ELECTRIC WELDING

W. B. STOREY, Jr.

ELECTRIC WELDING

CATALOGUE
NUMBER ONE

1916

THE WILSON WELDER
& METALS COMPANY Inc.
NEW YORK CITY, U.S.A.

Gift

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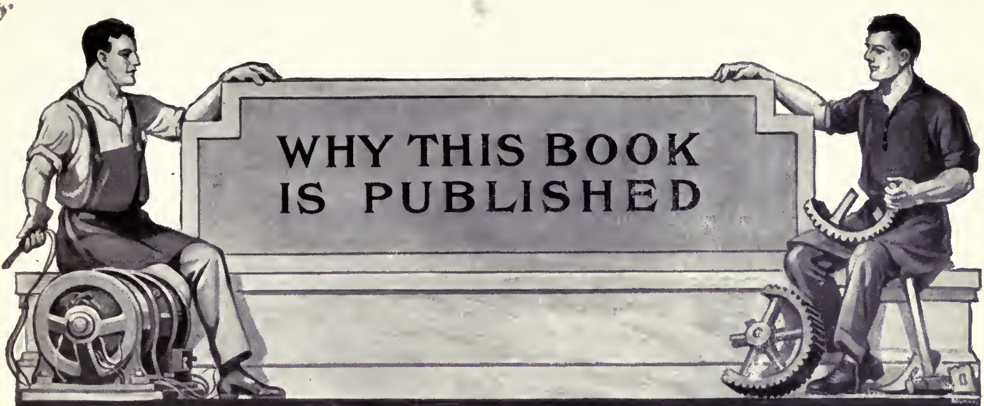


WHEN it was proposed to cross the Atlantic Ocean with a ship propelled by steam, the greatest English engineer and scientist at that time ridiculed the idea and said it would be quite as feasible to make a trip to the moon (distance 238,840 miles), while men of prominence in the engineering profession, both in England and America, looked upon the early efforts of our pioneer marine engineers, Robert Fulton and John Fitch, as being the product of unsound minds.

For ages it was thought welding could only be accomplished by the traditional *Blacksmith*, with *Forge*, *Anvil* and *Hammer*. But in this, as in many other of the arts and sciences, there has been great strides in recent years.

Electricity is now doing for man what steam has done in the past eighty or one hundred years.

The railways spent last year for maintenance of way and equipment the

STUPENDOUS SUM OF $951,416,485.00

Just how much of this could have been saved by the use of a first-class Electric Welding System we do not know. We do know, however, that the saving in *One Year* will more than pay for an equipment in service.

In the following pages may be found details of an Electric Welding System and Specially Prepared Metals, together with examples of possible economies from its use, that should be of interest alike to the *Workman*, *Official* or *Shareholder*.

CONTENTS

PRESENTED TO W. B. Starey jr

OFFICIAL TITLE

WITH COMPLIMENTS OF W. E. Symon

Wilson Welder and Metals Company

Incorporated

DEVELOPMENT OF THIS SYSTEM

THE Wilson System of Electric Welding was developed on a large trunk line railroad. Some years ago this road was among the first to introduce electric welding, which proved to be very economical, especially when making quick repairs. Its adoption, however, soon developed the fact that while the most expert operators secured fairly good results on some classes of work this was the exception rather than the rule. Consequently there were many failures, due to defective welds, that bore evidence of damage from excessive heat. As these conditions became more serious the railroad officers, after satisfying themselves that the heat *could not be properly controlled* by any of the electric welding systems on the market at that time, resolved to develop a Welding System that would control the heat, and eliminate the personal equation as much as possible.

After consulting various electrical engineers regarding the design and construction of a machine that would control the heat of the arc, with little or no encouragement, the problem was assigned to the Railway Company's Chief Electrical Engineer to work out.

After a long period of scientific research and experimental work a machine was produced that could be regulated at any predetermined heat and hold that heat constant (within approximately 6%) as long as the arc was maintained. In comparison with other machines then in use on the line, it was found that welds made under the same identical conditions by this machine showed far greater tensile strength and ductility. This System was then given more than one year's test on all kinds of railway maintenance work, after which able critics endorsed it as the most advanced state of the art, both as to *Economy in Operation* and *High Character of Product.*

The Wilson System

ITS SCOPE OF WORK AND POINTS OF SUPERIORITY

THE Wilson System of Electric Welding is the latest and most scientific system now on the market. Machinery from small details to massive parts is readily repaired at small cost. Cast steel, cast iron, wrought iron, brass, copper, and in fact any weldable metal, can be welded with this System.

In comparison with other systems on the market the Wilson System uses from 33 to 50% of the power required for the same operation. Also, a very material saving in labor is effected, due to the fact that the control of the energy is placed conveniently for the operator, which eliminates the necessity of having to go back and forth between the work and control board.

This is the only device which enables any number of welders to work from one large machine without one welder interfering with the work of another. The power is located at one point, where it can have proper supervision, and it can be distributed to convenient points throughout the shop, which is preferable to having a number of individual motor sets, with the consequent greater cost of operation and maintenance.

Attention is drawn to the fact that welding with the Wilson System is uniform. This superiority over other systems is due to the fact that the heat is controlled at the point of application of the metal. In welding there is a critical temperature at which steel can be worked to give the greatest tensile strength, and also ductility of metal. By raising the heat 15 or 20 amperes above this critical amperage a fracture of the weld will show segregation of carbon and slag pockets, which, of course, weakens the weld. If the amperage is decreased from the critical temperature, a fracture of the weld will show that the metal has been deposited in globules, with many voids, which proves that the weld has been made with insufficient heat. This shows that with a fluctuating amperage or voltage, it is impossible to obtain the uniformly high grade welds made by the Wilson System.

From the foregoing may be formed a general idea as to the efficiency of the Wilson System as applied to restoring broken and damaged parts of all kinds of *Machinery* and *Boilers* without regard to their form, weight, original condition or use—a field, by the way, differing widely from its value in *Manufacturing Lines.*

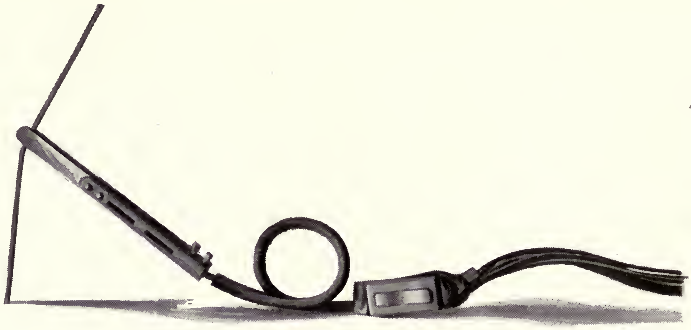
Specially Prepared Welding Metals

IN the earlier application of Electric Welding, attention was directed solely to developing the machines employed in the operation, and very little to the welding metal used, or how it should be used, with the result that many welds failed, due to the change in characteristics of the metal resulting from the effect of heat from the electric arc.

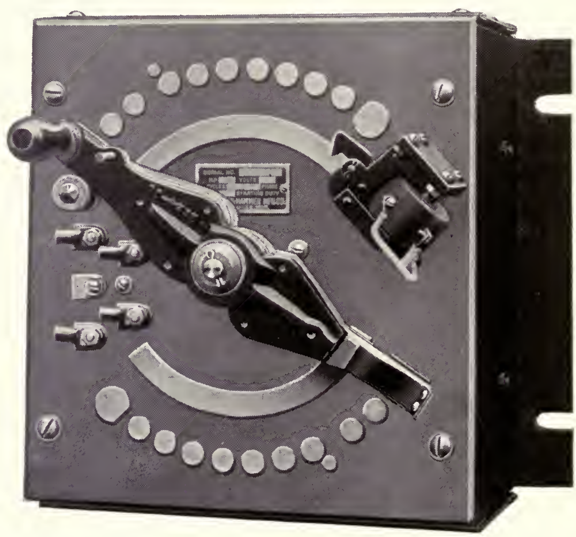
The Wilson System of Welding not only controls fluctuations of the heat at the arc, but also provides metals that are not adversely affected by the heat of the arc. Our specially prepared welding metal is in the form of an electrode and is composed of a homogeneous alloy combined with such excess of manganese as will compensate for losses while passing through the electric arc, thus insuring a substantial amount of manganese in the welded joint which is essential to its toughness.

We also have a manganese copper alloy welding metal electrode which is composed of iron homogeneously combined with such an excess of manganese and copper over the amount lost in the arc as will insure to the welded joint a substantially additional degree of toughness and ductility. With no other system of welding can these metals be used. Therefore, such merit as they possess is only available to those who use our equipment and metals, whose interest in the advanced state of the art we stand committed to serve. We have developed each of these metals to the highest point of efficiency through the services of some of the best metallurgists in the United States, and to insure their proper composition and uniformity, the mills maintain complete records and analysis of each heat.

These metals are patented for the joint protection of our customers and ourselves. For details see page 35.



Welding Tool or Electrode Holder with Distant Control Switch



Direct Current

Starter

No-Voltage

Release

Polyphase

Starter

No-Voltage

Release

PHOTOGRAPHS OF EQUIPMENT

AND

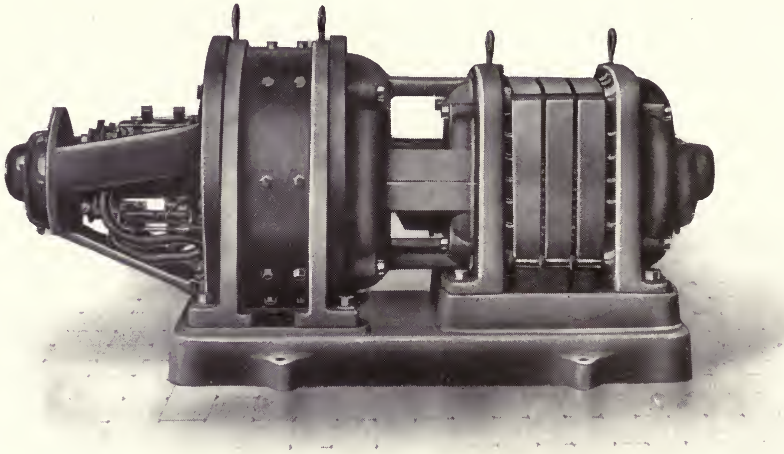
SPECIFICATIONS

OF

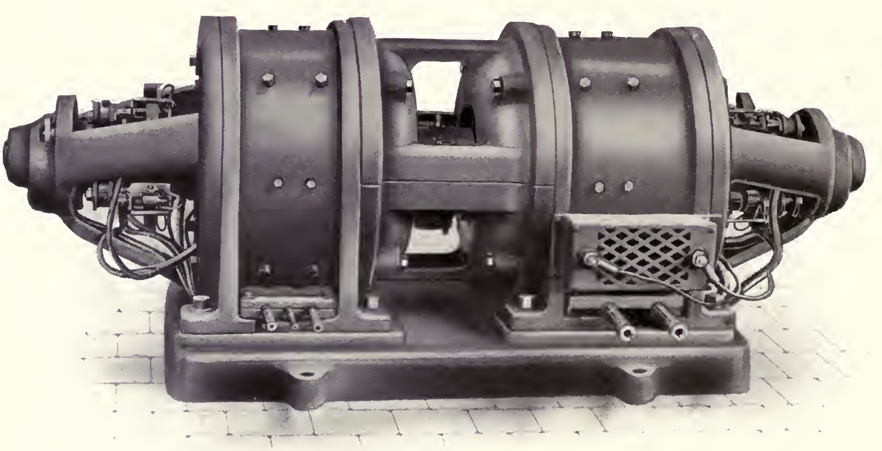
DESIGN, CONSTRUCTION

AND MATERIAL

WILL BE FOUND IN PAGES 10 TO 40
INCLUSIVE

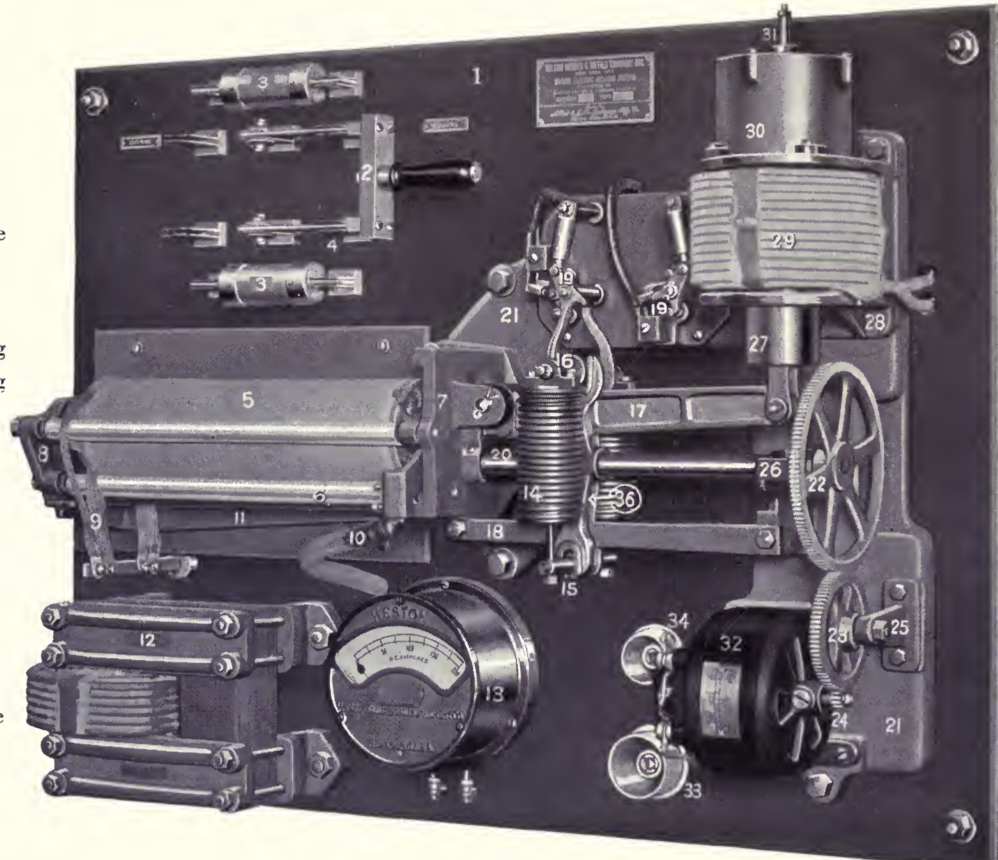


Four Arc, or 600 Ampere Capacity, Motor-Generator Set Alternating Current



Four Arc, or 600 Ampere Capacity, Motor-Generator Set Direct Current

Control Panel with List of Parts

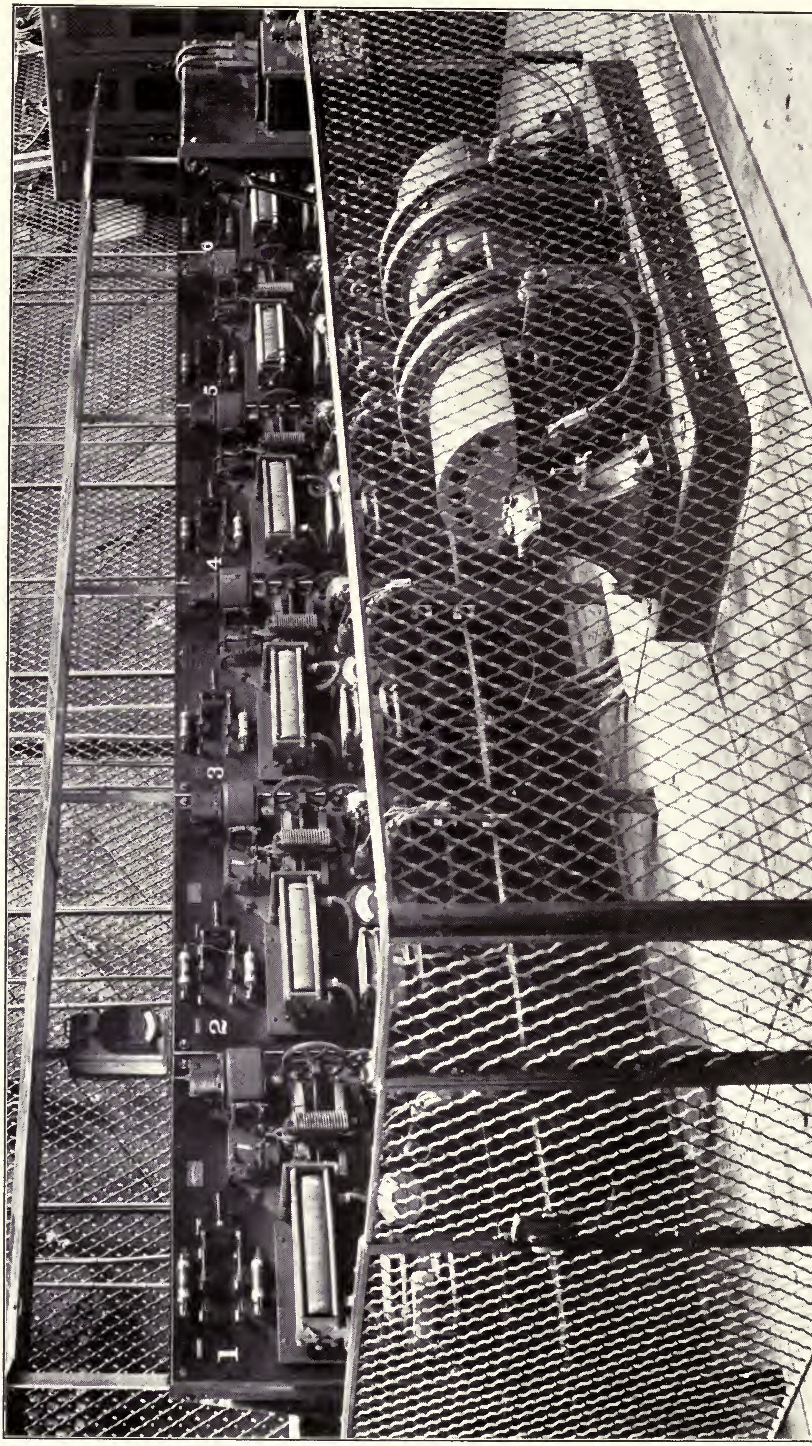


PARTS

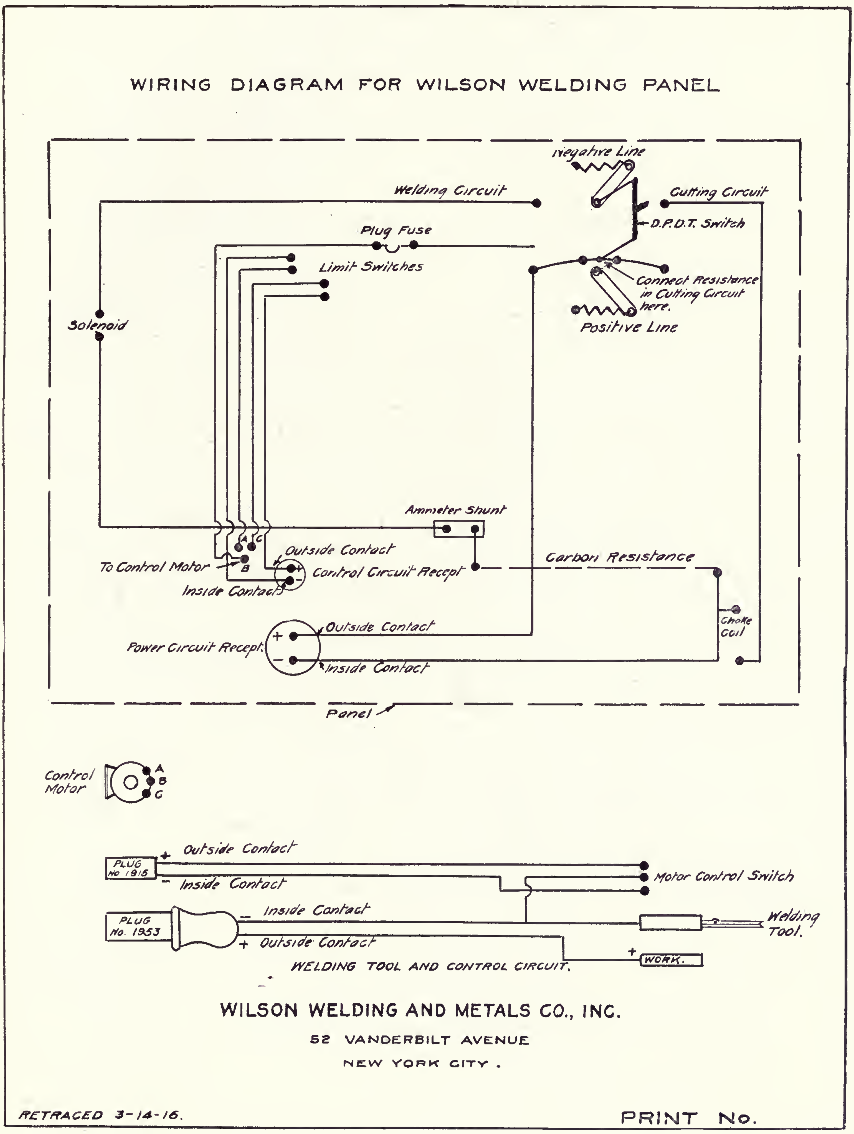
1 Slate Panel
2 Double Throw Switch
3 300 Ampere Fuse
4 Switch Receptacle
5 Carbon Pile
6 Tie Rods
7 Front End Casting
8 Back End Casting
9 Back End Disk Cable
10 Front End Disk Cable
11 Asbestos Board
12 Choke Coil
13 Ammeter
14 Bronze Coil Springs
15 Bottom Cross Axle
16 Top Cross Axle and Rollers
17 Brass Lever
18 Guide Bar

PARTS

19 Toggle Circuit Breakers
20 Lead Screw
21 Main Body Casting
22 Master Gear
23 Intermediate Gear
24 Pinion
25 Inter-Gear Bracket
26 Master Gear Bracket
27 Solenoid Plunger
28 Solenoid Casting
29 Solenoid
30 Dash Pot
31 Piston Rod to 30
32 Motor 1/10 H. P.
33 Welding Circuit Plug
34 Control Circuit Plug
35 Angle Iron Supports
36 Brass Cross Head



Six Panel Installation, American Locomotive Company, Brooks Works, Dunkirk, N. Y.



Wiring Diagram of Wilson Welding Panel Control Switch, and Electrode Holder

Wilson Welder and Metals Company

Incorporated

52 Vanderbilt Avenue, New York City

CATALOGUE OF PARTS

OF

WELDING GENERATORS AND MOTORS

GENERAL DIRECTIONS FOR ORDERING REPAIR PARTS

1. Always give the machine number as stamped on the name plate and state whether the machine is a generator or a motor.
2. Give both name and number of part wanted.
3. Shunt Field Coils and Series Field Coils are shipped fully insulated and ready for assembly in machine.
4. Armature coils for both motor and generator of 1, 2 and 4-arc sets are shipped fully insulated. For 6 and 8-arc sets, separate slot boxes are used and should be separately ordered.

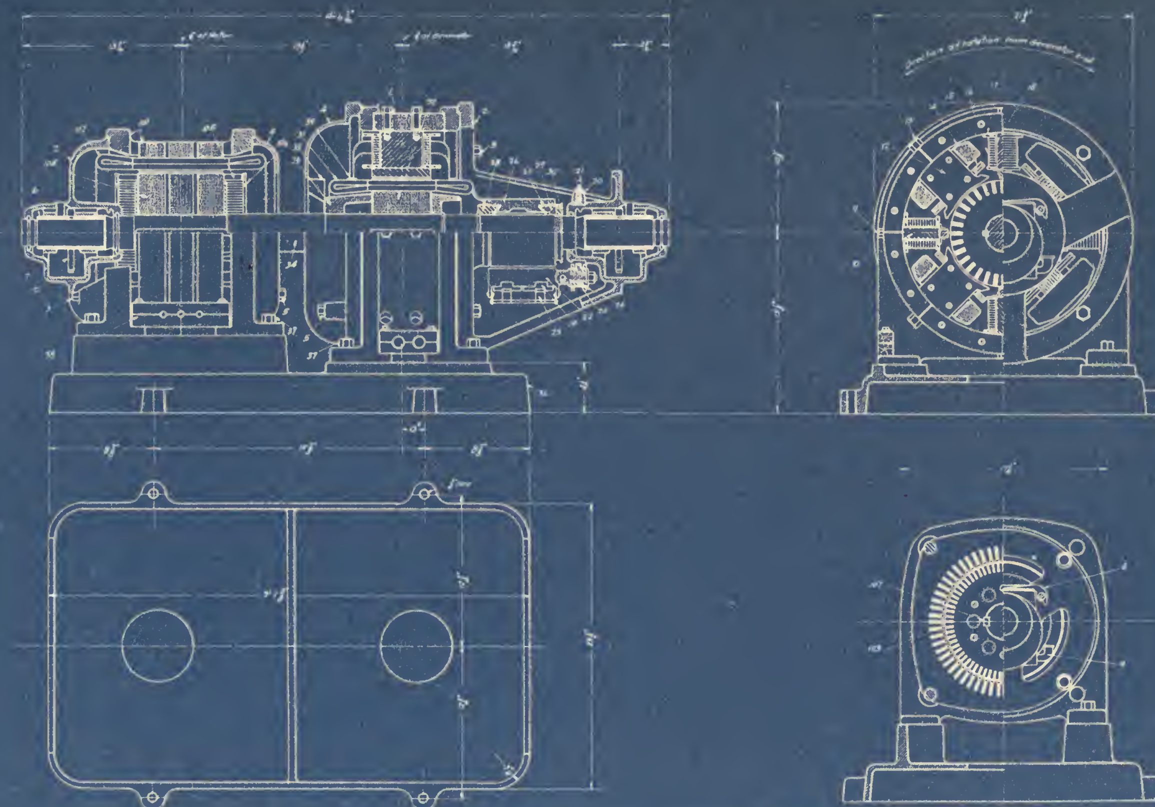
DIRECT CURRENT MOTORS AND GENERATORS

List of Parts by Number and Name

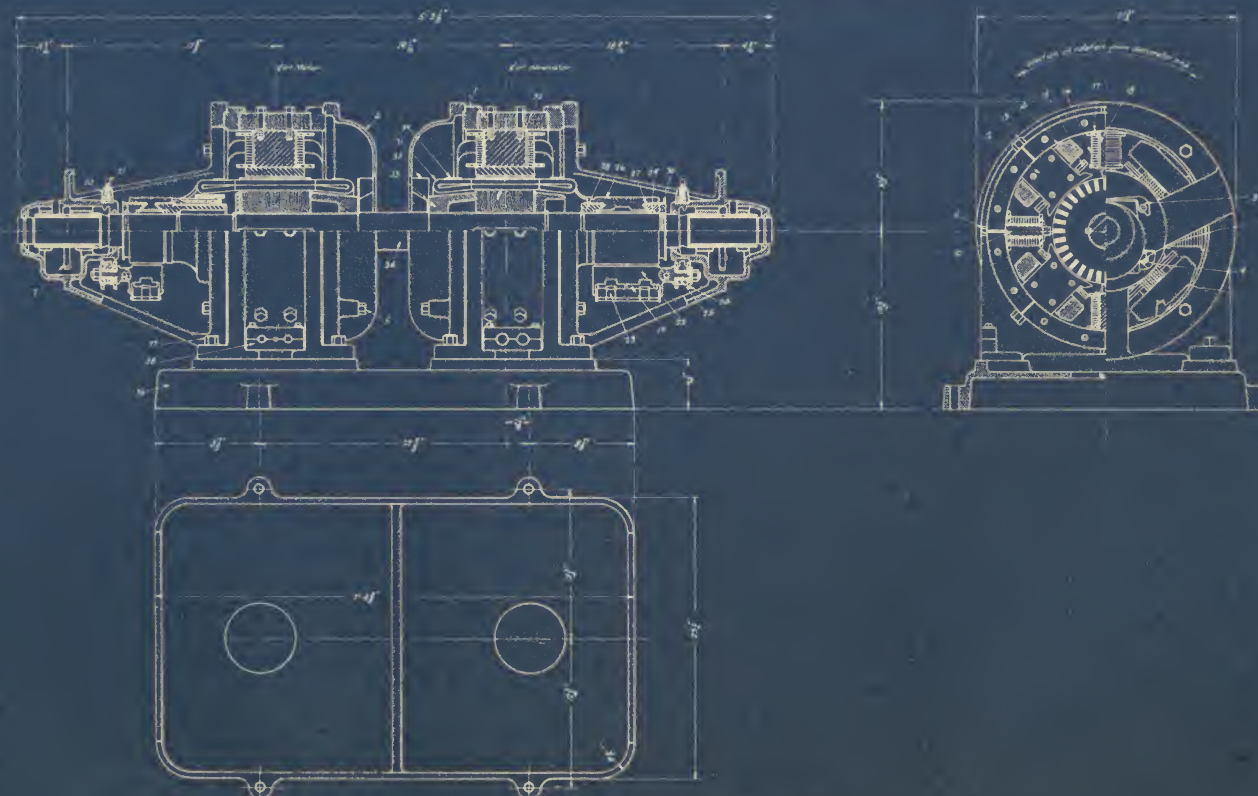
1 Field Ring.
2 Bearing Bracket.
3 Bearing Bracket Bolt.
4 Winding Guard.
5 Winding Guard Bolt.
6 Bearing Bushing.
7 Oil Ring.
8 Oil Hole Cover.
9 Oil Gauge.
10 Commutation Pole.
11 Commutation Pole Bolt.
12 Pole Piece.
13 Pole Piece Bolt.
14 Shunt Field Coil.
15 Series Field Coil.
16 Commutation Pole Coil.
17 Commutation Pole Insulating Washers.
18 Commutation Pole Core Insulation.
19 Brush.
20 Brush Yoke.
21 Brush Yoke Set Screw.
22 Brush Holder.
23 Brush Holder Spring.
24 Brush Holder Insulating Washer.
25 Brush Holder Insulating Bushing.
26 Commutator.
27 Commutator "V" Ring.
28 Commutator Shell, Back Part.
29 Commutator Shell, Front Part.
30 Commutator Shell Nut.
31 Armature Coil.
32 Armature Core.
33 Armature Clamping Plate.
34 Armature Shaft.
35 Ventilating Fan.
36 Base.
37 Holding Down Bolts.
38 Terminal Block.
39 Armature Binding Wire.
40 Commutator Cross Connections.
41 Armature Slot Boxes.

INDUCTION MOTORS

101 Stator Frame and Core.
102 Stator Coil.
103 Stator Slot Wedge.
104 Rotor Core.
105 Rotor Bar.
106 Rotor End Ring.
107 Rotor Shaft Key.
108 Stator Slot Box.



ALTERNATING CURRENT MOTOR-GENERATOR FOUR ARC CAPACITY



DIRECT CURRENT MOTOR-GENERATOR FOUR ARC CAPACITY

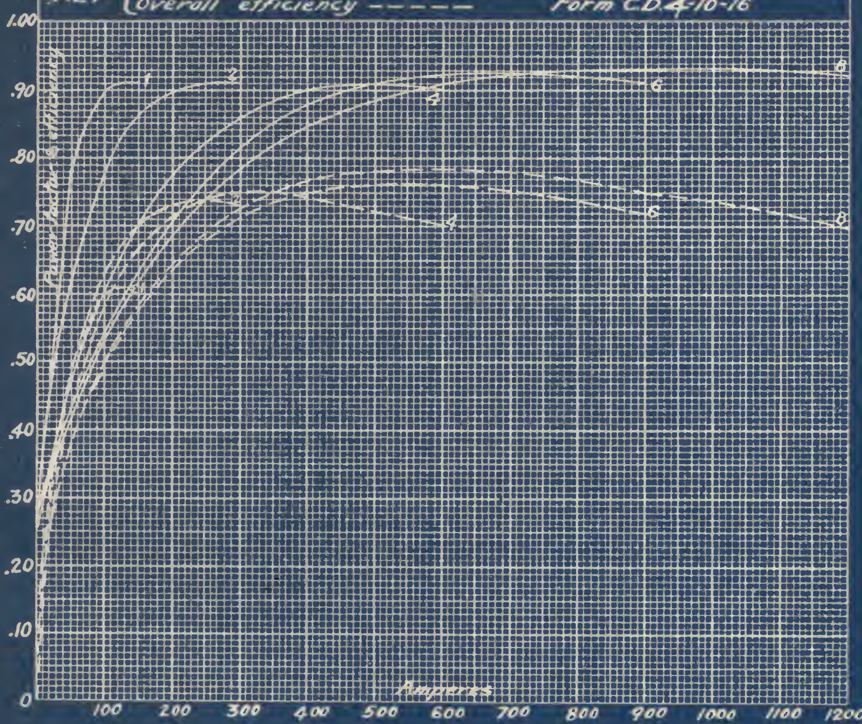
WILSON WELDER & METALS CO., INC.
52 VANDERBILT AVENUE - NEW YORK CITY.

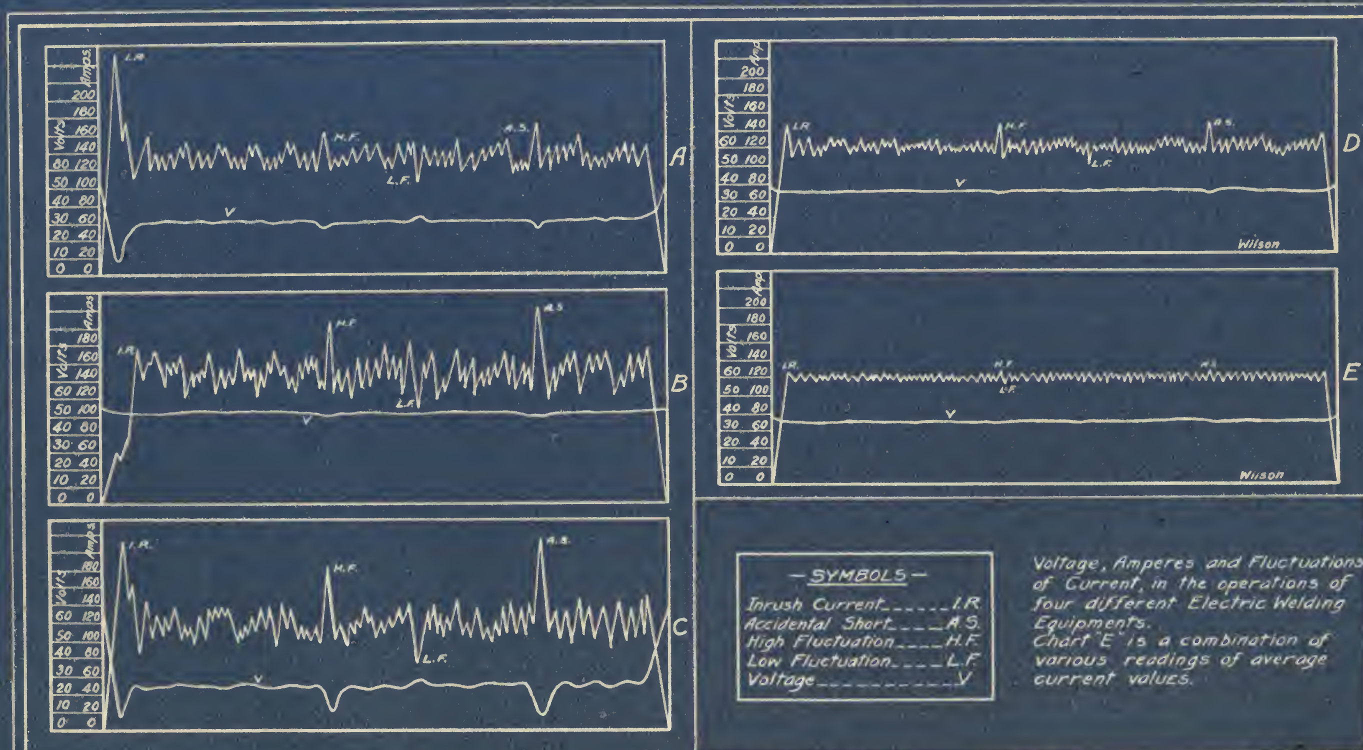
Overall Efficiency Power Factor and Regulation
of
1, 2, 4, 6, & 8 Arc Capacity Motor Generator Sets

Power factor curve is for induction motor drive
Voltage is constant at 35 Volts for all loads

KEY { Power factor ————
 Overall efficiency – – – – –

Form C.D.4-10-16





ELECTRIC WELDING CYCLES

SPECIFICATIONS FOR

Electric Arc Welding Motor-Generator Sets

CONSISTING OF

Direct Current, Compound, Interpole Generators and Squirrel Cage, Polyphase, Induction Motors

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GENERAL—The machines are designed and built with special reference to the intermittent character of the load to be carried and will be so adjusted as to operate with fixed brushes at any load from no-load to maximum, and will not show any tendency to flash when maximum is suddenly removed.

The entire magnetic circuit of the generator is constructed of thin sheet steel plates, castings being used only for mechanical and not for magnetic purposes, thus providing an extremely quick recovery coefficient and permitting the operation of more than one welding circuit from the generator without interference.

The commutation will be sparkless under all conditions and changes of load within the rating of the machine and the set will operate without undue noise or vibration.

DATA

Rated Capacity of Generator in Welding Arcs	1	2	4	6	8
Rated Capacity of Generator in Amperes	150	300	600	900	1200
Rated Capacity of Motor in Horse Power	7½	15	30	45	60
Full Load Speed	1750	1150	1150	1150	1150
Number of Poles on Motor . .	4	6	6	6	6
Number of Poles on Generator	4	4	4	4	4
Number of Interpoles	4	4	4	4	4
Voltage of Motor	220 or 440	220 or 440	220 or 440	220 or 440	220 or 440
Voltage of Generator	35	35	35	35	35
Temperature Rise—Duty Cycle	50°C	50°C	50°C	50°C	50°C
Overall Efficiencies at Full Load					
¾ Load					
½ Load					
¼ Load					
Power Factor at Full Load . .	. . .	. . . .	. . . .	. . . .	. . . .
Length of Set in Inches . . .	42 15/16	57½	66½	74⅝	82 7/16
Width of Set in Inches	14	18¼	21¾	28	28
Weight of Set in Pounds . . .	1000	1600	2200	4100	4300

ELECTRIC WELDING MOTOR-GENERATOR SET

Construction—This Motor-Generator Set will consist of a Squirrel Cage Induction Motor and 35-Volt, Direct Current, Compound Wound, Interpole Generator, mounted on a heavy cast iron subbase and provided with self-oiling bearings lined with hard genuine babbitt.

The rotors of both machines being mounted on a single shaft of high carbon steel supported on two, three or four bearings, the bearing housing of the set will be of the demountable type so as to permit the easy removal of the rotors.

Compensators equipped with a No-Voltage release will be furnished with each set.

Machines will be of the protected type and in strict accordance with the Standardization Rules of the A I E E—Class "A" insulation being used throughout, with the exception of the commutator, which will be mica insulated.

INDUCTION MOTOR

Stator—The stator core will be built of punchings of thin sheet steel of high magnetic quality, each sheet being varnished to reduce the core losses. The core will be rigidly held and supported by two heavy cast iron clamping rings which form the frame of the stator—all bolts holding these clamping rings together being outside of the magnetic circuit.

The windings will be of form wound coils, treated with insulating compound, taped, varnished and baked. The slots of the winding of the Six and Eight Arc Machines will be lined with insulating material of the best quality suitable for the purpose—form pressed coils being used in the smaller size machines. The windings will be securely held in place by wedges driven in between the tips of the core teeth and the terminals of the winding will be brought out so that connection to the power lines may be easily made, connectors being supplied for this purpose.

Neat and substantial guards will be bolted to the frame to protect both ends of the windings from mechanical injury.

Rotor—The rotor core will be built of punchings of thin sheet steel of high magnetic quality, each sheet being varnished to reduce core losses. The core will be securely keyed direct to the shaft between clamp plates to prevent the bending of the end sheets.

The rotor conductors will be placed in partly closed insulated slots, and securely riveted and soldered at both ends to short-circuiting rings.

Ventilation—The periphery of the stator will be entirely exposed to the air and where necessary ducts will be provided in both the rotor and stator cores, permitting the most perfect ventilation through cores and windings.

DIRECT CURRENT GENERATOR

Field—The field will be of the ring type, constructed of laminated steel—no castings being included in the magnetic circuit. The pole pieces, also built of laminated steel, will be belted in place and will be so arranged that any field coil and its core may be easily removed. The field coils will be form wound, without metal spools, and thoroughly insulated.

Interpoles—one for each main pole on the machine—will be used for the purpose of securing improved commutation and fixed brushes.

Armature—The armature will be of the slotted drum type, having a core of thin sheet steel of high magnetic quality—each sheet being varnished to reduce core losses. The winding will be of formed coils or rectangular bars, thoroughly insulated and securely held in place by wedges driven into grooves between the tips of the teeth, or by mica insulated band wires, and when necessary by binding wire over the outer ends of the coils.

The commutator will be built of hard drawn copper bars, thoroughly insulated with mica and rigidly held in place by heavy clamping rings.

Brush Holder—The brush holders will be of radial type, fitted with carbon brushes. These holders have no sliding contacts which carry current and the brushes are easily removable from the machine.

Ventilation—Care will be taken to provide ample ventilation and where necessary, air ducts will be left in the cores so that free circulation through the cores and windings is obtained. A fan will also be mounted integral with the armature, providing axial ventilation.

WORKMANSHIP AND MATERIAL

The Wilson Welder and Metals Company, Inc., guarantees that all material and workmanship employed under this specification shall be strictly first class of their respective kinds and for the purposes used.

GUARANTEE

The Wilson Welder and Metals Company, Inc., guarantees that Motor-Generator Sets built under this specification shall be strictly first class in every respect both mechanically and electrically, and if after installation any part of the machine discloses weakness or unsuitability for the work for which it is intended on account of defective *design*, *material* or *workmanship*, then, and in that event the Wilson Welder and Metals Company, Inc.,will make this good without expense to the purchaser any time inside of one year from date of installation and trial test, provided the entire equipment is operated in accordance with our instructions and advice.

Signed..
Wilson Welder and Metals Company, Inc.

Signed..
Purchaser

Approved ....
Wilson Welder and Metals Company, Inc.

Approved ....
Purchaser

Executed..191 .

SPECIFICATIONS FOR

Electric Arc Welding Motor-Generator Sets

CONSISTING OF

Direct Current, Compound, Interpole Generators and Interpole, Direct Current Motors

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General—The machines are designed and built with special reference to the intermittent character of the load to be carried and will be so adjusted as to operate with fixed brushes at any load from no-load to maximum, and will not show any tendency to flash when maximum load is suddenly removed.

The entire magnetic circuit of the generator is constructed of thin sheet steel plates, castings being used only for mechanical and not for magnetic purposes, thus providing an extremely quick recovery coefficient and permitting the operation of more than one welding circuit from the generator without interference.

The commutation will be sparkless under all conditions and changes of load within the rating of the machine and the set will operate without undue noise or vibration.

DATA

Rated Capacity of Generator in Welding Arcs	1	2	4	6	8
Rated Capacity of Generator in Amperes	150	300	600	900	1200
Rated Capacity of Motor in Horse Power	7½	15	30	45	60
Full Load Speed	1720	1200	1200	1200	1200
Number of Poles on Motor . .	4	4	4	4	4
Number of Poles on Generator	4	4	4	4	4
Number of Interpoles	4	4	4	4	4
Voltage of Motor	230	230	230	230	230
Voltage of Generator	35	35	35	35	35
Temperature Rise—Duty Cycle	50°C	50°C	50°C	50°C	50°C
Overall Efficiencies at					
Full Load					
¾ Load					
½ Load					
¼ Load					
Length of Set in Inches . . .	49⅛	65½	77½	79⅛	88
Width of Set in Inches	14	18¼	21¾	28	28
Weight of Set in Pounds . . .	1100	1750	2600	4200	4450

Construction—The Motor-Generator Sets will consist of an Interpole, Direct Current Motor and 35-Volt, Direct Current Compound Wound, Interpole Generator, mounted on a heavy cast iron subbase and provided with self-oiling bearings lined with hard genuine babbitt.

The rotors of both machines being mounted on a single shaft of high carbon steel supported on two, three or four bearings, the bearing housings of the set will be of the demountable type so as to permit the easy removal of the rotors.

Compensators equipped with a No-Voltage release will be furnished with each set.

Machines will be of the protected type and in strict accordance with the Standardization Rules of the A I E E—Class "A" insulation being used throughout, with the exception of the commutators, which will be mica insulated.

DIRECT CURRENT GENERATOR AND MOTOR

Field—The fields will be of the ring type, constructed of laminated steel. The pole pieces, also built of laminated steel, will be belted in place and will be so arranged that any field coil and its core may be easily removable. The field coils will be form wound, without metal spools, and thoroughly insulated.

Both machines will be furnished with interpoles—one for each main pole on the machines—for the purpose of securing improved commutation and fixed brushes.

Armature—The armatures will be of the slotted drum type, having a core of thin sheet steel of high magnetic quality—each sheet being varnished to reduce core losses. The winding will be of formed coils or rectangular bars thoroughly insulated and securely held in place by wedges driven into grooves between the tips of the teeth, or by mica insulated band wires, and when necessary by binding wire over the outer ends of the coils.

The commutators will be built of hard drum copper bars, thoroughly insulated with mica and rigidly held in place by heavy clamping rings.

Brush Holder—The brush holders will be of radial type, fitted with carbon brushes. These holders have no sliding contacts which carry current and the brushes are easily removable from the machine.

Ventilation—Care will be taken to provide ample ventilation and where necessary, air ducts will be left in the cores so that free circulation through the cores and windings is obtained. An exhaust fan will be mounted integral with each armature providing axial ventilation.

WORKMANSHIP AND MATERIAL

The Wilson Welder and Metals Company, Inc., guarantees that all material and workmanship employed under this specification shall be strictly first class in every respect, and as a part of this specification, both physical and chemical tests of material used is appended.

GUARANTEE

The Wilson Welder and Metals Company, Inc., guarantees that Motor Generator Sets built under this specification shall be strictly first class in every respect both mechanically and electrically, and if after installation any part of the machine discloses weakness or unsuitability for the work for which it is intended on account of defective *design*, *material* or *workmanship*, then, and in that event, the manufacturers make this good without expense to the purchaser any time inside of one year from date of installation and trial test.

Signed ....
Wilson Welder and Metals Company, Inc.

Signed ....
Purchaser

Approved ....
Wilson Welder and Metals Company, Inc.

Approved ....
Purchaser

Executed .... 191 .

Constant Current Control Panel for Welding and Cutting

General Description—The general function of this panel is to maintain a constant flow of current between the welding tool and the material operated on, regardless of variations in the resistance of the welding circuit, due to varying lengths of arc, or other causes.

The current regulator is to consist of a carbon pile held under compression by one or more helical springs, the pull of which is opposed by a solenoid through which the current to be regulated is passed. A suitable air dash pot is to be connected to the solenoid plunger to prevent all "hunting" or chattering, due to the tendency of the plunger and connected parts to travel beyond the desired point.

The pressure of the springs is to be transmitted to the carbon discs or plates through a lever, and the springs are to be mounted on a carriage in such a manner that the point at which they act upon the lever may be changed, thereby increasing or decreasing the leverage. The position of the control solenoid with regard to the lever is to be fixed. The movement of the spring carriage described above is to be produced by a small electric motor, so wired that it may be controlled by two push buttons located at the welding tool, or near enough to the welding tool so that the welding operator can use them without changing his position.

The panel is also provided with a reactance coil of a size sufficient to materially assist the operator in maintaining an arc with a graphite pencil when the panel is used for "cutting" or burning away metal in preparing for the welding process, or other purposes.

An ammeter is provided to indicate the amount of current used in the welding process, and a double throw switch of 200 amperes capacity, for use in changing from the welding circuit to the cutting circuit.

Equipment—The equipment consists of:

1 Slate panel 30″ x 40″ x 1½″ thick, mounting.
1 Current regulator complete with carbon pile, control solenoid, pressure springs, dash pot, carriage for moving pressure springs, and control motor to produce the change in the position of the springs when desired.
1 200 Ampere Ammeter.
1 Reactance coil of 200 amperes capacity.
1 200 ampere, 250 volt, double pole, double throw knife switch with fuse connections and fuses mounted on front of the board.
1 Electric Vehicle Association Standard 50 Ampere Type "N" Charging Receptacle.
1 Hand tool.
1 Control switch.
1 50 Ampere Electric Vehicle Association Standard Type "N" Plug.
1 150 Ampere Electric Vehicle Association Standard Type "N" Plug.

Wiring—The panel will be completely wired, in accordance with the attached blueprint.

All wiring and all material used in making the connection conform strictly to the "National Electrical Code."

Regulation—While the welding operator maintains an arc between his welding tool and the work, the control panel must maintain the current constant within five per cent. (5%) of the mean value, regardless of the actual value of current that is flowing, provided the flow is between the limits of 80 and 175 Amperes.

Range of Control — The range of current is from 80 to 175 amperes.

The value of current is under the control of the welding operator wherever he may be working.

Carbon Pile—The discs or plates of the carbon pile are composed of clear homogeneous carbon, with parallel faces, and to be of uniform size and thickness.

Carbon Pile Mounting—The rods which support the carbon discs, and those which serve as guides on the sides of the pile, are to be covered with an insulation material presenting a smooth no-abrasive surface to the carbon discs.

Solenoid—The control solenoid is to be insulated both between turns and between the coil and the supporting frame with asbestos insulations, or such a heat resisting insulation as will positively prevent the coil from becoming inoperative, due to such heat as may be generated in it under the most severe conditions encountered in the use of the panel.

Control Motor—The motor for controlling the position of the spring carriage is to be a series wound motor so wired that its entire motion in either direction may be controlled by two push buttons located at a distance.

Limited Switches—Suitable automatic control switches, which will stop the motor, are to be provided to prevent the spring carriage from travelling too far in either direction.

WORKMANSHIP AND MATERIAL

The Wilson Welder and Metals Company, Inc., guarantees that all material and workmanship employed under this specification shall be strictly first class of their respective kinds and for the purpose used.

GUARANTEE

The Wilson Welder and Metals Company, Inc., guarantees that the Motor-Generator Sets and welding and cutting panels built under this specification shall be strictly first class in every respect both mechanically and electrically, and if after installation any part of the machine discloses weakness or unsuitability for the work for which it is intended on account of defective *design*, *material* or *workmanship*, then, and in that event, the Wilson Welder and Metals Company, Inc., will make this good without expense to the purchaser any time inside of one year from date of installation and trial test, provided the entire equipment is operated in accordance with our instructions and advice.

Signed ....
Wilson Welder and Metals Company, Inc.

Signed ....
Purchaser

Approved ....
Wilson Welder and Metals Company, Inc.

Approved ....
Purchaser

Portable Equipments

POWER AND HAND MOVED

FIELD TYPE

THIS equipment is mounted on a heavy motor truck chassis with a high power internal combustion engine, which is suitable for use where it is necessary to move an equipment from place to place with its own power.

The design is considered a desirable one for the Government in connection with troop trains or Commissary Department, when at points away from railway lines. It would also be suitable around mining plants, and in connection with steamship and industrial work in cities where it is necessary to have a portable equipment.

The design is shown on page 37 and is fully described in specification, pages 33-34. This equipment complete would weigh about 8000 pounds, which includes two welding panels with a generator of sufficient capacity to supply them, and the usual amount of accessories, such as: tools, extra welding metals, etc.

HAND MOVED—SHOP TYPE

For use in railway shops, industrial concerns, or on shipboard, where it is desirable to move a welding outfit from point to point, either with a view of having the equipment more flexible, or for the purpose of favoring certain wiring plans, we have prepared a portable Shop Type equipment, shown on page 38. As will be observed from the drawing this equipment can be moved by hand from point to point, either in a shop or on board ship. The weight of the truck is about 700 pounds, and with a two-arc motor-generator set, two welding panels, and the usual amount of wiring, tools, etc., the total weight would be about 3500 pounds.

Our specifications and guarantees on pages 21 to 30 inclusive cover the welding equipment contemplated in connection with both portable sets.

THE LAST WORD IN ELECTRIC WELDING

Both in the foregoing and following pages we endeavor to present the essential facts with respect to our Electric Welding System and trust we have fully covered the ground.

The development of the Wilson System as outlined herein, represents years of research and experimental work both as to design and construction of machines, composition of metals and methods of use. We have not discontinued our efforts in any of these directions and shall not, for it is our intention to retain

THE LEADERSHIP

IN THE

ELECTRIC WELDING FIELD

We are prepared to not only furnish the very latest and best Electric Welding System on the market, but stand committed to a solution of such problems as may arise in the progress of the art, and to this end we not only solicit inquiries from ALL our patrons and friends, but extend to them our services in any matter pertaining to the

ELECTRIC WELDING ART

SPECIFICATIONS FOR

Two Ton Worm Drive Chassis, Portable Welding Outfit

"FIELD TYPE"

MOTOR—4 cylinder—4 cycle—25.6 H. P. A. L. A. M. 4 x 5 inches. Unit Power Plant. Sealed governor. Only three (3) motor gears; camshaft gear, crankshaft gear and gear for driving water pump and magneto. Water jacketed inlet manifold. Twinned exhaust manifold.

Inclosed valves oiled by breathers. Pistons removable through bottom crankcase.

Three-inch diameter crank-shaft bearings. Connecting rods 12½ inches long.

IGNITION—High tension magneto.

LUBRICATION—Oil fed by mechanically driven pump.

FUEL CONSUMPTION—Under ordinary conditions, will travel 9 to 10 miles per gallon of gasoline. Tank holds 20 gallons. Uses approximately 1 gallon of lubricating oil for every 180 miles.

RADIATOR—"Honeycomb" type. Special mounting to withstand vibration due to solid tires. Water circulation by gear-driven pump. Belt-driven fan, mounted on roller bearings. Eccentric belt tightener.

SPEED (MAXIMUM)—High, 16 miles per hour; medium, 9.11 miles per hour; low, 4.77 miles per hour; reverse, 3.68 miles per hour.

TRANSMISSION—Integral with motor. Three speeds. Gears of best alloy nickel steel. Run on "Timken" bearings.

DIFFERENTIAL—Is in the rear axle, and is of the accepted bevel gear type. Gears are nickel steel, specially heat-treated.

CONTROL—Very simple and efficient. Emergency brake and gear shift lever on power plant in center of truck, allowing driver to manipulate them easily with right hand, while driving truck with left.

Clutch—"Dry plate" type, six (6) plates lined on both sides with friction material, operating against six (6) plain plates. Very successful type, requiring no attention; been used four years.

Brakes—Internal and external brake on brake drums 16¾ inches in diameter. The foot brake is on the outside; the emergency brake on the inside.

Steering—Steering gear is on the left-hand side of truck; "worm, wheel and shaft" type, the final thrust to the drag link being through a special forging on a squared shaft which can be tightened.

Springs—Semi-elliptic: front and rear. Front springs: 40 inches by 2½ inches—8 leaves. Rear springs: 48 inches by 3 inches—11 leaves.

Axles—Front axle drop forged I-beam. Hubs fitted with "Timken" bearings, complete.

Rear axle—Final drive through a "worm and gear" rear axle. Full floating, wheel and spring load being taken on the casing entirely, only the drive being on the shafts which are attached to the hub of the wheel on the outside. Worm and wheel are of special composition of the well-known "David Brown" type. The drive is taken through springs, in this way, when starting under heavy load new surfaces are presented on the worm and wheel, giving the drive a flexibility, which may be compared to the action of couplers on a railroad train. The mountings of the worm and worm wheel are "Timken" bearings; the wheel bearings are also "Timken."

Wheels—Front: Spokes 2 inches, fitted with solid rubber tires 36 inches by 4 inches single. Rear: Spokes 2½ inches, fitted with solid rubber tires 36 inches by 4 inches dual.

Wheelbase—144 inches and 162 inches—58½ inches tread. Long wheel base will turn in 29-foot radius; short wheel base will turn in 25-foot radius.

Frame—Special pressed steel channel section of ample proportions made very strong and rigid by cross members.

Fenders—Sheet steel.

Dust Pan—Is also sheet steel, extending from radiator to rear of transmission, completely housing all working parts.

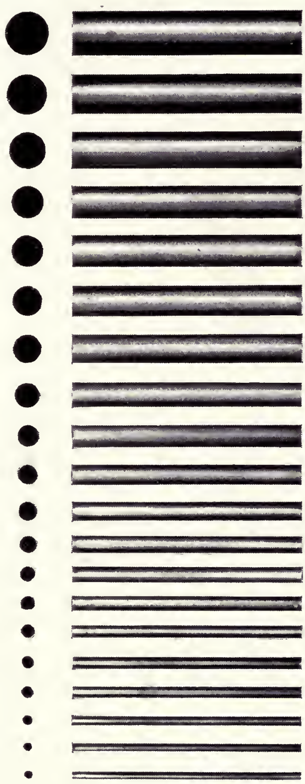
Equipment—Open metal seat, sliding sidedoors, horn, lamps, spare parts, bumper, etc.

(INTERNATIONAL MOTOR COMPANY'S TRUCK DESIGN)

WELDING METALS

Our specially prepared metal electrodes are, unless otherwise ordered, Gage 9. 5-32, .1483 on list below.

FULL SIZES OF PLAIN WIRE



Sizes of Wire: Steel Wire Gage No.	Sizes of Wire: Common Fractions	Sizes of Wire: Decimally	Weight One Mile Pounds	Pounds Per Foot
1		.2830	1128.0	.2136
	9–32	.28125	1114.0	.211
2		.2625	970.4	.1838
	1–4	.250	880.2	.1667
3		.2437	836.4	.1584
4		.2253	714.8	.1354
	7–32	.21875	673.9	.1276
5		.2070	603.4	.1143
6		.1920	519.2	.0983
	3–16	.1875	495.1	.0937
7		.1770	441.2	.0835
8		.1620	369.6	.070
	5–32	.15625	343.8	.0651
9		.1483	309.7	.0586
10		.1350	256.7	.0486
	1–8	.1250	220.0	.0416
11		.1205	204.5	.0387
12		.1055	156.7	.0296
	3–32	.09375	123.8	.0234
13		.0915	117.9	.0223
14		.0800	90.13	.0170
15		.0720	73.01	.0138
16	1–16	.0625	55.0	.0104
17		.0540	41.07	.0077
18		.0475	31.77	.006
19		.0410	23.67	.0044
20		.0348	17.05	.0032

(FROM AMERICAN STEEL AND WIRE COMPANY)

We furnish the following grades:

Grade No.	Purpose Used	Tensile Strength of Welds
6	Boilers	
8	Can be Machined	40,000
9	Engine Frames, etc.	to
17	Filling Castings, etc.	60,000
20	Bronze Alloy Bells, etc.	Pounds

These metals unless otherwise arranged for, are of Gage 9, approximately 5-32 inch diameter and are shipped in coils of about 160 pounds weight. When customers order electrodes cut, straightened and boxed, or of dimensions less than .148, an extra charge is made.

No Fluxes are used with our metals.

A Complete Electric Welding Equipment of the Wilson System Consists of the Following

Included in Welder Company's Schedule of Equipment Furnished

- Motor Generator Set.
- Starting Box. Oil-immersed. No-voltage release.
- Control Panel for each arc of capacity, with Angle Iron Supports and Bolts for fastening.
- Ammeter on each Panel.
- Plugs for attaching welding and control leads to Panel.
- Electrode holder for each Panel.
- One push button control to each holder.
- About ten feet of flexible welding cable.

***Not* Included in Welder Company's Schedule of Equipment, but Should be Provided by Purchaser**

- Operator's Helmets or Shields.
- Extra piece of colored glass.
- Steel Brushes.
- Supply of welding metals of different grades.

We furnish welding equipments of the following size and capacity:

CAPACITY		Voltage (Fixed)	Number of Panels	
Arc or Operators	Amperes			
1	150	35	1	Prices Furnished on Request Correspondence Solicited
2	300	35	2	
4	600	35	4	
6	900	35	6	
8	1200	35	8	

PATENTS

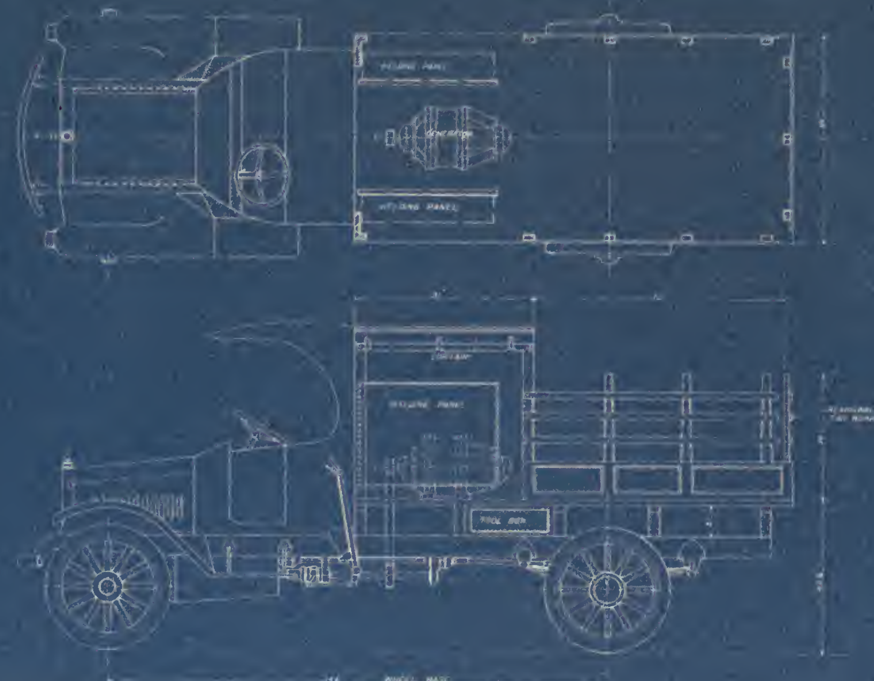
The Wilson System of Electric Welding and Specially Prepared Welding Metals is protected by United States and Foreign Patents.

WILSON WELDER AND METALS COMPANY INC. PORTABLE WELDING OUTFIT "FIELD TYPE"

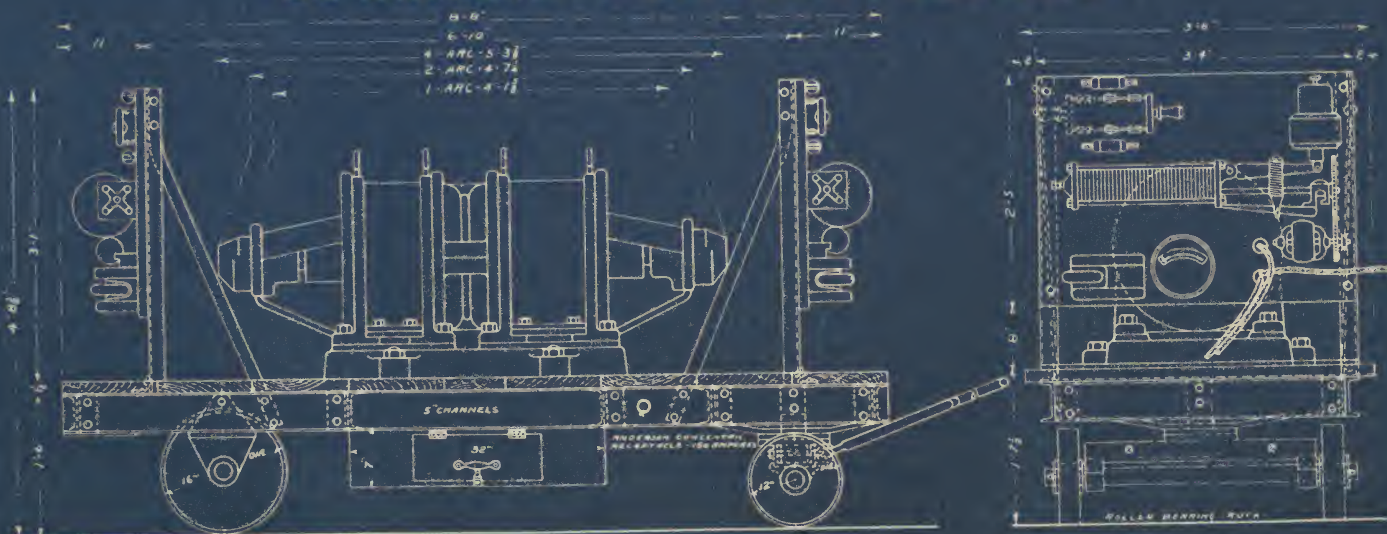
(INTERNATIONAL MOTOR COMPANY'S CHASSIS – WILSON WELDER COMPANY'S WELDING EQUIPMENT)

TWO (2) ARC WELDING TOOLS - EACH 35 VOLTS - 100 AMPERES.

ONE (1) ARC CUTTING TOOL ------ 35 VOLTS - 300 AMPERES.



WILSON WELDER AND METALS COMPANY INCORPORATED
52 VANDERBILT AVE. NEW YORK CITY



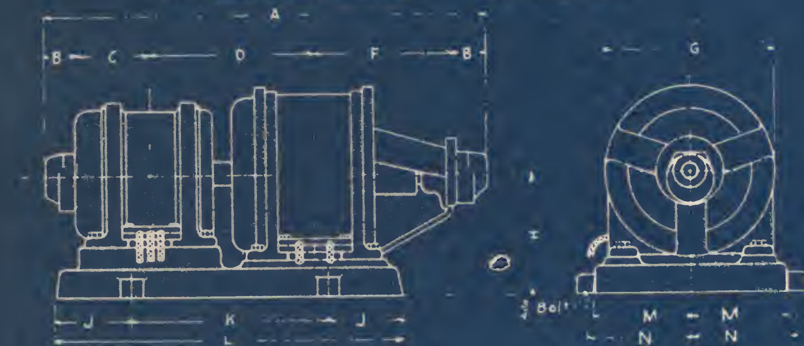
PORTABLE WELDING OUTFIT — SHOP TYPE

FOR ______ AT ______ 191__

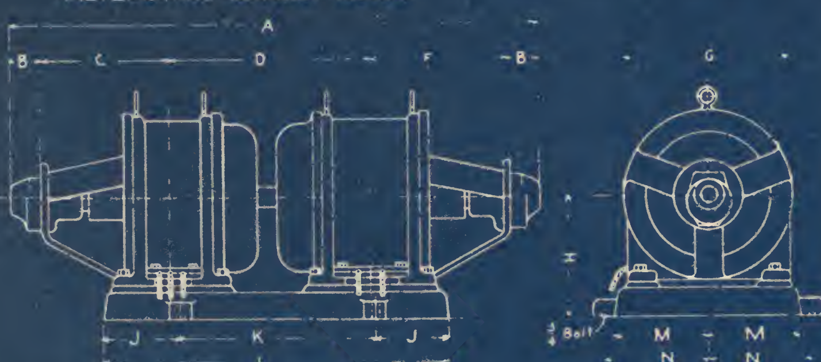
WILSON WELDER & METALS CO.

INCORPORATED

52 VANDERBILT AVENUE - NEW YORK N.Y.



ALTERNATING CURRENT MOTOR

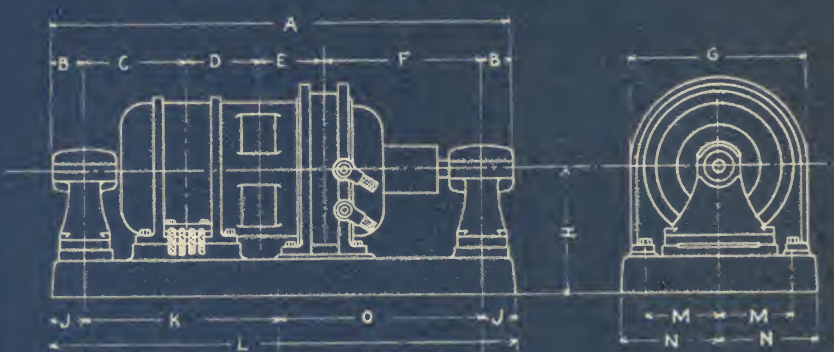


DIRECT CURRENT MOTOR

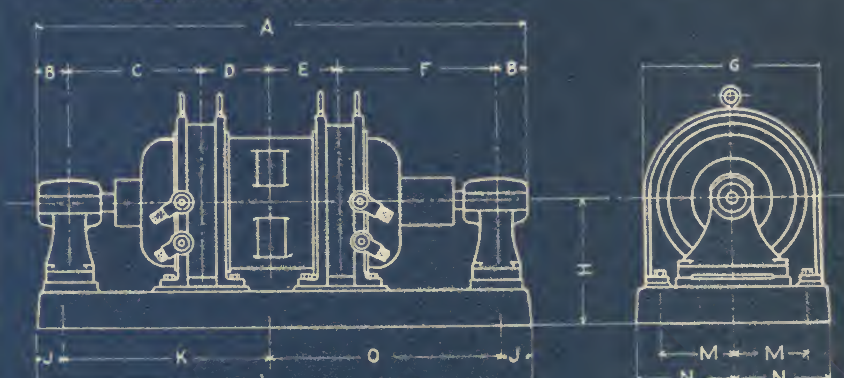
Approximate dimensions and weight of welding sets

	SIZE	A	B	C	D	F	G	H	J	K	L	M	N	WEIGHT
A-C	1 ARC	3-6 1/2	2 7/8	7 1/2	16 3/8	12 5/8	14	10 3/4	8	18	2-10	8 1/8	9 1/8	1000
	2 ARC	4-9 1/2	3 1/2	8	27 3/8	15 5/8	18 1/4	13	8 5/8	2-6 1/8	3-11 1/8	10 3/8	11 3/8	1600
	4 ARC	5-6	4 3/16	9 1/4	30 [illegible]	7-11/16	21 3/4	15 1/8	8 7/8	2-8 1/2	4-2 1/4	11 3/4	12 3/4	2200
D-C	1 ARC	4-1 1/8	2 7/8	13 8	17 7/16	12 9/16	14	10 3/4	8	[illegible]	2-10	8 1/8	9 [illegible]	1100
	2 ARC	5-5 5/8	3 1/8	14 3/16	29 3/16	15 1/8	18 1/4	13	8 3/8	6	3-11 5/8	10 3/8	11 3/8	1750
	4 ARC	6-3	4 3/16	17 1/8	27 9/16	17 11/15	21 3/4	15 8	8 1/8	2-2 1/2	4-2 1/4	11 3/4	12 3/4	2600

WILSON WELDER & METALS CO.
INCORPORATED
52 VANDERBILT AVENUE — NEW YORK N.Y.



ALTERNATING CURRENT MOTOR



DIRECT CURRENT MOTOR

Approximate dimensions and weight of welding sets

	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	N	O	WEIGHT
D.C.	6 ARC	6'-7 1/8"	5"	21 1/4"	12 3/16	11 15/16	24 1/2	2'-4	19 3/4	5 1/4	2'-7 9/16	6'-10 15/16	12 1/4	15 1/2	3'-4 7/8	4200
	8 ARC	7'-4"	5"	23"	13 1/8	13 1/2	24 1/2	2'-4	19 3/4	5 1/4	3'-1 5/8	7'-5"	12 1/4	15 1/2	3'-4 7/8	4450
A.C.	6 ARC	6'-2 5/8	5"	16 1/16	12 1/8	11 15/16	24 1/2	2'-4	19 3/4	5 1/4	2'-5 3/16	6'-3 1/8	12 1/4	15 1/2	2'-11 7/16	4100
	8 ARC	6'-10 7/16	5"	17 1/4	13 5/16	13 1/2	2'-4 3/8	2'-4	19 3/4	5 1/4	2'-7 3/16	6'-10 15/16	12 1/4	15 1/2	3'-4 7/8	4300

Results Obtained from the Use of the Wilson System

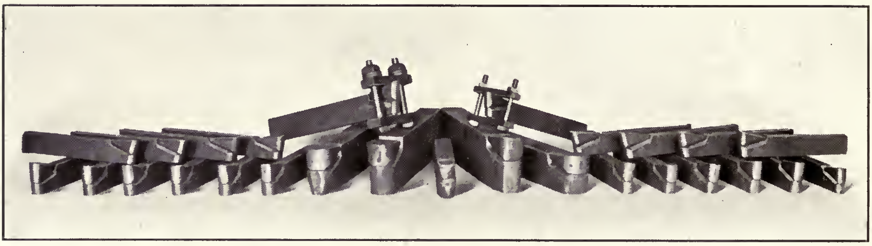
Having reviewed the development of the Wilson System of Electric Welding and Special Metals, with photographs, drawings and specifications of the equipment in the preceding pages, we now invite your attention to certain results obtained from their use both in the matter of *High Character of Finished Product* and *Economy of Operation.*

No.	Examples of Character of Work Involved and Saving Effected	Cost	Amount Saving	See Page
1	Reclamation of Pneumatic Hammer Handle	$ .76	$3.16	42
2	Car Repair Yards and Maintenance of Way Dept. Saving on three jacks	.44	3.26	43
3	Reclamation of Locomotive Bell (Bronze)	2.60	7.50	44
4	Walking Beam of Circulating Pump, U. S. S. S. "Drayton"	2.25	17.50	44
5	Building up Flat Spots on Locomotive Drivers . . .	2.00	200.00	46
6	Reclamation of Locomotive Cylinder	63.48	401.27	45
7	Saving in Expensive Tool Steels (1000 Tools) . . .	1.360	7,360.00	42
8	Reclamation of Freight Car Knuckles. (Per year)	4.897	26,000.00	43
9	Union of Various Sections of Steel, Wrought and Cast Iron	Samples	Samples	43
10	Variety of Operations possible at one and the same time	Multiple	Unit	46

The foregoing represent only a few of the hundreds of operations that are being daily performed by the Wilson Welder which result in great economy, both in the items of initial cost and increased earning power of equipment, due to reduced dead time while undergoing repairs.

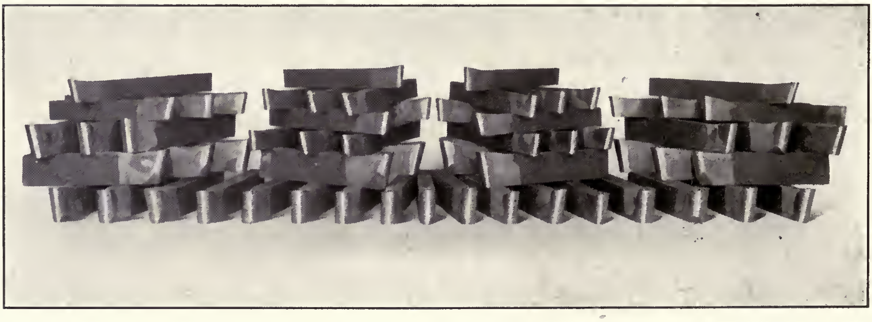
On the next following pages will be found photographic reproductions of some of the operations mentioned.

No. 1 Reclamation of Pneumatic Hammer Handle



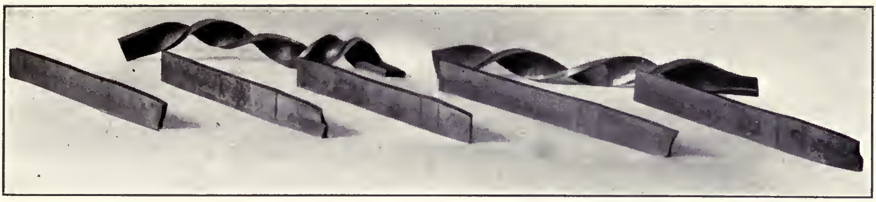
No. 2 Cutting Tools Ready for Welding Points

No. 3 Cutting Tool Points Welded on

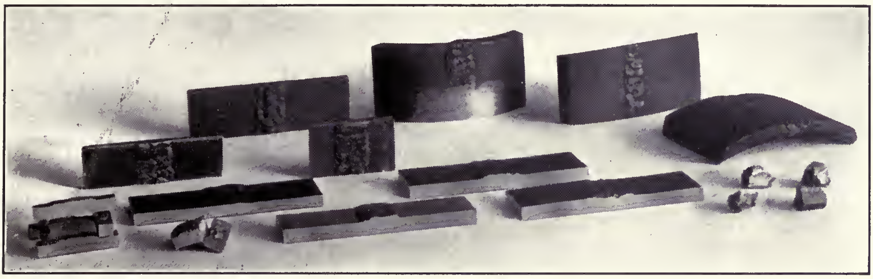


No. 4 Cutting Tools Ready for Use

Cuts 2, 3 and 4 show the application of high grade cutting points to low carbon tools



Boiler Plate Welds that Never Break



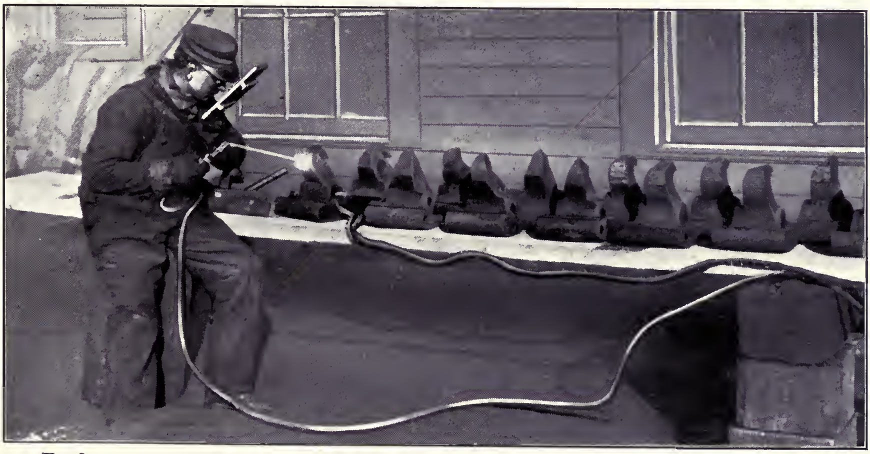
Samples of Welded Cast Iron and Steel, Wrought Iron and Boiler Plate

Reclamation of

Track and Shop Jacks

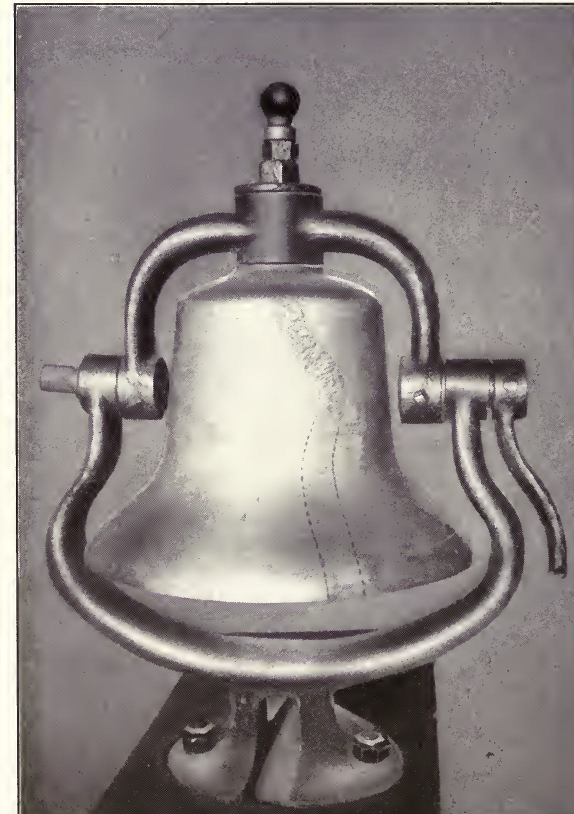
Cost - - $ .44

Saving - $3.26

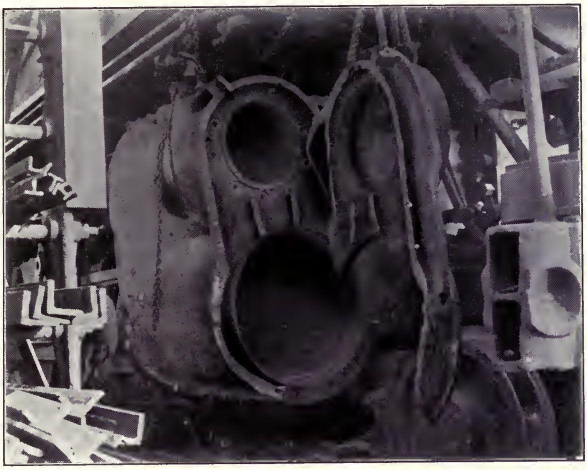


Reclamation of Freight Car Knuckles on a Trunk Line. The saving in one year on this item alone was more than $20,000.00.

Damaged Walking Beam Circulating Pump, U. S. S. Drayton
Cost $2.35 Saving $17.50



Reclamation of Locomotive Bell
Cost $2.60 Saving $7.50



Fractured

Steam Chest

and

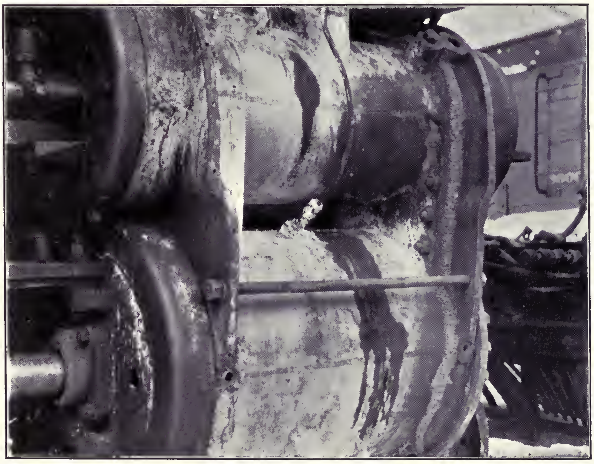
Cylinder

Repairs

being made

with Wilson

Electric Welder



Damaged Parts

Restored Good

as New

Cost, $63.48

Saving, $401.27

Reclamation of Fractured Cylinder and Steam Chest on Modern Pacific Type Locomotive

Building up Flat Spots on Locomotive Drivers. Cost $2.00; Saving $200.00

Variety of operations at one and the same time. Four operators welding four different metals, each with a different amperage from a single Generator at the same time and without interfering with each other.

Physical Tests of Electrically Welded Joints

Wilson Electric Welding has been subjected to the severest kinds of tests. Among these are included heat treatment, vibratory tests, tortional and twisting strains of all kinds, crushing tests, tensile strength tests, etc.

The figures shown in following tables were obtained by taking a piece of rectangular boiler plate 18 by 20 inches, of known minimum tensile strength, cutting through center the long way and welding with the grade of welding wire suitable for this purpose. These plates were then cut into test pieces one and one-half inches wide and tested in the regular way in a physical testing machine.

The results shown below are the average of many hundred tests made by this company to determine the proper quality of welding wire to use for this purpose.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps	Plate	Weld			
1	35	95	.532	.532	28140	52900	6.25
2	35	95	.544	.544	28250	52000	4.25
3	35	95	.546	.546	30450	55800	7.80
4	35	95	.558	.558	31070	55700	7.80
5	35	95	.555	.555	31200	56200	6.25
6	35	95	.566	.566	31000	54800	6.25
7	35	95	.578	.578	32100	55000	6.25
8	35	95	.585	.585	33050	56500	7.80
9	35	95	.585	.585	30300	51800	6.25
10	35	95	.602	.602	30630	50900	6.25
11	35	95	.589	.589	32000	54300	7.80
12	35	95	.540	.540	31640	58600	7.80
Average	35	95	.565	.565	30820	54500	6.90

NOTE:—Above test pieces planed flush with sheet.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps.	Plate	Weld			
1	35	80	.630	.630	32490	52800	6.25
2	35	80	.615	.615	34000	53300	6.25
3	35	80	.637	.637	33200	53800	6.25
4	35	80	.616	.616	35320	57200	6.25
5	35	80	.617	.617	35610	57800	9.38
6	35	80	.616	.616	34650	52200	9.38
7	35	80	.622	.622	35370	56800	7.80
8	35	80	.665	.665	35230	53300	6.25
9	35	80	.638	.638	35530	55600	9.38
10	35	80	.630	.630	33890	53700	7.80
11	35	80	.621	.621	34210	55100	9.38
Average	35	80	.628	.628	34500	54700	7.67

NOTE:—Above test pieces had weld planed flush with plate; test Nos. 5, 7, 8 and 9 broke outside of weld.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps.	Plate	Weld			
1	35	100	.517	.517	30700	59300	9.38
2	35	100	.548	.548	30600	56000	9.38
3	35	100	.555	.555	30900	55700	7.80
4	35	100	.556	.556	30600	55000	9.38
5	35	100	.552	.552	29000	52500	7.80
6	35	100	.579	.579	29200	50400	7.80
7	35	100	.569	.569	40000	56500	7.80
8	35	100	.579	.579	40000	55400	7.80
9	35	100	.576	.576	40200	55200	7.80
Average	35	100	.562	.562	35100	55200	8.53

NOTE:—Test piece No. 3 broke outside of weld.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps.	Plate	Weld			
1	35	90	.610	.610	31360	51400	7.80
2	35	90	.615	.615	34840	56600	9.38
3	35	90	.599	.599	34640	57800	9.38
4	35	90	.604	.604	35090	58000	9.38
5	35	90	.611	.611	33810	55300	10.90
6	35	90	.622	.622	32680	52600	6.25
7	35	90	.592	.592	33840	57200	9.38
8	35	90	.602	.602	34770	57600	9.38
9	35	90	.598	.598	33620	56100	7.80
10	35	90	.592	.592	33010	55900	7.80
11	35	90	.585	.585	32830	56100	10.90
Average	35	90	.603	.603	33680	55800	8.94

NOTE:—Above test pieces had weld planed flush with plate; test Nos. 2, 4, 5, 8 and 9 broke outside weld.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps.	Plate	Weld			
1	35	80	.538	.538	31540	58600	10.90
2	35	80	.545	.545	29500	54200	10.90
3	35	80	.605	.605	33000	54600	10.90
4	35	80	.615	.615	34440	56000	9.38
5	35	80	.584	.584	33640	57500	9.38
6	35	80	.589	.589	34600	58700	9.38
7	35	80	.590	.590	33800	57300	9.38
8	35	80	.595	.595	33600	56500	10.90
9	35	80	.488	.488	27800	57000	9.38
Average	35	80	.572	.572	32400	56700	10.00

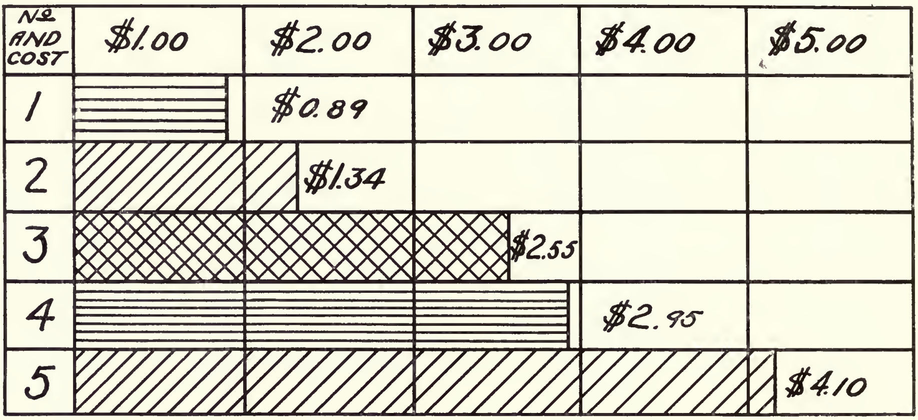
NOTE:—In above tests, Nos. 1, 3, 4 and 6 broke outside of weld.

Test No.	CURRENT		AREA		Breaking Load	Tensile Strength per Sq. In. Weld	% Elongation in 2 In.
	Volts	Amps.	Plate	Weld			
1	35	80	.612	.612	36100	59000	9.37
2	35	80	.585	.585	33300	56900	6.25
3	35	80	.605	.605	36000	59500	7.81
4	35	80	.589	.589	35600	60400	7.81
5	35	80	.605	.605	35100	58000	7.81
6	35	80	.598	.598	35700	59700	9.37
7	35	80	.597	.597	35800	60000	6.25
8	35	80	.582	.582	35000	60100	7.81
9	35	80	.600	.600	34800	58000	7.81
10	35	80	.588	.588	35000	59500	6.25
11	35	80	.580	.580	32700	56400	6.25
Average	35	80	.595	.595	35000	58900	7.53

NOTE:—Above test pieces all planed down flush with plate; test Nos. 3, 4, 7, 8 and 10 broke outside weld.

The above experiments conducted on standard firebox steel demonstrate that by the use of the Wilson Electric Welding process, practically a 100 per cent. efficient seam is secured.

ECONOMY AND WHAT IT MEANS



EXPLANATORY NOTES

No. 1. Wilson type of machine, 35 volts, 90 amperes, positive heat control arc.

No. 2. Variable voltage constant current machine with no resistance in circuit, 80 volts with no load and 20 to 25 volts with load, 150 amperes.

No. 3. Constant voltage machine, fixed resistance control of current, 65 volts, 125 to 175 amperes.

No. 4. Constant voltage machine, fixed resistance control of current, using 75 volts, 125 to 175 amperes.

No. 5. Constant voltage machine, fixed resistance control of current, using 90 volts, 125 to 175 amperes.

The object of the development of the Wilson System of Electric Welding was primarily to overcome defective welds and secondarily to reduce cost of operation. There are still many machines of the No. 5 type in service.

In a competitive test on a trunk line railroad recently the Wilson System and Metals proved to be superior to others on the following items in welding boiler tubes.

Total amount of metal deposited.	.87.22%
Net time per pound of metal applied	.45.4 %
Kilowatts per pound of metal applied . . .	.49.35%
Ounces of metal per flue	.72.2 %

This is spelling E C O N O M Y with capital letters.

A Lesson in Preparedness

SOME COLD FACTS

THE REVENUES OF OUR RAILWAYS LAST YEAR WERE		$3,030,346,306.00
This money was earned by about 63,000 freight and passenger locomotives, or an average per engine per year of		$48,107.00
Average per day		$131.77
THE REVENUE FROM FREIGHT WAS		$2,114,697,629.00
This was earned by about 34,000 locomotives, or an average per year of		$62,197.00
Average per day		$170.00
MILEAGE OF FREIGHT LOCOMOTIVES FOR THE YEAR WAS		695,276,668.00
AVERAGE PER ENGINE — per year	20,449	
per month	1,704	
per day	56	
per hour	2.3	
From the foregoing it is clear that the average return from a freight engine is $170.00 per day, or $7.08 per hour, for 24 hours, while if we assume they are in service 10 hours of each 24, then the earning value per hour is		$17.00
As there are hundreds of freight engines regularly making more than 3,000 miles per month, or 100 miles per day, then the low average of 1,704 miles per month and only 56 miles per day is the result of a large number being in the shop for repairs.		
On a certain Trunk line it is estimated the cost to work flues applied in the old way is about $54.00 per engine, per year, while for those electrically welded, the cost is $15.00 for welding and nothing for repairs. Net saving approximately $39.00 per year, and on 100 engines		$3,900.00
Assuming the number of engine hours lost, account working flues to be three, and that this is necessary twice each month, we then have 3 x $17.08 x 24 = $1,229.76 per year for one engine and on 100 engines, loss of earning power . . .		$122,976.00
CREDIT ELECTRIC WELDING — Increased Earning Power		$122,976.00
Saving in Repairs . .		3,900.00
Total		$126,876.00

On this subject a word to the *Wise* is sufficient. The cost of repairing flues between setting and the loss of earning power of engines due to flue failures can be eliminated by the use of an Electric Welder. No other investment will yield the same returns, but there are many other operations in railway maintenance that will yield to the same treatment and with like results.

USEFUL INFORMATION

WEIGHTS AND MEASURES

Linear Measure

			In.	Ft.	Yd.	Rd.	Fur.	Mi.
12	Inches	=1 Foot						
3	Feet	=1 Yard	36	3	1			
5½	Yards	=1 Rod	198	16.5	5.5	1		
40	Rods	=1 Furlong	7920	660	220	40	1	
8	Furlongs	=1 Mile	63360	5280	1760	320	8	1

Square Measure

144	Sq. Inches	=1 Sq. Foot
9	Sq. Feet	=1 Sq. Yard
30¼	Sq. Yards	=1 Sq. Rod
160	Sq. Rods	=1 Acre
640	Sq. Acres	=1 Sq. Mile

Cubic Measure

1728	Cubic Inches	=1 Cu. Ft.
27	Cubic Feet	=1 Cu. Yd.
128	Cubic Feet	=1 Cord
24¾	Cubic Feet	=1 Perch

Avoirdupois Weight

437.5	Grains	=1 Ounce
16	Ounces	=1 Pound
100	Pounds	=1 C. W. T.
20	C. W. T.	=1 Ton
2240	Pounds	=1 Long Ton

Troy Weight

24	Grains	=1 Penny Weight
20	Penny Wt.	=1 Ounce
12	Ounces	=1 Pound
1	Pound	=5760 Grains

Dry Measure

2	Pints	=1 Quart
8	Quarts	=1 Peck
4	Pecks	=1 Bushel
2150.42	Cu. Ins.	=1 Bushel

Liquid Measure

4	Gills	=1 Pint
2	Pints	=1 Quart
4	Quarts	=1 Gallon
31½	Gallons	=1 Barrel
2	Barrels	=1 Hogshead

ELECTRICAL UNITS

The electrical units are derived from the following mechanical units of the Metric System.

Centimeter—Unit of length. One thousand millionth part of a quadrant of the earth's circumference.

Gramme—Unit of weight. Weight of a cubic centimeter of water at temperature of 4 degrees centigrade.

Second—Unit of time. The time of one swing of a pendulum making 86,400 swings in a solar day.

The unit of area is the square centimeter. The unit of volume is the cubic centimeter.

Volt—Unit of electro-motive force: Pressure of potential. Symbol E.

Ohm—Unit of resistance. Symbol R.

Megohm—1,000,000 Ohms.

Ampere—Unit of current. Symbol C.

Ampere-hours—Current in amperes by time in hours.

Watt—Unit of power. Product of 1 volt by 1 ampere. Symbol W. (746 watts equal one horse power).

Horsepower—746 watts = 33,000 lbs. one foot in one minute.

Kilowatts—1,000 watts. Symbol K.W.

Kilowatt-hours—Kilowatts by time in hours = 1.341 H.P. hours.

Farad—Unit of capacity.

Microfarad—One-millionth of a farad. Written M.F.

Coulomb—Unit of quantity. Quantity of current which impelled by one volt would pass through one ohm in one second.

Joule—Unit of work. The work done by one watt in one second.

Mils and Circular Mils—The one-thousandth part of one inch. Written .001 and usually called one mil, is taken as the unit of diameter, from which one square mil would be the unit of area. If you measure the diameter of a round wire in thousandths of an inch, or mils, by means of a micrometer, and multiply this number by itself, *i.e.*, square it, you obtain in square mils the cross sectional area of a square wire having four sides, each the same length as the diameter of the round wire that you have calipered.

Circular Mil—(Usually written C.M.) Applies to all round wires and has a value .7854 times that of the square mil.

Consequently the square of the diameter of any round wire, measured in mils, gives its cross sectional area in circular mils, without any further multiplication.

Formula for Shop Wiring

A good formula for wiring circuits for electric equipments will be found at the bottom of wiring table, pages 54–55.

Examples of Wire Calculations

To find the size of wire required to carry 100 Amperes 500 feet with 5 volts drop:

FORMULA A

$$\text{C.M.} = \frac{\text{Feet x Amperes x 10.7}}{\text{Volts Drop}}$$

$$\text{C.M.} = \frac{500 \text{ x } 100 \text{ x } 10.7}{5} = 107.000 \text{ C.M.}$$

Therefore the nearest standard wire required as per tables attached is No. 0 which is a 106.000 C.M.

FORMULA B

To find the volts drop having the distance of 1000 feet No. 0000 B. & S. gauge wire and a current of 100 Amperes.

$$\text{Volts drop} = \frac{\text{Feet x 10.7 x Amperes}}{\text{C.M.}}$$

$$\text{Volts drop} = \frac{1000 \text{ x } 100 \text{ x } 10.7}{212.000} = 5$$

FORMULA C

To find the current in Amperes which a No. 000 gauge wire will carry 500 feet with a 5 volt drop.

$$\text{Amperes} = \frac{\text{C.M. x Volts drop}}{\text{10.7 x Feet}}$$

$$\text{Amperes} = \frac{168.000 \text{ x } 5}{10.7 \text{ x } 500} = 157 \text{ Amperes}$$

Note.—Above formulas are correct when the return is approximately Zero resistance, such as bonded Railroad tracks, steel frame work, &c. If metallic return is to be used then double the C. M.

WIRING TABLE

Size of Cable C. M.	Ohms per 1000 Feet 25° C (=77° F)	Pounds per M Feet	STANDARD CONCENTRIC STRANDING No. of Wires	Diam. of Wires in Mils.	O. D. in Mils.	FLEXIBLE CONCENTRIC STRANDING No. of Wires	Diam. of Wires in Mils.	O. D. in Mils.	Wall Thickness of Insulation	Finish	Overall Diameter
16 500	.654	51.0	7	48.6	146.	19	29.5	147.	5/64	Tape 1	.58
20 800	.519	64.3	7	54.5	164.	19	33.1	166.	3/32	Cotton &	.63
26 300	.410	81.0	7	61.2	184.	19	37.2	186.	3/32	1 Fish Twine	.65
33 100	.326	102.	7	68.8	206.	19	41.7	209.	3/32	Braid	.67
41 700	.259	129.	7	77.2	232.	19	46.9	234.	3/32	"	.70
52 600	.205	163.	7	86.7	260.	19	52.6	263.	3/32	"	.73
66 400	.162	205.	7	97.4	292.	19	59.1	296.	3/32	"	.76
83 700	129	258.	19	66.4	332.	37	47.6	333.	7/64	"	.83
106 000	.102	326.	19	74.5	373.	37	53.4	374.	7/64	"	.87
133 000	.0811	411.	19	83.7	418.	37	60.0	420.	7/64	"	.92
168 000	.0642	518.	19	94.0	470.	37	67.3	471.	7/64	"	.97
212 000	.0509	653.	19	105.5	528.	37	75.6	533.	7/64	"	1.03
250 000	.0431	772.	37	82.2	575.	61	64.0	576.	4/32	"	1.11
300 000	.0360	926.	37	90.0	630.	61	70.1	631.	4/32	"	1.16
350 000	.0308	1080.	37	97.3	681.	61	75.7	682.	4/32	"	1.21
400 000	.0270	1240.	37	104.0	728.	61	81.0	729.	4/32	"	1.26
450 000	.0240	1390.	37	110.3	772.	61	85.9	773.	4/32	"	1.30
500 000	.0216	1540.	37	116.2	814.	61	90.5	815.	4/32	"	1.35
550 000	.0196	1700.	61	95.0	855.	91	77.7	855.	9/64	"	1.42
600 000	.0180	1850.	61	99.2	893.	91	81.2	893.	9/64	"	1.46
650 000	.0166	2010.	61	103.2	929.	91	84.5	930.	9/64	"	1.49
700 000	.0154	2160.	61	107.1	964.	91	87.7	965.	9/64	"	1.53
750 000	.0144	2320.	61	110.9	998.	91	90.8	999.	9/64	"	1.56
800 000	.0135	2470.	61	114.5	1031.	91	93.8	1031.	9/64	"	1.59
850 000	.0127	2620.	61	118.0	1062.	91	96.6	1063.	9/64	"	1.63
900 000	.0120	2780.	61	121.5	1093.	91	99.4	1094.	9/64	"	1.66
950 000	.0114	2930.	61	124.8	1123.	91	102.2	1124.	9/64	"	1.69
1 000 000	.0108	3090.	61	128.0	1152.	91	104.8	1153.	9/64	"	1.72
1 100 000	.009 81	3400.	91	109.9	1209.	127	93.1	1210.	5/32	"	1.80
1 200 000	.008 99	3710.	91	114.8	1263.	127	97.2	1264.	5/32	"	1.86
1 300 000	.008 30	4010.	91	119.5	1315.	127	101.2	1315.	5/32	"	1.91
1 400 000	.007 70	4320.	91	124.0	1364.	127	105.0	1365.	5/32	"	1.96
1 500 000	.007 19	4630.	91	128.4	1412.	127	108.7	1413.	5/32	"	2.01
1 600 000	.006 74	4940.	127	112.2	1459.	169	97.3	1460.	5/32	"	2.05
1 700 000	.006 34	5250.	127	115.7	1504.	169	100.3	1504.	5/32	"	2.10
1 800 000	.005 99	5560.	127	119.1	1548.	169	103.2	1548.	5/32	"	2.14
1 900 000	.005 68	5870.	127	122.3	1590.	169	106.0	1590.	5/32	"	2.18
2 000 000	.005 39	6180.	127	125.5	1631.	169	108.8	1632.	5/32	"	2 23

10.7—Resistance of one mil foot.
D—Distance from Generator to Panel.
A—Amperes total. V=Volts drop.
—Load factor. Use same load factor as shown Welder-Distance-Circular Mill (Table).

Formula for Using the above Wiring Table.

$$\frac{10.7 \times D \times A}{V} = \text{C. M.}$$

NOTE:—The formula is good only where the shops are grounded and the resistance of the return is practically nil.

For cable return double the circular mils.

TABLE SHOWING SIZE OF WIRE BETWEEN MOTOR-GENERATORS AND WELDING PANELS, ONE TO EIGHT IN NUMBER, AND AT DISTANCES OF ONE HUNDRED FEET TO ONE THOUSAND FEET INCLUSIVE, EXPRESSED IN CIRCULAR MILLS.

Number of Welders	Load Factor Per Cent.	100′	200′	300′	400′	500′	600′	700′	800′	900′	1000′
1	100%	33,000	66,000	99,000	132,000	165,000	198,000	231,000	264,000	297,000	330,000
2	100%	66,000	132,000	198,000	264,000	330,000	396,000	462,000	528,000	594,000	660,000
3	90%	89,100	178,200	267,300	356,400	445,500	534,600	623,700	712,800	801,900	891,000
4	85%	112,200	224,400	336,600	448,800	561,000	673,200	785,400	897,600	1,009,800	1,122,000
5	80%	132,000	264,000	396,000	528,000	660,000	792,000	924,000	1,056,000	1,188,000	1,320,000
6	75%	148,500	297,000	445,500	594,000	742,500	891,000	1,039,500	1,188,000	1,336,500	1,485,000
7	70%	161,700	323,400	485,100	646,800	808,500	970,200	1,131,900	1,293,600	1,455,300	1,617,000
8	70%	184,800	369,600	554,400	739,200	924,000	1,108,800	1,293,600	1,478,400	1,663,200	1,848,000

NOTE—This table is based on ground returns of negligible resistance.

USEFUL INFORMATION

SPECIFIC GRAVITY AND FUSING POINT OF METALS

	Metal	Specific Gravity	Weight per Cubic Foot	Melting Point Fahrenheit	Value per Ton
1	Aluminum	2.67	166.5	1175	$1,000
2	Antimony	2.76	421.6	1160	852
3	Brass	8.40	523.8	1650	360
4	Bronze	8.85	552	1692	420
5	Cobalt	8.55	533.1	6000	4,000
6	Gold Pure	19.26	1201	1935	41,340
7	Copper	8.85	552	1940	480
8	Iridium	22.38	1396	4280	. . . .
9	Iron, Cast—Pig	7.21	450	2200	19
10	Iron, Wrought—Bars . . .	7.70	480	2900	50
11	Lead	11.38	709.7	620	120
12	Manganese	8	499	6000	120
13	Mercury	13.58	846	38	. . . .
14	Nickel	8.8	548.7	2600	900
15	Platinum	21.5	1347	3110	200,000
16	Silver	10.50	655	1800	1,330
17	Steel, O. H.	7.85	489	2600	45
18	Tin	7.35	458	449	840
19	Tungsten	17.3	1078.7	5252	. . . .
20	Zinc	7	436.5	786	480

SPECIFIC GRAVITY AND WEIGHT PER CUBIC FOOT OF VARIOUS SUBSTANCES

	Substance	Specific Gravity	Wt. per Cu. Ft.		Substance	Specific Gravity	Wt. per Cu. Ft.
1	Asphalt	1.39	87	21	Lignum Vitae . .	1.333	83
2	Brick	1.79	112	22	Oak Heart . . .	1.170	73
3	Cement	1.42	90	23	Orange	.705	44
4	Cement, Portland .	2.90	180	24	Poplar	.383	24
5	Clay	2.00	135	25	Pine Yellow . . .	.660	41
6	Earth	1.20	75	26	Walnut	.671	42
7	Emery	4	250	27	Alcohol	.792	49
8	Glass	2.60	165	28	Beer, Lager . . .	1.034	64
9	Granite	1.8	110	29	Champagne . . .	.997	62
10	Gypsum	2.2	140	30	Honey	1.450	90
11	Hornblend	3.4	210	31	Human Blood . .	1.054	65
12	Ice	.88	56	32	Petroleum . . .	.825	51
13	Limestone	2.5	160	33	Linseed Oil . . .	.940	59
14	Magnesia	2.4	150	34	Olive Oil	.915	57
15	Marble	2.7	170	35	Whale Oil	.932	58
16	Mica	2.8	175	36	Tallow, Sheep . .	.924	56
17	Pitch	1.15	72	37	Water, Dead Sea .	1.240	77
18	Plaster Paris . . .	1.70	100	38	Water, Distilled .	1.000	62
19	Slate	2.79	175				
20	Quartz	2.64	165				

HIGH TEMPERATURES JUDGED BY COLORS

(Kent)

	Colors	Centigrade	Fahrenheit
1	Red, visible in dark	400	752
2	Red, visible in twilight	474	885
3	Red, visible in daylight	525	975
4	Red, visible in sunlight	581	1070
5	Dark red	700	1292
6	Cherry red	900	1652
7	Bright cherry-red	1000	1832
8	Orange-red	1100	2012
9	Orange-yellow	1200	2192
10	Yellow-white	1300	2372
11	White welding-heat	1400	2552
12	Brilliant white	1500	2732
13	Dazzling white (bluish-white)	1600	2912

VARIOUS TEMPERATURES OF FURNACES

(Reprint from King Optical Co.)

Process	Fahrenheit
Electric Arc	6200
Electric Arc under pressure	6450
Oxy-Hydrogen	3600
Oxy-Acetylene Welding and Cutting	4350
Thermit Welding	4500
Metal at Tuyeres (B. F.'s)	3500
Metal at Tapping	2300–2800
O. H. Furnace Flame	3400–3600
Bessemer Converter	3400–3600
Open Hearth in Ladle	2800–2900
Bessemer	2800–2900
Soaking Pits—Low Carbon	2500–2600
Soaking Pits—High Carbon	2200
Gas Heating Furnace	2400–2800
Large Gas Heating Furnace	2900–3200
Heat Units Petroleum, pound	20000
Heat Units Anthracite Coal, pound	15000
Heat Units Bituminous Coal, pound	14500
Heat Units Coke	13500
Heat Units Wood	8000

How We Have Been Received

The Wilson Welder and Metals Company was organized December, 1915, and at that time executed the first order which was for a single arc welder of the belted type. During the first ten (10) months of operation the results have been most flattering, constituting as they do a strong endorsement of the *Wilson System.*

Railway mileage covered by first order	60
Railway mileage covered by first ten months' orders	57,634
Mileage Increase	57,574 miles

Among our list of customers will be found the largest and best railway systems in America reaching from the *Atlantic* to the *Pacific* and from *Canada* to the *Gulf of Mexico* and to these may be added *The United States Government* and the two largest *Locomotive Works* in the *World.*

THE ABLEST CRITICS HAVE SPOKEN AND WE ACCEPT THEIR VERDICT

COMPARISON OF ELECTRIC AND HAND WELDED FLUES														ACCESSORIES, MILEAGE, COST, ETC.					
Eng. No.	No. Flues	Size Inches	Date Applied	How	Cost Cents per Flue	Cost Cents per Foot	Total Feet	Pounds Metal Used	Reprs. per Year	Flue Fail-ures. Num-ber	Miles to Flue Fail-ures	Miles to Engine Fail-ures	Brick Arch	Super-heaters	Total Mileage	Cost Cents Reprs. per Mile	Lub. per M Miles	Miles Per Ton Coal

REPORT OF WORK PERFORMED AND ECONOMIES EFFECTED IN THE 191

AT .... SHOPS .... R. R. ....

ITEMS	ELECTRICAL				OTHER METHOD				CLASSIFIED SAVING
	Labor	Material	Current	Total	Labor	Material	Total	Saving	
Boilers..........................									
Machinery......................									
Cars, Freight....................									
Cars, Passenger................									
Shop Tools......................									
Miscellaneous..................									
GRAND TOTAL..............									

Approved.. Signed..

INDEX

MEMORANDUM

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