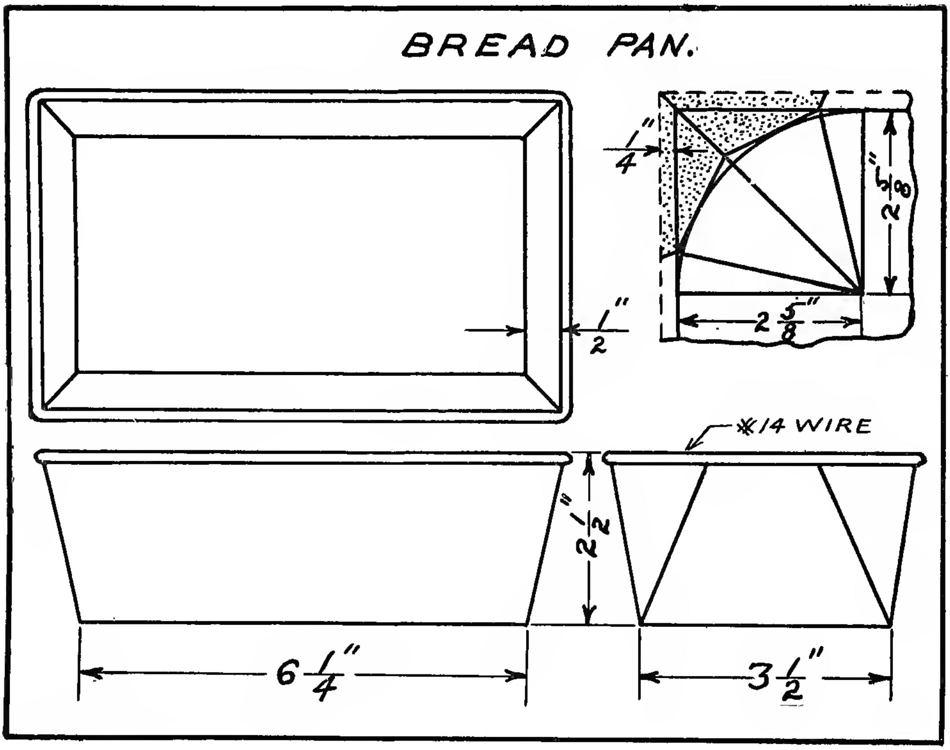


Plate VIII. Bread Tin.

1. This pan is of the standard construction with equal tapering sides and solid corners. It may be made easier to construct by cutting away part of each corner. In this case the pan will not be water tight but will serve very well for a baking tin.
2. If the solid pan is wanted, cut out the pattern as marked and form the corners over a hatchet stake. Then turn the sides and ends over a block of hard wood cut just the shape of the inside of the pan. Use the hatchet stake and the mallet to close over the flaps but watch carefully to see that heavy blows are not used and that each corner is bent exactly on the lines. A pair of wide nosed pliers may be used to help turn the flaps.
3. The wiring may be done by bending the edge of the sheet over the hatchet stake, and tucking the wire in place with the mallet and the wiring machine.

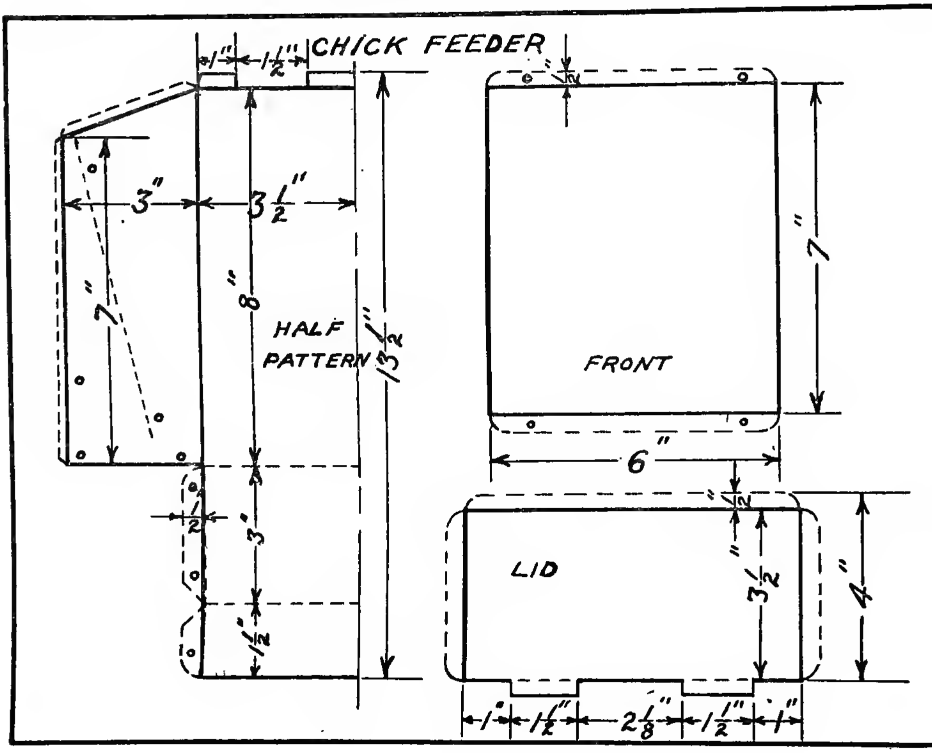


Plate IX. Chick Feeder.

1. Cut one piece of 30 guage galvanized stock thirteen and one-half inches square. Cut another piece six inches by eight inches for the front and one 4⅜ by 8⅛ inches for the lid.
2. Lay off all these pieces according to the drawing and cut to size and shape.
3. Fold main pattern to shape and rivet the bottom in place with 12 oz. rivets. One-half of the rivet holes may be punched before bending to position.
4. Rivet the front in place on the dotted line shown in the drawing.
5. Form the metal for the hinges and slip in a piece of No. 10 wire to form the hinge.
6. Attach the lid after folding the edges at right angles.

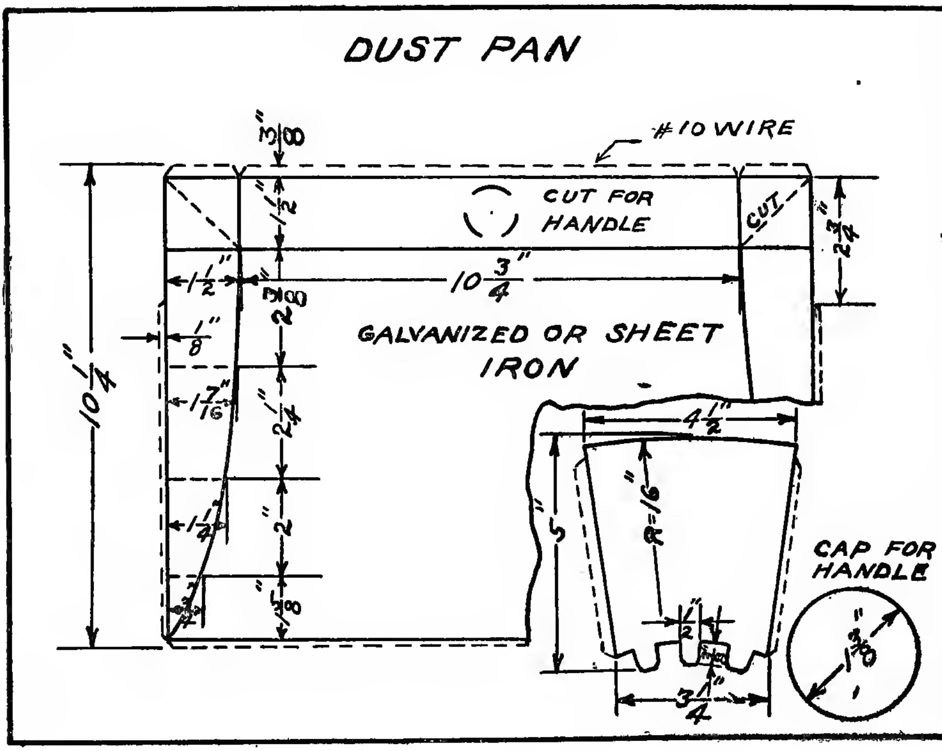


Plate X. Dust Pan.

1. Cut stock from 28 guage galvanized iron or from black stove pipe iron. Cut one piece 10¼ by 14 inches and one 5 by 5 inches.
2. Lay off lines as indicated. Cut notches, clip corners and cut diagonal cuts for folding. Fold ⅛ inch hem on three sides. Run beading wheel over curved line to start bend.
3. Turn edge for wiring setting folder ¼ inch. Fold corners and prepare wire for wiring. Bend wire in vise to get sharp bend 1½ inches from each end. Wire the edge as directed by the instructor and solder the ends in place using acid flux.
4. Prepare handle with lock seam and set in place through cuts marked in back as indicated. Hold handle firmly in place and turn flaps inward and solder down. If desired these flaps may be covered with a circular piece of metal soldered down. A narrow collar may also be soldered around the outside, where the handle joins the pan. A cap should be cut to fit the handle and soldered in place.

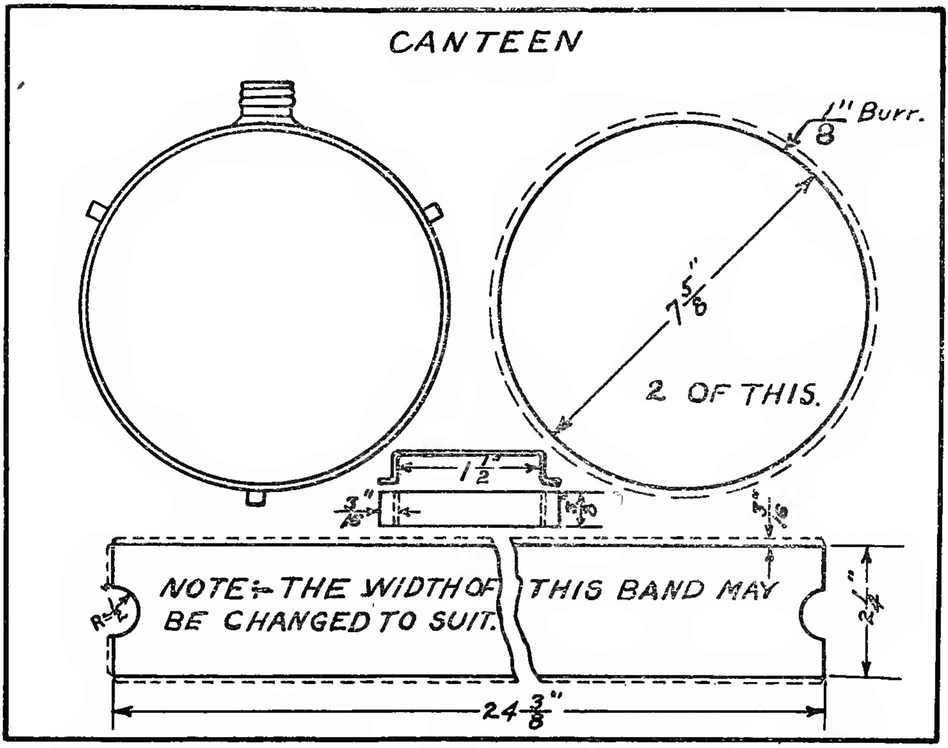


Plate XI. Canteen.

1. Cut two sides on the circular shear and burr the edges ⅛ inch. Cut a band of tin of the desired width and fold both edges and flatten down in the brake with a ¼ inch strip of 24 guage black iron under the edges. With the hollow chisel cut a semicircle from each end about one inch in diameter.
2. Form the band into a circle on the former and remove the strips of iron carefully with a pair of pliers. Slip one of the sides carefully in place and tack with solder. Finish soldering and see that a very neat and smooth job is done.
3. Slip second side in place and press out with a rod of wood introduced through the opening. See that it comes into place nicely before soldering as you did the first side.
4. Cut three strips of scrap tin ⅞ inch wide and fold a double hem in each edge. Bend these to the shape shown and solder in place on the outside as in the drawing. Solder on a screw cap taken from a can or purchased from a dealer.
5. The sides of this canteen may be padded and the outside covered with cloth or imitation leather if desired.

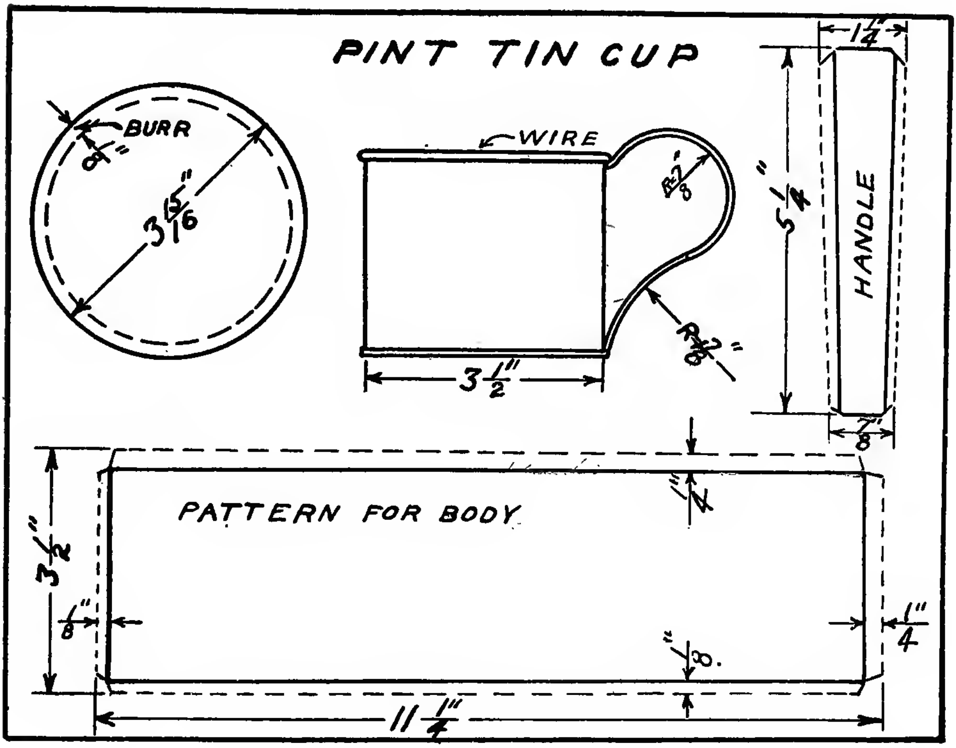


Plate XII. One Pint Tin Cup.

1. Cut three pieces of IC tin according to the dimensions given.
2. Burr the edge of the bottom with the burring attachment on the circular shear.
3. Prepare the ends of the long piece for a lock seam after carefully notching the corners.
4. Wire the top edge of this piece with 14 guage wire. Form into a cylinder being careful not to spoil the fold for the seam.
5. Finish the lock seam and solder on the inside.
6. Burr the bottom edge on the burring machine and slip on the bottom. Turn the edge of the bottom carefully over the edge of the body with a hammer and fasten with a setting down machine. If a double seaming machine is available it should be used at this point. If not, do the best you can with the mallet and the stake.
7. Solder seam on the inside.
8. Make the handle as you did the handle for the sugar scoop and solder it in place over the seam.

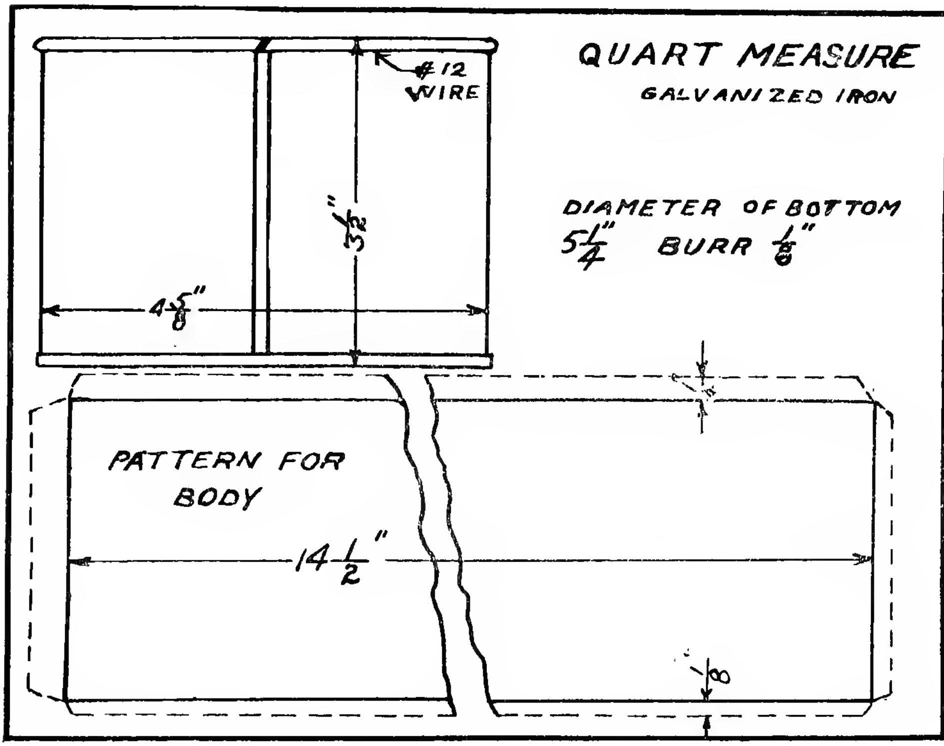


Plate XIII. Quart Dry Measure.

1. This measure may be made of 30 guage galvanized iron. It is calculated to hold 58 cubic inches. The instructions for making it are the same as for the tin cup, except for the handle.

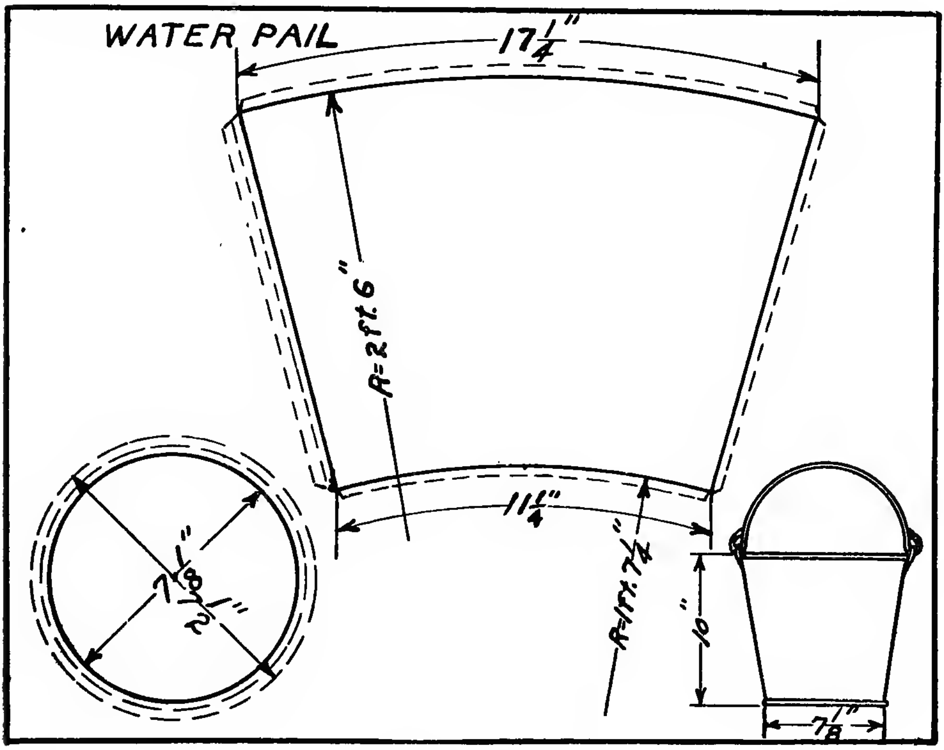


Plate XIV. Water Pail.

1. Cut two pieces just alike for the body of the pail. Double seam these together on one edge and form to shape of pail and double seam again. Solder the inside of the seams carefully after grooving.
2. Wire the top edge with No. 9 wire with the joint in the wire at one of the seams.
3. Double seam the bottom as in other exercises, and solder inside.
4. Rivet on two malleable ears and form a bail out of No. 6 wire and fasten in place.

Note:—Other sizes of pails may be worked out in the same way. Use galvanized sheets not lighter than the 27 guage for a durable pail.

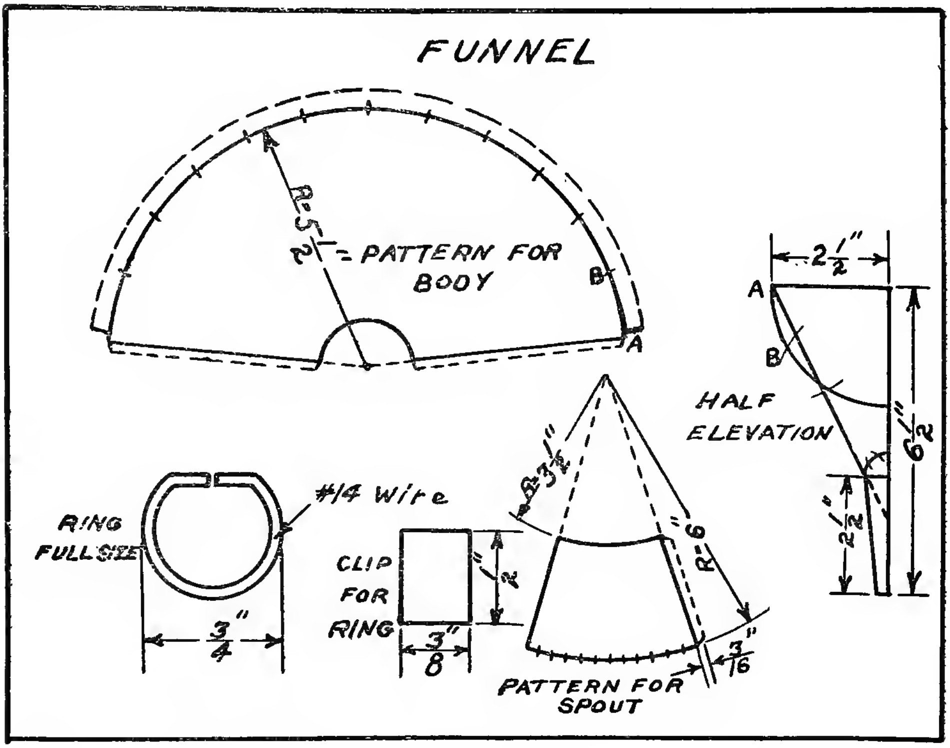


Plate XV. . .Funnel.

1. Lay out parts from patterns or make patterns from stiff paper in drawing room and submit to your teacher for inspection. Notice that the drawing gives the method generally followed in laying out any funnel pattern.
2. Fold two straight edges of body in opposite directions and form to shape with your hands over a funnel stake. Groove the seam with a hand groover and solder inside.
3. Turn the edge for wiring on the turning machine. Form the wire and fasten it in place with a mallet. Finish wiring on the machine.
4. The spout may be made with a lap seam or with a lock seam. In either case it should be neatly soldered in place outside of the body of the funnel.
5. Form the ring to shape with pliers and hammer, and solder clip in place just under the wire over the seam.

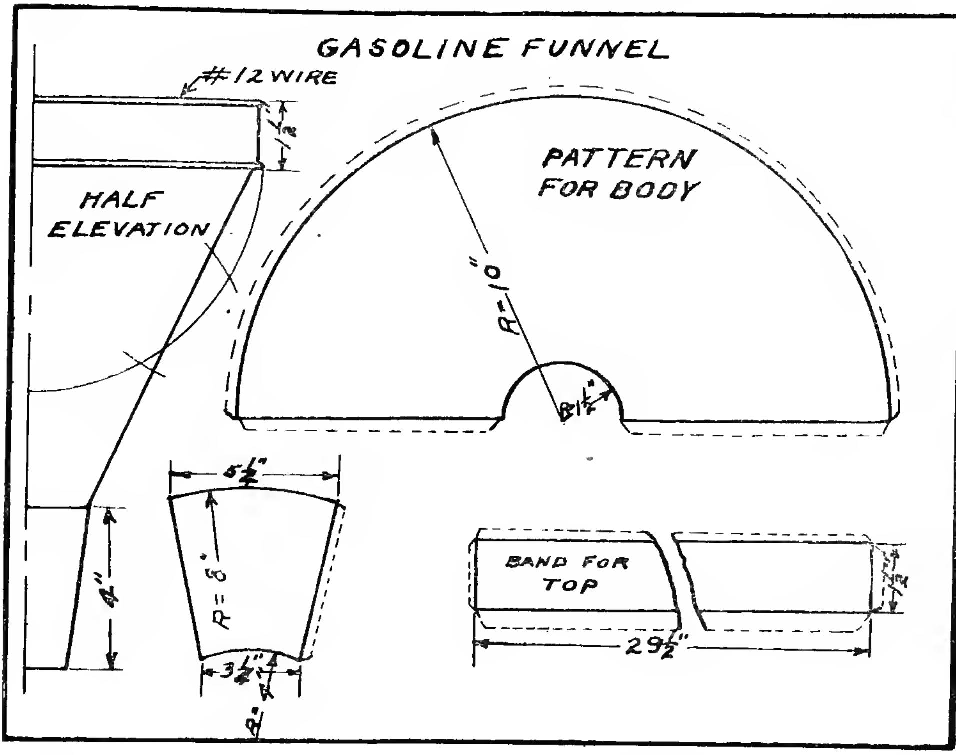


Plate XVI. Gasoline Funnel.

1. Follow instructions for small funnel except for top. Instead of wiring this edge make a band of metal one edge of which is wired in the flat.
2. Form this band into a ring which is ⅜ inch less in diameter than the diameter of the unfinished funnel. Solder the lock seam.
3. Burr an edge on the band and with the elbow edging rolls turn a V shaped groove on the inside edge of the funnel and double seam. It should not be necessary to solder this joint. A second band may be made to slip inside this funnel to hold a piece of chamois skin in place, if desired.

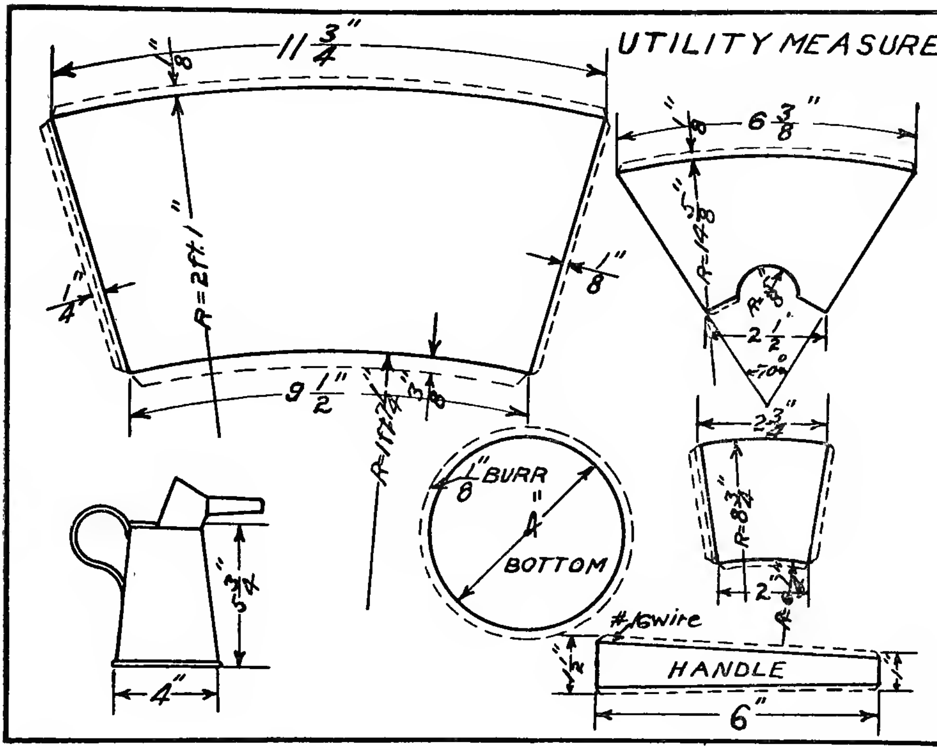


Plate XVII. Utility Measure.

1. This may be used as a measure and funnel combined or as common bottle filler.
2. Cut the four pieces of stock as directed in the drawing.
3. Form the body and solder the side seam on the inside. Wire the top edge and burr the bottom edge to receive the bottom.
4. Double seam the bottom in place. Solder inside.
5. Turn a hem on the curved edge of the hood with the burring machine and flatten with mallet.
6. Form the hood to shape and solder the lap seam. Turn a groove in the edges which are to fit on the top edge of the measure with the small turner. Solder the hood in place beginning at the back and fitting the joint carefully.
7. Solder the handle and the spout in place. The handle should fit over the seam.

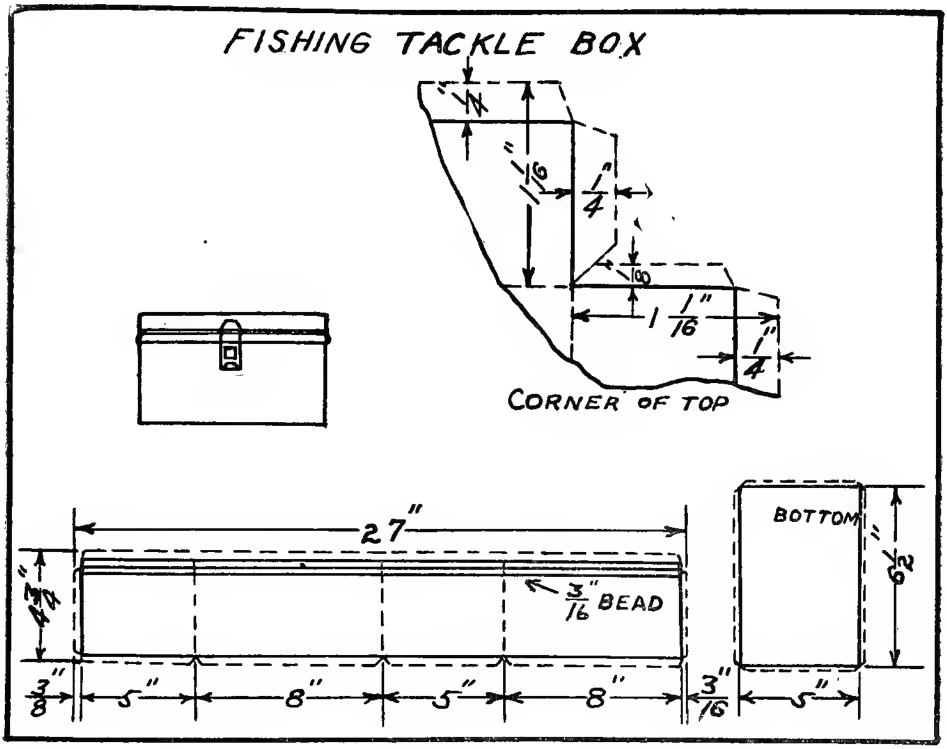


Plate XVIII. Fishing Tackle Box.

1. Cut stock for sides and ends in one piece, 4¾ by 26 9-16 inches. Lay off bends carefully with try square. Cut notches in lower edge and at corners. Turn a ⅜ inch hem at the top edge. Turn a loose hem in bottom edge and roll a bead just below the hem in the upper edge. This bead will stiffen the box and serve as a stop for the lid.
2. Form a cash box joint in the ends and bend sides and ends to meet.. Fit this joint neatly and solder inside.
3. Make the top like a pan with corners folded over and fastened down on the outside and with a wired edge.
4. Cut two pieces of tin for the hinges and after bending them around the wire slip through slits cut in the box just above the bead and solder down on on the inside.
5. Design a clasp for the box and fasten in place.

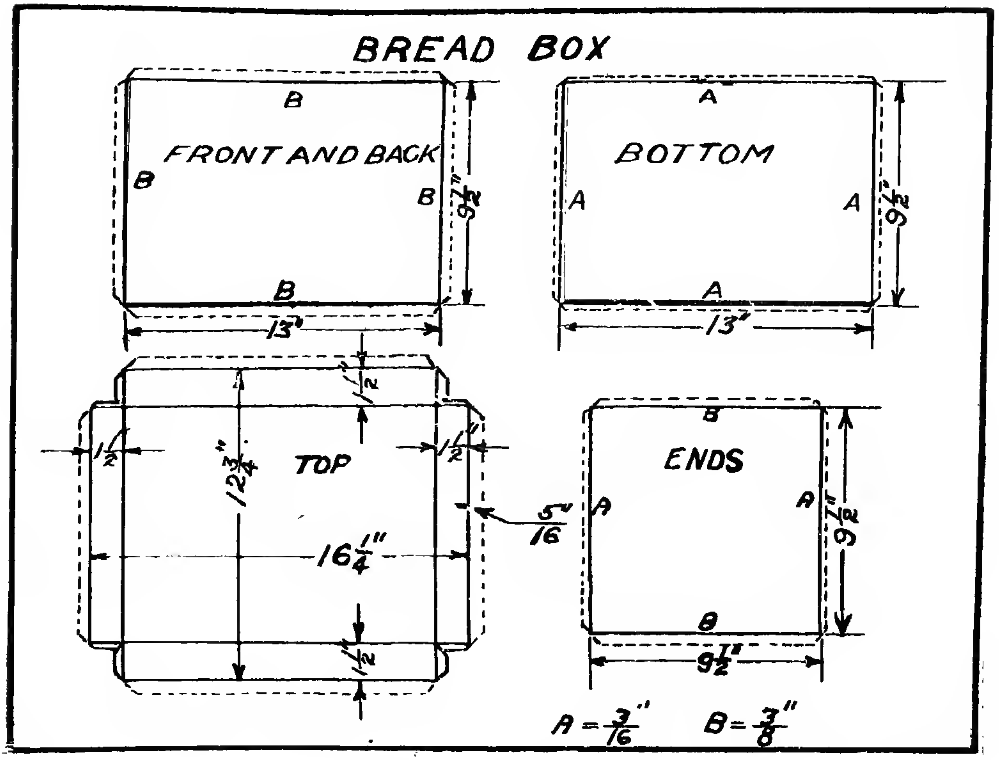


Plate XIX. Bread Box.

1. This box requires quite a large amount of material and should not be attempted by pupils who are careless. It should be made of good tin plate, heavier than that used for most exercises. When finished it may be enameled and nicely finished for use.
2. Cut the six pieces of stock as dimensioned. Allow for joints at all corners the amount marked. Also allow for wiring the edge of the cover.
3. Turn all edges marked "A" at right angles, setting the folder at 3-16 inch. Turn all edges marked "B" all the way over with the same setting, but do not flatten down. Turn a double hem at the top.
4. Fasten the front and back and ends together by double seaming. It will not be necessary to solder.
5. Set the bottom in place and double seam over a square stake.
6. The top is a simple pan with a wired edge which may be hinged in place in several ways. It should not fit too tightly.
7. Handles may be soldered in place on the ends and a clasp may be designed and used to hold the lid in place.

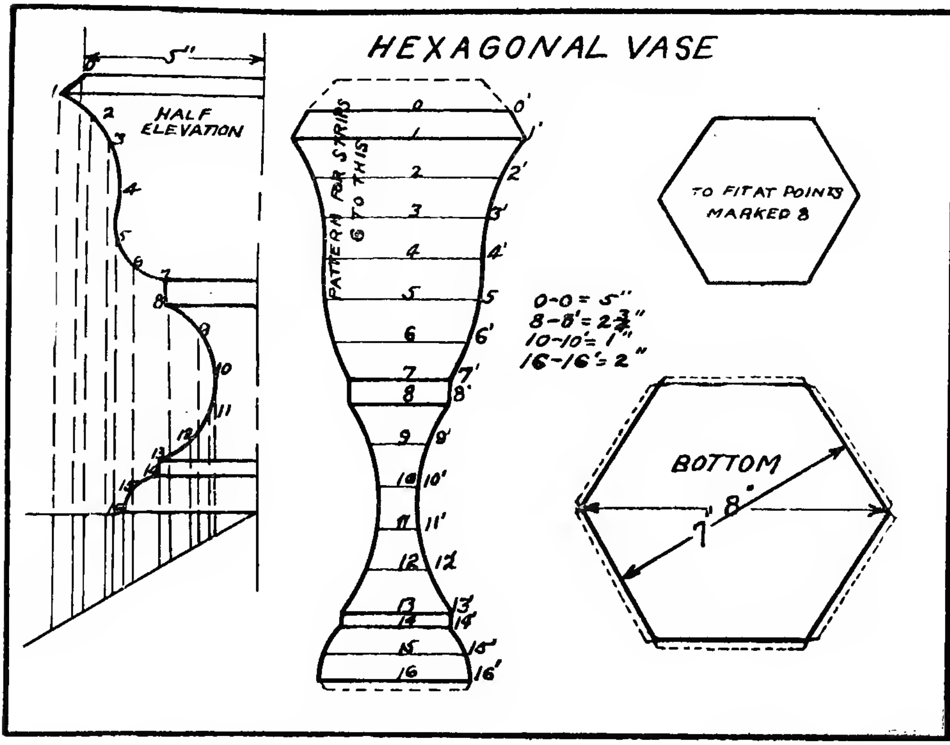


Plate XX. Hexagonal Vase.

1. This vase may be made of tin plate, galvanized iron or zinc. The pattern should first be worked out on paper and tested for accuracy.
2. Cut six pieces from the standard pattern. Cut a template from scrap material which has an angle of 120 degrees.
3. Begin bending the strips near the middle, using the cornice brake with curved wooden forms to secure the proper curvature.
4. When all the parts have been bent as nearly the correct form as possible, begin soldering them together, using the template to test the interior angls. Tack the parts at important intersections first and see that the vase does not get twisted in building it up. Great care should be taken to see that the strips are carefully fitted together before soldering. All the soldering can be done from the inside.
5. A bottom and a false bottom can be soldered in place when the vase is completed.