General Electric Company
Schenectady, N.Y.

SUPPLY DEPARTMENT

January, 1910 *Bulletin No. 4714*

RAILWAY SIGNAL VOLT-AMMETER—TYPE S

IN testing direct current railway signal apparatus and doing similar work on telephone and telegraph circuits, an instrument of the moving coil, permanent magnet type is necessary if reliable results are to be obtained. Such an instrument shows polarity, has no hysteresis errors and very low internal losses. The permanent magnet instrument also measures the average value of a pulsating direct current, which is the value generally required for storage battery work. Instruments of other types may introduce resistance and inductance into the circuit, and the indications are often misleading.

TYPE S VOLT-AMMETER

CONSTRUCTION

The General Electric Railway Signal Volt-Ammeters are of the permanent magnet, D'Arsonval type with terminals so arranged that either current or potential can be

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measured. The standard instruments are arranged for four capacities or combinations so that two voltage ranges and two current ranges, or three current ranges and one voltage range can be obtained.

practically free from errors due to variations in temperature.

These Railway Signal Volt-Ammeters are small, compact and very substantial, and adequately fulfill the requirements of a small

TYPE S VOLT-AMMETER, COVER AND TERMINAL BOARD REMOVED

The internal arrangement of these instruments is shown in the above illustration.

The principle of operation is similar to that of the highest grade, direct current instruments, the measuring element consisting of a wire wound coil mounted on an aluminum frame which moves through the field of a permanent magnet. The pole-pieces of the magnet, and the inner core are carefully machined, and all parts are finished and mounted in a substantial manner. The shunts for the ammeter connections are of manganin, and the resistance wire for the voltmeter circuits has a very low temperature co-efficient so that readings are

combination instrument for the general testing of railway signals and other apparatus operated with batteries or by low voltage direct current circuits.

Scale and Needle

The scale is approximately $2\frac{1}{4}$ in. long and is doubly marked so that the different capacities can be read directly or by using even multipliers. To eliminate errors due to parallax, the instruments are equipped with flat pointers viewed on edge and a mirror is placed under the scale.

Damping

The fluctuations of the pointer are damped by Foucault currents set up in the aluminum ring on which the armature winding is mounted.

Magnets

The magnets used in these are made from the best quality of magnet steel and are subjected to aging processes which insure their permanency.

Capacities

For convenience, the instruments are listed in three combinations which have been laid out to meet general testing conditions.

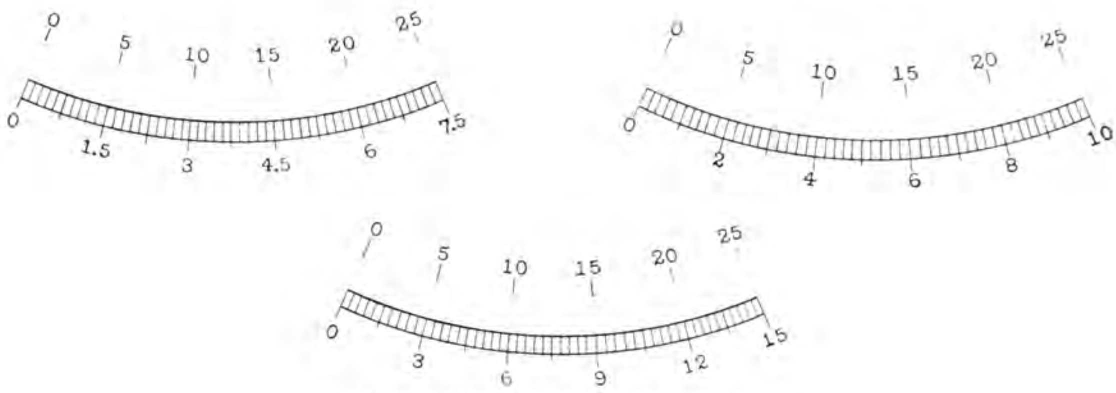
Terminals

The terminals are arranged with one common post marked (0), and four others, each marked for a particular capacity. To use the instrument as a voltmeter, the ammeter connection is opened by backing out a milled head thumb screw. When used as an ammeter, this thumb screw is turned firmly down to its shoulder.

Dimensions

These instruments are contained in polished mahogany cases, the outside dimensions of which are $6\frac{7}{8}$ x $3\frac{3}{4}$ x 3 in.

	Cat. No.	Capacity	List Price
Combination No. 1	100518	5 volts, 1 ampere 25 volts, 10 ampere	$55.00
Combination No. 2	100519	25 volts, 1.5 amperes 150 Mil-amperes, 15 amperes	55.00
Combination No. 3	100520	25 volts, 150 mil-amperes 25 mil-amperes, 7.5 amperes	55.00



SCALES OF RAILWAY SIGNAL VOLT-AMMETERS
(Actual Size)

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:
(Address nearest office.)

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 30 Church Street.
SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Bldg.
BALTIMORE, MD., Continental Trust Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Bldg.
PITTSBURG, PA., Park Building.
RICHMOND, VA., 712 Mutual Building.
ATLANTA, GA., Empire Building.
MACON, GA., Grand Building.
NEW ORLEANS, LA., Maison-Blanche Bldg.
CINCINNATI, OHIO, Provident Bank Building.
COLUMBUS, OHIO, Columbus Savings & Trust Bldg.
CLEVELAND, OHIO, Citizens Building.
NASHVILLE, TENN., Stahlman Building.
INDIANAPOLIS, IND., Traction Terminal Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.)
ST. LOUIS, MO., Wainwright Building.
KANSAS CITY, MO., Dwight Building.
BUTTE, MONTANA, Phœnix Building.
MINNEAPOLIS, MINN., 410-412 Third Avenue, North
DENVER, COLO., Kittredge Building.
SALT LAKE CITY, UTAH, Newhouse Building.
SAN FRANCISCO, CAL., Union Trust Building.
LOS ANGELES, Delta Building.
PORTLAND, ORE., Worcester Building.
SEATTLE, WASH., Colman Building.
SPOKANE, WASH., Paulsen Building.

For all TEXAS and OKLAHOMA Business.
General Electric Company of Texas,
Dallas, Texas, Praetorian Bldg.
El Paso, Tex., Chamber of Commerce Bldg.
Oklahoma City, Okal., Insurance Bldg.

FOREIGN:

FOREIGN DEPARTMENT,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
LONDON OFFICE, 83 Cannon St., London, E.C., England.

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

General Electric Company
Schenectady, N.Y.
SUPPLY DEPARTMENT

January, 1910 *Bulletin No. 4716*

THOMSON WATT-HOUR METERS WITH PREPAYMENT ATTACHMENTS FOR DIRECT AND ALTERNATING CURRENT

TYPES CP, CP3, IP AND IP3

Prepayment meters are recognized as invaluable for certain installations where it is desirable to obtain payment for electric energy in advance. Although they do not at present have the same popularity as the gas meter of this type, this is probably due to the fact that comparatively few of these devices which have previously been placed on the market have proven reliable and is not on account of any lack of demand for the right article. There is a large field now open which can be profitably covered by a good prepayment wattmeter.

THOMSON WATT-HOUR METER WITH COMBINED PREPAYMENT DEVICE—TYPE CP3 FOR DIRECT CURRENT

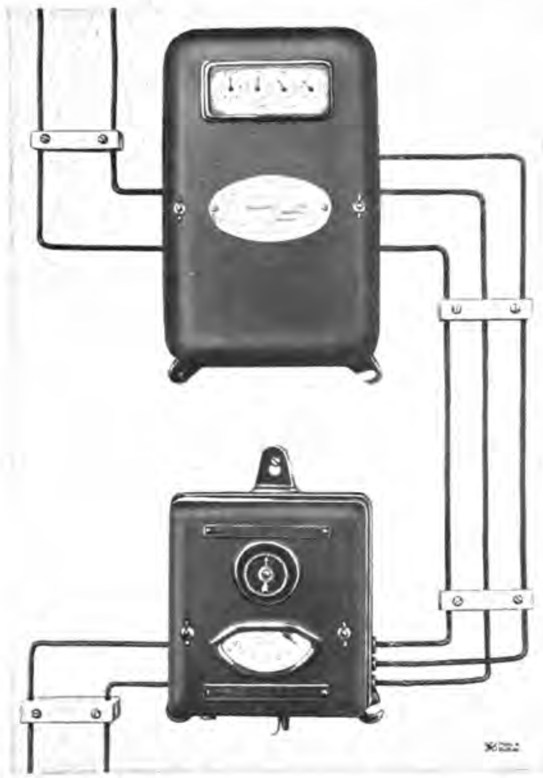
The "pay as you go" principle is very popular with many people by whom a monthly bill is considered bothersome and possibly a hardship. In addition to this there is the small consumer whose business is not solicited because the cost involved in reading his meter, keeping his account, sending out bills, etc., when added to that of the original investment leaves very little profit. Much of this expense may be dispensed with and the business made profitable by installing prepayment meters.

Such meters are inherently more complicated than the standard watt-hour meter, on account of the extra parts involved and thus demand more attention to keep them in perfect operating condition.

THOMSON HIGH TORQUE WATT-HOUR METER WITH COMBINED PREPAYMENT DEVICE—TYPE IP3 FOR ALTERNATING CURRENT

The problem has been to produce a satisfactory prepayment meter having a minimum number of complicated parts, and sufficiently strong to withstand the rough treatment incident to transportation and commercial use.

The new prepayment attachment, for use with Thomson Watt-Hour Meters, is a redesign of the "Wood" attachment formerly furnished. It is supplied either in combination with the Type I or Type C 6 wattmeters or as a separate device. The principle of operation is the same in each case, but the connection between meter and attachment is mechanical in the former, and electrical in the latter. The attachment consists of four principal parts, the escapement train, coin device, switch, and rate device.



THOMSON WATT-HOUR METER WITH SEPARATE PREPAYMENT DEVICE—TYPE CP FOR DIRECT CURRENT

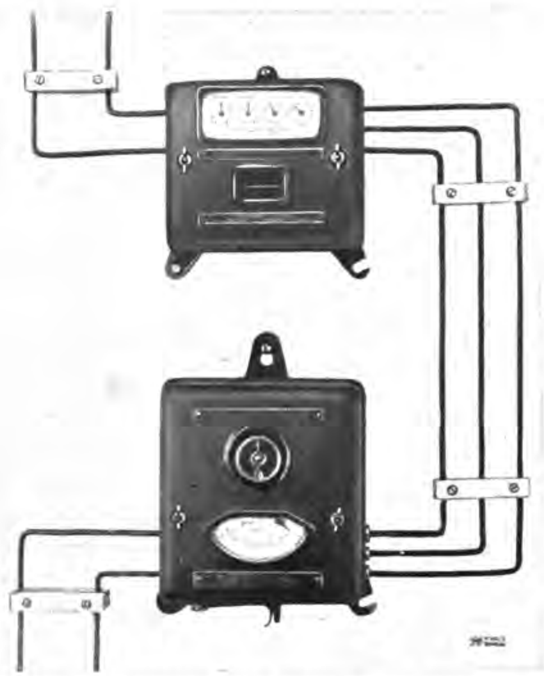
Operation

When it is desired to make an advance payment the winding knob is turned so that the arrow points upward. A quarter dollar is then inserted in the slot and the knob turned to the right, the coin serving as a key which operates the mechanism within the device, turning the registering wheel and placing the coin to the credit of the customer. If the circuit is open when the coin is deposited the same motion of the knob which moves the registering mechanism closes the circuit switch contained within the case of the attachment.

The dial of the combined prepayment meter contains, in addition to the standard marking, a scale marked in plain figures over which a pointer passes indicating the number of coins remaining to the credit of the depositor. When the meter has a separate prepayment attachment, the dial showing the number of coins standing to the customer's credit is placed on the attachment.

When the first coin is deposited and the knob turned closing the main switch, the pointer rests opposite the first division on the scale. If a second coin is deposited before the current purchased with the first coin has been consumed, a second motion of the knob will bring the pointer opposite the second division on the scale. Twelve coins can thus be deposited consecutively, after which the switch is opened so that no more current can be obtained until one or more coins have been deposited.

The indicating mechanism shows only the number of coins which stand to the credit of the customer, but, by consulting the meter dial, one can determine what fractional part of the prepayment next to be cancelled remains to the credit of the customer.



THOMSON HIGH TORQUE WATT-HOUR METER WITH SEPARATE PREPAYMENT DEVICE—TYPE IP FOR ALTERNATING CURRENT

slot is automatically closed and further prepayment cannot be made until the value of one or more coins has been consumed.

Whenever energy to the value of one coin has been delivered through the meter, the escapement is released mechanically in the combined device and electrically in the separate device, turning the pointer back one division. This process continues until all the energy for which payment has been made has been delivered. Thus the depositor can ascertain at any time how much energy can be obtained without further payment. When all energy has been delivered the circuit

Actuating Force

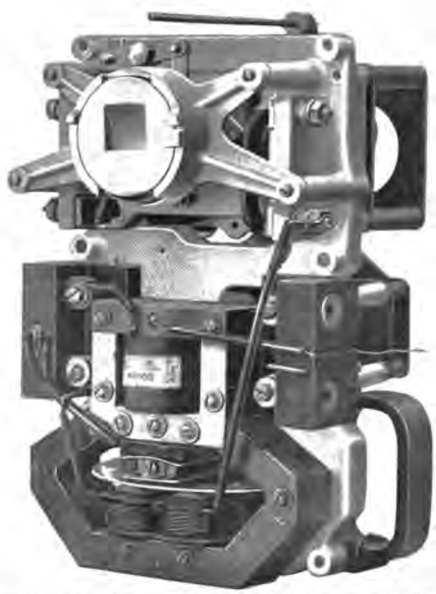
The actuating force which operates the device is a large flat coil spring enclosed in a barrel or drum to which its outside end is attached. The operating knob winds this main spring by turning the drum. The spring has many turns and as the operation of the device never equals one whole turn, the spring always exerts a practically constant force.

Rate Device

This consists of a small train of gears secured to the front of the frame directly back of the register. The gear ratio of the rate device varies, depending upon the price charged for the service to be metered. Each device is marked with the price per kw.-hour for which it should be used. It will be noted that this device is a separate member secured independently to the meter frame. It can thus be easily removed and replaced in case a change of rate is desired.

Switch

The switch is of the double-pole, double-break type with leaf contacts, the construction being similar to that used in heavy current circuit breakers. The toggle joint used to close the switch arms against the terminal blocks makes it impossible for the switch to open through accidental jar and also prevents any back pressure from being transmitted to the escapement train in such a way as to retard its action. The switch is liberally rated and will without injury to itself open any circuit carrying current up to the maximum overload allowable for the largest meter with which the device can be used.



INTERIOR OF THOMSON WATT-HOUR METER WITH COMBINED PREPAYMENT DEVICE—TYPE IP3

Unit of Prepayment and Coin Receptacle

The standard prepayment device is designed for use with quarter dollars. The coin receptacles are placed at the back of the meters so that the covers may be removed without interfering with the receptacle in any way. This feature possesses the advantage of permitting the testing of the meter without affording access to the coin box. It also prevents the collector, who is usually unfamiliar with the electrical features of the meter, from inadvertently injuring its adjustment. The coins fall into a drawer which is removable from the bottom of the case and which may be secured by a padlock. These locks are not furnished with the meter, it being thought best to permit the customer to use the lock which he considers most reliable for this purpose. The slot in which the coin is inserted is situated at the top of the meter case near the back.

Rates of Charge

Standard rates of charge are 8, 10, 12, 12 1/2, 15, 18 and 20 cents per kilowatt hour. The meter can be furnished, at a slight addition in price, adapted for other rates ranging from 5 cents to 20 cents per kilowatt hour in steps of 1/2 cent. The rate must always be specified on the order or it will be held pending this information. The rate of the combined or separate prepayment devices may be easily changed by the customer if he so desires. In the case of the combined device a different "rate device" is substituted for the one already installed in the meter; while in the case of the separate device a rate and contact making device, also made up as a unit, is substituted. These devices can be furnished as supply parts adapting the meters for any of the above standard rates.

Beating

Every precaution has been taken to guard against beating. A coin or washer larger than the coin for which the device is designed cannot be introduced into the receiving slot and a smaller one will not operate the device.

The knob, once started with a coin locked in, cannot be reversed, but must be given a half-turn to release the coin, which falls through a tube to the money box below. The coin is locked in as soon as the knob is moved and cannot be abstracted except by unlocking the money box. It is only by turning the knob that the consumer can obtain credit for his payment. A coin having a thread or wire attached will operate the mechanism, but the motion of the actuating handle prevents the withdrawal of the coin, which generally passes into the receiving box. Should bits of string prevent the coin from passing to the drawer the intended fraud will be readily detected.

THOMSON WATT-HOUR METERS FOR DIRECT CURRENT WITH FORM 4 SEPARATE PREPAYMENT DEVICE—TYPE CP

100–120 volts, 2 wire		200–240 volts, 3 wire		200–240 volts, 2 wire	
Cat. No.	Amps.	Cat. No.	Amps.	Cat. No.	Amps.
103224	5	103228	5	103232	5
103225	10	103229	10	103233	10
103226	15	103230	15	103234	15
103227	25	103231	25	103235	25

WITH COMBINED PREPAYMENT DEVICE—TYPE CP3

100–120 volts, 2 wire		200–240 volts, 3 wire		200–240 volts, 2 wire	
Cat. No.	Amps.	Cat. No.	Amps.	Cat. No.	Amps.
103236	5	103240	5	103244	5
103237	10	103241	10	103245	10
103238	15	103242	15	103246	15
103239	25	103243	25	103247	25

THOMSON HIGH TORQUE WATT-HOUR METERS FOR ALTERNATING CURRENT WITH FORM 4 SEPARATE PREPAYMENT DEVICE—TYPE IP

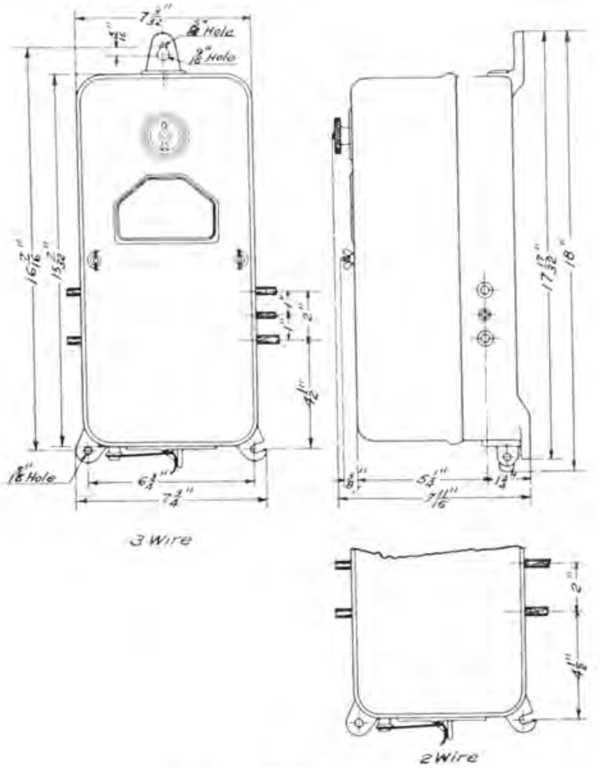
100–120 volts, 2 wire		200–240 volts, 3 wire		200–240 volts, 2 wire	
Cat. No.	Amps.	Cat. No.	Amps.	Cat. No.	Amps.
103511	3	103512	3	103513	3
103248	5	103252	5	103256	5
103249	10	103253	10	103257	10
103250	15	103254	15	103258	15
103251	25	103255	25	103259	25

WITH COMBINED PREPAYMENT DEVICE—TYPE IP3

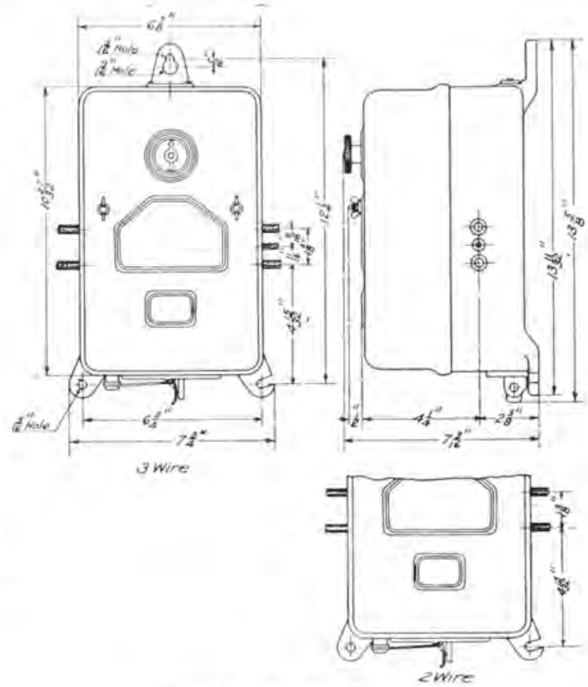
100–120 volts, 2 wire		200–240 volts, 3 wire		200–240 volts, 2 wire	
Cat. No.	Amps.	Cat. No.	Amps.	Cat. No.	Amps.
103514	3	103515	3	103516	3
103260	5	103264	5	103268	5
103261	10	103265	10	103269	10
103262	15	103266	15	103270	15
103263	25	103267	25	103271	25

DIMENSIONS OF THOMSON WATT-HOUR METERS WITH COMBINED PREPAYMENT ATTACHMENTS—TYPES CP3 AND IP3 AND FORM 4 SEPARATE ATTACHMENT

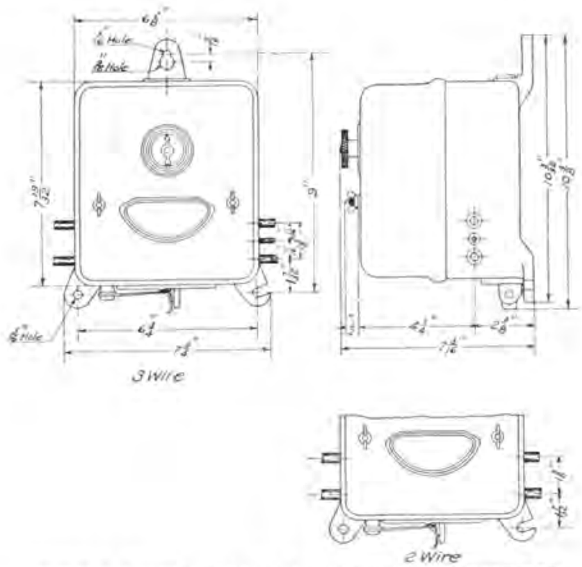
100-120 AND 200-240 VOLTS TWO-WIRE AND 200-240 VOLTS THREE-WIRE



5 TO 25 AMPERES—TYPE CP3



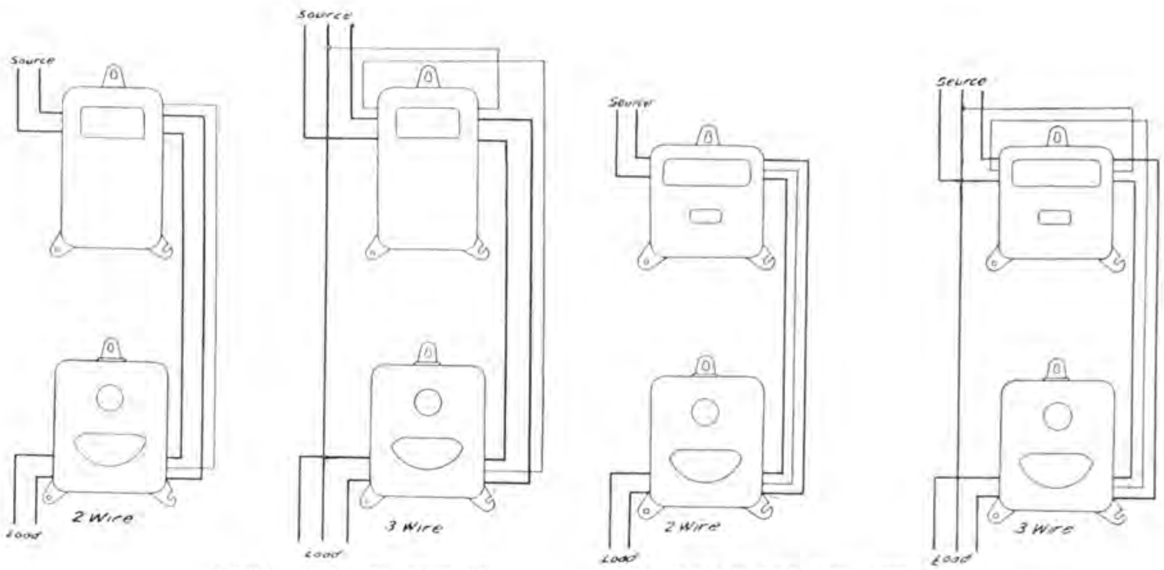
3 TO 25 AMPERES—TYPE IP3



FORM 4 ATTACHMENT FOR USE WITH ALL TYPES CP AND IP PREPAYMENT METERS

CONNECTIONS OF THOMSON WATT-HOUR METERS WITH SEPARATE FORM 4 PREPAYMENT ATTACHMENT—TYPES CP AND IP

100-120 AND 200-240 VOLTS TWO-WIRE AND 200-240 VOLTS THREE-WIRE



5 TO 25 AMPERES—TYPE CP 3 TO 25 AMPERES—TYPE IP

FAN MOTORS

GENERAL ELECTRIC COMPANY

GENERAL ELECTRIC FAN MOTORS

AND

SMALL POWER MOTORS

GENERAL ELECTRIC COMPANY

SUPPLY DEPARTMENT

SCHENECTADY, N. Y.

January, 1910 *Bulletin No. 4719

*Supersedes Bulletin No. 4632

INTRODUCTION

FOLLOWING its annual custom, the General Electric Company has prepared a catalogue of its Fan Motors for the season of 1910, and presents it with the hope that it will prove of service to the Company's patrons, present and prospective, and be the means of increasing the number of users of General Electric Fan Motors, and so add to the popularity of the motor.

General Electric Fan Motors for the coming season are, in appearance, substantially the same as those of last season, although various improvements have been made in the general design. The line of motors has been increased by the addition of 8-inch motors and a six-blade 12-inch motor, all of which will be found particularly well suited to residence and small office use. These 8-inch motors are small and light, and consume very little energy, as will be seen by reference to the accompanying tables.

The manufacture of oscillating fan motors is confined to the larger sizes, namely, 12- and 16-inch fans.

The General Electric Company is prepared to furnish, in addition to its line of ceiling motors, column fan motors which, by the use of attractive standards, are adapted to floor or counter use.

General Electric Fan Motors are designed for all standard voltages and frequencies.

This catalogue illustrates also some of the sewing machine motors and small power motors adapted to domestic and business purposes.

Any desired information not contained in this catalogue will be gladly furnished on application to the nearest sales office of the Company.

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Fan Motors for Residences and Telephone Booths

A C. Desk Motor

A.C. Bracket Motor

D.C. Bracket Motor

D.C. Desk Motor

Eight-Inch, Four-Blade Fans

IN RESPONSE to the demand for a fan for residence and small office use, the General Electric Company has developed a neat 8-inch fan motor which can be finished to harmonize with the surroundings of the place in which it is to be used.

The frame and base are made of drawn metal, the weight being thereby reduced, and a smooth external surface obtained.

SPECIAL FINISHES. Motors are carried in stock finished in Black Oxide with Fan, Guards and Trimmings in Lacquered Brass. Oxidized Copper, Polished Copper, Polished Brass or Brushed Brass can be supplied at an additional cost.

SPEEDS. Desk, Bracket and Telephone Booth Fans are equipped with a Three-Speed Control Switch which provides a regulation sufficient for all requirements.

ADJUSTMENT. The motor body is attached to the base by a hinge joint. A friction clamp with a wing nut allows a vertical adjustment of the fan for either desk or bracket use.

The Telephone Booth Motor is suspended from a suitable bracket by means of a spring suspension which prevents the slight vibration, incident to the operation of any motor, being transmitted to the wall of the booth, and also provides for a horizontal and vertical adjustment of the fan.

OPERATING CHARACTERISTICS

Motors are carried in stock for alternating current circuits of from 25 to 60 cycles, at 110 volts or 220 volts, and for 40 cycles, 120 volts, operating over a range of voltage or frequency 5 per cent. either above or below normal ratings.

Direct Current Motors are for 110 and 220 volt circuits, operating over a range of voltage 5 per cent. either above or below normal.

Fan Motors for Residences and Telephone Booths

Telephone Booth Motor

Six-Blade, Twelve-Inch Alternating Current Residence Motor

Eight-Inch Alternating Current Desk, Bracket and Telephone Booth Fan Motors

Cat. No. Desk	Cat. No. Booth	Rating Cycles	Rating Volts	Watts at Fast Speed	Speed	Net Wt. Lb.	Shipping Wt. Lb.	List Price Desk	List Price Booth
76373	76374	25	110	20	1350	6½	13½	$21.00	$24.00
75955	75952	40	120	33	1900	6½	13½	20.50	23.50
75956	75953	60	110	25	1540	6½	13½	20.00	23.00
75957	75954	60	220	30	1540	6½	13½	22.00	25.00

Eight-Inch Direct Current Desk, Bracket and Telephone Booth Fan Motors

Cat. No. Desk	Cat. No. Booth	Volts	Watts at Fast Speed	Speed	Net Wt. Lb.	Shipping Wt. Lb.	List Price Desk	List Price Booth
75960	75958	110	18	1600	5	12	$18.00	$21.00
75961	75959	220	18	1600	5	12	20.00	23.00

FINISH. Black Oxide; blades, guards and trimmings finished in dipped and lacquered brass.

Twelve-Inch Alternating Current, Six-Blade Residence, Desk and Bracket Fan Motors
Swivel and Trunnion Frame

Cat. No.	Rating Cycles	Rating Volts	Watts at Fast Speed	Speed	Net Wt. Lb.	Shipping Wt. Lb.	List Price
76361	25	110	57	1100	24½	42¾	$33.00
76362	40	120	56	1100	24½	42¾	31.00
76363	60	110	54	1100	24½	42¾	30.00
76364	60	220	54	1100	24½	42¾	32.00
76365	133	110	65	1250	24½	42¾	30.00

FINISH. Frame and base of motor finished in black enamel; guard, blades and trimmings finished in dipped and lacquered brass.

These fans are designed for use in residences, hospitals and other places, where the humming sound produced by the blades of the four-blade fans operated at speeds necessary to produce a sufficient circulation of air, is considered objectionable.

Residence type fans are furnished in the 12 in. size only. With the exception of being wound for lower speeds and equipped with six blades, the motors are identical with the standard four-blade type. For further specifications see page 8.

Alternating Current Twelve- and Sixteen-Inch Desk and Wall Bracket Fan Motors

SPECIFICATIONS

FINISH. Motors are carried in stock with motor body and base finished in black japan; blades, guards and trimmings in dipped and lacquered brass. Special colored enamel or plated finishes can be furnished when necessary, at an additional cost. Prices will be quoted upon application.

SPEEDS. Motors are equipped with four-point regulating switch which provides three running speeds.

The regulating coil is mounted on a switch base of a special material which is an excellent insulator, and not easily broken. The operating lever passes over a cam which lifts it from one contact to another, and insures a positive setting of the lever.

RANGE OF OPERATION. All motors are guaranteed to operate on the first and second speed points, 5% either above or below normal voltage when in any position, and will operate on low speed at normal voltage.

ADJUSTMENT. The yoke supporting the body is hinged to the base and a stop is provided to lock it in position. This enables the motor to be readily adjusted for either desk or bracket use without the addition of any parts.

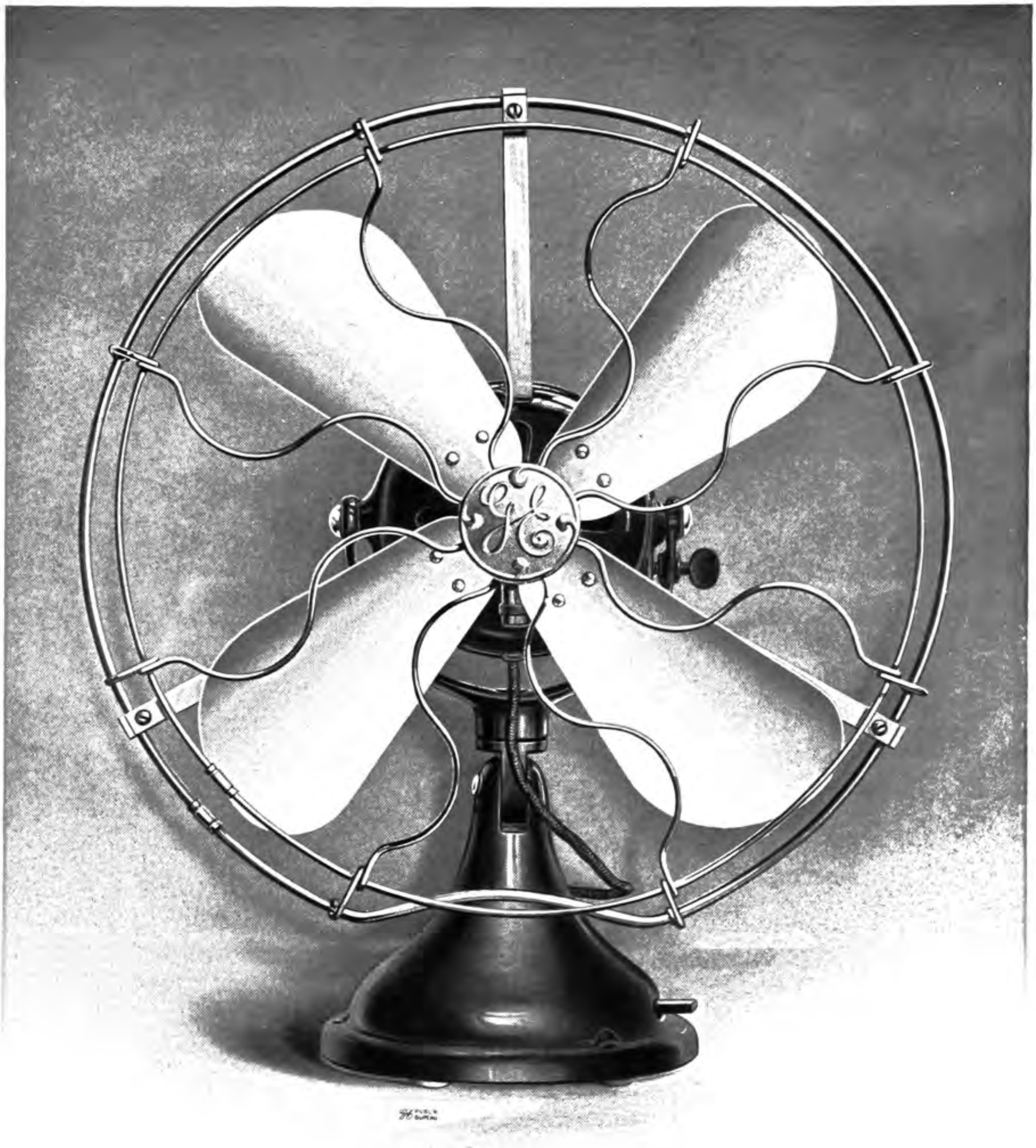
OSCILLATING FAN MOTORS

General Electric oscillating motors for 1910 are, in appearance, substantially the same as those of last season, although various improvements have been made in the general design.

MECHANISM. The mechanism is so applied that it does not interfere with the vertical adjustments, or the change from desk to bracket type, and vice versa. The connecting link can be attached to the gear at two points, thus providing for two angles of operation. A range of 90 degrees can be obtained, if desired. A knob on the gear spindle enables the oscillating mechanism to be instantly thrown in or out of action, while the motor is running.

Oscillating fan motors have, approximately, the same general characteristics as desk motors of similar rating. The additional power required to operate the oscillating device is but three to five watts, or approximately one-tenth of the power consumed by an ordinary 16 c.p. lamp.

At full speed the motors will make approximately six complete oscillations per minute. This rate is considered the most efficient and best suited to general conditions and is uniform and positive throughout the entire range.



Alternating Current Desk Fan Motor

Alternating Current Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors

TWELVE-INCH FANS

Desk Motor

Wall Bracket Motor

Cat. No.	Cycles	Voltage	Watts at Fast Speed	Fast Speed	WEIGHT Net	Shipping	List Price
34267	25	110	65	1300	24¼	42¼	$33.00
33594	40	120	80	1600	24¼	42¼	31.00
34017	60	110	50	1500	24¼	42¼	30.00
34018	60	220	50	1500	24¼	42¼	32.00
34019	133	110	100	1800	24¼	42¼	30.00

FINISH. Frame and base of motor finished in black enamel; guard, blades and trimmings finished in dipped and lacquered brass.

Alternating Current Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors

SIXTEEN-INCH FANS

Wall Bracket Motor

Desk Motor

Cat. No.	Cycles	Voltage	Watts at Fast Speed	Fast Speed	WEIGHT Net	Shipping	List Price
58294	25	110	130	1300	26	44	$38.00
58295	40	120	145	1600	26	44	36.00
34021	60	110	85	1400	26	44	35.00
34022	60	220	85	1400	26	44	39.00
34023	133	110	155	1750	26	44	35.00

FINISH. Frame and base of motor finished in black enamel; guard, blades and trimmings finished in dipped and lacquered brass.

Alternating Current Oscillating Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors

TWELVE-INCH FANS

Desk Motor

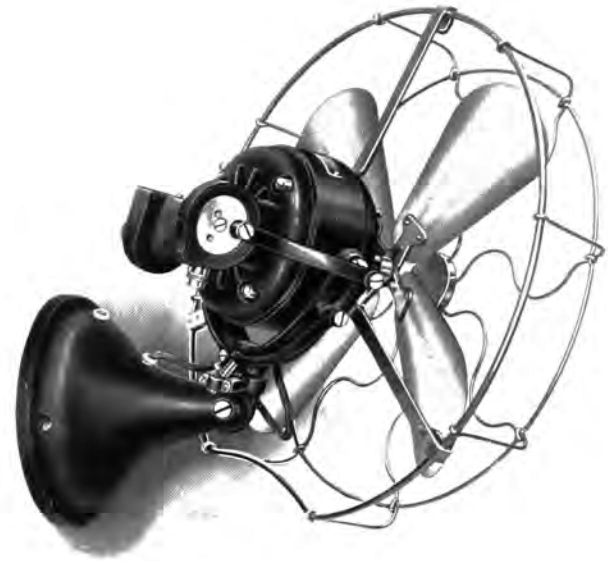
Wall Bracket Motor

Cat. No.	Cycles	Voltage	FAST SPEED Watts	R.P.M.	WEIGHT Net	Shipping	List Price
75433	25	110	70	1300	27½	45½	$41.00
75431	40	120	85	1600	27½	45½	39.00
75423	60	110	55	1500	27½	45½	38.00
75424	60	220	55	1500	27½	45½	40.00
75427	133	110	105	1750	27½	45½	38.00

FINISH. Frame and base of motor finished in black enamel; guard, blades and trimmings finished in dipped and lacquered brass.

Alternating Current Oscillating Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors

SIXTEEN-INCH FANS



Wall Bracket Motor

Desk Motor

Cat. No.	Cycles	Voltage	FAST SPEED Watts	R.P.M.	WEIGHT Net	Shipping	List Price
75434	25	110	135	1300	29	47	$47.00
75432	40	120	150	1600	29	47	45.00
75425	60	110	90	1400	29	47	44.00
75426	60	220	90	1400	29	47	46.00
75429	133	110	160	1700	29	47	44.00

FINISH. Frame and base of motor finished in black enamel; guard, blade and trimmings finished in dipped and lacquered brass.

Direct Current Twelve- and Sixteen-Inch Desk and Wall Bracket Fan Motors

SPECIFICATIONS

FINISH. Motors are carried in stock with motor body and base finished in black enamel; blades, guards and trimmings in dipped and lacquered brass.

Special colored enamel or plated finishes can be furnished when necessary at an additional cost. Prices will be named upon request.

SPEEDS. Motors are equipped with four-point regulating switch which provides three running speeds.

The resistance coil is mounted on a switch base of a special material which is an excellent insulator and not easily broken. The operating lever passes over a cam which lifts it from one contact to another and insures a positive setting of the lever.

RANGE OF OPERATION. All motors are guaranteed to operate on voltages 10% either above or below normal rating with the motor in any position.

ADJUSTMENT. The yoke supporting the body is hinged to the base and a stop is provided to lock it in position. This enables the motor to be readily adjusted for either desk or bracket use without the addition of any parts.

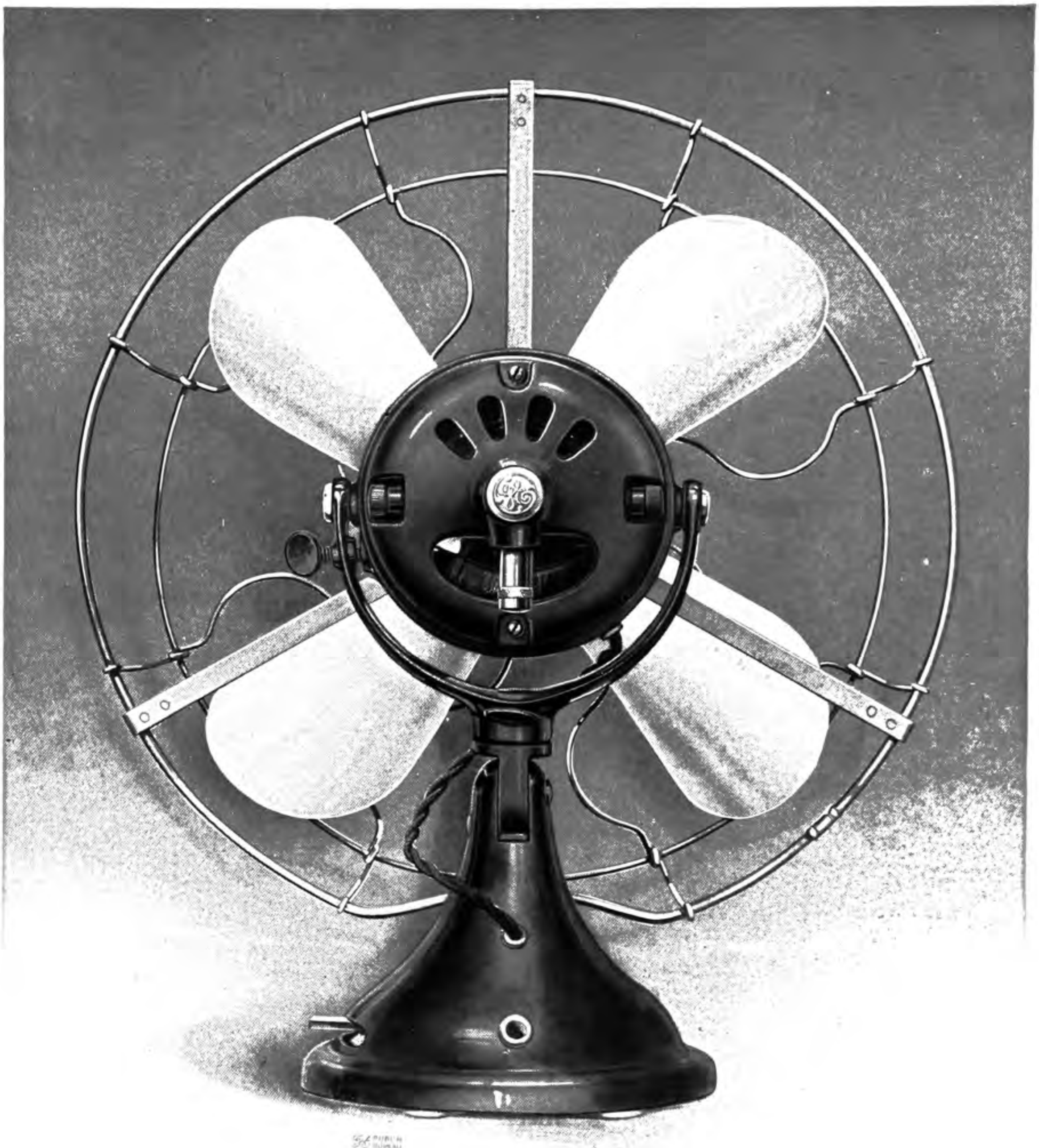
OSCILLATING FAN MOTORS

General Electric oscillating motors for 1910 are, in appearance, substantially the same as those of last season, although various improvements have been made in the general design.

MECHANISM. The mechanism is so applied that it does not interfere with the vertical adjustment, or the change from desk to bracket type, and vice versa. The connecting link can be attached to the gear at two points, thus providing for two angles of operation, the maximum being 90 degrees. A knob on the gear spindle enables the oscillating mechanism to be instantly thrown in or out of action while the motor is running.

Oscillating fan motors have, approximately, the same general characteristics as desk motors of similar rating. The additional power required to operate the oscillating device is but three to five watts, or about one-tenth of the power consumed by an ordinary 16 c.p. lamp.

At full speed the motors will make approximately six complete oscillations per minute. This rate is considered to be the most efficient and best suited to general conditions. and is uniform and positive throughout the entire range.



Direct Current Desk Fan Motor

Direct Current Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors

Desk Motor

Wall Bracket Motor

TWELVE-INCH FANS

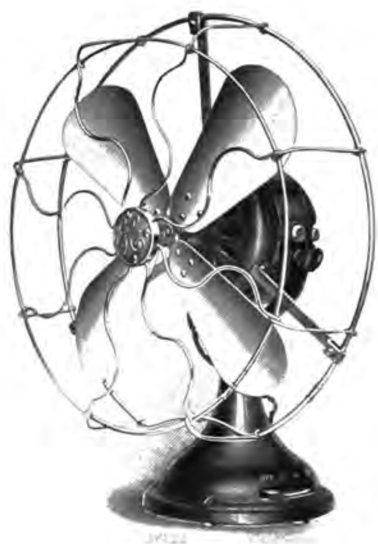
Cat. No.	Volts	Watts at Fast Speed	Speeds	WEIGHT Net	Shipping	List Price
34003	110	47	1600–1300–1000	18	36	$27.00
34004	220	47	1600–1300–1000	18	36	29.00

SIXTEEN-INCH FANS

Cat. No.	Volts	Watts at Fast Speed	Speeds	WEIGHT Net	Shipping	List Price
34005	110	80	1450–1200– 800	25	43	$31.00
34006	220	80	1450–1200– 800	25	43	33.00

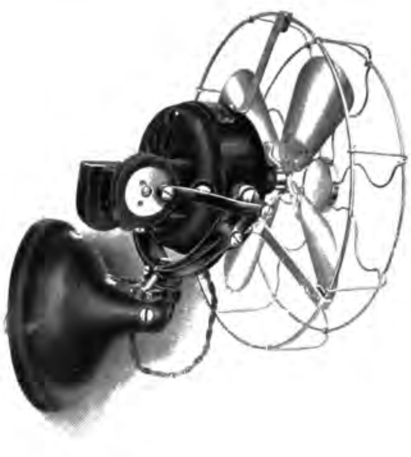
FINISH. Frame and base of motor finished in black enamel; guard, blades and trimmings finished in dipped and lacquered brass.

Wall Bracket Motor



Desk Motor

Direct Current Oscillating Desk and Wall Bracket Swivel and Trunnion Frame Fan Motors



Wall Bracket Motor

Desk Motor

TWELVE-INCH FANS

Cat. No.	Volts	Watts at Fast Speed	Speeds	Weight Net	Weight Shipping	List Price
60559	110	50	1550–1200– 950	22	40	$34.00
60560	220	50	1550–1200– 950	22	40	36.00

SIXTEEN-INCH FANS

Cat. No.	Volts	Watts at Fast Speed	Speeds	Weight Net	Weight Shipping	List Price
60561	110	85	1500–1150– 850	28	46	$40.00
60562	220	85	1500–1150– 850	28	46	42.00

FINISH. Frame and base of motor finished in black japan; guard, blades and trimmings finished in dipped and lacquered brass.

Desk Motor

Wall Bracket Motor

Alternating and Direct Current Ceiling and Column Fan Motors

SPECIFICATIONS

SUSPENSIONS. Unless otherwise specified on the order, Style "B" adjustable suspension for 10½ to 12 foot ceilings will be furnished with all Ornamental Type Ceiling Fan Motors. (For other heights of ceilings see page 28.) Plain Type Ceiling Fan Motors are furnished with hanger, hook and ceiling canopy, but without suspension rod. A table giving the necessary lengths of suspensions for various heights of ceilings will be found on page 28.

Floor Column Fan Motors are furnished complete with floor plate and standard holding blades approximately 7½ ft. from floor. Counter Column Fan Motors are furnished complete with counter flange and standard holding blades approximately 5 ft. from counter.

ELECTROLIER ATTACHMENTS. All Ceiling and Column Fans are wired for two or four lights. Catalogue numbers do not include sockets or any other electrolier fittings, Short nipples permitting the attachment of sockets will be furnished with all ceiling and column fan motors at 50 cents per set of four, if desired.

RANGE OF VOLTAGE. Alternating Current, *105 volt, 50 and 60 cycle* motors are designed to operate within a range of 100 to 110 volts.

115 volt, 50 and 60 cycle motors are designed to operate within a range of 112 to 120 volts.

220 volt, 50 and 60 cycle motors are designed to operate within a range of 210 to 230 volts.

110 volt, 25 cycle, and 120 volt, 40 cycle motors are designed to operate satisfactorily on circuits having a variation of 5% above or below normal, but the sum of the two variations should not exceed 5%.

Direct Current Motors can be operated satisfactorily on circuits the voltage variation of which is not more than 10% above or below the rated voltage.

RANGE OF FREQUENCIES. Motors can be furnished for use on 25, 40, 50 and 60 cycle circuits, but will not be furnished for higher frequencies. They can be operated satisfactorily on frequencies having a variation of 5% above or below normal, but the sum of the variations should not exceed 5%.

SPEEDS. A.C. Plain Type Ceiling and Column Motors are equipped with a three-point regulating switch which provides two running speeds. Ornamental Type Ceiling and Column Motors are equipped with a four-point regulating switch which provides three running speeds.

D.C. Plain Type Ceiling and Column Motors are furnished for one speed only and are equipped with a starting and stopping switch. Ornamental Type Ceiling and Column Motors are furnished for single and three speeds. Single-Speed Motors are equipped with starting and stopping switch which provides one running speed only. Three-Speed Motors are equipped with four-point regulating switch which provides three running speeds.

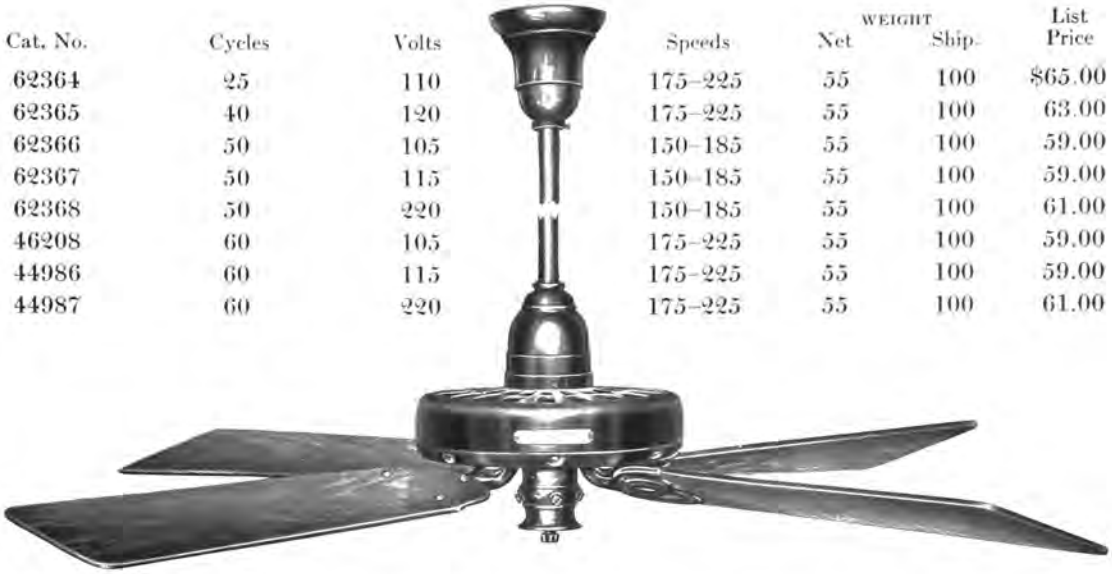
BLADES. All motors are equipped with four blades.

Two-blade motors can be furnished whenever desired at same price as four-blade.

Alternating Current, Four-Blade, Fifty-Two-Inch Sweep Ceiling Fan Motors

Plain Type

Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62364	25	110	175–225	55	100	$65.00
62365	40	120	175–225	55	100	63.00
62366	50	105	150–185	55	100	59.00
62367	50	115	150–185	55	100	59.00
62368	50	220	150–185	55	100	61.00
46208	60	105	175–225	55	100	59.00
44986	60	115	175–225	55	100	59.00
44987	60	220	175–225	55	100	61.00



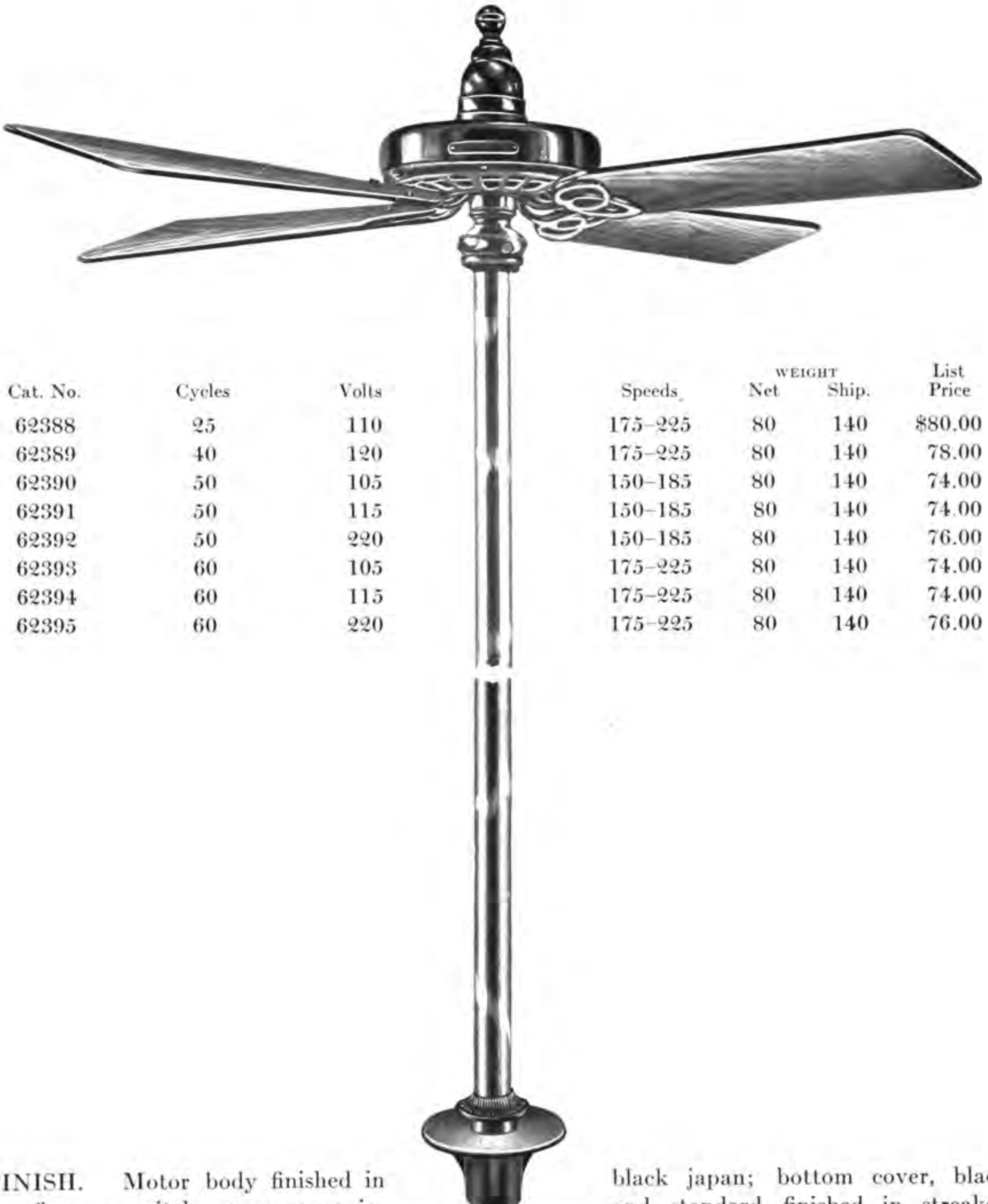
FINISH. Motor body finished in black japan; bottom cover, blade flanges, switch cover and switch support finished in streaked oxidized copper. Current consumed at fast speed, 140 watts. For further specifications, see page 18.

Ornamental Type

Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62359	25	110	125–175–225	62	105	$71.00
62360	40	120	125–175–225	62	105	69.00
62361	50	105	115–150–185	62	105	65.00
62362	50	115	115–150–185	62	105	65.00
62363	50	220	115–150–185	62	105	67.00
46209	60	105	125–175–225	62	105	65.00
44988	60	115	125–175–225	62	105	65.00
44989	60	220	125–175–225	62	105	67.00

FINISH. Complete in streaked oxidized copper. Current consumed at fast speed, 140 watts. For further specifications, see page 18.

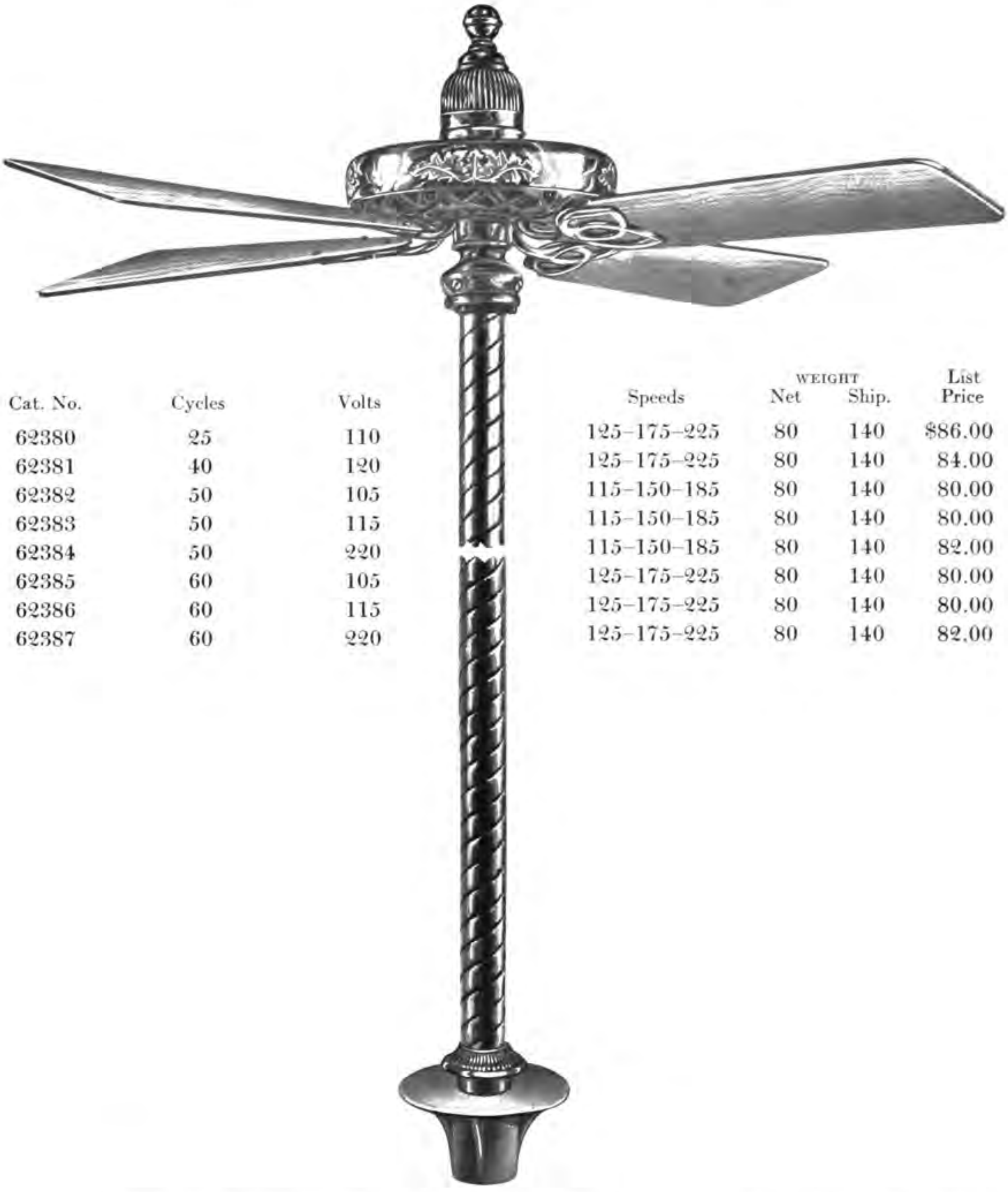
Alternating Current, Four-Blade, Fifty-Two-Inch Sweep Counter Column Fan Motors—Plain Type



Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62388	25	110	175–225	80	140	$80.00
62389	40	120	175–225	80	140	78.00
62390	50	105	150–185	80	140	74.00
62391	50	115	150–185	80	140	74.00
62392	50	220	150–185	80	140	76.00
62393	60	105	175–225	80	140	74.00
62394	60	115	175–225	80	140	74.00
62395	60	220	175–225	80	140	76.00

FINISH. Motor body finished in black japan; bottom cover, blade flanges, switch cover, canopies and standard finished in streaked oxidized copper. Current consumed at fast speed, 140 watts. For further specifications, see page 18.

Alternating Current, Four-Blade, Fifty-Two-Inch Sweep Counter Column Fan Motors—Ornamental Type



Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62380	25	110	125–175–225	80	140	$86.00
62381	40	120	125–175–225	80	140	84.00
62382	50	105	115–150–185	80	140	80.00
62383	50	115	115–150–185	80	140	80.00
62384	50	220	115–150–185	80	140	82.00
62385	60	105	125–175–225	80	140	80.00
62386	60	115	125–175–225	80	140	80.00
62387	60	220	125–175–225	80	140	82.00

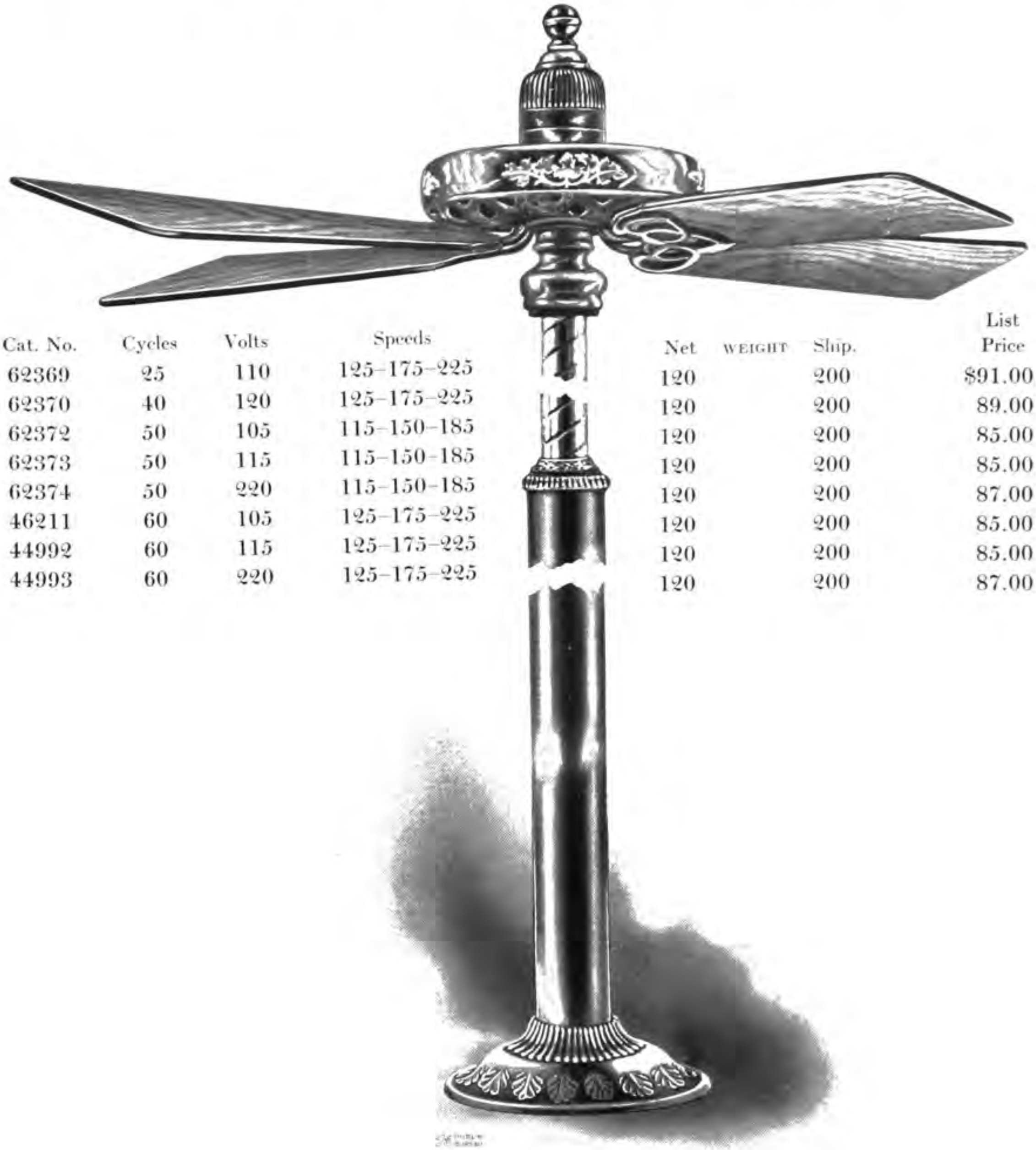
FINISH. Complete in streaked oxidized copper. Current consumed at fast speed, **140 watts.** For further specifications, see page 18.

Alternating Current, Four-Blade, Two-Speed, Fifty-Two-Inch Sweep Floor Column Fan Motors — Plain Type

Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62375	25	110	175–225	120	200	$85.00
62376	40	120	175–225	120	200	83.00
62377	50	105	150–185	120	200	79.00
62378	50	115	150–185	120	200	79.00
62379	50	220	150–185	120	200	81.00
46210	60	105	175–225	120	200	79.00
44990	60	115	175–225	120	200	79.00
44991	60	220	175–225	120	200	81.00

FINISH. Motor body and lower half of standard finished in black japan; bottom cover, blade flanges, switch cover, canopy and upper half of standard finished in streaked oxidized copper. Current consumed at fast speed, 140 watts. For further specifications see page 18.

Alternating Current, Four-Blade, Three-Speed, Fifty-Two-Inch Sweep Floor Column Fan Motors — Ornamental Type

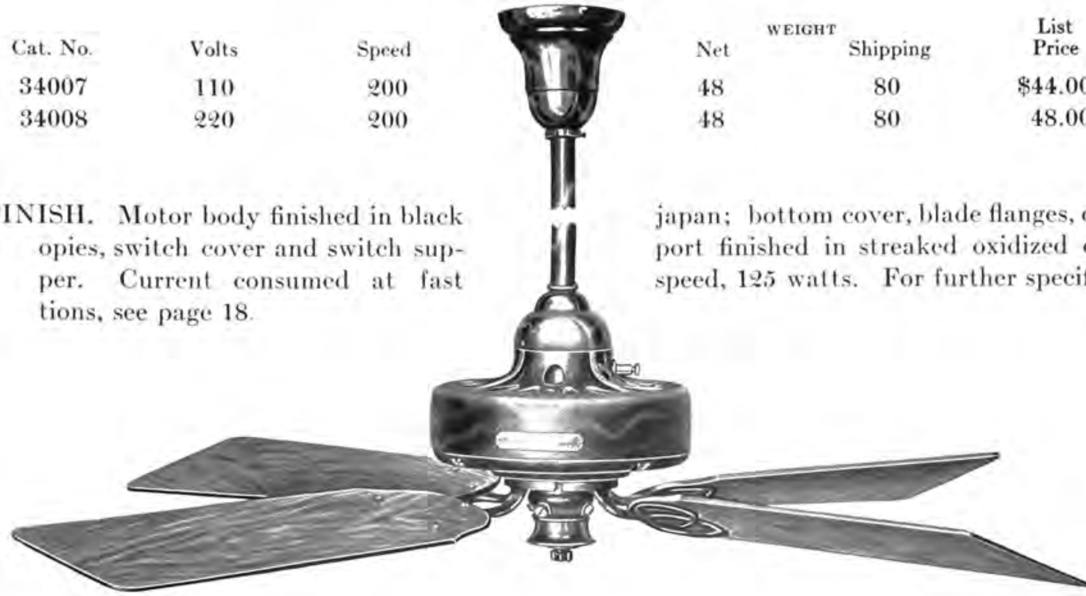


Cat. No.	Cycles	Volts	Speeds	Weight Net	Weight Ship.	List Price
62369	25	110	125–175–225	120	200	$91.00
62370	40	120	125–175–225	120	200	89.00
62372	50	105	115–150–185	120	200	85.00
62373	50	115	115–150–185	120	200	85.00
62374	50	220	115–150–185	120	200	87.00
46211	60	105	125–175–225	120	200	85.00
44992	60	115	125–175–225	120	200	85.00
44993	60	220	125–175–225	120	200	87.00

FINISH. Motor finished complete in streaked oxidized copper with upper half of standard covered with rope casing. Current consumed at fast speed, 140 watts. For further specifications, see page 18.

Direct Current, Four-Blade, Single-Speed, Fifty-Eight-Inch Sweep Ceiling Fan Motors — Plain Type

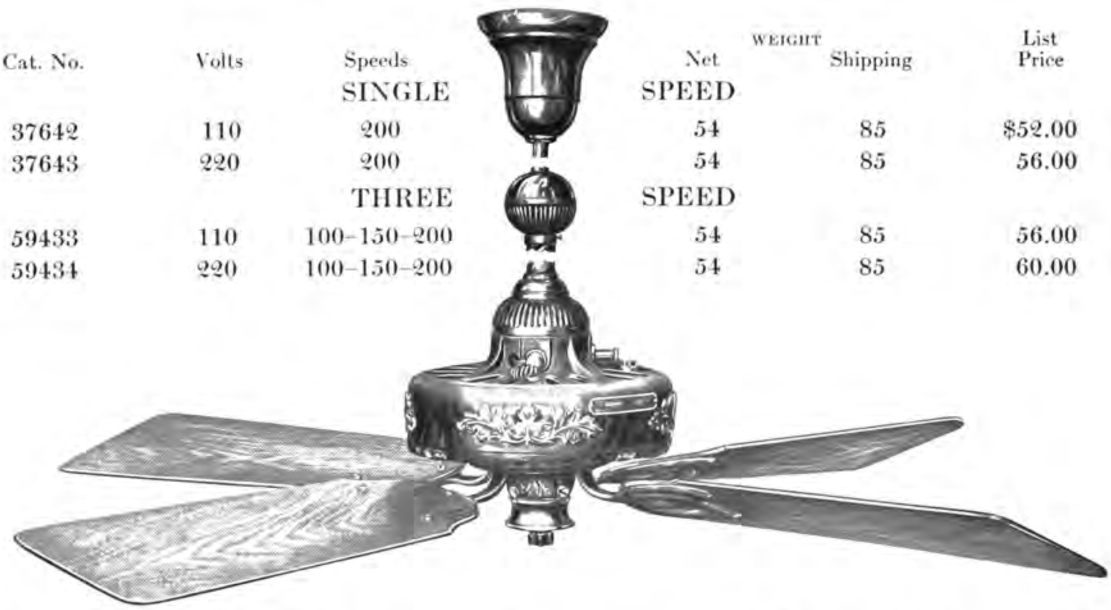
Cat. No.	Volts	Speed	Weight Net	Weight Shipping	List Price
34007	110	200	48	80	$44.00
34008	220	200	48	80	48.00



FINISH. Motor body finished in black japan; bottom cover, blade flanges, canopies, switch cover and switch support finished in streaked oxidized copper. Current consumed at fast speed, 125 watts. For further specifications, see page 18.

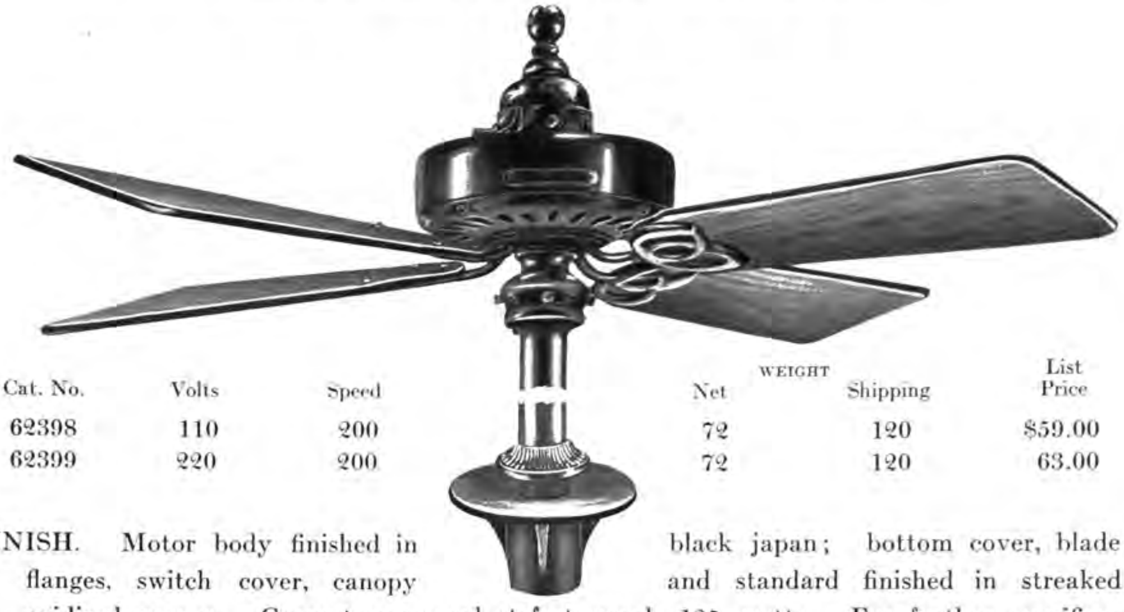
Direct Current, Four-Blade, Single- and Three-Speed, Fifty-Eight-Inch Sweep Ceiling Fan Motors — Ornamental Type

Cat. No.	Volts	Speeds	Weight Net	Weight Shipping	List Price
		SINGLE SPEED			
37642	110	200	54	85	$52.00
37643	220	200	54	85	56.00
		THREE SPEED			
59433	110	100–150–200	54	85	56.00
59434	220	100–150–200	54	85	60.00



FINISH. Complete in oxidized copper. Current consumed at fast speed, 125 watts. For further specifications, see page 18.

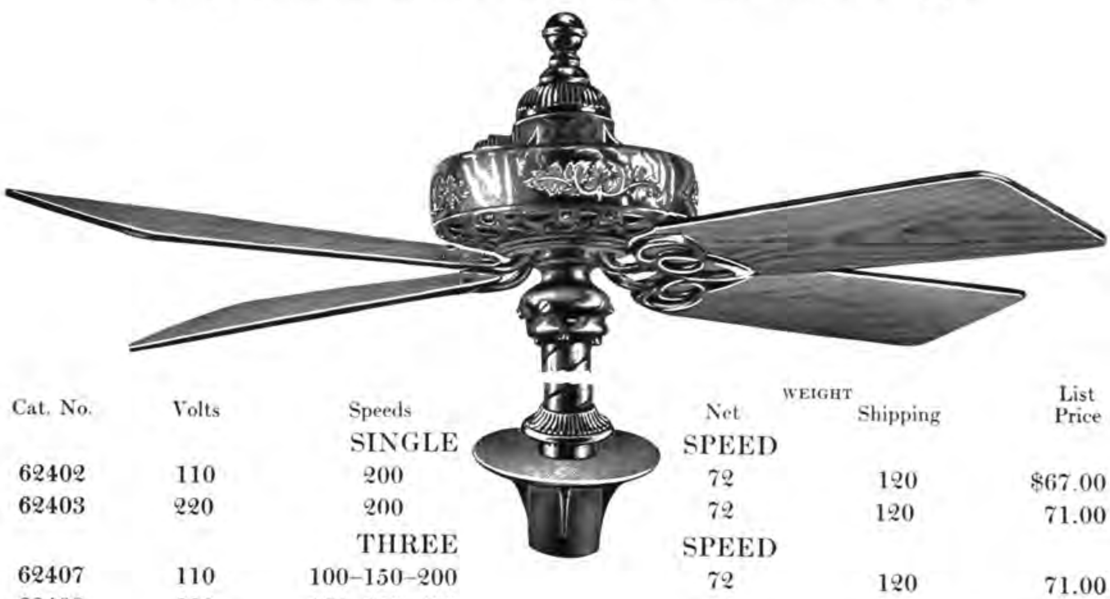
Direct Current, Four-Blade, Single-Speed, Fifty-Eight-Inch Sweep Counter Column Fan Motors—Plain Type



Cat. No.	Volts	Speed	Weight Net	Weight Shipping	List Price
62398	110	200	72	120	$59.00
62399	220	200	72	120	63.00

FINISH. Motor body finished in black japan; bottom cover, blade flanges, switch cover, canopy and standard finished in streaked oxidized copper. Current consumed at fast speed, 125 watts. For further specifications, see page 18.

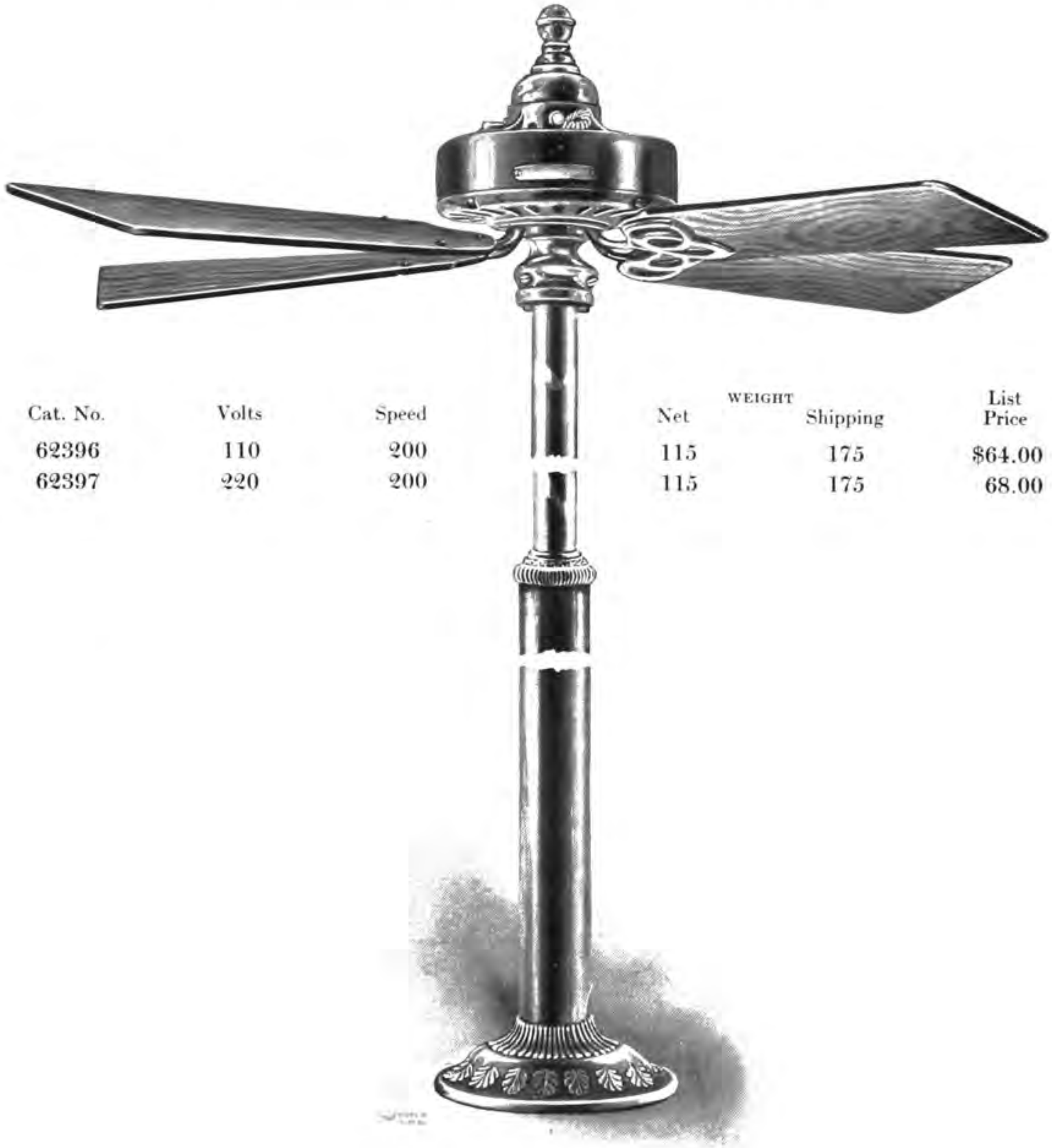
Direct Current, Four-Blade, Single- and Three-Speed, Fifty-Eight-Inch Sweep Counter Column Fan Motors—Ornamental Type



Cat. No.	Volts	Speeds	Weight Net	Weight Shipping	List Price
		SINGLE	SPEED		
62402	110	200	72	120	$67.00
62403	220	200	72	120	71.00
		THREE	SPEED		
62407	110	100–150–200	72	120	71.00
62408	220	100–150–200	72	120	75.00

FINISH. Complete in streaked oxidized copper. Current consumed at fast speed, 125 watts. For further specifications, see page 18.

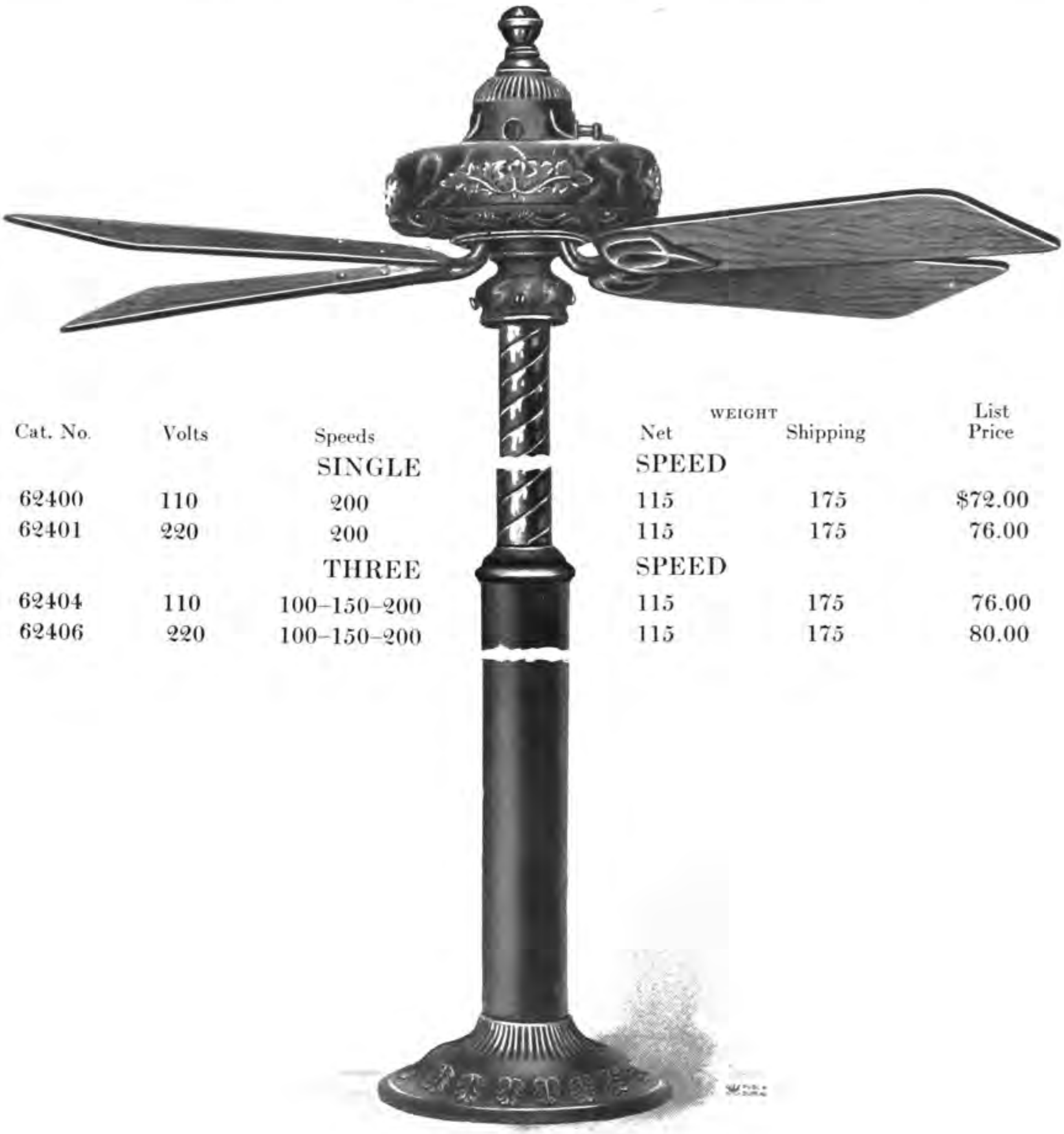
Direct Current, Four-Blade, Single-Speed, Fifty-Eight-Inch Sweep Floor Column Fan Motors—Plain Type



Cat. No.	Volts	Speed	WEIGHT Net	Shipping	List Price
62396	110	200	115	175	$64.00
62397	220	200	115	175	68.00

FINISH. Motor body and lower half of standard finished in black japan; bottom cover, blade flanges, switch cover, canopy and upper half of standard finished in streaked oxidized copper. Current consumed at fast speed 125 watts. For further specifications, see page 18.

Direct Current, Four-Blade, Single- and Three-Speed, Fifty-Eight-Inch Sweep Floor Column Fan Motors—Ornamental Type



Cat. No.	Volts	Speeds	Weight Net	Weight Shipping	List Price
		SINGLE	SPEED		
62400	110	200	115	175	$72.00
62401	220	200	115	175	76.00
		THREE	SPEED		
62404	110	100–150–200	115	175	76.00
62406	220	100–150–200	115	175	80.00

FINISH. Complete in streaked oxidized copper with upper half of standard covered with rope casing. Current consumed at fast speed, 125 watts. For further specifications, see page 18.

Suspensions

Japanned Iron Pipe for Plain Type Ceiling Fan Motors

Height of Ceiling	Length of Pipe Over all	Price	Height of Ceiling	Length of Pipe Over all	Price
8½ ft.	3½ in.	$0.15	13½ ft.	5 ft. 3 in.	$0.90
9 ft.	9½ in.	.15	14 ft.	5 ft. 10 in.	.90
9½ ft.	15½ in.	.30	14½ ft.	6 ft. 3 in.	1.05
10 ft.	21½ in.	.30	15 ft.	6 ft. 10 in.	1.05
10½ ft.	2 ft. 3 in.	.45	15½ ft.	7 ft. 3 in.	1.20
11 ft.	2 ft. 10 in.	.45	16 ft.	7 ft. 10 in.	1.20
11½ ft.	3 ft. 3 in.	.60	16½ ft.	8 ft. 3 in.	1.35
12 ft.	3 ft. 10 in.	.60	17 ft.	8 ft. 10 in.	1.35
12½ ft.	4 ft. 3 in.	.75	17½ ft.	9 ft. 3 in.	1.50
13 ft.	4 ft. 10 in	.75	18 ft.	9 ft. 10 in.	1.50

When lengths above specified are used the switch handle of the motor will be approximately 7½ ft. from the floor.

Adjustable Suspensions for Ornamental Type Ceiling Fan Motors

Style	Length of Hanger	Height of Ceiling	When Furnished With Motor	When Furnished Without Motor
A	19 to 28 in.	10 to 11 ft.	.....	$3.00
B	24 to 40 in.	10½ to 12 ft.	.....	3.00
C	42 to 76 in.	12 to 15 ft.	$1.50	4.50
D	60 to 112 in.	15 to 18 ft.	3.00	6.00

The suspensions specified above for various ceiling heights may be adjusted so that the switch handle of the motor will be approximately 7½ ft. from floor.

Style B suspensions will be regularly furnished unless otherwise specified

For ceilings less than 10 ft. in height, a solid suspension with rope casing will be furnished.

Solid Suspensions

Solid suspensions covered with rope casing may be furnished with Ornamental Type Ceiling Motors in place of adjustable suspensions, if desired. For ceilings higher than 12 ft. an additional charge of 75 cents per foot, or fraction thereof, of extra length required of solid suspension with casing will be made.

Ventilating Fan Motors

Alternating Current Outfits

Cat. No.	Diam. Fan.	Cycles	Volts	Approx. Wt. Lb. Net	Ship.	List Price
35307	12″	25	110	23	50	$30.00
35308	12″	40	120	23	50	28.00
34025	12″	60	110	23	50	27.00
34026	12″	60	220	23	50	29.00
58298	16″	25	110	25½	55	36.00
58299	16″	40	120	25½	55	34.00
34029	16″	60	110	25½	55	33.00
34030	16″	60	220	25½	55	35.00

Note.—Prices include motor complete with six-blade fan and tripod together with a separate starting device with which is combined a three speed controller in the same box.

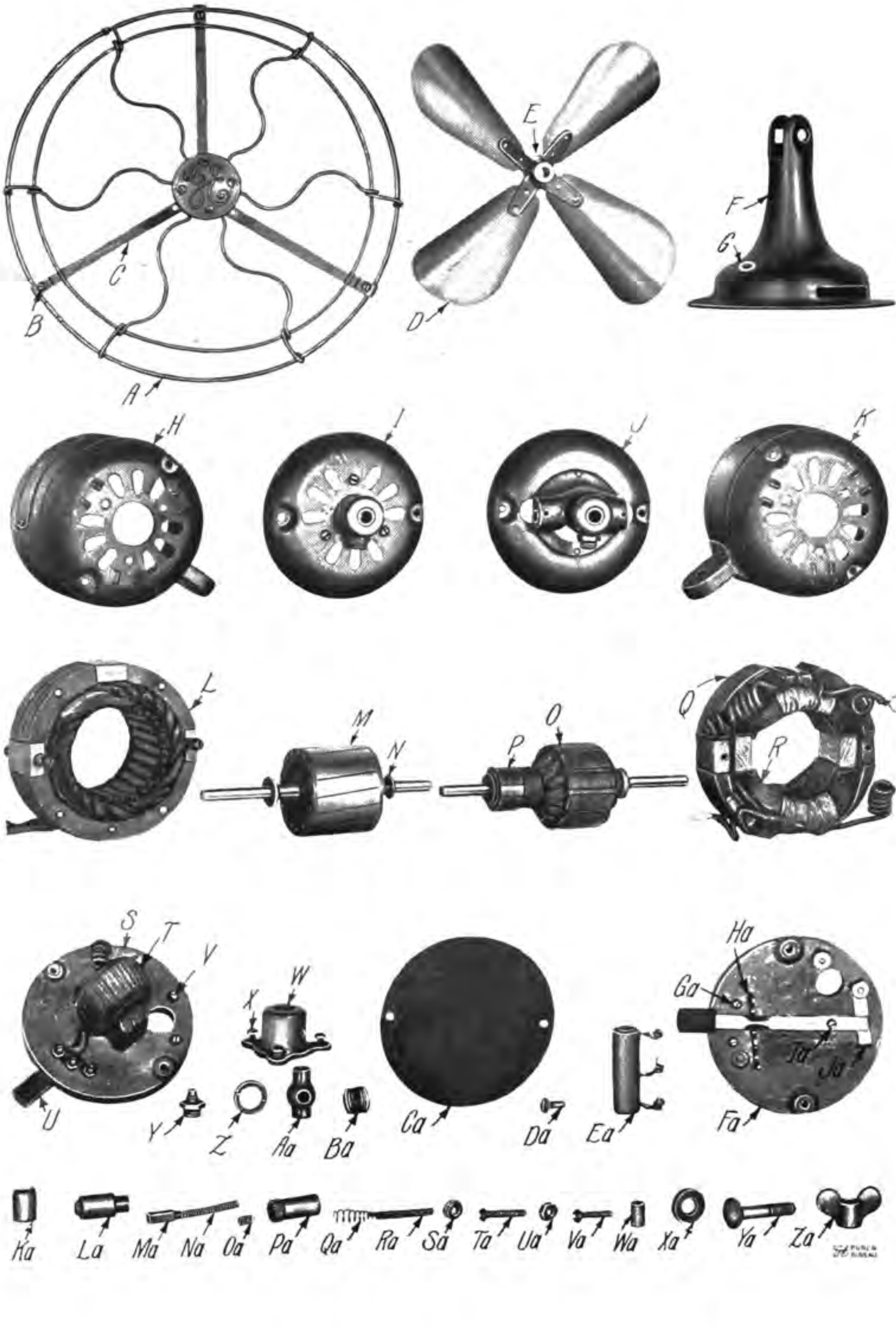
Direct Current Outfits

Cat. No.	Diam. Fan	Volts	Approx. Wt. Lb. Net	Ship.	List Price
34009	12″	110	21	60	$23.00
34010	12″	220	21	60	25.00
34011	16″	110	30	90	31.00
34012	16″	220	30	90	33.00

Speed Controllers for Direct Current Motors

34034	12″	110	$4.50
34035	12″	220	5.00
34036	16″	110	5.00
34037	16″	220	5.50

Supply Parts for Alternating and Direct Current Eight-Inch Desk and Wall Bracket Fan Motors



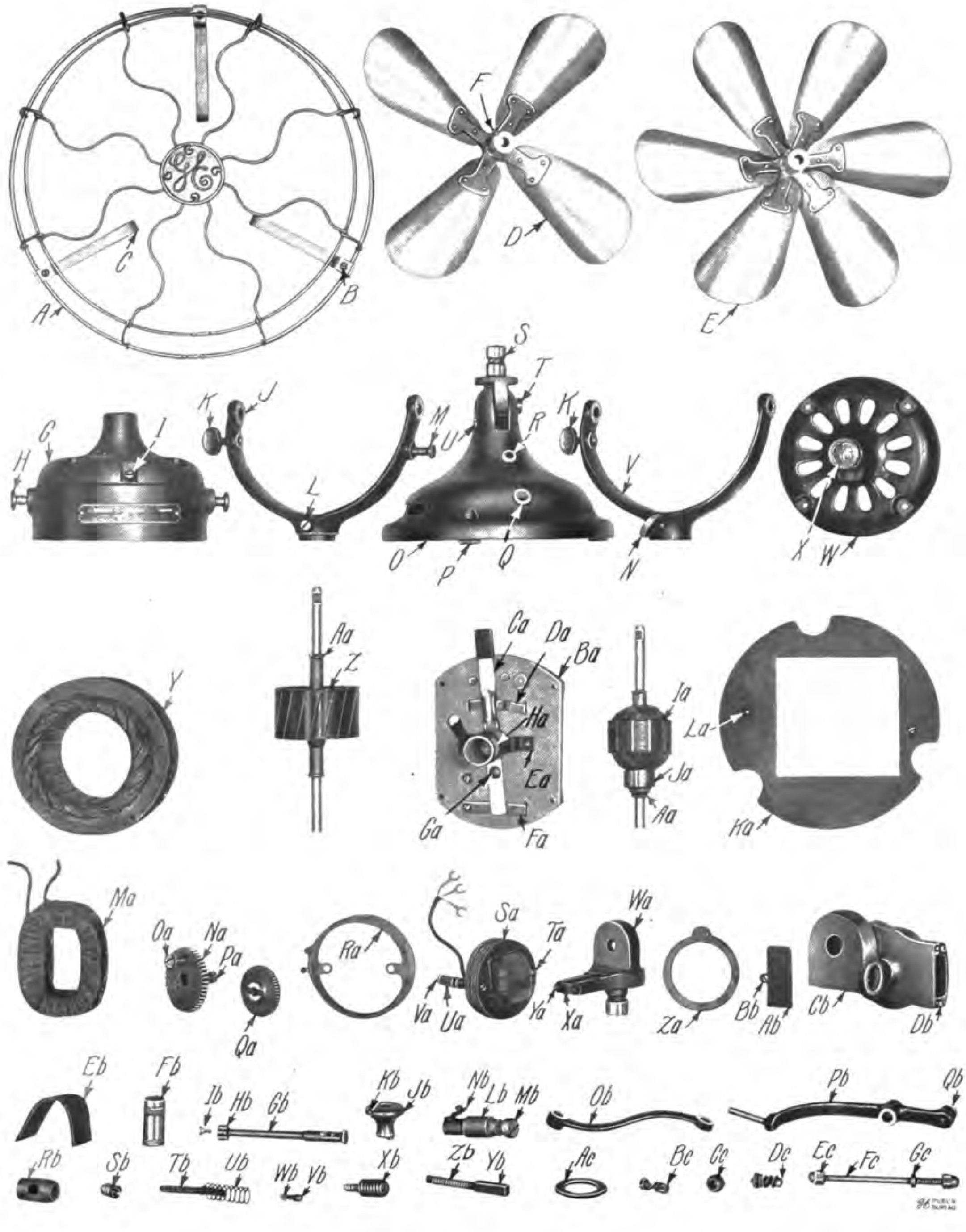
Supply Parts for Alternating and Direct Current Eight-Inch Desk and Wall Bracket Fan Motors

In ordering give name of part, reference letter and serial number of motor.

			List Price
A	Fan guard complete		$1.25
B	Guard clamping screw	per 100	.50
C	Guard support with screw	per 100	5.25
D	Fan complete		.75
E	Set screw for fan	per 100	.35
F	Base with bushing		1.25
G	Soft rubber bushing for base	per 100	2.50
H	Frame—A.C.		1.00
I	Cap with bearing complete—A.C.		2.10
J	Cap with bearing complete—D.C		2.25
K	Frame—D.C.		1.00
L	Field complete of A.C. motors		
	60 cycle 110 volt		4.50
	60 cycle 220 volt		6.50
	40 cycle 120 volt		6.00
	25 cycle 110 volt		6.25
M	Armature complete—A.C.		3.00
N	Armature shaft washer	per 100	.35
O	Armature complete—D.C.		
	110 volt		4.00
	220 volt		5.00
P	Commutator		.90
Q	Field complete—D.C.		
	110 volt		3.50
	220 volt		4.50
R	Field coils for D.C.		
	110 volt	per set	2.00
	220 volt	per set	3.00
S	Regulating switch complete with coil—A.C.		1.50
T	Regulating coil only—A.C.		.85
U	Switch blade		.10
V	Binding post with nut and washer		.10

			List Price
W	Bearing		$1.00
X	Screw for bearing and guard support	per 100	.50
Y	Oil wick collar		.08
Z	Bearing nut	per 100	2.00
Aa	Shaft bearing		.10
Ba	Bearing spring	per 100	2.50
Ca	Fibre base plate		.10
Da	Screw for resistance unit	per 100	.75
Ea	Resistance unit for D.C. motor		.25
Fa	Regulating switch complete with resistance unit—D.C.		.75
Ga	Switch contact plug with nut and washer		.08
Ha	Switch ratchet	per 100	1.75
Ia	Screw for switch blade	per 100	1.00
Ja	Switch contact plate	per 100	1.75
Ka	Brush-holder cap		.08
La	Brush-holder		.20
Ma	Brush		.15
Na	Brush spring	per 100	1.50
Oa	Set screw for brush-holder	per 100	.75
Pa	Oil cup		.08
Qa	Oil wick spring	per 100	2.25
Ra	Oil wick	per 100	2.50
Sa	Thumb nut for regulating switch screw		.04
Ta	Screw for regulating switch and base plate	per 100	.75
Ua	Spacing nut for base plate		.04
Va	Screw for motor cap	per 100	.55
Wa	Spacing sleeve for motor cap	per 100	1.75
Xa	Washer for hinge bolt	per 100	1.75
Ya	Hinge bolt		.08
Za	Thumbnut for hinge bolt		.15

Supply Parts for Alternating and Direct Current Twelve- and Sixteen-Inch Desk and Wall Bracket Fan Motors



Supply Parts for Alternating and Direct Current Twelve- and Sixteen-Inch Desk and Wall Bracket Fan Motors

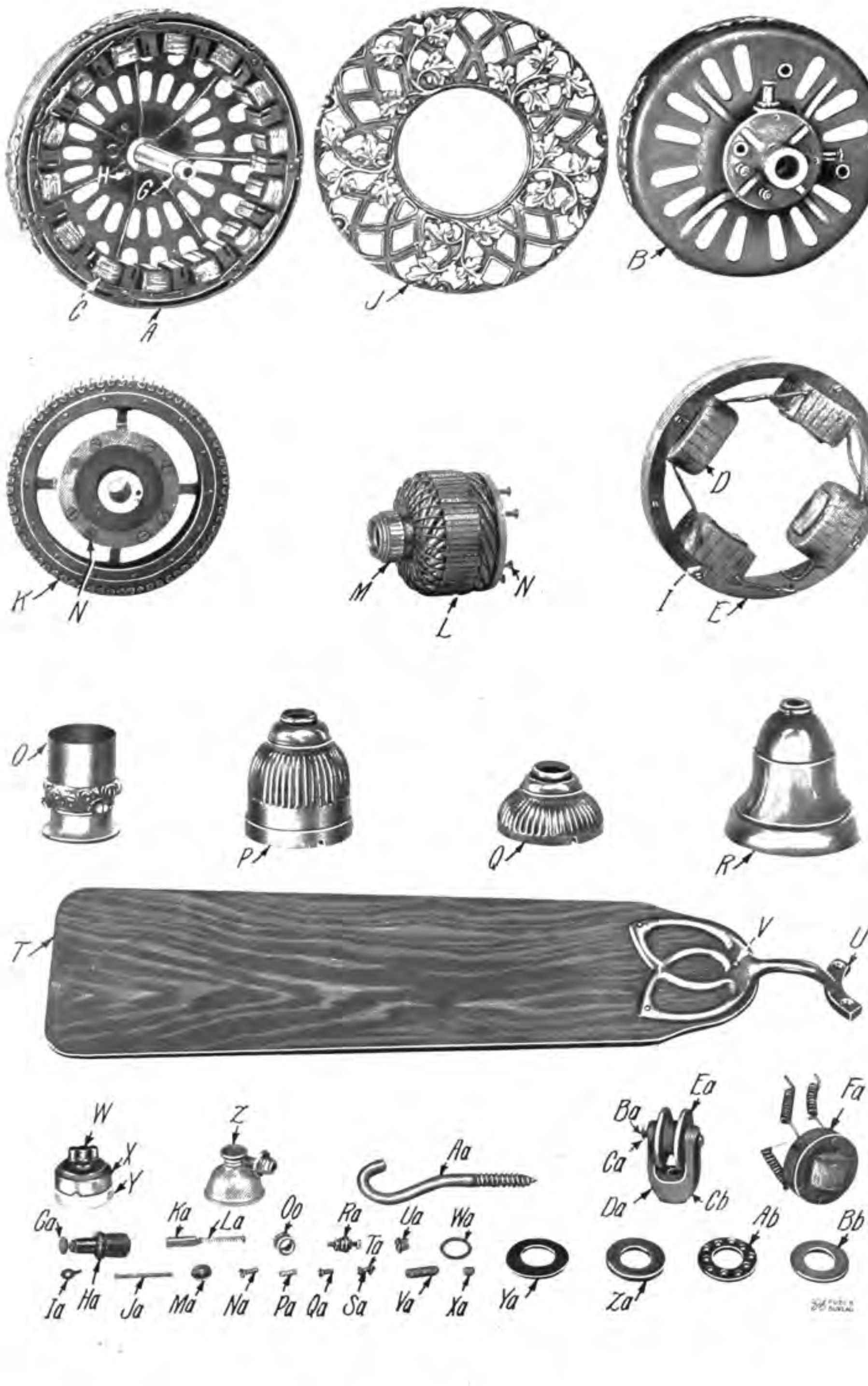
In ordering give name of part, reference letter and serial number of motor.

			List Price
*A	Fan guard complete		
	12″		$2.00
	16″		3.00
*B	Guard clamping screw	per 100	1.00
*C	Guard supports with clips		
	12″		.30
	16″		.50
*D	Fan complete with set screw (4-blade)		
	12″		1.50
	16″		2.00
*E	Fan complete with set screw (6-blade)		
	12″		2.00
	16″		2.50
F	Set screw for fan		.35
†G	Motor frame		
	12″ and 16″ A.C.		3.00
	12″ D.C.		3.00
	16″ D.C.		3.75
H	Trunnion screw		.10
I	Guard support screw	per 100	1.00
J	Yoke for oscillator	per 100	1.00
K	Thumb screw for yoke and frame		.10
L	Set screw for yoke and swivel		.04
M	Stud for rocker arm		.05
N	Thumb screw for yoke and base		.10
*O	Base with screws and bushings		
	12″		2.10
	16″		2.50
P	Soft rubber foot for base	per 100	1.75
Q	Soft rubber bushing for attaching cord	per 100	2.50
R	Soft rubber bushing for field lead		2.00
S	Swivel stud		.60
T	Swivel stud clamping screw		.05
U	Swivel stud set screw		.03
V	Yoke for motors except oscillating		.85
†W	Motor cap		1.25
X	Cap monogram	per 100	2.50
†Y	Field complete for A.C. motors		
	12″ 60 cycles 110 volts		7.50
	60 cycles 220 volts		8.50
	40 cycles 120 volts		8.00
	25 cycles 110 volts		9.00
	16″ 60 cycles 110 volts		8.50
	60 cycles 220 volts		9.50
	40 cycles 120 volts		9.00
	25 cycles 110 volts		9.50
†Z	Armature complete for A.C. motors		3.00
Aa	Armature shaft washers	per 100	.25
Ba	Regulating switch, less coil		.80
Ca	Switch blade		.05
Da	Switch ratchet	per 100	1.75
Ea	Support for resistance unit		.03
Fa	Switch contact plate	per 100	1.75
Ga	Switch blade pivot		1.75
†Ha	Resistance unit for D.C. motors		
	12″ 110 volts		.30
	220 volts		.40
	16″ 110 volts		.30
	220 volts		.40

			List Price
†Ia	Armature complete for D.C. motors		
	12″ 110 volts		$5.00
	220 volts		5.50
	16″ 110 volts		5.50
	220 volts		6.50
Ja	Commutator		1.00
*Ka	Fibre base plate		.08
La	Screw for base plate	per 100	.35
†Ma	Field coil for D.C. motor		
	12″ 110 volt	per set	2.75
	220 volt	per set	4.00
	16″ 110 volt	per set	3.25
	220 volt	per set	4.25
Na	Spur gear		1.00
Oa	Screw for spur gear and connecting rod		.04
Pa	Screw with nut for spur gear		.04
Qa	Worm gear		.60
†Ra	Resistance unit for A.C. motors		.30
†Sa	Regulating coil for A.C. motors		1.00
Ta	Screw for regulating coil	per 100	.80
Ua	Spacing sleeve for regulating coil screw	per 100	1.75
Va	Nut for regulating coil screw	per 100	.50
Wa	Swivel for oscillating motor		1.75
Xa	Clamp for oscillating swivel		.85
Ya	Screw for swivel clamp	per 100	.35
Za	Shield for spur gear	per 100	2.50
Ab	Gear case lid	per 100	1.75
Bb	Screw for gear case lid	per 100	.35
Cb	Gear case		1.50
Db	Screw fast'ng gear case in position	per 100	1.75
*Eb	Field wedge—D.C.	per 100	1.75
Fb	Oil cup		.15
Gb	Gear spindle		.25
Hb	Pinion for gear spindle		.20
Ib	Screw for gear spindle		.04
Jb	Operating knob complete		.25
Kb	Set screw for operating knob	per 100	.21
Lb	Brush-holder comp. with brush and cap	per set	1.25
Mb	Brush-holder cap		.15
Nb	Brush-holder terminal clip with screw		.08
*Ob	Connecting rod		.35
Pb	Rocker arm		.50
Qb	Pivot screw for rocker arm		.05
Rb	Armature shaft bearing		.10
Sb	Oil wick collar		.04
Tb	Oil wick		.03
Ub	Oil wick spring		.02
Vb	Locking pin for operating knob	per 100	1.00
Wb	Compression spring for operating knob	per 100	.15
Xb	Worm		.35
Yb	Brush		.10
Zb	Brush spring		.02
Ac	Bearing washer for swivel stud		.10
Bc	Switch contact plug with nut and washer		.04
Cc	Ball for rocker arm		.10
Dc	Binding post complete		.10
Ec	Cap nut for field stud		.04
Fc	Field stud	per 100	1.75
Gc	Clamping nut for field stud	per 100	.50

*State size 12″ or 16″.
†State rating and serial number of motor.

Supply Parts for Alternating and Direct Current Ceiling and Column Fan Motors



Supply Parts for Alternating and Direct Current Ceiling and Column Fan Motors

In ordering give name of part, reference letter and serial number of motor.

			List Price	§List Price
*A	Frame, complete with field		$27.50	$26.00
†B	Frame		8.25	
*C	Single field coil		.35	
†D	Single field coil		1.50	
†E	Field, complete with coils		11.00	
†F	Screw for field	per 100	.75	
G	Shaft		2.10	
H	Set screw for shaft	per 100	1.75	
I	Coil clamp	per 100	.75	
J	Cover—D.C.		2.50	1.50
	Cover—A.C.		3.00	2.00
*K	Armature		11.00	
†L	Armature, complete with commutator		22.00	
M	Commutator		2.50	
N	Blade holder screw	per 100	.50	
O	Switch support		1.50	1.00
*P	Motor canopy		.80	
†Q	Motor canopy		.80	
R	Ceiling canopy		.80	
S	Set screw for ceiling canopy	per 100	1.75	
T	Blade		.75	
U	Blade-holder		.55	
V	Blade screw	per 100	.50	
W	Switch key			
X	Switch cover			
Y	Switch complete			
Z	Oil can		.10	
Aa	Hanger hook		.08	
Ba	Hanger pin		.05	

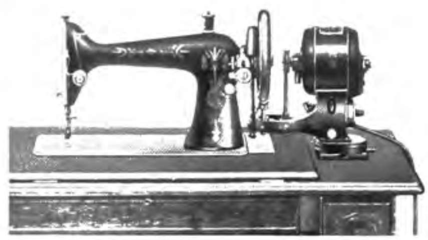
			List Price
Ca	Spring cotter for hanger pin		$0.50
Da	Hanger complete		.65
Ea	Hanger insulator		.10
Fa	Regulator coil		1.75
Ga	Brush-holder cap		.08
Ha	Brush-holder complete		.50
Ia	Lead clip	per 100	1.75
Ja	Screw for regulator coil	per 100	.65
Ka	Brush		.15
La	Brush spring	per 100	1.75
Ma	Binding post washer	per 100	2.50
Na	Cover screw	per 100	3.50
Oa	Soft rubber bushing	per 100	1.50
Pa	Brush-holder set screw	per 100	3.50
Qa	Lower canopy screw	per 100	1.75
Ra	Binding post, complete		.35
Sa	Switch screw	per 100	.50
Ta	Switch screw washer	per 100	1.50
Ua	Screw plug		.08
Va	Set screw for switch support		.05
Wa	Lead washer for shaft and switch support	per 100	2.50
Xa	Set screw for suspension	per 100	3.50
Ya	Leather washer for bearing		3.50
Za	Upper bearing washer		.80
Ab	Ball bearing		.20
Bb	Lower bearing washer		.80
Cb	Set screw for hanger	per 100	1.75

*For A.C. Motor. †For D.C. Motor. § For Ornamental Motors.

Small Power Motors

Domestic Buffing and Grinding Motor

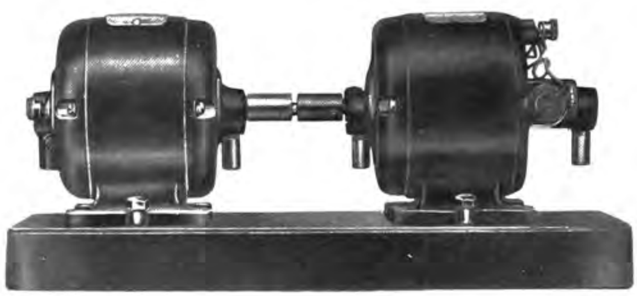
Commercial Buffing and Grinding Motor



Sewing Machine Motor

Alternating Current Motor

Direct Current Motor



Motor Generator Set

Direct Current Portable Drill

Alternating Current Portable Drill

STEAM & AIR FLOW METER

GENERAL ELECTRIC COMPANY

General Electric Company

Schenectady, N.Y.

SUPPLY DEPARTMENT

January, 1910

Bulletin No. 4720

STEAM AND AIR FLOW METERS

THE economical generation or consumption of steam, like that of electricity, gas and other commodities, depends on accurate information which will show the amount being generated, consumed or distributed. Equally important is the determination of the exact amount of air being delivered or consumed, where air is used in place of steam as the working agent.

The Recording and Indicating Steam and Air Flow Meters manufactured by the General Electric Company provide a means for obtaining such information.

RECORDING FLOW METER, TYPE R, FORM D

RECORDING FLOW METER

The Recording Flow Meter will accurately record the rate of flow of steam in lbs. per hour, in pipes of any diameter, at any condition of temperature, pressure or moisture met in commercial practice. It will give an accurate record on periodically intermittent flow, such as occurs in operating reciprocating steam engines, pumps, etc., as well as on constant flow, provided it is recalibrated after it is installed, or the arrangement of the piping permits the insertion of the nozzle plug at a point in the steam main where the flow is constant. Since all meters are carefully calibrated for constant flow before leaving the factory, it is necessary to recalibrate only when the flow is intermittent.

No change whatever in the main piping system of the station is necessary to install the meter, and as none of the steam being measured passes through it, the meter always remains cool. The meter may be located in any convenient place in the station so long as it is placed on a lower level than the nozzle plug. Drop in pressure caused by the insertion of the nozzle plug in the steam main is inappreciable, even at very high rates of flow.

SERVICE FOR WHICH THE METER IS ADAPTED

Recording the total amount of steam generated by a battery of boilers.

Recording the amount of steam delivered to any department of a manufacturing plant.

Recording the amount of steam sold for power, heating or manufacturing purposes.

Enabling equalization of load on individual boilers of a battery.

Means of discovering losses originating from leaks between boilers and points of consumption; *e.g.*, defective traps, gaskets and valves, where the loss otherwise could not be detected.

Means of discovering internal leaks in boilers shown by difference in the water input and the steam output.

Enabling determination of deterioration of efficiency of a boiler due to the formation in scale, etc.

Means of determining the efficiency in the method of stoking.

Principle of Operation

If the temperature and pressure of the gas be constant, the rate of flow in a pipe will be proportional to the velocity. To measure this velocity, a nozzle plug is screwed into the pipe at the point where the flow is to be measured. One set of openings, known as the leading set, extends horizontally across the steam main and faces against the direction of flow. The other three openings near the center of the plug constitute the trailing set. The steam, impinging against the leading set of openings sets up a pressure in them which is equal to the static pressure plus a pressure due to the velocity head. The pressure in the trailing set is equal to the static pressure minus a pressure due to the velocity head.

This difference of pressure existing in the two sets of openings is communicated through separated longitudinal chambers to the outer end of the plug and from there by proper piping to the meter.

Description

The meter consists of two cylindrical hollow cups filled to about half their height with mercury and joined together at the bottom by a tube. This arrangement of cups and connecting tube forms a "U" tube, which is supported on and free to move as a balance about a set of knife edges.

NOZZLE PLUG

A difference of pressure in the nozzle plug is communicated to the cups by flexible steel tubing placed inside the case. This difference of pressure causes the mercury to rise in the left hand cup and fall the same amount in the right hand cup until the unbalanced column of mercury exactly balances the difference in pressure.

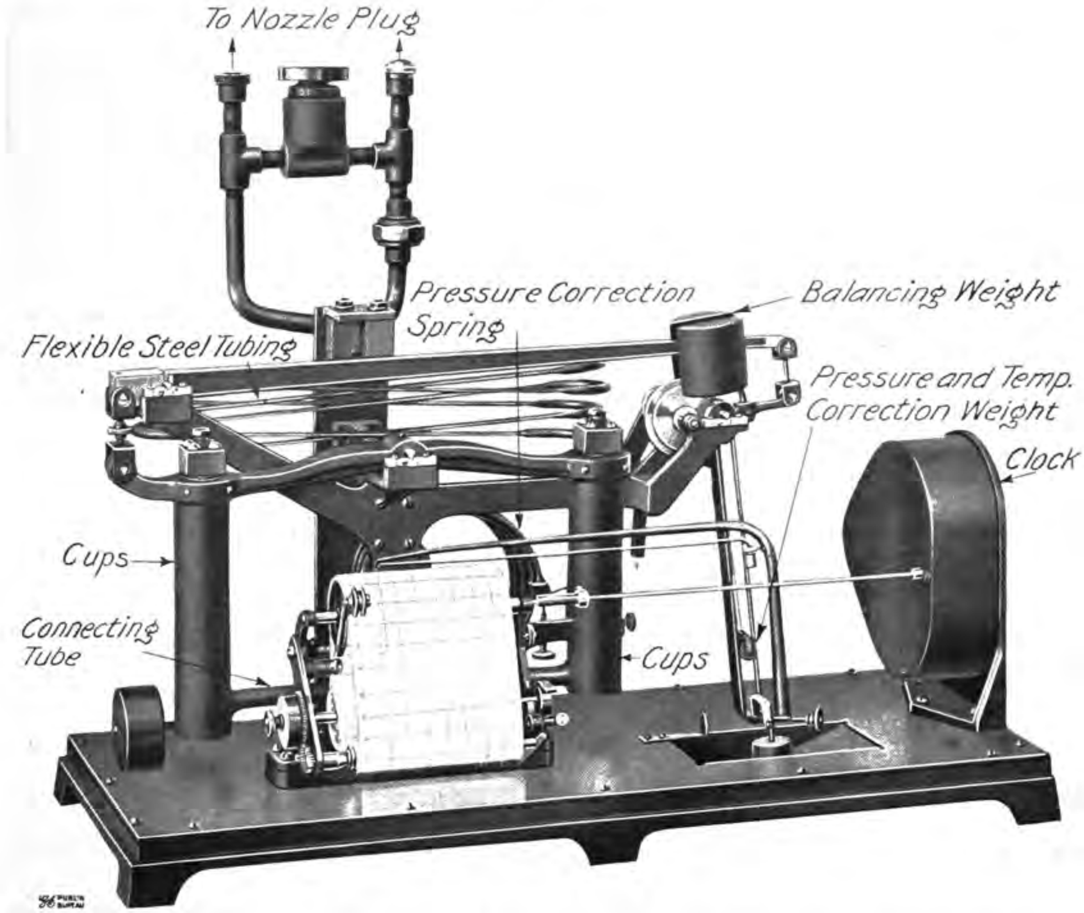
By the displacement of the mercury, the beam carrying the cups moves downward on the left hand side of the knife edges. This side will descend until the moment of the weights on the right of the knife edges exactly balances the moment caused by the displacement of the mercury in the right hand cup. The motion of the beam is multiplied by levers and actuates the pen which moves in proportion to the amount of mercury displaced.

The time element of the meter consists of an eight day clock which drives the drum feeding the paper. The paper on which the record is made is so calibrated that the rate of flow in lbs. per hour may be read at any instant or the average rate calculated for a given time. Each meter is equipped with a reroll device which is operated by a spring mechanism and this device is of sufficient capacity to accommodate one complete roll of paper.

Compensating Devices for Pressure and Superheat Variation

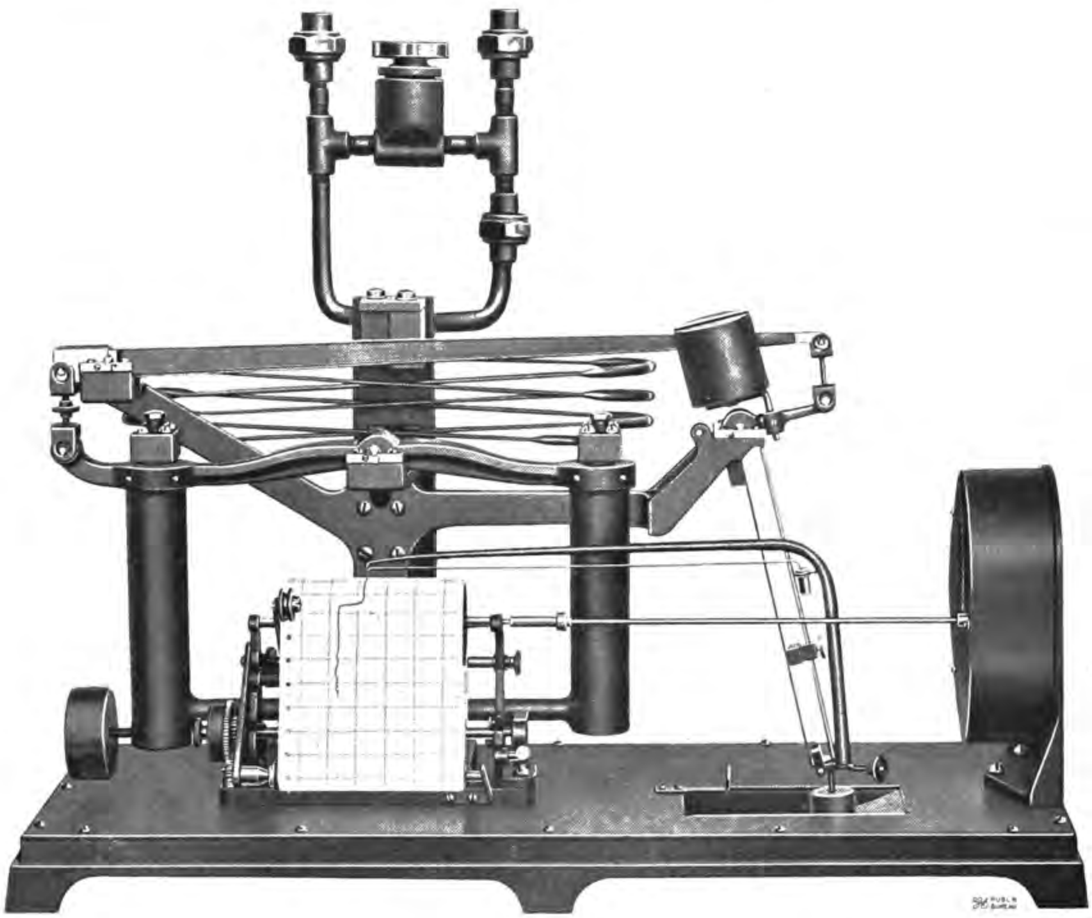
The velocity of the steam being measured may remain practically constant while the pressure and temperature vary over a considerable range. Therefore, to obtain the actual rate of flow in lbs. per hour, it is necessary to compensate for pressure and temperature fluctuations.

Compensation is made automatically in the case of pressure variations. A hollow spring, similar to the pressure spring in a steam gauge, is connected so as to be influenced by the static pressure at the point where the flow is being measured. Any variation of the static pressure causes the spring to expand or contract, and this movement actuates a small correction weight in such a manner as to affect the deflection of the pen so that the indicated rate of flow recorded is correct for the pressure existing in the steam main.



RECORDING FLOW METER, TYPE R, FORM D, WITH AUTOMATIC PRESSURE CORRECTION DEVICE

Compensation for temperature variations is made by an independent hand adjustment of the same correction weight which corrects the reading for pressure fluctuations. This adjustment is made by increasing or decreasing the distance of the correction weight from its point of suspension and this distance is determined from a curve sent out with each meter.



RECORDING FLOW METER, TYPE R, FORM D, WITHOUT AUTOMATIC PRESSURE CORRECTION DEVICE

METERS SUITABLE FOR MEASURING FLOW AT CONSTANT TEMPERATURE AND PRESSURE

In many stations, the temperature and pressure at which steam is delivered is held practically constant. To meet this condition the Recording Flow Meter will be furnished without the automatic pressure compensating device. The meters are calibrated by the factory to give the true rate of flow in lbs. per hour at the temperature and pressure existing in the steam main where the flow is to be measured.

If it is desired to measure the rate of flow at any other temperature and pressure than that at which the meter was calibrated, proper corrections can be readily made by setting the correction weight at a greater or less distance from its point of suspension. The exact distance for setting this weight, measured from its point of suspension for a given pipe diameter, temperature and pressure is found by referring to a curve sent out with each meter.

Finish

Interior and working parts of the meter are finished in dull black and nickel. The case is finished in dull black and nickel with glass front and top.

Weight

The meter weighs complete 55 lbs.

Dimensions 23"x9"x13".

FOR MEASURING THE RATE OF FLOW OF STEAM—PRESSURE 25 TO 225 LBS. GAUGE

WITH AUTOMATIC PRESSURE CORRECTION DEVICE		WITHOUT AUTOMATIC PRESSURE CORRECTION DEVICE	
*Cat. No.	Inches Pipe Diam.	*Cat. No.	Inches Pipe Diam.
108142	2	108150	2
108143	3	108151	3
108144	4	108152	4
108145	6	108153	6
108146	8	108154	8
108147	10	108155	10
108148	12	108156	12
108149	14	108157	14

*Cat. Nos. include meter complete with nozzle plug.

Meters can be furnished for pipes of larger diameter if desired.

WHEN ORDERING RECORDING FLOW METERS ALWAYS GIVE THE FOLLOWING INFORMATION

Cat. No. and type of meter desired.

Cat. Nos. of additional nozzle plugs required.

Nominal pipe diameter at point of inserting the nozzle plug.

Average maximum and minimum steam pressure in lbs. gauge.

State whether steam is wet, saturated or superheated.

(If wet, give per cent. moisture; if superheated, give temperature in degrees Fahrenheit.)

Maximum amount of steam flowing through the pipe in lbs. per hour. (Approximate.)

State whether steam is used for engine, turbine, heating or manufacturing process.

(If used for engine or turbine, give type and rating.)

Include a sketch showing plan and elevation of the piping between the boiler and the apparatus consuming the steam. Give dimensions. Indicate on the sketch the point at which you desire to locate the meter.

INDICATING FLOW METER, TYPE I, FORM F

The Type I, Form F Flow Meter will meet general commercial requirements where an indicating rather than a recording instrument is desired. Owing to its simplicity of construction, light weight and durability, it will be found especially useful for testing work, locating trouble due to leaks, etc.

This meter will indicate the instantaneous rate of flow of steam, air, or any gas at any condition of temperature, pressure or moisture

INDICATING FLOW METER, TYPE I, FORM F

met in commercial practice. The meter, if used to measure steam flow, gives a true indication of the instantaneous rate of flow in pounds per hour per sq. inch of pipe cross-sectional area. If used to measure air, the units are in cubic feet of free air at 70° Fahrenheit, but the same meter can not be used interchangeably for measuring steam and air flows.

When used on periodically intermittent flow, the same conditions must be satisfied in regard to installation and recalibration as in the case of the recording meter.

The piping, reservoirs, and nozzle plugs are of the same general design as those used with the recording meter.

The meter is portable and is provided with leather carrying strap.

INDICATING FLOW METER, TYPE I, FORM F
FOR MEASURING STEAM FLOW

Service for Which the Meter is Adapted For Measuring Steam Flow

The indicating flow meter will serve the same purposes and give the same information as the recording meter with the exception that no continuous record is made, all readings being instantaneous values of the rate of flow.

Since the Type I, Form F meter will measure the instantaneous rate of flow independently of pipe diameter, pressure or temperature, a single meter may be utilized to obtain readings in any number of different pipe lines throughout a station. It is necessary only that each pipe be provided with the proper nozzle plug to which the meter can be connected.

INDICATING FLOW METER, TYPE I, FORM F FOR MEASURING AIR FLOW

For Measuring Air Flow

The Type I, Form F meter can be furnished for measuring the instantaneous rate of flow of air as well as steam. This opens up an additional field of usefulness for the meter where air is used for power or in manufacturing processes. The meter will indicate the exact amount of air furnished to mines, blast furnaces, forced-draught apparatus, compressed air machinery, etc.

Principle of Operation and Description

Use is made of the nozzle plug for obtaining a difference in working pressure proportional to the velocity in exactly the same manner as in the recording meter.

The meter itself consists of an iron casting which is cored out to form a "U" tube. This is filled for part of its height with mercury or water depending on whether the meter is used for measuring steam or air flow. (See Fig. A.) A difference of pressure in the nozzles of the plug causes a difference of level of the liquid in the "U" tube. A small float suspended by a silk cord actuates a pulley over which the cord passes. The pulley in turn moves a small bar magnet on the end of the shaft next to the dial in proportion to the change in level of the working fluid in the "U" tube. (See Fig. A.)

The indicating needle is mounted in a separate cylindrical casing. On the inner end of the needle shaft another bar magnet is mounted, which is free to turn in the same plane as the magnet on the inside of the meter casting. The mutual attraction of these two magnets keeps them always parallel and the necessity of a packed joint in transmitting the motion of the pulley to the indicating needle is thus eliminated.

When the valve in the by-pass is open, the dial can be rotated until the indicating needle reads zero. Opening of the valve also prevents blowing out of the working fluid in the "U" tube by excessive pressure in either leg.

Method of Making Observations

The proper adjustments for pipe diameter, temperature and pressure are readily made by setting the graduated cylinders (see Fig. A) which actuate the rack carrying the pointer. When these settings are made, the rack is rotated by hand until the pointer coincides with the indicating needle. The point on the graduated scale at the intersection of the needle and pointer gives the true instantaneous rate of flow per sq. in. of pipe cross section.

If the temperature and pressure of the gas remain practically constant, but one adjustment of the graduated cylinders is necessary for making observations.

Finish

The meter is finished in black japan and nickel.

Weight

The meter weighs complete 25 lbs.

WHEN ORDERING (INDICATING) STEAM FLOW METERS, ALWAYS GIVE THE FOLLOWING INFORMATION

Cat. No. and type of meter desired.

Cat. Nos. of additional nozzle plugs required.

Nominal pipe diameter at the point of inserting the nozzle plug.

Average maximum and minimum steam pressure in lbs. gauge.

State whether steam is wet, saturated or superheated.

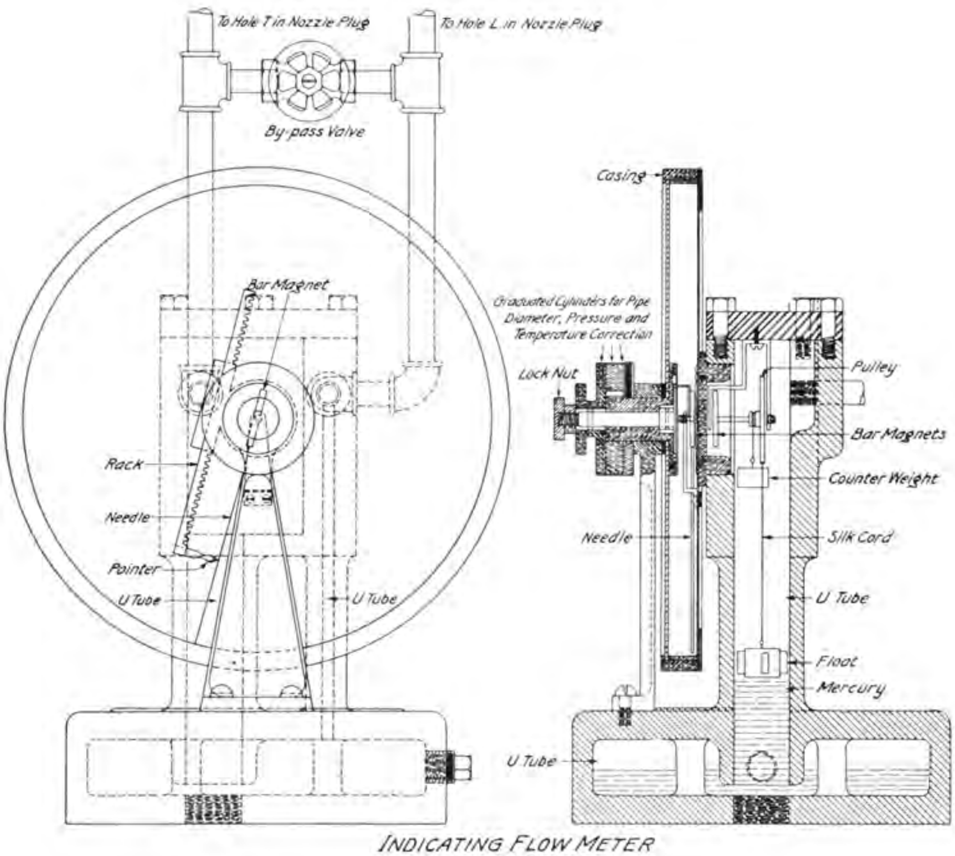
(If wet, give per cent. moisture; if superheated, give temperature in degrees Fahrenheit.)

Maximum amount of steam flowing through the pipe in lbs. per hour (Approximate.)

State whether steam is used for engine, turbine, heating or manufacturing process.

(If used for engine or turbine, give type and rating.)

Include a sketch showing plan and elevation of the piping between the boiler and the apparatus consuming the steam. Give dimensions. Indicate on the sketch the point at which you desire to locate the meter.



INDICATING FLOW METER
TYPE I FORM F
Figure A

FOR MEASURING THE RATE OF FLOW OF STEAM

*CAT. NO.

Pressure 10-40 lbs. abs. Dial range 0-260 lbs. per sq. in. pipe area	Pressure 20-80 lbs. gauge. Dial range 0-700 lbs. per sq in. pipe area	Pressure 75-225 lbs. gauge. Dial range 0-1825 lbs. per sq. in pipe area	Inches Pipe Diam.
Superheat Scale—4% Moisture to 260° Fahrenheit			
108158	108166	108174	2
108159	108167	108175	3
108160	108168	108176	4
108161	108169	108177	6
108162	108170	108178	8
108163	108171	108179	10
108164	108172	108180	12
108165	108173	108181	14

*Cat. Nos. include meter complete with nozzle plug.
Meter can be furnished for pipes of larger diameter if desired.

WHEN ORDERING (INDICATING) AIR FLOW METERS, ALWAYS GIVE THE FOLLOWING INFORMATION

Cat. No. and type of meter desired.

Cat. Nos. of additional nozzle plugs required.

Nominal pipe diameter at point of inserting the nozzle plug.

Average maximum and minimum air pressure in lbs. gauge.

Range of temperature of air and normal temperature in degrees Fahrenheit.

Maximum amount of air flowing through the pipe in cu. ft. of free air. (Approximate.)

State for what purpose air is used.

Include sketch showing plan and elevation of the piping. Give dimensions. Indicate on the sketch the point at which you desire to locate the meter.

FOR MEASURING THE RATE OF FLOW OF AIR

*CAT. NO.

Pressure 12-35 lbs. abs. Dial range 0-21 cu. ft. at 70° per sq. in. pipe area	Pressure 10-120 lbs. gauge. Dial range 0-124 cu. ft. at 70° per sq. in. pipe area	Inches Pipe Diam.
Temperature Scale 30° to 210° Fahrenheit		
108182	108190	2
108183	108191	3
108184	108192	4
108185	108193	6
108186	108194	8
108187	108195	10
108188	108196	12
108189	108197	14

*Cat. Nos. include meter complete with nozzle plug.
Meters can be furnished for pipes of larger diameter if desired.

THE INDICATING FLOW METER, TYPE I, FORM B

This meter is designed as a laboratory meter where maximum flexibility of operation is of fundamental importance. It is adapted to measure the instantaneous rate of flow at very high or very low velocities. The Type I, Form B meter is furnished only for measuring the instantaneous rate of flow of steam.

Principle of Operation

The principle of operation of this meter is the same as the Recording Flow Meter, Type R, Form D, and the Indicating Flow Meter, Type I, Form F.

Description

The meter consists of a "U" tube with glass legs which are filled for part of their length with mercury. Located centrally with respect to the glass tubes is a cylindrical chart from which is read the rate of flow. Suitable auxiliary scales are provided so that the indication is correct at any condition of pressure and temperature and for pipes of any diameter.

The two legs of the "U" tube are connected as shown with the two series of openings in the nozzle plug. There are no moving parts exposed to the fluid being metered, and consequently no wear or friction to be overcome. No foundation is necessary as the meter is provided with leveling screws so that it may be mounted on any approximately level surface.

Method of Making Observation

After the meter has been filled and the piping connected the level is adjusted and the steam is turned on. It remains only to adjust the meter for the pressure and temperature of the fluid. This is done by rotating the inner handwheel at the lower end of the meter. The two sights are set to coincide with the meniscuses of the mercury in the glass "U" tube. The indication of the movable pointer on the chart multiplied by a constant depending on the inclination of the meter is the rate of flow in lbs. per hour per sq. in. of pipe cross section. The inclination of the meter from the vertical position is easily varied, and in this way it is enabled to indicate very high and very low rates of flow with equal facility.

INDICATING FLOW METER, TYPE I, FORM B

Finish

The meter is finished in black japan and nickel.

Weight

The meter weighs complete 45 lbs.

FOR MEASURING THE RATE OF FLOW OF STEAM

*CAT. NO. Pressure 75-225 lbs. Gauge. Chart range 0-1220 lbs. per sq. in. pipe area	Inches Pipe Diam.
Superheat Scale 4% Moisture to 260° Fahr.	
108198	2
108199	3
108200	4
108201	6
108202	8
108203	10
108204	12
108205	14

*Cat. Nos. include meter complete with nozzle plug.

Meters can be furnished for pipes of larger diameter if desired.

WHEN ORDERING (INDICATING) STEAM FLOW METERS, ALWAYS GIVE THE FOLLOWING INFORMATION

Cat. No. and type of meter desired.

Cat. Nos. of additional nozzle plugs required.

Nominal pipe diameter at the point of inserting the nozzle plug.

Average maximum and minimum steam pressure in lbs. gauge.

State whether steam is wet, saturated or superheated.

(If wet, give per cent. moisture; if superheated, give temperature in degrees Fahrenheit.)

Maximum amount of steam flowing through the pipe in lbs. per hour. (Approximate.)

State whether steam is used for engine, turbine, heating or manufacturing process.

(If used for engine or turbine, give type and rating.)

Include a sketch showing plan and elevation of the piping between the boiler and the apparatus consuming the steam. Give dimensions. Indicate on the sketch the point at which you desire to locate the meter.

NOZZLE PLUGS

FOR USE WITH RECORDING FLOW METERS TYPE R, FORM D, FOR MEASURING STEAM FLOW		FOR USE WITH INDICATING FLOW METERS, TYPE I, FORM F, FOR MEASURING STEAM FLOW	
*Cat. No.	Inches Pipe Diameter	*Cat. No.	Inches Pipe Diameter
103541	2	103549	2
103542	3	103550	3
103543	4	103551	4
103544	6	103552	6
103545	8	103553	8
103546	10	103554	10
103547	12	103555	12
103548	14	103556	14

FOR USE WITH INDICATING FLOW METERS TYPE I, FORM F, FOR MEASURING AIR FLOW		FOR USE WITH INDICATING FLOW METERS, TYPE I, FORM B, FOR MEASURING STEAM FLOW	
*Cat. No.	Inches Pipe Diameter	†Cat. No.	Inches Pipe Diameter
103557	2	103565	2
103558	3	103566	3
103559	4	103567	4
103560	6	103568	6
103561	8	103569	8
103562	10	103570	10
103563	12	103571	12
103564	14	103572	14

* Cat. Nos. include separators, valves and piping between nozzle and separators.

† Cat. Nos. include valves and piping between nozzle plug and valves; no separators are necessary.

Nozzle plugs for pipes of larger diameter can be furnished if desired.

General Electric Company
Schenectady, N.Y.

SUPPLY DEPARTMENT

October, 1910 — *Copyright, 1909 by General Electric Company* — **Bulletin No. 4721A*

THOMSON DIRECT CURRENT WATTHOUR METERS TYPES C-6, C-7 AND CQ

THE Thomson Watthour Meter in its simplest form embodies three necessary elements, namely, a motor causing rotation, a generator providing the necessary load or drag, and a registering device, the function of which is to integrate the instantaneous values of the electrical energy passing in the system to be measured.

The element of the direct current Thomson Watthour Meter causing rotation is an electric motor which, being without iron in its fields and armature and rotating at a very low speed, has little or no counter electromotive force. Its armature current, therefore, is independent of the speed of rotation, and is constant for any definite potential applied at its terminals. The torque of this motor being proportional to the product of its armature and field currents, must vary directly as the energy passing through its coils. In order then, that the meter shall record correctly it is necessary only to provide some means for making the speed proportional to the torque. This is accomplished by applying a load or drag, the strength of which varies directly as the speed. This leads to a brief consideration of the generator element.

THOMSON WATTHOUR METER
TYPE C-6

The electromotive force induced in a conductor passing through a field of constant strength is proportional to the number of magnetic lines of force cut in a given time; therefore, if the resistance of the conductor remains constant, the drag is proportional to the speed. An aluminum disk is directly connected to the meter armature by means of a vertical shaft and, passing between the jaws of permanent magnets (the field of fixed strength), constitutes the second necessary element of the Thomson Watthour Meter.

A means of combining all the instantaneous values of energy is found in the registering mechanism, the third element of the Thomson Watthour Meter. This is a revolution counter properly calibrated in the desired energy unit, for which purpose the watthour or kw. hour has become almost universally adopted.

These three fundamentals are embodied in the Thomson Watthour Meters for direct current service, Types C-6, C-7 and CQ. Their development, application and perfection, as described herein, have been accomplished only after years of investigation and experiment, with closest attention to the most exacting requirements.

* *Supersedes Bulletin No. 4721.*
Second Edition.

The following general description applies also to the Type C-7 meter, which is for use on circuits of from 500-600 volts.

TYPE C-6

Method of Support

The meter is supported by three lugs, the upper one of which is key-holed, and the lower right-hand one slotted. This permits of rapid and accurate levelling as the top screw can be inserted and the meter hung thereon approximately level. The right-hand screw may then be placed in position and the meter adjusted as may be required before forcing the screw tightly home.

Cover

The cover which is slightly domed is fastened by studs and wing nuts and is removed directly toward the front. This obviates the necessity of leaving a space above the meter sufficient to remove the cover. The doming of the cover increases its stiffness and makes it difficult to bend it out of shape by screwing the sealing nuts down too tightly or by other means, so that the cover touches the disk.

Sealing

The meter may be sealed by the wing nuts that hold the cover in place. A sealing wire is passed through the wing nuts and their respective studs, thus necessitating the use of but one wire. This method of sealing is a positive preventive of tampering without detection.

BINDING POSTS AND DUSTPROOF QUALITIES

The binding posts are situated at the sides of the meters. It is standard practice to furnish flexible cable leads provided with copper terminals for meters of 100 amp. capacity and above. For meters of lower capacity, the leading-in wires are fastened in suitable brass binding posts with set screws. The leading-in holes are provided with insulating bushings and equipped with felt guards which fit closely about the wires after insertion and exclude both dust and insects. The groove which entirely surrounds the edge of the cover is lined with a cotton felt strip and the dial window is set in putty further enhancing its dustproof qualities.

Register

The register is of the four pointer type, registering directly in kw. hours, in all sizes up to 30 kw. In meters of capacities of 30 kw. or above, a dial constant of 10, 100, 1000, etc., is required. By adopting this system the actual energy unit remains the same in all sizes, and the reading is obtained by the addition of one or more cyphers to the indication of the pointers. The dial face is made of porcelain having a dull finish. The figures are large and black, which, with the pure white background, renders the dial very legible and minimizes the chances of error in reading.

Bearings

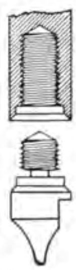
Almost any material of a fair degree of hardness and capable of receiving a high polish may be made into a bearing for a meter, but experience has proved that but two substances will continue to give satisfactory operation. These are the Oriental sapphire and the diamond. It is necessary that every stone be selected with the greatest care, undergo the most severe tests and be subjected to a most careful cutting, grinding and polishing to insure a satisfactory bearing. The stones that are discarded by the General Electric Company as unfit for use form a very large proportion of the company's entire purchases. The General Electric Company has but recently perfected a method for grinding and polishing diamonds in a concave form, by means of which is secured a surface unsurpassed even by jewels having a flat face. Diamond bearings are practically indestructible and are very desirable for large meters.

The cup diamond bearing is furnished in all Type C-6 meters of capacities of fifty kilowatts or above; the sapphire jewels are furnished in meters of smaller sizes.

All jewel bearings in meters manufactured by the General Electric Company are mounted upon spring supported plungers. It has been determined by a series of exhaustive tests that the length of jewel life depends upon the relation that the weight of the moving element bears to the strength of the supporting spring. For this reason all jewel springs are carefully gauged by high and low limit weights, any springs not coming within the prescribed limits being rejected.

Pivots

The pivots or shaft ends which are used in Thomson Watthour Meters are unique in their construction, inasmuch as they may be removed by unscrewing them from the shaft or spindle proper. It is a well known fact that a roughened or damaged pivot is almost invariably coincident with a defective jewel and for this reason the General Electric Company recommends, and the majority of central stations make a practice of, inserting a new pivot in a meter at the time of replacing a worn jewel whether or not the pivot itself appears to be damaged. Quite frequently it will be found that the shaft of a meter has become more or less magnetized, and in case a steel pivot is used great difficulty is experienced in removal. To avoid this a brass pivot has been adopted, into the end of which is forced a small piece of the highest grade piano wire, drawn under such enormous pressure that the finest grain is obtained. This piano wire then, glass hardened and highly polished, forms the actual bearing surface of the rotating parts.



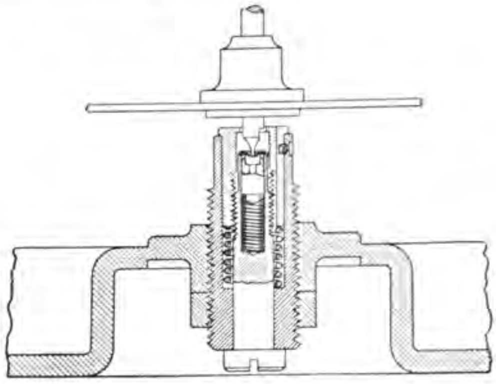
PIVOT

Top Bearing Plug

The form of the top bearing plug is similar to that used in meters of earlier design. The bearing hole is of just sufficient size to permit the meter shaft to revolve freely.

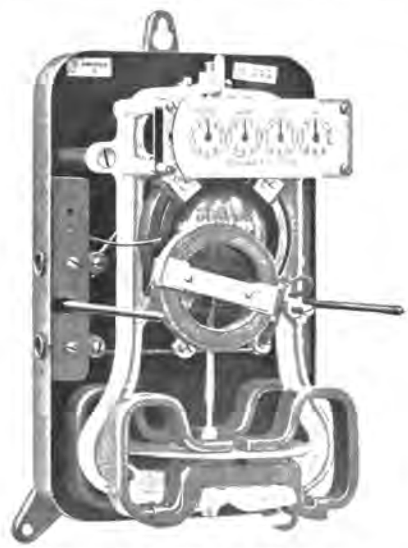
Shipping Device

For protection during shipment and any subsequent transportation, the Type C-6 meter is provided with a clamping device which holds the moving element securely in position. This consists of a brass cap which is normally drawn down and held by the jewel screw against the force of a lifting



METER SHIPPING DEVICE

spring. When the cap is drawn down the moving element is free to rotate. When the jewel screw is backed out the cap is released



INTERIOR OF TYPE C-6 THOMSON WATTHOUR METER

and the spring causes it to lift the moving element from the jewel and hold it firmly.

Shaft

The armature shaft, or spindle, is tubular, combining great strength with extreme lightness. The strength of the shaft is such that it will withstand the stresses of armature and disk without buckling, yet the weight is exceedingly small compared with that of a solid shaft such as has been used heretofore.

Accessibility

The entire mechanism is assembled upon a skeleton casting which in turn is fastened within the meter casing. By removing four screws and disconnecting the windings from the terminals the mechanism may be removed for inspection and repair.

The plane of the field coils is parallel to the back of the meter, hence by the removal of the front series coil and the register, and the loosening of the shunt field coil, the moving element may be taken out. This does not necessitate the removing of the magnets and, therefore, full load calibration is unaffected.

An automatic link between the worm wheel and the register permits removal and replacement of the latter without in any way affecting the proper mesh of gear and worm.

The four magnets are permanently fastened together in sets of two and each set may be removed from its supporting shelf by the loosening of two screws.

Commutator and Brushes

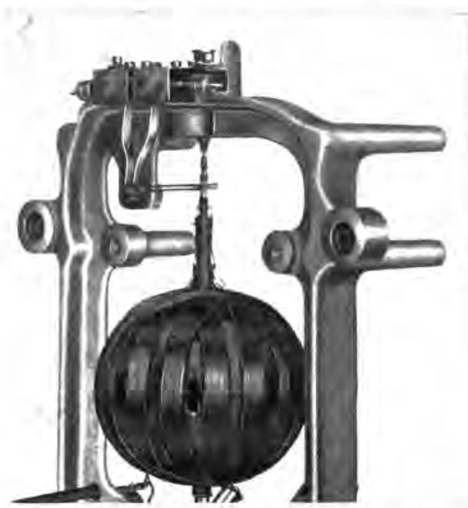
The commutator is made up of silver bars assembled about the upper end of the shaft and fastened rigidly to it but insulated both from the shaft and from each other. The commutator is but one-tenth of an inch diameter, very much smaller than has hitherto been found practicable, owing to difficulties experienced in proper insulation.

This material reduction in size has decreased the commutator friction in about the same ratio as the decrease in diameter, yet no sacrifices have been made in commutator insulation.

A form of brush with gravity instead of spring control has been adopted, giving an even tension on the two brushes as well as on each individual leaf. A counterweight composed of two knurled thumb nuts on each brush-holder can be adjusted quickly and accurately to give the desired tension, thus obviating the necessity of a spring adjustment which, even to the most experienced, is a delicate operation. The use of two nuts permits of locking the counterweight so that any vibration will not disturb the adjustment.

Armature and Field Windings

To secure the highest torque with the lowest possible watt loss has been one of the chief aims in the design of the Type C-6 Thomson Watthour Meter, and to accomplish this it is absolutely necessary that the greatest possible number of magnetic lines



INTERIOR OF THOMSON WATTHOUR METER TYPE C-6 SHOWING SMALL COMMUTATOR AND GRAVITY BRUSHES

be intercepted by the armature during each revolution. A spherical armature moving within circular field coils is the construction that most nearly fulfills this condition, and has, therefore, been adopted in this meter. The armature is wound on a very thin and light paper shell, sufficiently stiff to withstand the strain incident to winding and subsequent handling and use. The wire composing the armature is of the smallest gauge consistent with mechanical strength.

The field coils, as before stated, are circular, and are placed as near each other as possible, one on either side of the armature, with the internal diameter just sufficient to give the necessary clearance for the rotating element. This construction prevents magnetic leakage.

Ribbon wire is employed for the field coils, thus economizing space and further carrying out the idea of concentration.

Combined Resistance and Adjustable Shunt Field Coil

In all C-6 meters for use on circuits of 250 volts or less the necessary resistance, which is in series with the armature, is combined with the adjustable shunt field coil into a single winding. This coil may be moved up and down, in a plane parallel to that of the field coils, to give the required compensation on light loads. The combined resistance and adjustable shunt field coil is circular in form and retains its shape without the use of a core or other support.

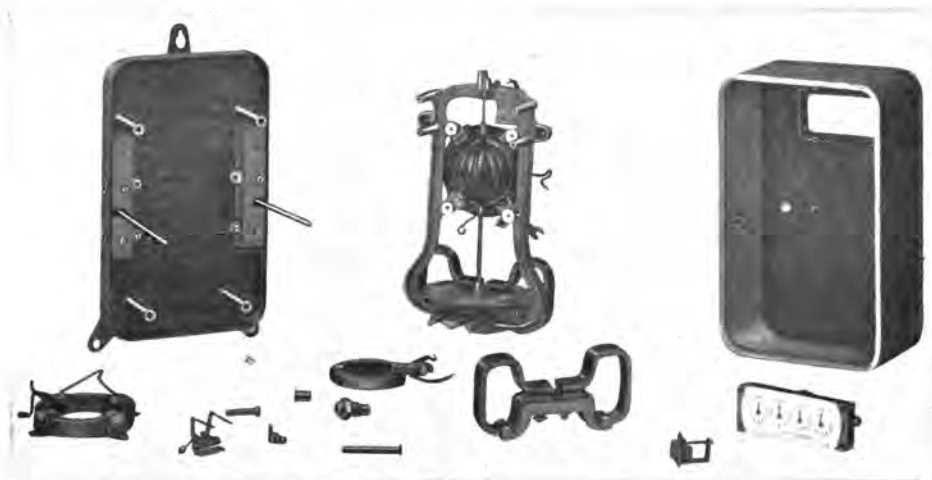
In 500-600 volt meters, Type C-7, the resistance is mounted on the outside of the meter back and is enclosed by a perforated sheet metal cover.

Magnets

Absolute permanency of the retarding magnets is essential to the correct operation of a meter, and when it is remembered that the speed is inversely proportional to the square of the magnet strength, the serious effect of any change is at once apparent.

The magnets of the Types C-6, C-7 and CQ meters are subjected to a rigid process of selection, construction, magnetization and aging, and the processes used insure their permanence.

Only certain grades of steel can be safely used for permanent magnets, therefore, the utmost care must be exercised in the selection of the original bars. After the bars are formed, certain chemical and physical processes are applied before they are magnetized, in order that absolute permanence may be assured. After being magnetized they are carefully measured and then stored for a period of aging. If upon remeasurement no change has taken place the magnets are regarded as satisfactory; if any change has occured they are rejected.



PARTS OF TYPE C-6 THOMSON WATTHOUR METER

Torque

The value of high torque has become universally recognized as the most essential feature of a motor meter.

The peculiar design of the field coils and armature of the Type C-6 meter gives the greatest possible torque combined with minimum losses and weight of moving element. Expressed in units, the torque of this meter is greater than that of any other motor meter in commercial use.

The friction drag has been reduced to the lowest possible limits by the introduction of small commutator, gravity brushes, and an exceedingly light moving element. This combination of high torque with minimum friction is indicative of the "life with accuracy" that must inevitably result.

Accuracy

The Type C-6 meter being a structure without iron and, therefore, involving no considerations of magnetic saturation, has a straight line characteristic throughout its entire range even to the point of physical destruction.

For the same reason the meter is not subject to hysteresis error on direct current or to wave form or frequency errors on alternating current circuits.

Changes of temperature do not affect its accuracy, as the temperature coefficients of both the motor and the generator elements are the same; consequently, a decreased torque due to increased resistance in the armature is at once offset by a correspondingly lessened drag in the disk.

By means of the adjustable shunt field coil the Type C-6 meter may, at the point of installation, be made to register correctly on light loads regardless of vibration and variation of potential from the normal, and this without affecting full load accuracy.

There is, moreover, a sufficient range of adjustment to permit of compensation for friction increase after a period of use. Normal aging of the commutator is not deleterious, as friction resulting from it quickly becomes constant. It is advisable to regulate light load accuracy by means of the shunt coil rather than by polishing the commutator.

Overloads

The Type C-6 Thomson Watthour Meter is most liberally rated, and its low losses permit of operation under heavy overloads for considerable periods of time without detrimental effects, either permanent or temporary.

The magnetic circuit is so constructed that the meter is not sensitive to short circuits. The magnets are at some distance from the field coils, and lying in planes parallel to the coils, any projected field from the coils is at right angles to the magnetic flux. Furthermore, the field coils are so near together that the stray field effect is reduced to a minimum.

Capacities

The Type C-6 Thomson Watthour Meter is manufactured in capacities ranging from 5 to 600 amperes inclusive, two-wire, and from 5 to 300 amperes inclusive, three-wire, and for potentials of 100 to 250 volts.

Meters of like ampere rating but for potentials of 500 to 600 volts are known as Type C-7.

Connections

The Types C-6 and C-7 meters are furnished with side connections, the line wires entering at the left and the load wires at the right. Both sides of the system are carried through the meter in all sizes up to and including 50 amperes Type C-6, and 25 amperes Type C-7. In meters of larger ampere capacities a potential tap is used.

Finish

Types C-6 and C-7 meters are provided with all metal covers finished in black japan.

TYPE CQ

The Thomson Watthour Meter, Type CQ, is a Type C-6 meter modified to render it as far as possible free from errors due to external magnetic fields. This valuable characteristic is secured by a special four-pole field and armature construction.

In external appearance, the Type CQ meter is the same as the Type C-6. Since the same cover, register, bearings, etc., are used in both meters, the preceding description of the Types C-6 and C-7 meters applies to the Type CQ, with the following modifications:

Armature and Field Windings

The field windings are not circular, but are formed in quadrants to embrace as closely as possible the spherical armature. The field coils are strip wound and the armature is wound from film coated wire, as in the Type C-6 meter.

Commutator and Brushes

The diameter of the commutator is the same as in the Type C-6 meter, but the commutator is slightly longer to accommodate

THOMSON WATTHOUR METER—TYPE CQ

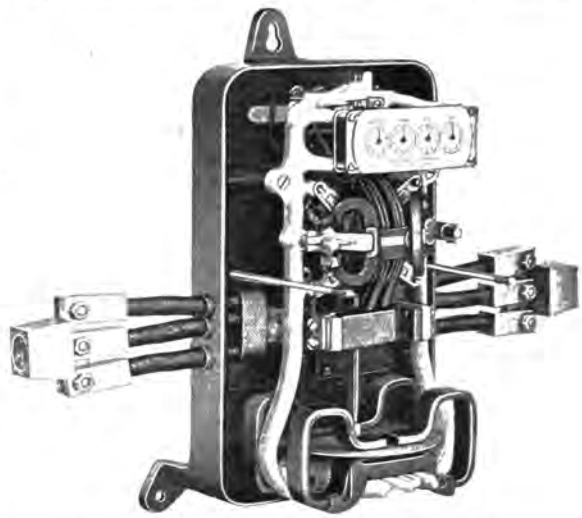
the four gravity brushes which are necessary on account of the four-pole construction of the armature.

Resistance and Shunt Field Coils

The Type CQ meter has two adjustable shunt field coils to give the required compensation on light loads. The resistance in series with the potential circuit for front connected 2-wire meters in capacities up to and including 300 volts and 3-wire meters up to and including 600 volts is placed in an extension of the meter back as in the Type C-7. Meters of higher voltages will be furnished with an external resistance box.

Capacities

The Type CQ Thomson Watthour Meters are manufactured in capacities ranging from



THOMSON WATTHOUR METER—TYPE CQ
(Interior View)

50 to 400 amperes inclusive, two-wire, and 50 to 200 amperes inclusive, three-wire, and for potentials of from 100 to 600 volts.

Connections

The meters may be furnished with either front or back connections. In front connected meters the positions of the leading-in wires and cables are the same as in the Type C-6, so that either type of meter may be installed in the same location.

Back Connected Meters

The meters described in this bulletin can be furnished with back connections adapting them for mounting on a switchboard. Back connected Types C-6 and C-7 meters are known as Type C-9. Type CQ meters furnished with back connections are known as Type CQ-2.

Back connected meters can be furnished with either a metal or moulded glass cover. The finish is the same as for front connected meters.

THOMSON WATTHOUR METERS, TYPES C-6, C-7 AND CQ

FRONT CONNECTED, METAL COVER, JAPAN FINISH

TYPE C-6, 100-120 VOLTS, 2-WIRE

Cat. No.	* Lights	Amp.
37594	10	5
37595	20	10
37596	30	15
37597	50	25
37598	100	50
37599	150	75
37600	200	100
37601	300	150
37602	600	300
37603	1200	600

TYPE C-6, 200-240 VOLTS, 3-WIRE

Cat. No.	* Lights	Amp.
37604	20	5
37605	40	10
37606	60	15
37607	100	25
37608	200	50
37609	300	75
37610	400	100
37611	600	150
37612	1200	300

TYPE C-6, 200-240 VOLTS, 2-WIRE

Cat. No.	* Lights	H.P	Amp.
37614	20	1¼	5
37615	40	2	10
37616	60	3½	15
37617	100	7	25
37618	200	15	50
37619	300	20	75
37620	400	25	100
37621	600	40	150
37622	1200	80	300
37623	2400	160	600

TYPE C-7, 500-600 VOLTS, 2-WIRE

Cat. No.	H.P.	Amp.
37624	2½	5
37625	5	10
37626	7½	15
37627	15	25
37628	30	50
37629	50	75
37630	60	100
37631	100	150
37632	200	300
37633	400	600

TYPE CQ, 100-120 VOLTS, 2-WIRE

Cat. No.	* Lights	Amp.
65275	100	50
65276	150	75
65277	200	100
65278	400	200
65279	800	400

TYPE CQ, 200-240 VOLTS, 3-WIRE

Cat. No.	* Lights	Amp.
65280	200	50
65281	300	75
65282	400	100
65283	800	200

TYPE CQ, 200-240 VOLTS, 2-WIRE

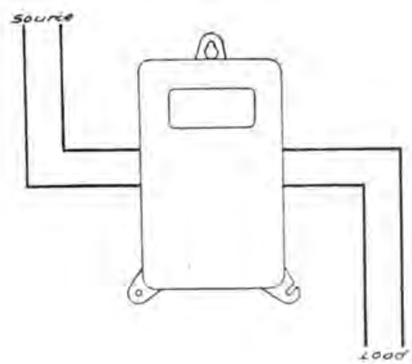
Cat. No.	* Lights	H.P.	Amp.
65284	200	15	50
65285	300	20	75
65286	400	25	100
65287	800	50	200
65288	1600	100	400

TYPE CQ, 500-600 VOLTS, 2-WIRE

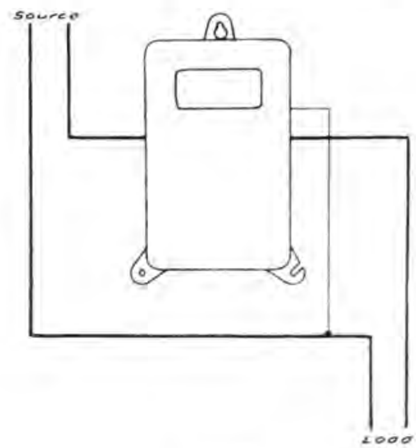
Cat. No.	H.P.	Amp.
65289	30	50
65290	50	75
65291	60	100
65292	125	200
65293	250	400

* Rated on basis of 50 watts per lamp.
NOTE.—Always state normal voltage of circuit.

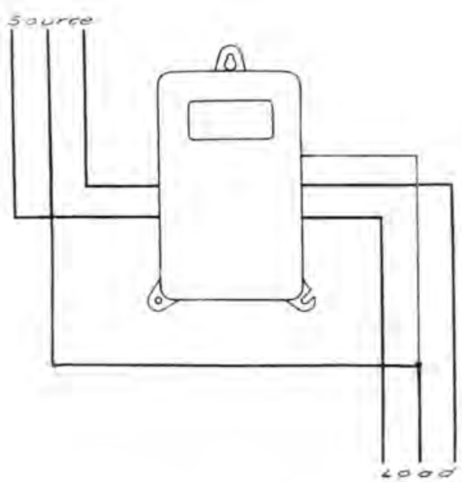
CONNECTIONS OF THOMSON WATTHOUR METERS, TYPES C-6, C-7 AND CQ



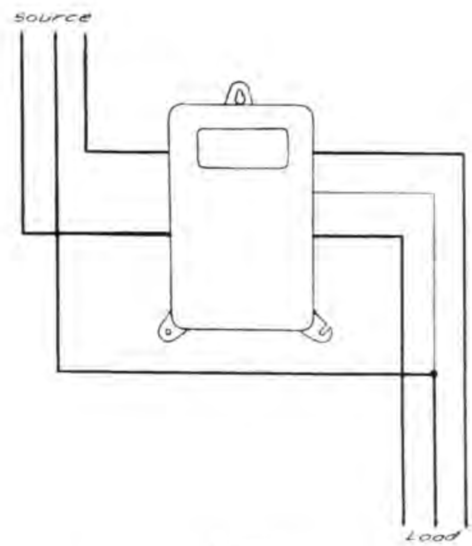
2-WIRE
TYPE C-6, 5 TO 50 AMPERES
100-120 VOLTS, 200-240 VOLTS
TYPE C-7, 5 TO 25 AMPERES, 500-600 VOLTS



2-WIRE
TYPE C-6, 75 TO 600 AMPERES AND
TYPE CQ, 50 TO 400 AMPERES
100-120 VOLTS, 200-240 VOLTS
TYPE C-7, 50-600 AMPERES, 500-600 VOLTS

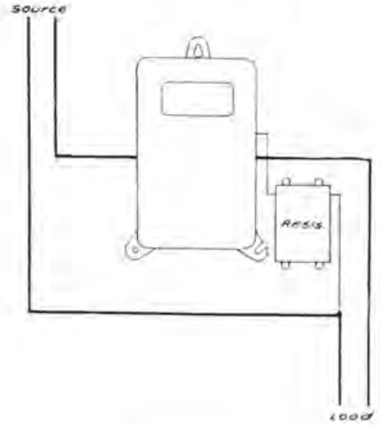


3-WIRE
TYPE C-6, 5 TO 50 AMPERES
200-240 VOLTS



3-WIRE
TYPE C-6, 75 TO 300 AMPERES AND
TYPE CQ, 50 TO 200 AMPERES
200-240 VOLTS

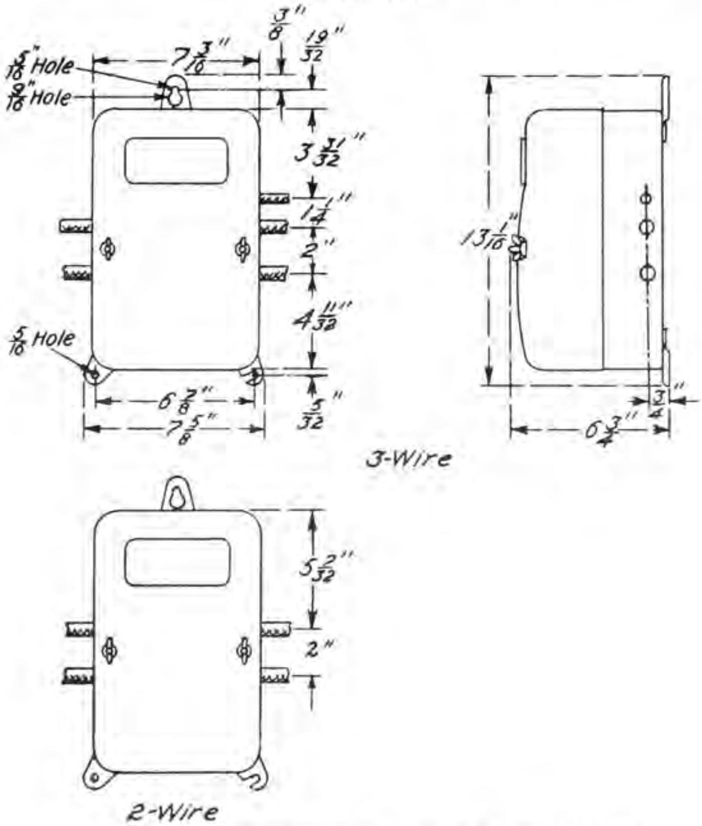
CONNECTIONS OF THOMSON WATTHOUR METERS—(Continued)



2-WIRE
TYPE CQ, 50-400 AMPERES
500-600 VOLTS

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

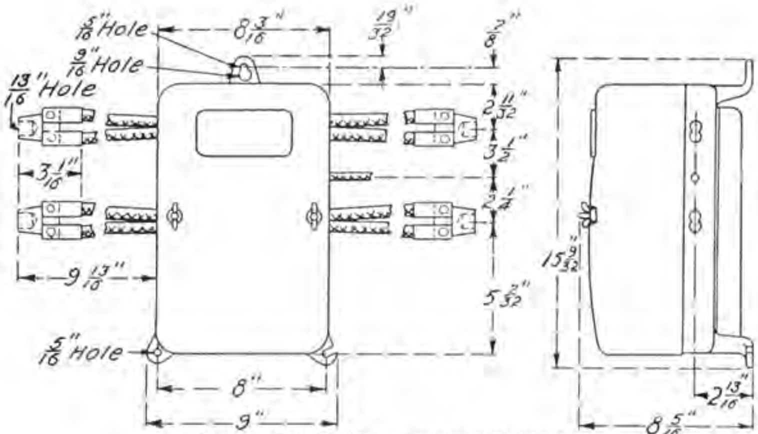
DIMENSIONS



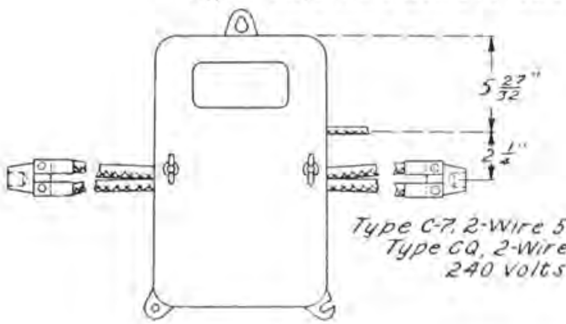
TYPE C-6, 5-50 AMPERES, 2-WIRE UP TO 240 VOLTS
3-WIRE 200-240 VOLTS

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

DIMENSIONS

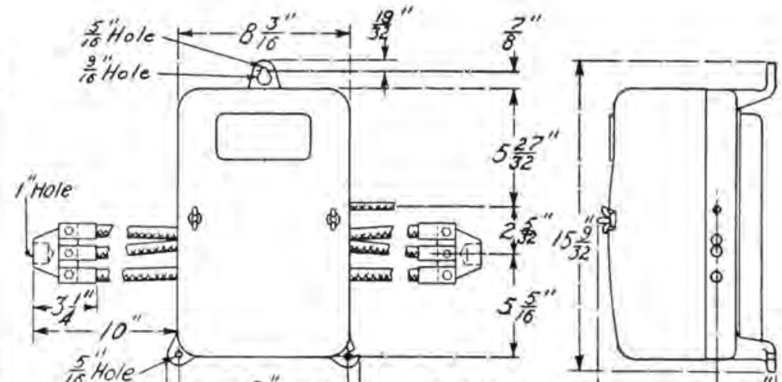


Type CQ, 3-Wire 200-240 Volts

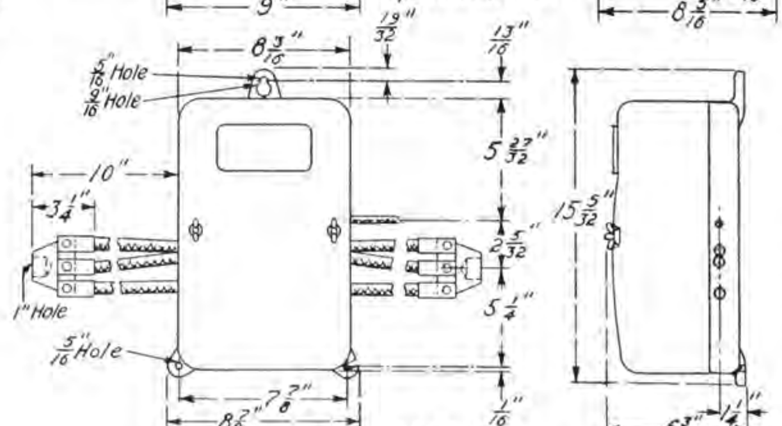


Type C-7, 2-Wire 500-600 Volts
Type CQ, 2-Wire up to 240 Volts

TYPE CQ, 200 AMPERES TYPE C-7, 300 AMPERES



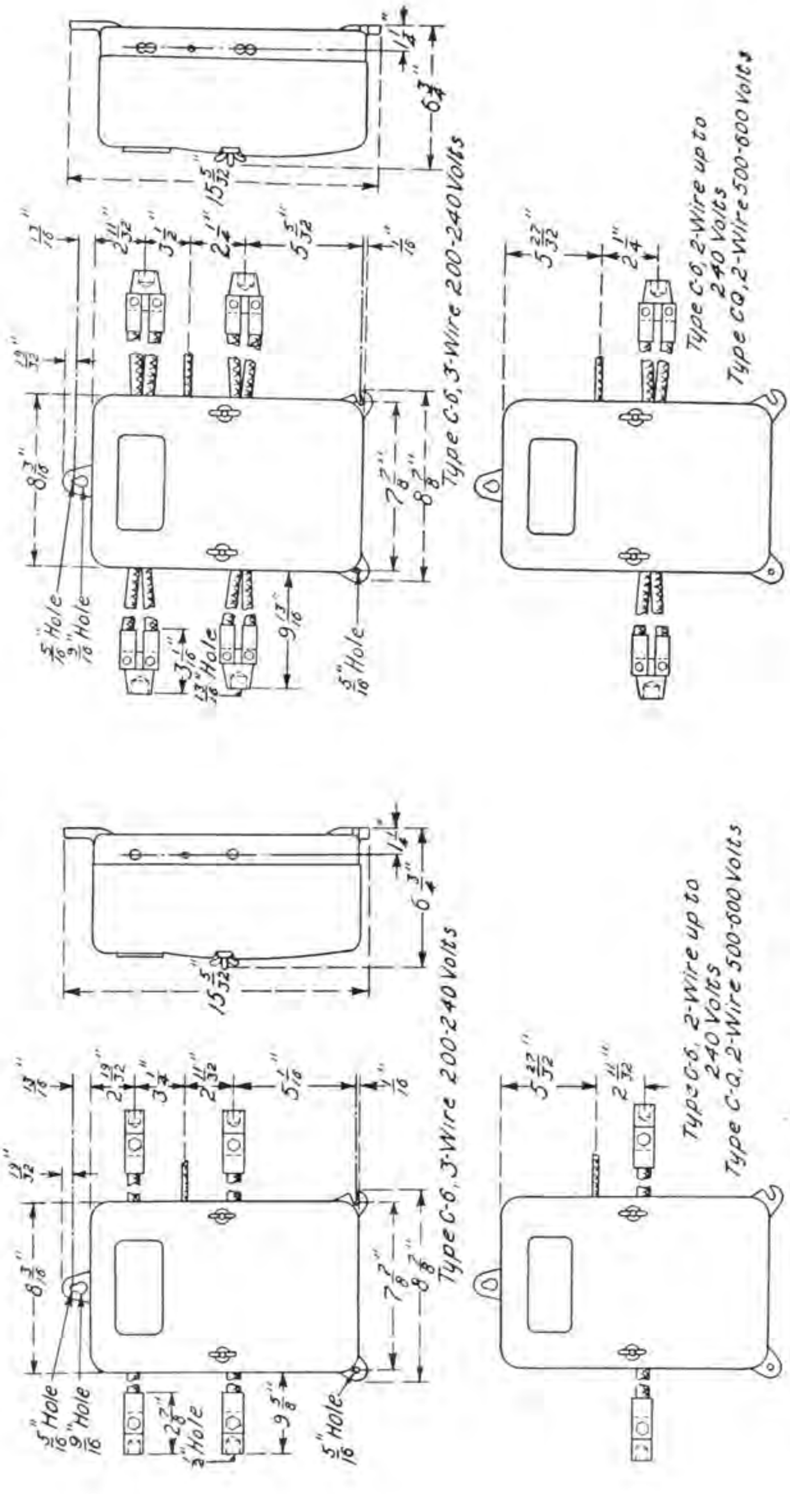
Up to 240 Volts



500-600 Volts
Type CQ, 400 Amperes, 2-Wire

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

DIMENSIONS

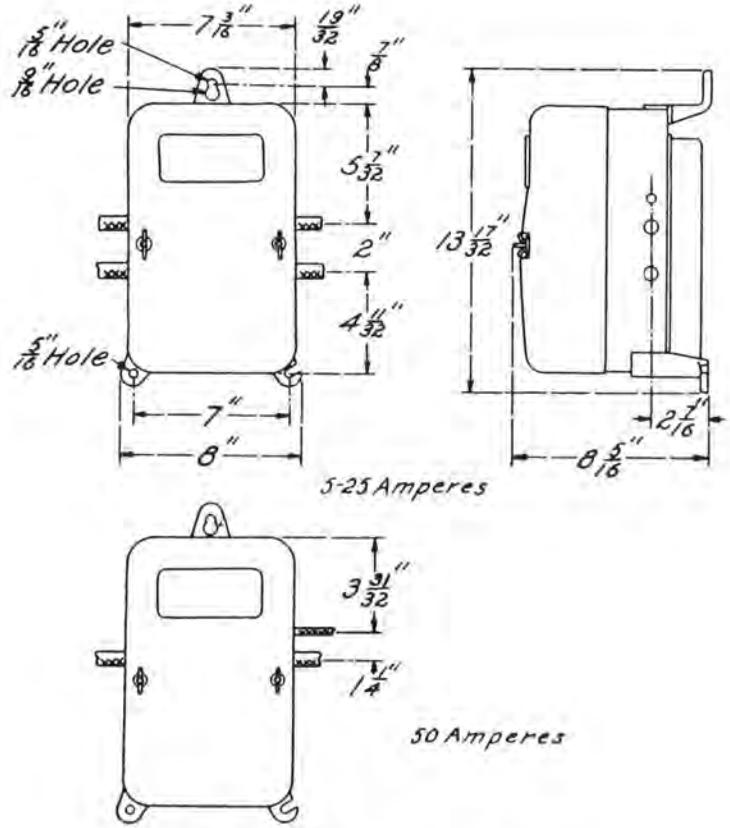


TYPE C-6, 300 AMPERES   TYPE CQ, 200 AMPERES

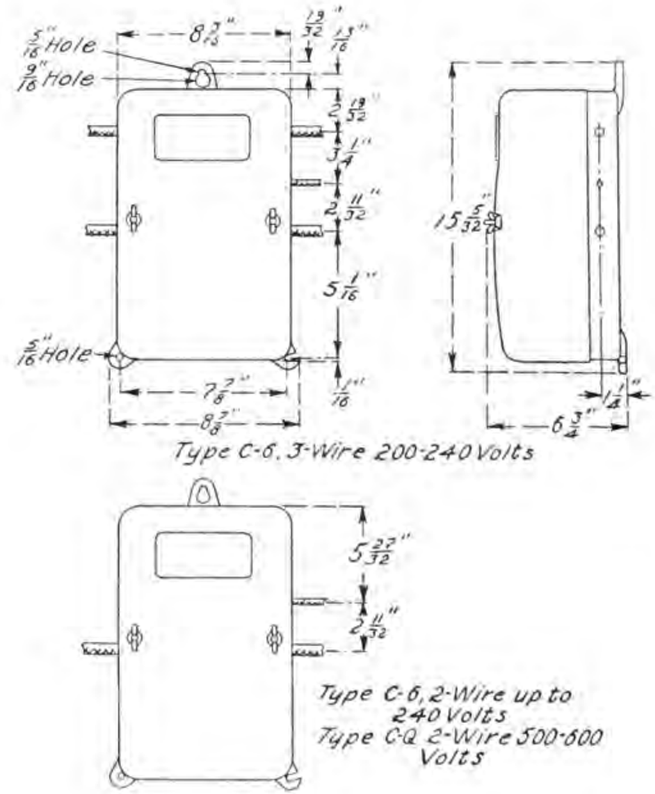
TYPE C-6, 100 AND 150 AMPERES   TYPE CQ, 100 AMPERES

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

DIMENSIONS



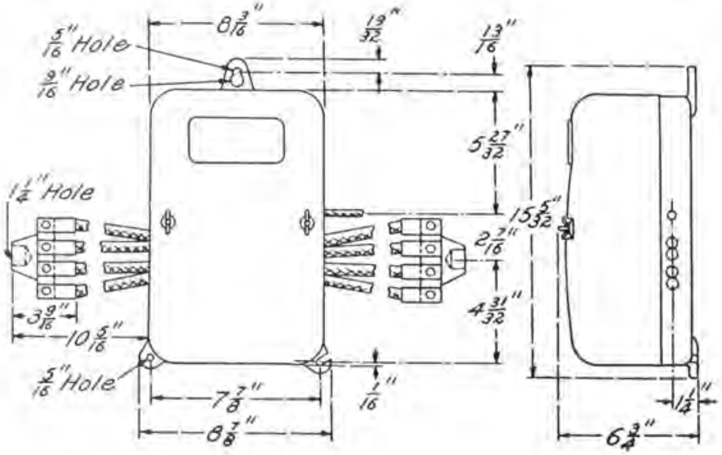
TYPE C-7, 5-50 AMPERES, 2-WIRE 500-600 VOLTS



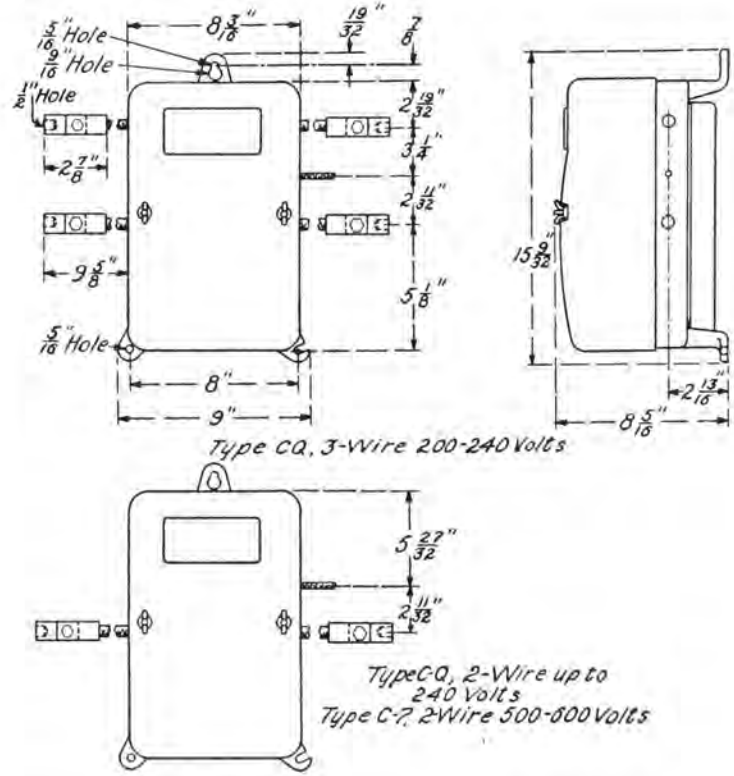
TYPE C-6, 75 AMPERES TYPE CQ, 50 AND 75 AMPERES

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

DIMENSIONS



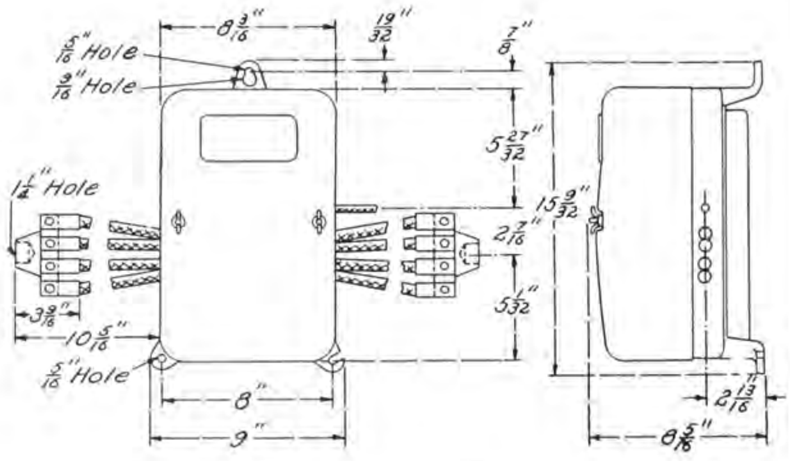
TYPE C-6, 2-WIRE 600 AMPERES UP TO 240 VOLTS



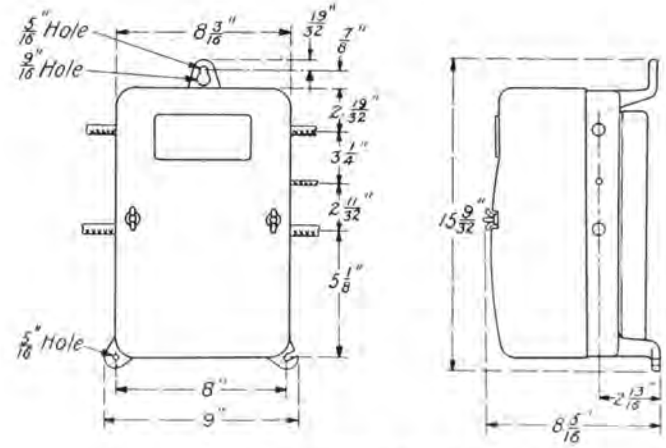
TPYE C-7, 100 AND 150 AMPERES TYPE CQ, 100 AMPERES

THOMSON DIRECT CURRENT WATTHOUR METERS, TYPES C-6, C-7 AND CQ

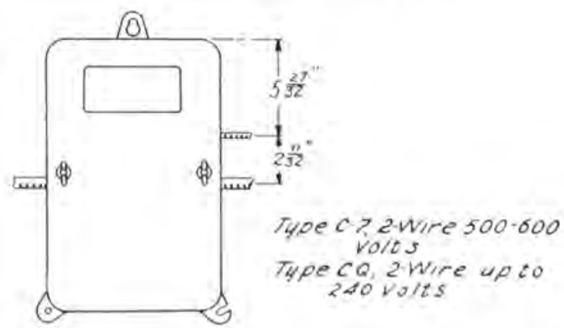
DIMENSIONS



TYPE C-7, 2-WIRE 600 AMPERES, 500-600 VOLTS



TYPE CQ, 3-WIRE 200-240 VOLTS



TYPE C-7, 75 AMPERES TYPE CQ, 50-75 AMPERES

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

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BOSTON, MASS., 84 State Street.
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SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Building.
BALTIMORE, MD., Electrical Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Building.
ERIE, PA., 632 State Street.
PITTSBURG, PA., Park Building.
RICHMOND, VA., 712 Mutual Building.
ROANOKE, VA., Strickland Building.
ATLANTA, GA., Empire Building.
BIRMINGHAM, ALA., Brown-Marx Building.
MACON, GA., Grand Building.
NEW ORLEANS, LA., Maison-Blanche Building.
CINCINNATI, OHIO Provident Bank Building.
COLUMBUS, OHIO, Columbus Savings & Trust Building.
CLEVELAND, OHIO, Citizens Building.
CHATTANOOGA, TENN., James Building.
MEMPHIS, TENN., Randolph Building.
NASHVILLE, TENN., Stahlman Building.
INDIANAPOLIS, IND., Traction Terminal Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.)
ST. LOUIS, MO., Wainwright Building.
KANSAS CITY, MO., Dwight Building.
BUTTE, MONTANA, Phœnix Building.
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General Electric Company
Schenectady, N.Y.

March, 1910

Bulletin No. 4723

REGULATING POLE ROTARY CONVERTERS

The extensive use of rotary converters, particularly in connection with electric lighting and industrial power plants, frequently necessitates a variable ratio between the A.C. and D.C. voltages, for charging storage batteries and compensating for line drop as well as for numerous other special requirements.

Heretofore, the variation of conversion ratio has been obtained by means of auxiliary apparatus such as induction regulators, or voltage varying dial switches connected to taps in the transformer windings. These devices, however, require attention, and involve complications and expense in cable connections.

To simplify the wiring arrangements and reduce the cost of auxiliary devices, the General Electric Company has developed a line of regulating pole rotary converters. In these machines the field structure is divided into two parts—a main pole and a regulating pole. The ratio between the voltages on the direct current and alternating current sides may be readily varied by varying the excitation of the regulating poles,

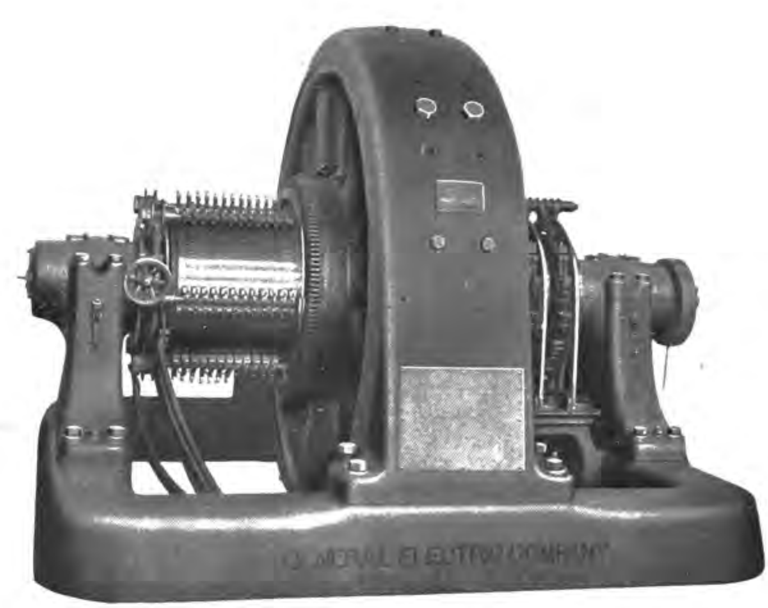


Fig. 1. HCB-6-500-500-270 VOLT REGULATING POLE ROTARY CONVERTER

NOTE: The data in this publication are for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication. Subject to change without notice.

the only auxiliary apparatus required being a field rhesotat for controlling the exciting current. Where Automatic Regulation is required, machines may be provided with compound windings, or automatic field regulators may be used responsive to either voltage or current.

These converters are adapted for a variety of purposes where a variable conversion ratio is required, either to maintain constant D.C. voltage with varying A.C. voltage or to vary the D.C. voltage as required. Converters may be operated inverted where range between 240 and 300 volts, to cover the usual lighting circuit requirements. In design, they are similar to standard rotary converters with the exception that the regulating poles are located next to the main pole pieces and a slightly different form of pole piece bridge is used for the main poles, in order to allow the auxiliary poles to be readily removed or assembled.

Principle of Operation

Inasmuch as the characteristics of this type of machine are novel, the following explanation

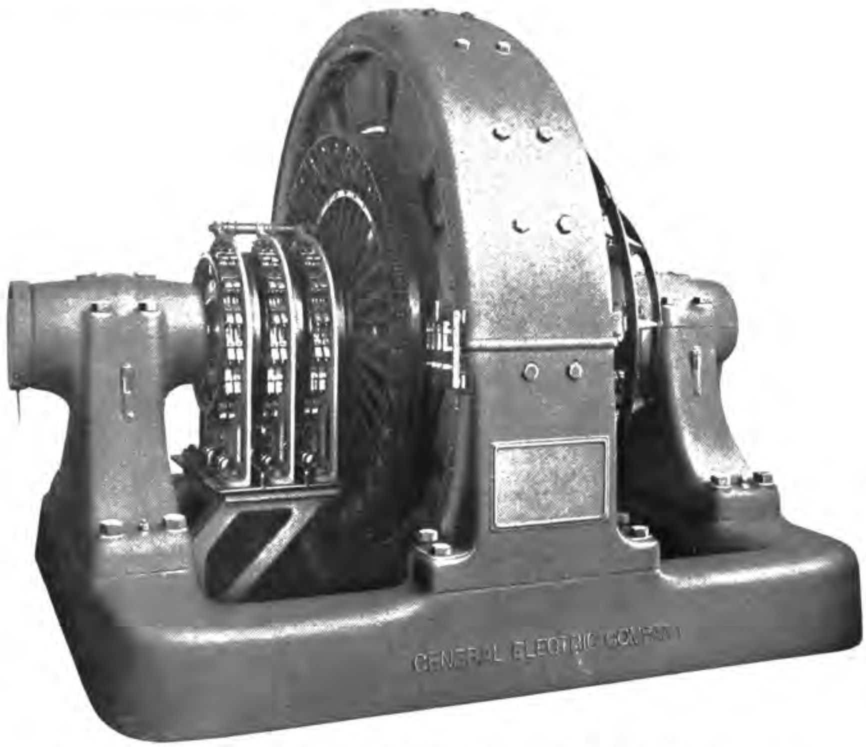


Fig. 2. HCB-10-1000-300-240/300 VOLT REGULATING POLE ROTARY CONVERTER

it is required to furnish constant or variable A.C. voltage from a D.C. source. Where converter and inverted converter operation are desired, an opposite direction of rotation is required for the inverted operation.

Converters of this type are built in capacities from 300 kw up to 3000 kw. A list of standard sizes is given on page 7, which are constructed to give a voltage

of the principles involved is given to facilitate a clear understanding of its operation.

Consider a machine with a field structure as shown in Fig. 3, resembling in appearance a machine with commutating poles, but with the brushes so set that one of the regulating poles adds its flux to that of one main pole, cutting the conductors between two direct current brushes. The regulating pole is shown with a width equal to 20 per cent. of that of the main pole. To obtain definite figures, it will be assumed that the machine at normal speed, with the main poles excited to normal density, but with no excitation on the regulating poles, gives 250 volts D.C. Then with each regulating pole excited to the same density as the main poles, and with a polarity corresponding to that of the main pole in the same section between brushes, the D.C. voltage will rise to 300 volts at the same

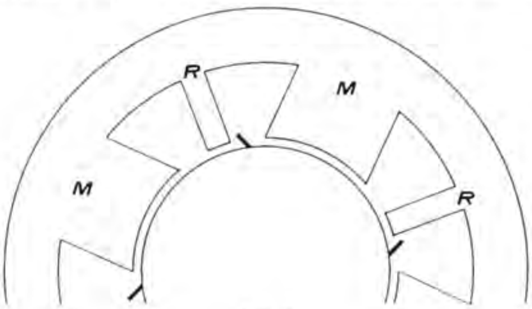


Fig. 3

speed, since the total flux cutting the conductors in one direction between brushes has been increased 20 per cent. If, on the other hand, the excitation of the regulating poles is reversed and increased to the same density as that of the main poles, the D.C. voltage will fall to 200 volts, since in this case the regulating poles give an e.m.f. opposing that generated by the main poles.

Now if the machine is equipped with collector rings; *i.e.*, if it is a converter, this method of varying the D.C. voltage from 200 volts to 300 volts does not give nearly as great a variation of the A.C. voltage; in fact the A.C. voltage will be the same when delivering 200 volts as when delivering 300 volts D.C., if the main field excitation is the same. This may be seen by reference to Fig. 4, which is a diagram of the A.C. voltage developed in the armature windings by the two sets of poles. The horizontal line OA represents the A.C., e.m.f. generated by the main poles alone, with the regulating poles unexcited; that is, when delivering 250 volts D.C. For a six-phase converter OA measures about 180 volts diametrical, that is between electrically opposite collector rings. If now the regulating poles are excited to full strength, to bring the D.C. pressure up to 300 volts, the A.C. voltage generated by the regulating poles will be 90° out of phase with that generated by the main poles (since they are spaced midway between the main poles), and will be about 40 volts as shown by the line AB. The resultant A.C. volts across the collector rings will be represented by the line OB with a value equal to 184.

If, on the other hand, the regulating poles are reversed at full strength, to cut the D.C. voltage down to 200 volts, the A.C. voltage of the main and regulating poles will be OA and AC respectively, giving the resultant OC equal to OB with a value of 184 volts.

Hence the D.C. volts may be either 200 or 300 volts with the same A.C. volts, and if the main field is kept constant, the D.C. volts may range between 200 and 300 volts, while the A.C. volts vary only between 180 and 184 volts.

The A.C. volts can be kept constant through the full range of D.C. volts by changing the main field so as always to give an equal and opposite flux change to that of the regulating field. A constant total flux may thus be obtained equal to the radius of the cir-

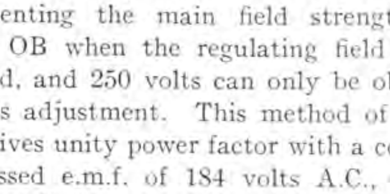


Fig. 4

cle BAC (see Fig. 4.) In this case the line OA, representing the main field strength, will equal OB when the regulating field is unexcited, and 250 volts can only be obtained at this adjustment. This method of operation gives unity power factor with a constant impressed e.m.f. of 184 volts A.C., with a range of D.C. voltage from 200 to 300 volts.

Construction Used

In practice machines are not built as indicated diagrammatically; that is, with regulating poles spaced midway between the main poles, because a better construction is obtained by placing the regulating pole closer to the corresponding main pole, as shown in Fig. 5. Except for magnetic leakage from the main pole to the regulating pole when the latter is opposed to the former, *i.e.*, when the D.C. voltage is being depressed,

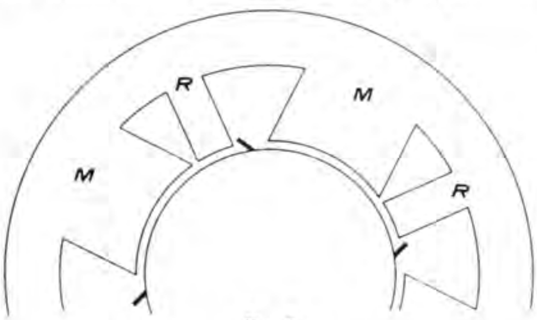


Fig. 5

the effect on the D.C. voltage remains unchanged, by the altered location of the regulating poles. The effect on the A.C. voltage is, however, somewhat altered. Fig. 6 shows the effect on the A.C. voltage of varying the regulating field strength of a machine, proportioned according to Fig. 5, from a density equal to that in the main poles to the same density reversed, the main field strength remaining constant. The D.C. voltage in this case varies from 30 per cent,

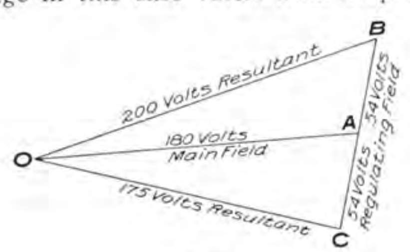


Fig. 6

above that produced by the main field alone to 30 per cent. below, or from 325 to 175 volts, while the A.C. voltage varies only from 200 to 175 volts.

To keep the A.C. voltage constant with such a machine the main field must be strengthened as the regulating field is weakened or reversed to reduce the D.C. voltage. This strengthening increases the core loss, particularly on low D.C. voltages, which, however, are rarely required, hence a machine proportioned as in Fig. 5 would not be operated through so wide a range as 175 to 325 volts. Assume therefore that the range is 240 to 300 volts, and that at the highest voltage both main and regulating fields have the same density, presenting to the armature practically one continuous pole face of uniform flux intensity. The diagram of A.C. component voltages to give constant A.C. resultant voltage across the rings for this case, is shown in Fig. 7.

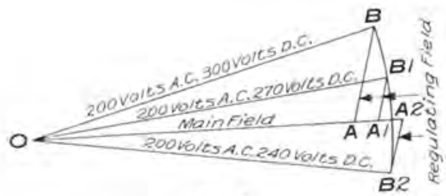


Fig. 7

At 300 volts D.C. the main field produces an A.C. voltage OA, and the regulating field a voltage AB, with a resultant OB equal to about 200 volts A.C. At 270 volts D.C. the main field produces an A.C. voltage OA and a regulating field voltage AB, giving a resultant A.C. voltage OB, equal to 200 volts. Similarly, at 240 volts D.C. the main field produces an A.C. voltage OA, and the regulating field (now reversed) produces the counter voltage AB, giving the resultant OB again equal to 200 volts. It will be noted that, theoretically, the main field strength must be increased about 15 per cent. above its value at 300 volts D.C. in order to keep the D.C. voltage at 250 volts.

Wave Shape

When the design of this machine was first considered some criticism was aroused, because, it was stated that relatively high losses would be experienced, due to the distortion of the voltage wave shape. These ideas originated from a theoretical discussion of the characteristics of the machine and were shown to be untenable when the proper theoretical treatment was used. The best answer to these objections lies, however in the fact that the machines actually built have proved efficient in operation and have not shown any greater temperature rise than is experienced with standard machines.

Commutation

Another objection put forward was that the commutation of the machine would be bad if not impossible, but this has been demonstrated as untrue. By properly proportioning the pole pieces and running the armature from the brushes toward the main poles as shown in Fig. 3 or 5, the slight weakening of the main field with increasing D.C. voltage does not appreciably affect commutation.

Transformer Connections

Six-phase machines may be supplied from transformers with double delta secondaries or if a D.C. neutral is desired for three-wire service, diametrical connections may be used, provided the transformer primaries are Y connected. Diametrical secondaries with delta primaries should not be used. Three-phase regulating pole converters can use the same options of transformer connections as fixed ratio converters.

Starting

Regulating pole converters can be started either A.C. or D.C. with the same facility as standard rotary converters.

Machines In Service

Two regulating pole converters are installed in the new plant of the Indiana Steel Co., at Gary, Indiana, and have a capacity of 2000 kw. each with a voltage range of 200 to 300 volts. The generating plant is driven by gas engines with a storage battery auxiliary. The converters are supplied with automatic field varying apparatus responsive to changes in load on the A.C. generators, so arranged that the battery charges on light loads and drives the converters inverted at heavy loads, supplying power to the A.C. system

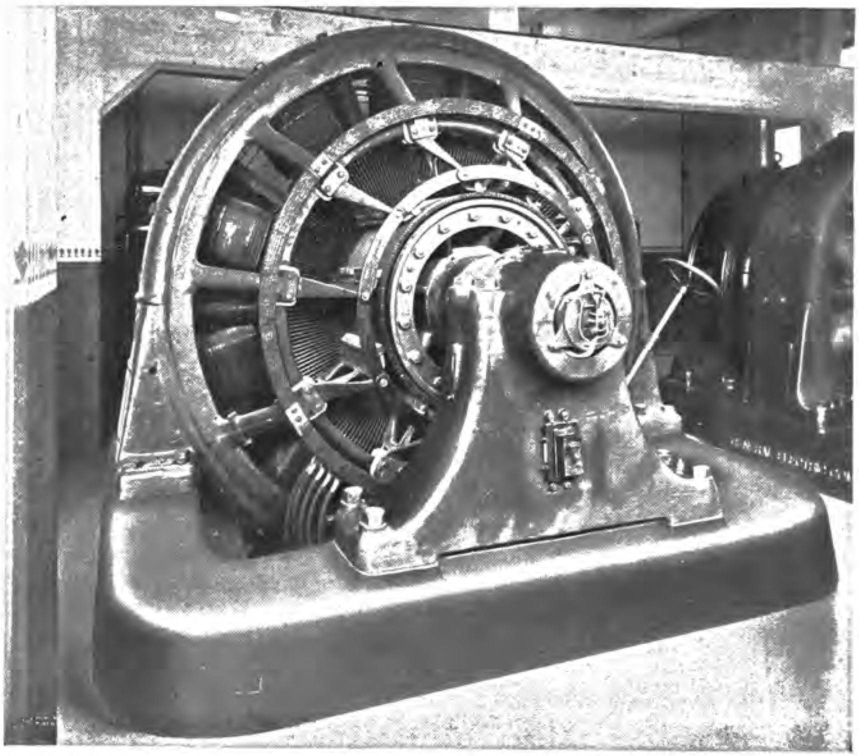


Fig. 8. HCB-10-1000-300-240/300 VOLT REGULATING POLE ROTARY CONVERTER

and relieving the gas engine driven units of a considerable portion of the load fluctuations.

Four 1000 kw. machines for electric lighting service, with a voltage range of 240 to 300 volts, have been installed by the Brooklyn Edison Co.

The Potomac Electric Power Co., of Washington, D.C., is using two 1000 kw. converters for supplying current to the Washington Railway & Electric Co. By varying the D.C. voltage, any desired subdivision of load between the various substations can be obtained.

The Rochester Railway and Light Company have installed a 1500 kw. converter in order to regulate the power purchased from Niagara Falls, the balance of power required being generated in the Company's own plant. By this means not only will a high load factor be obtained but constant load will be drawn from the Supply Company, the importance of which will be readily appreciated. The converter will be connected between the Niagara Falls transmission line and the Company's railway circuit, and provided with automatic regulating devices so that a practically constant load will be drawn from the transmission line, the load fluctuation being taken care of by the Company's own plant.

The Chicago Edison Company is operating a 500 kw. converter with a range of 230 to 300 volts. This machine was tested through a range of 200 to 325 volts, and gave excellent commutation at all voltages and currents up to 50 per cent. overload. It is required to carry 150 kw. out-of-balance three-wire load of which the neutral is derived from transformers diametrically connected.

Fig. 9. HCB-6-500-500-240/300 VOLT REGULATING POLE ROTARY CONVERTER

The machines already installed have given most satisfactory results in service, and the development of this type of converter will therefore meet a variety of special conditions for which good engineering methods have not hitherto been available.

The following is a list of machines installed and on order:

RATING	CUSTOMER	NO. INSTALLED	NO. ON ORDER
HCB—6—500—500—225/300 volts	Buffalo G.E. Co.	2	
	Commonwealth Edison Co., Chicago	1	
HCB—14—500—514—245/260 volts	Rochester Rwy. and Ltg. Co.		1
HCB—8—1000—375—575/600 volts	Potomac Elec.-Pwr. Co., Washington, D.C.	2	1
HCB—10—1000—300—240/300 volts	Potomac Elec.-Pwr. Co., Washington, D.C.	1	1
	Brooklyn Edison Co.	4	
HCB—12—1000—400—250/275 volts	Schenectady Works		1
HCB—10—1500—300—525/600 volts	Rochester Rwy. and Ltg. Co.	1	
HCB—14—1500—214—240/300 volts	N. Y. Central R. R. Co.	1	
HCB—18—2000—166—200/300 volts	Indiana Steel Co., Gary, Ind.	2	

The following ratings are standard:

HCB—6—500—500—240/300 volts
HCB—8—750—375—240/300 volts
HCB—10—1000—300—240/300 volts
HCB—14—1500—214—240/300 volts
HCB—18—2000—166—240/300 volts

SEWING MACHINE MOTORS

GENERAL ELECTRIC COMPANY

General Electric Company
Schenectady, N.Y.

SMALL MOTOR DEPARTMENT

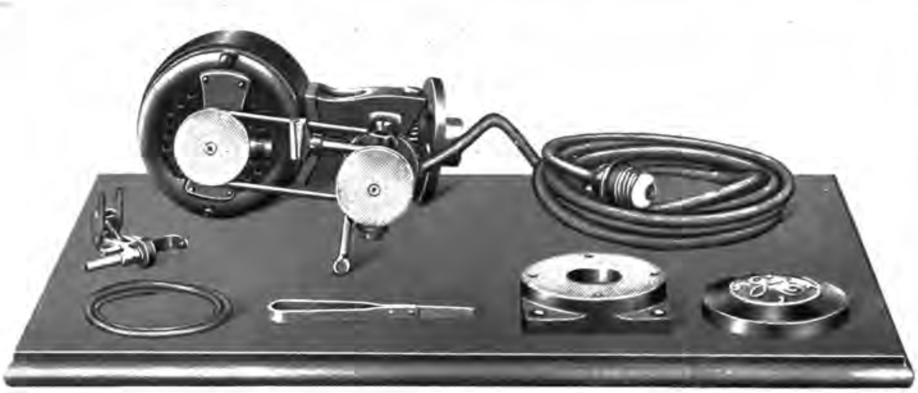
April, 1910 — *Copyright, 1910 by General Electric Company* — **Bulletin No. 4727*

SEWING MACHINE MOTORS

FOR FAMILY SIZE MACHINES

Of all the mechanisms devised to lighten the labors of the housewife the sewing machine is perhaps the best example. Since 1845, when Howe first produced a satisfactory machine, vast numbers of sewing machines have been made and marketed for all conceivable purposes. Of these, probably the greatest number sold are those designed for household use.

With the advantages of convenient, uniform and rapid sewing by machine there yet comes the unpleasant and sometimes dangerous fatigue engendered by the long continued pumping action of the feet upon the sewing machine treadle. Many are the auxiliary devices proposed to avoid this laborious operation of foot power supply. Among all such, the modern electric motor of small size, comparatively easy application and reasonable cost is undoubtedly the most favored in all dwellings where electric power is available.



DISASSEMBLED VIEW OF MOTOR AND BASE FOR HIGH ARM SEWING MACHINE

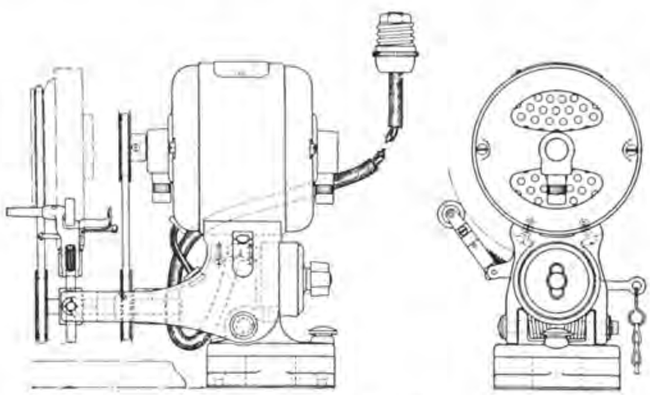
To meet the demand for a motor for this service, the General Electric Company has recently perfected a new design of small motor and utilized this advanced construction in the apparatus illustrated and described herewith. It is intended for ordinary domestic use—usually classified as for intermittent service. The motor is fitted with perforated covers protecting the internal revolving parts and still providing for proper ventilation of the windings.

On account of the lack of uniformity in the detail design of the different makes of sewing machines, we have found it desirable

**Superseding No. 4611*

to offer two varieties of motors. These are known as Forms HC and KC for the alternating current type (DSS) and Forms H and K for the direct current type (DSD).

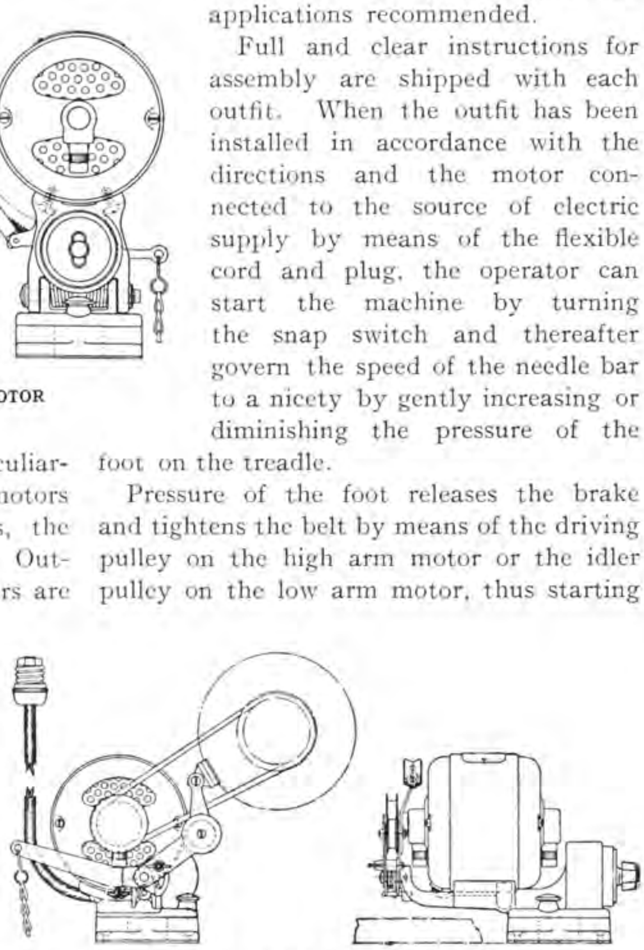
The Forms HC and H motors are applicable to most makes of high arm sewing machines of either the drop head or stationary head styles. On some machines, owing to peculiarities in the design of the heads, the H motors cannot be applied. For these cases, the Forms KC and K motors are offered. Outlines of the Forms HC and KC motors are shown herewith.



TYPE DSS 1/30 H.P. FORM HC MOTOR

The Forms KC and K motors, while particularly intended for use with low arm, automatic type sewing machines, may be applied to the high arm machines as well. Both outfits are complete, but the high arm type is slightly easier to install; it does not overhang the sewing machine table and is therefore preferable for all applications where it may be applied.

The accompanying illustrations show typical applications of the high and low arm types.



TYPE DSS 1/30 H.P. FORM KC MOTOR

The complete outfits consist of:

Form HC or H motor complete with bracket, belt tightener, indicating snap switch, 10 feet of cord with attaching plug, baseplate, bobbin winder, treadle pull, one leather driving belt, one rubber belt, ornamental cover, screw driver and four wood screws.

Form KC or K motor complete with bracket, belt tightener, indicating snap switch, 10 feet of cord with attaching plug, baseplate, treadle pull, one leather driving belt, one rubber belt, ornamental cover, screw driver and four wood screws.

The table on page 4 gives the applications recommended.

Full and clear instructions for assembly are shipped with each outfit. When the outfit has been installed in accordance with the directions and the motor connected to the source of electric supply by means of the flexible cord and plug, the operator can start the machine by turning the snap switch and thereafter govern the speed of the needle bar to a nicety by gently increasing or diminishing the pressure of the foot on the treadle.

Pressure of the foot releases the brake and tightens the belt by means of the driving pulley on the high arm motor or the idler pulley on the low arm motor, thus starting the machine or increasing the speed. Reduction of pressure on treadle loosens the belt and reduces the speed.

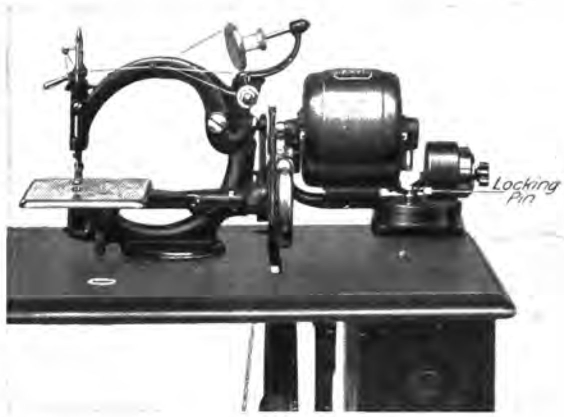
To stop the machine quickly, remove all pressure from the treadle and the brake will be set automatically against the handwheel, stopping the needle immediately.

The Forms HC and H motors are fitted with a bobbin winder designed to take all forms of bobbins. The Forms KC and K motors are intended for so called automatic or chainstitch machines and therefore are not furnished with bobbin winder. When they are used with high arm sewing machines, if the winder furnished with the machine is one ordinarily operated by contact with the machine belt, we provide an elastic rubber belt which may be snapped over the motor pulley and used to drive the winder direct. When the winder is driven by friction con-

TYPE DSS 1/30 H.P. FORM HC MOTOR—HIGH ARM TYPE

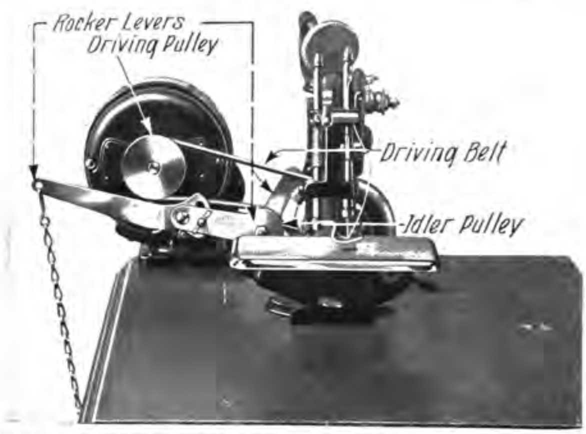
tact with the sewing machine handwheel, the use of the motor drive makes no change in the method of operation.

Not all sewing machines run in the same direction, hence the need of a reversible motor. All General Electric sewing machine motors can be made to run in either direction, in the following manner: Alternating current motors.—Remove the switch cover and the two machine screws holding the switch. It will then be observed that two of the wires leading to the back of the switch are colored. The connections of these should be interchanged and the parts reassembled. Direct Current Motors.—The leads connected to the brush-holders should be in-



TYPE DSS 1/30 H.P. FORM KC MOTOR — LOW ARM TYPE
FRONT VIEW

terchanged and the connections properly tightened. Unless otherwise ordered, a regular stock motor will be supplied connected for clockwise rotation, *i.e.*, producing rotation of the top of sewing machine handwheel towards the operator.



TYPE DSS 1/30 H.P. FORM KC MOTOR — LOW ARM TYPE
SIDE VIEW

The illustration on page 6 shows the appearance of the sewing machine when closed and with the motor removed. This is a very easy operation; it is only necessary to twist and

4727-4 Sewing Machine Motors

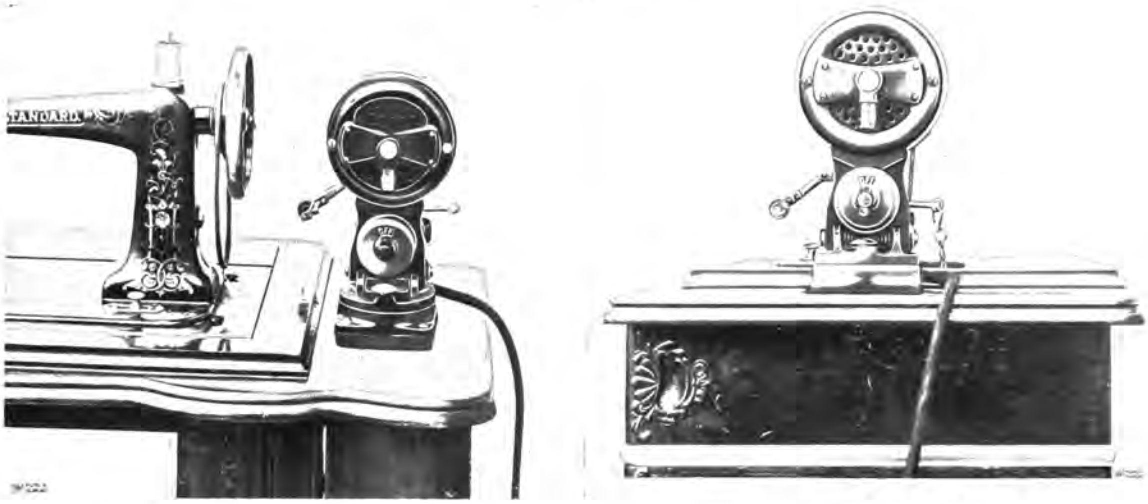
The following applications are recommended for the sewing machines listed:

Make of Sewing Machine	Style	Rotation	Motor Form
Advance	DH	C.W.	H
Advance	SH	C.W.	H
Alliance	DH	C.W.	H
Albion	SH	C.W.	H
Albion	DH	C.W.	H
American	SH	C.W.	H
American Union	DH	C.W.	H
Avon	SH	C.W.	H
Avon	DH	C.W.	H
Beacon	DH	C.W.	H
Boston	DH	C.W.	H
Burdick	SH	C.W.	H
Burdick	DH	C.W.	H
Capital	DH	C.W.	H
Challenge	DH	C.W.	H
Chelsea	DH	C.W.	H
Crescent Rotary	DH	C.W.	H
Crown Crescent	DH	C.W.	H
Champion	SH	C.C.W.	H
Climax	SH	C.W.	H
Collins	DH	C.W.	H
Commonwealth	DH	C.W.	H
Continental	SH	C.W.	H
Davis D	DH	C.W.	H
Davis Rotary	SH	C.W.	K
Davis Rotary	DH	C.W.	K
Davis UF	SH	C.W.	H
Davis UF	DH	C.W.	H
Davis VF	SH	C.W.	H
Davis VF	DH	C.W.	H
Davis Improved (Vertical feed)	DH	C.W.	H
Daytonia	DH	C.W.	H
Demorest	SH	C.C.W.	H
Demorest	DH	C.C.W.	H
Domestic	SH	C.C.W.	H
Domestic	DH	C.C.W.	H
Eldredge	SH	C.W.	H
Eldredge Rotary	DH	C.W.	H
Eldredge Special	DH	C.W.	H
Eldredge "B" Improved	DH	C.W.	H
Eldredge Automatic	SH	C.C.W.	K
Eldredge Automatic	DH	C.C.W.	K
Expert	SH	C.W.	H
Expert	DH	C.W.	H
Franklin	DH	C.W.	H
Favorite	DH	C.W.	H
Fireside	DH	C.W.	H
Household	SH	C.C.W.	H
Household	DH	C.C.W.	H
Howard	SH	C.W.	H
Howard	DH	C.W.	H
Howe No. 1	DH	C.W.	H
Howe No. 2	DH	C.W.	H
Improved New Companion	DH	C.W.	H
Kruse & Murphy	Automatic	C.C.W.	K
King	DH	C.W.	H
Mayflower	SH	C.W.	H
Minnesota	DH	C.W.	H
Monarch	DH	C.W.	H
Montgomery Ward	DH	C.W.	H

Make of Sewing Machine	Style	Rotation	Motor Form
National Seamstress	SH	C.W.	H
National Seamstress	DH	C.W.	H
Navalle	DH	C.W.	H
New Companion	SH	C.W.	H
New Companion	DH	C.W.	H
New Adelaid	DH	C.W.	H
New Boston	SH	C.W.	H
New Crown	SH	C.W.	H
New Crown	DH	C W.	H
New Daytonia	DH	C.W.	H
New Home	SH	C.W.	H
New Home	DH	C.W.	H
New Home	Automatic	C.C.W.	K
New Idea	DH	C.W.	H
New Ideal	SH	C.W.	H
New Rose	DH	C.W.	H
New Royal	DH	C.W.	H
Norwood	DH	C.W.	H
Outlet	DH	C.W.	H
Outlet Special	DH	C.W.	H
Peerless	DH	C.W.	H
Pemberton	DH	C.W.	H
Princess Special	DH	C.W.	H
Paragon	DH	C.W.	H
Pilgrim	DH	C.W.	H
Princess	DH	C.W.	H
Queen Crescent	DH	C.W.	H
Rose	DH	C.W.	H
Service	DH	C.W.	H
Seigal	DH	C.W.	H
Seigal Special	DH	C.W.	H
Singer	SH	C.W.	H
Singer	DH	C.W.	H
Singer Rotary	DH	C.C.W.	K
Shetucket	DH	C.W.	H
Standard Rotary	SH	C.C.W.	H
Standard Rotary	DH	C.C.W.	H
Standard Vibrating	SH	C.C.W.	H
Standard Vibrating	DH	C.C.W.	H
Stearling	DH	C.W.	H
Steinway (Vibrating)	SH	C.W.	H
Sterling	DH	C.C.W.	H
Unique (Davis Style H)	DH	C.W.	H
Victory	SH	C.W.	H
Velox	DH	C.W.	H
Vindex B	DH	C.W.	H
Wanamaker	SH	C.W.	H
Wanamaker	DH	C.W.	H
Wheeler & Wilson	SH	C.C.W.	K
Wheeler & Wilson	DH	C.C.W.	K
White Rotary	SH	C.C.W.	H
White Rotary	DH	C.C.W.	H
White Vibrating	SH	C.W.	K
White Vibrating	DH	C.W.	K
Wilcox & Gibbs	SH	C.C.W.	K
Wilcox & Gibbs	DH	C.C.W.	K
Will C Free Vibrating	DH	C.W.	H
Winner	DH	C.W.	H
Yale	DH	C.W.	H
Youths' Companion	DH	C.W.	H

NOTE.—Form HC also applies where "H" is indicated.
Form KC also applies where "K" is indicated.
Rotation—C.W. indicates clockwise rotation of motor pulley—corresponding to motion o top of sewing machine handwheel toward the operator.
Rotation—C.C.W. indicates counter-clockwise rotation of motor pulley—corresponding t motion of top of sewing machine handwheel away from the operator.

lift the latch when the motor may be lifted out of its swiveling base plate and placed safely away, thereby protecting it from dust and accident. An ornamental cover is provided for the base plate.



View with Motor Turned on Swivel Base

View with Motor Aligned with Sewing Machine

SEWING MACHINE EQUIPPED WITH A DSD 1/30 H.P. FORM HC MOTOR

Owing to the widely varying conditions of operation it is impossible to give accurate figures with regard to the power required to drive various sewing machines, but under average conditions it is safe to assume that when operating the ordinary family sewing machine the direct current motor will require about 45 watts, which is a little less than the power consumed by a 16 c.p. incandescent lamp. The 60 cycle alternating current motor requires about 55 watts.

ACCESSORY PARTS OF SEWING MACHINE MOTOR

The motor runs normally at approximately constant speed, and the speed variation of the sewing machine is not dependent upon the introduction of resistance in the circuit with its consequent waste of power. Furthermore, as the motor itself runs constantly at its maximum speed the immediate acceleration of the sewing machine to full speed is assured, when the greatest working capacity is desired.

Satisfactory operation of direct current motors may be expected where the voltage of the supply circuit does not vary more than 10 per cent. either way from the normal voltage rating as stamped on the motor name plate. In the case of alternating current motors the maximum permissible variation is 5 per cent. of either frequency or voltage above or below normal. Where both frequency and voltage vary, the sum of the two variations should not exceed 5 per cent.

The catalogue numbers and ratings given below apply to family size sewing machine motors. The catalogue numbers include all parts comprising complete outfits.

In ordering, give Cat. No. of outfit, make and style of sewing machine, and direction of rotation of top of sewing machine handwheel.

BASE PLATE WITH ORNAMENTAL COVER

FAMILY SIZE SEWING MACHINE MOTORS

ALTERNATING CURRENT—60, 40 AND 25 CYCLES—SINGLE-PHASE

Catalogue No.		Type	H.P.	Speed (Sync.)	Cycles	Volts	Approx. Weight in Pounds			
							Net		Shipping	
Form HC Motor	Form KC Motor						Form HC	Form KC	Form HC	Form KC
68148	68154	DSS	1/30	1800	60	110	19	18	30	29
68149	68155	DSS	1/30	1800	60	220	19	18	30	29
68150	68156	DSS	1/30	2400	40	110	20	19	31	30
88464	88465	DSS	1/30	2400	40	120	20	19	31	30
68151	68157	DSS	1/30	2400	40	220	20	19	31	30
68152	68158	DSS	1/40	1500	25	110	20	19	31	30
68153	68159	DSS	1/40	1500	25	220	20	19	31	30

CONTINUOUS CURRENT—SHUNT WOUND

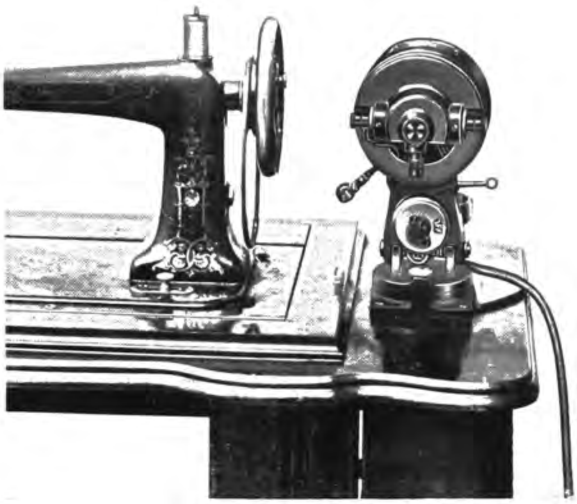
Catalogue No.		Type	H.P.	Approx. Speed	Volts	Approx. Weight in Pounds			
						Net		Shipping	
Form H Motor	Form K Motor					Form H	Form K	Form H	Form K
68144	68146	DSD	1/30	1700	110	19	18	30	29
68145	68147	DSD	1/30	1700	220	19	18	30	29

Unless otherwise specified, motors are furnished to run the handwheel toward the operator.

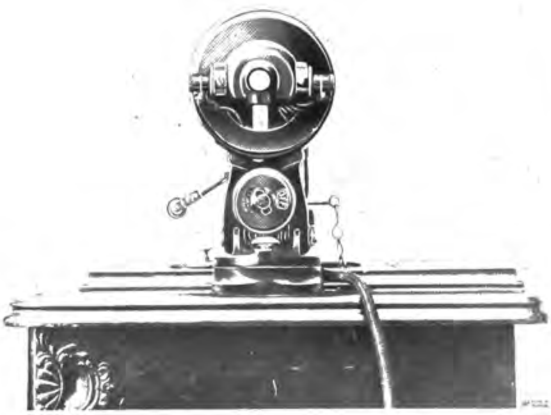
The motors listed above are not powerful enough for dressmaking and tailoring or for light manufacturing purposes, as sewing machines for these uses are considerably heavier and require more power than those designed for ordinary domestic purposes.

For applications requiring power in excess of 1/30 horse-power see separate publications.

The new family size sewing machine motors combine strength, reliability, simplicity of application, facility and economy of operation. They are gracefully designed, carefully made, finely finished and leave nothing to be desired. Persons having once tried this method of drive find it absolutely indispensable.



SEWING MACHINE EQUIPPED WITH A DSD 1/30 H.P. FORM H MOTOR — VIEW WITH MOTOR TURNED ON SWIVEL BASE



DSD 1/30 H.P. FORM H MOTOR — SIDE VIEW

DSS 1/30 H.P. FORM HC MOTOR INSTALLED ON SEWING MACHINE

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:

(Address nearest office.)

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 30 Church Street.
SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Building.
BALTIMORE, MD., Electrical Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Bldg.
PITTSBURG, Pa., Park Building.
RICHMOND, VA., 712 Mutual Building.
ROANOKE, VA., Strickland Building.
ATLANTA, GA., Empire Building.
MACON, GA., Grand Building.
NEW ORLEANS, LA., Maison-Blanche Building.
CINCINNATI, OHIO, Provident Bank Building.
COLUMBUS, OHIO, Columbus Savings & Trust Building
CLEVELAND, OHIO, Citizens Building.
CHATTANOOGA, TENN., James Building.
MEMPHIS, TENN., Randolph Building.
NASHVILLE, TENN., Stahlman Building.
INDIANAPOLIS, IND., Terminal Traction Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.)
ST. LOUIS, MO., Wainwright Building.
KANSAS CITY, MO., Dwight Building.
BUTTE, MONTANA, Phœnix Building.
MINNEAPOLIS, MINN., 410–412 Third Avenue, North.
DENVER, COLO., Kittredge Building.
SALT LAKE CITY, UTAH, Newhouse Building.
SAN FRANCISCO, CAL., Union Trust Building.
LOS ANGELES, CAL., Delta Building.
PORTLAND, ORE., Electric Building.
SEATTLE, WASH., Colman Building.
SPOKANE, WASH., Paulsen Building.

For TEXAS and OKLAHOMA Business refer to
General Electric Company of Texas,
Dallas, Tex., Praetorian Building.
El Paso, Tex., Chamber of Commerce Building.
Oklahoma City, Okla., Insurance Building.

FOREIGN:

FOREIGN DEPARTMENT,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
LONDON OFFICE, 83 Cannon St., London, E. C., England.

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

General Electric Company
Schenectady, N.Y.

SUPPLY DEPARTMENT

March, 1910 — *Bulletin No. 4728

THOMSON SINGLE-PHASE HIGH TORQUE WATTHOUR METERS

The General Electric Company manufactures three types of Single-phase High Torque Watthour meters, as follows:

Type I metal cover, for house installation.

Type IS–2 metal cover, for switchboard use.

Type IS–3 glass cover, for switchboard use.

These meters, which are constructed on the induction principle, differ in many respects from their predecessors, and contain the essential features of an ideal meter, as each change in design has been in keeping with the rapid advancement in the art.

Accuracy, the prime requisite of a satisfactory meter, means not only initial accuracy under ideal operating conditions, but also continual accuracy over long periods of use, and under those variations from normal conditions that are commonly experienced in central station practice. In the Single-phase High Torque Watthour meters, the General Electric Company has succeeded in obtaining a continued maintenance of the initial accuracy under all ordinary circumstances.

THOMSON HIGH TORQUE WATTHOUR METER—TYPE I

*Supersedes Bulletin No. 4498.

NOTE.—The data in this publication are for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication. Subject to change without notice.

GENERAL DESCRIPTION—TYPE I WATTHOUR METERS

The appearance of the General Electric High Torque Watthour meter, Type I, is particularly pleasing. It is small, compact and simple, although strong and durable in construction, and is exceptionally light in weight.

The mechanism is contained in a rectangular case which is provided with three

THOMSON HIGH TORQUE WATTHOUR METER WITH COVER REMOVED

supporting lugs or feet. The cover is pressed sheet metal and is light and stiff. Two rectangular windows sealed into the cover provide means for observing the register and meter disk.

MECHANICAL FEATURES

Register

The meter register is of the four dial type reading directly in kilowatt hours. One complete revolution of the most rapidly moving pointer on the Type I meter equals 10 kilowatt hours.

No multiplying constants are used on 60 cycle meters of 15 kw. capacity or less, nor on 40 or 50 cycle meters of 10 kw. or less. On meters of larger capacities a constant of 10 or multiple thereof is used. This decimal system renders possible the use of the same unit (the kilowatt hour) for all registers, and the same value per revolution of each pointer.

Cover and Sealing

The cover is held by two studs and wing nuts which firmly clamp it down on a felt packing, making a dust-proof and insect-proof joint. The disk and register windows are set in putty, thus augmenting the dust-proof qualities.

The meter is sealed by passing a single sealing wire through the wing nuts and their respective studs. This method of sealing is extremely simple and convenient and positively prevents tampering.

Binding Posts

The binding posts in meters up to and including 100 amperes are located at the sides near the top of the case. Meters having a capacity in excess of 100 amperes have binding posts at the sides near the bottom of the case. Fibre and felt guards secured to the case at the point where the wires enter prevent introduction of dust, etc., and insulating bushings are provided at the leading-in holes. Both sides of the line are carried through the meter in all capacities up to and including 100 amperes.

Accessibility

The entire mechanism is assembled upon a skeleton casting or frame which in turn is fastened to the meter case. By removing two retaining screws and the two sealing studs, the frame and mechanism can be removed for inspection or repair.

By removing the register and pivot, the moving element can be taken out. It is unnecessary to change the position of the magnets during this operation and therefore full load calibration is unaffected.

An automatic dog, between the worm wheel and register, permits removal and replacement of the register without in any way affecting the proper mesh of worm and worm wheel.

The two permanent magnets are fastened rigidly together and by loosening two screws, may be removed as a unit from the supporting shelf.

Jewels and Pivots

Almost any material if well polished will give, *initially*, low friction, and, therefore, prove satisfactory as a bearing. But for satisfactory continuous operation this condition of low friction must be maintained, and to secure this the jewel and pivot must be of the hardest material and possess the highest possible polish. The eastern sapphire and the diamond have proved to be the only materials which give satisfactory service in integrating wattmeters. The greatest care is exercised in selecting the stones used in the General Electric Company's meters, and they are cut, polished and inspected by skilled workmen.

The jewel is set in a brass plug which in turn rests on a compression spring. The strength of each spring is carefully tested by a high and low limit gauge and all springs not within the proper limits are rejected.

The pivots are made from the highest grade of piano wire, drawn under such enormous pressure that the finest grain is obtained. These pivots are glass hardened and polished.

Rotating Element

The rotating element consists of an aluminum disk mounted on a small bronze shaft. The lower end of the shaft carries a removable steel pivot, while the upper end contains a suitable worm for transmitting the disk rotation to the register.

Shipping Device

For protection during shipment or any subsequent transportation these meters are provided with a clamping device which holds the moving element securely, at the same time lifting it entirely free from the jewel bearing. This clamping device consists of a brass cap which is normally drawn down and held by the jewel screw against the force of a lifting spring. When the cap is drawn down, the moving element is free to rotate. When the jewel screw is backed out, the cap is released, and, because of the spring, lifts the moving element and holds it firmly.

ELECTRICAL FEATURES

Shielding

These meters are so designed that the magnetic circuit is practically closed upon itself, and stray fields which might tend to demagnetize the magnets are reduced to a minimum.

The magnets are further protected by their position; they are some distance from the coils, and the plane in which they lie is at right angles to any projected field.

Prevention of Creeping

All General Electric induction meters are designed so as to prevent "creeping" or rotating on potential alone. The disk contains two small holes placed near the periphery and diametrically opposite each other. These holes increase the resistance to the flow of the eddy currents in the disk. When these openings are in the neighborhood of the potential pole, any tendency to rotate on potential alone is overcome and the disk is therefore prevented from rotating more than half a revolution. When current is flowing in the series coils, rotation of the disk is in no way affected, nor the accuracy of the meter impaired.

Light Load Adjustment

Light load accuracy is highly important in all meters, as a very large portion of the central station's revenue is derived from the individually small, long hour demand of its customers. That the best results be obtained, it is essential that means be provided for controlling light load accuracy, and the devices used must be simple and convenient, as their adjustment should easily be accomplished by inspectors.

These meters are provided with a light load adjustment or starting plate, consisting of a small sliding rectangular conductor placed between the potential coil and the disk. When this rectangular conductor is moved from its central position in the direction of rotation of the disk, the torque produced is positive; if moved in the opposite direction, the torque produced is negative. A lever is provided for moving the plate backward or forward over the meter disk, thus permitting a wide adjustment. The letters "S" and "F" are cast in the meter frame close to the lever arm indicating which way to move the lever for "slow" or "fast."

TORQUE

The importance of high torque, or turning moment, is not generally appreciated at its true value.

A meter should theoretically do no work except the generation of eddy (Foucault) currents in the disk. This is possible, however, only in theory; in practice, two classes of work are done, first, the generation of eddy currents, and, second, the overcoming of friction. The first varies according to the law of the perfect meter, but friction does not; hence, variations of friction produce inaccuracy. It is obvious that the work done according to the law of the meter should be very large compared with the work which is not, *i.e.*, friction. The variable factor will then represent a variation on only a small proportion of the total energy expended.

Reduced to its practical elements this means that to retain accuracy for a long period and without depreciation in value, a meter must be so constructed as to do a relatively large amount of work in the generation of eddy currents. In other words, a high torque, permitting a heavy drag or load, is essential to permanent and sustained accuracy. The factor of "Torque per Unit Weight" should also be of high value, in order that errors due to friction shall be negligible. Both of these requirements can be obtained only by the careful proper proportioning of the various elements, and have been fully met in the Thomson High Torque Watthour meter.

MAGNETS

In order that a meter shall record correctly, the retardation of its moving element must vary directly with its speed. This retardation is produced by the mutual reaction of eddy currents generated in the disk and the magnetic field of the permanent magnets. It is proportional to the square of the magnet strength; consequently, a slight change in the magnet strength will cause serious inaccuracies of the meter.

The experience of the General Electric Company, extending over the past twenty years, has been so complete and thorough as to guarantee the results in the manufacture of permanent magnets. This experience is the result of an actual commercial production of more than four million magnets.

ACCURACY ON OVERLOADS

The losses in the meters are extremely low, hence permit accurate operation on heavy overloads, even for considerable periods of time, without detrimental effects either permanent or temporary.

The perfect shielding of the magnetic circuit, referred to above in relation to stray magnetic fields, protects the permanent magnets from the usual consequencies of short circuits, or other sudden current surges.

INDUCTIVE LOAD ACCURACY

Accuracy on loads of low power factor is essential to an induction meter for general alternating current service.

Thomson Single-phase Watthour meters are so designed and adjusted as to secure the highest possible inductive load accuracy, and may be relied upon to record true kilowatt hours either upon an entirely non-inductive load, such as incandescent lamps, or upon a highly inductive load, such as fan or other motors.

VARIATIONS OF FREQUENCY

Thomson's High Torque Watthour meters in common with all other meters of their class, are designed and calibrated for the frequency upon which they are to be used.

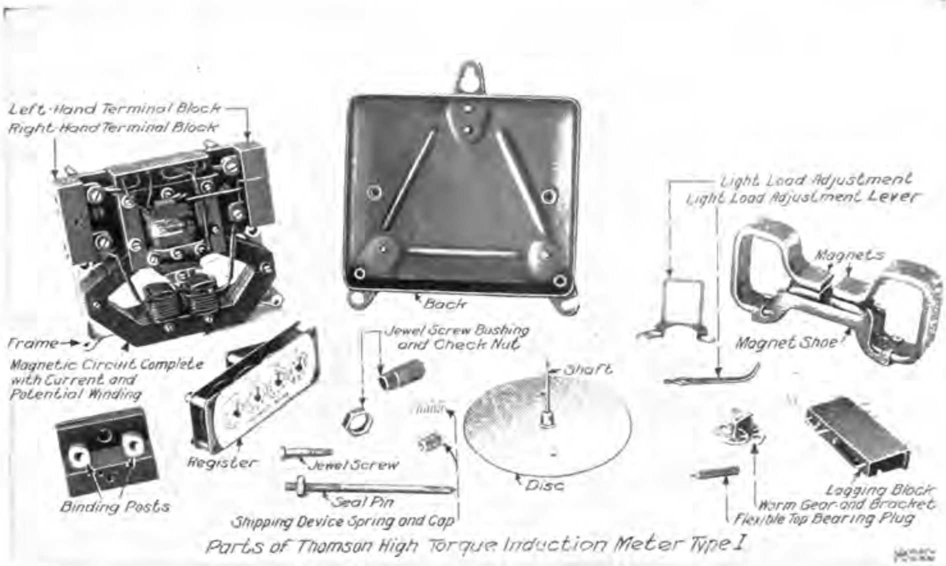
In view of the fact that 125 to 133 cycle systems are now quite generally being converted into 60 cycle systems, all Type I meters ordered for use on 125 or 133 cycle systems are provided with means for immediate re-connection on 60 cycle circuits.

These induction meters are practically unaffected by a 10 per cent. variation either way from the normal rated frequency for which they are calibrated.

VARIATIONS OF POTENTIAL

It is highly important that meters be accurate, irrespective of potential variations. This is especially true of meters used on systems of moderate size where voltage regulation is not always perfect and potential variations occur on different sections of the lines, or during portions of the twenty-four hours. This characteristic may be readily determined by test, and constitutes an important consideration.

The accuracy of these meters is unaffected by a 10 per cent. variation in voltage either above or below that for which they are calibrated.



PARTS OF THOMSON HIGH TORQUE WATTHOUR METER—TYPE

TESTING

For convenience in testing before installation, a testing loop has been provided in Type I meters. Any number of meters can be tested in series without recording the losses in the potential circuits by disconnecting this loop and connecting the potential coil of each meter to the source of potential at some point, before the wires enter the first meter of the series. The testing loop is conveniently placed on the left hand terminal board.

FINISH

The Type I meter is intended for house installation and therefore is made for side connections only. The finish is dull black japan, which has proved to be the most permanent and pleasing for the house type of meter. If desired, this meter can be furnished with glass covers, of the same general outline as the aluminum covers, without additional charge.

CAPACITIES

Special attention is called to the fact that the Thomson High Torque Watthour meter, Type I, is manufactured as a standard device for 2-wire and 3-wire service, and no auxiliary external devices are necessary for either application. The Type I meter is made for direct connection into the circuit up to and including 300 amperes, 2-wire, and 150 amperes, 3-wire service. Current transformers are not used unless the current is above these limits, or the voltage greater than 650 volts.

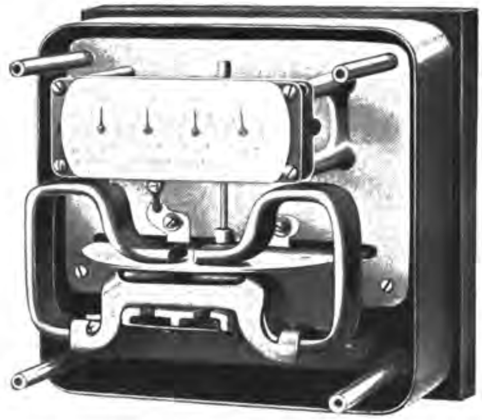
Potential transformers must be used above 650 volts.

SINGLE-PHASE WATTHOUR METERS FOR SWITCHBOARD INSTALLATION TYPES IS-2 AND IS-3

The General Electric Company strongly advocates the practice of metering individual generators rather than using a single meter to measure the total output of a station.

SWITCHBOARD WATTHOUR METER—TYPE IS-2

By the use of a meter with each generator and feeder, a far better load factor on individual meters is obtainable, resulting in greater accuracy. Furthermore, convenience of arrangement and connection is greatly increased, testing facilitated and



SWITCHBOARD WATTHOUR METER—TYPE IS-2 WITH COVER REMOVED

additions to the switchboard may be made with minimum expense and difficulty.

For switchboard use the General Electric Company has developed a line of single-phase meters known as Types IS-2 and IS-3.

General Description

These meters are in many respects similar to the Type I Watthour meters already described but are designed and adapted for switchboard use.

They differ widely from earlier single-phase switchboard meters, not only in mechanical construction but also in electrical design. The new design is more compact, much neater in appearance and the instruments have greater accuracy than the earlier forms. At the same time, all the desirable and essential features are retained.

The Types IS-2 and IS-3 meters embody the many recent improvements that are common in other types of the General Electric Company's meters, and tests show them to be the most accurate switchboard meters ever placed in commercial service. The "Torque per Unit Weight" is the highest of any induction meter. The interior parts are secured to a frame which may be removed by loosening four screws, disconnecting the leads from the binding posts, and lifting the entire meter free from its case, thus greatly simplifying inspection.

Registers

The register is of the four-dial type, reading directly in kilowatt hours on meters of low capacity. On larger meters, a dial face multiplier of 10, 100, 1000, etc., is required. By using this system, the actual energy units remain the same in all sizes, the reading being obtained by the addition of one or more ciphers to the indication of the first pointer. To permit greater accuracy where frequent readings are taken, the register on switchboard meters is constructed to record ten times faster than the corresponding capacity Type I meter. One revolution of the most rapidly moving pointer equals 10 kilowatt hours in meters without constants, except in the case of some low-capacity meters where the usual switchboard meter register would have a dial face multiplier of 1/10. To overcome the use of a fractional multiplier in such cases, a dial face is used having 1 over the right-hand dial, 10 over the second dial, etc. In other words, such dials read 1 kilowatt hour for one revolution of the most rapidly reading pointer. To distinguish these dials, the right-hand circle is black, pointer and figures being white. This distinguishing feature will prevent errors due to any oversight in noting the different units in which the dials read.

GLASS ENCLOSED, SWITCHBOARD WATTHOUR METER TYPE IS-3

Finish

The Type IS-2 meter has a cast metal cover and the Type IS-3 meter a rectangular glass cover. The finish of both meters is dull black, the front of the Type IS-2 cover having a pebbled surface with raised portions polished copper, making a very agreeable appearance. In the Type IS-3 meter, the frame, register, magnets, etc. are all finished in dull black.

Capacities

The Types IS-2 and IS-3 meters are standard in capacities up to 150 amperes for 1150 and 2300 volt circuits. When used on 650 volt circuits and over, they are furnished with potential transformers, and above 1150 volts are supplied with both current and potential transformers.

THOMSON HIGH TORQUE WATTHOUR METER—TYPE I SINGLE-PHASE

FRONT CONNECTED, METAL OR GLASS COVER, JAPAN FINISH

100-120 VOLTS, 40-133 CYCLES, TWO-WIRE

Cat. No.	* Lights	Amperes
51173	6	3
51174	10	5
51175	20	10
51176	30	15
51177	50	25
51178	100	50
51179	150	75
51180	200	100
51181	300	150
33584	400	200
33585	600	300

* Rated on a basis of 50 watts per lamp.

THOMSON HIGH TORQUE WATTHOUR METERS—TYPE I SINGLE-PHASE

FRONT CONNECTED, METAL OR GLASS COVER, JAPAN FINISH

200-240 VOLTS, 40-133 CYCLES, THREE-WIRE			200-240 VOLTS, 40-133 CYCLES, TWO-WIRE		
Cat. No.	* Lights	Amperes	Cat. No.	* Lights	Amperes
33588	12	3	19042	12	3
33589	20	5	51182	20	5
33590	40	10	51183	40	10
51191	60	15	51184	60	15
51192	100	25	51185	100	25
51193	200	50	51186	200	50
51194	300	75	51187	300	75
51195	400	100	51188	400	100
51196	600	150	51189	600	150
			33586	800	200
			33587	1200	300

* Rated on a basis of 50 watts per lamp.
Note.—Always state normal voltage of circuit.

THOMSON HIGH TORQUE WATTHOUR METERS FOR SWITCHBOARD SERVICE—RECTANGULAR PATTERN

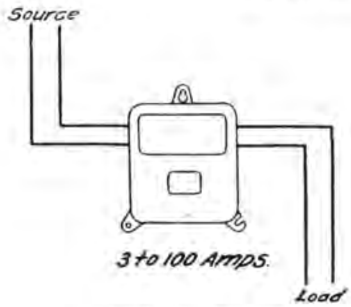
SINGLE-PHASE PRIMARY CIRCUITS—60-133 CYCLES

TYPE IS-2—CAST METAL CASE, DULL BLACK FINISH				TYPE IS-3—GLASS CASE, INTERIORS, DULL BLACK FINISH			
* 1000-1150 VOLTS		† 2000-2300 VOLTS		* 1000-1150 VOLTS		† 2000-2300 VOLTS	
Cat. No.	Amperes	Cat. No.	Amperes	Cat. No.	Amperes	Cat. No.	Amperes
41429	5	41515	5	41568	5	41576	5
41430	10	41516	10	41569	10	41577	10
41431	15	41517	15	41570	15	41578	15
41432	25	41518	20	41571	25	41579	20
41511	50	41519	30	41572	50	41580	30
41512	75	41520	40	41573	75	41581	40
41513	100	41521	60	41574	100	41582	60
41514	150	41522	80	41575	150	41583	80
		41523	100			41584	100
		41524	150			41585	150

* Furnished with potential transformers.
† Furnished with current and potential transformers.

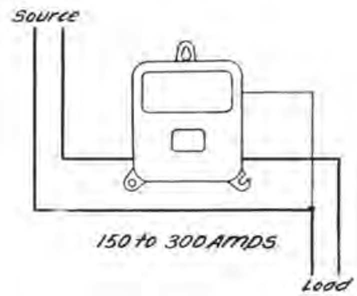
CONNECTIONS OF THOMSON WATTHOUR METERS—TYPE I

100 TO 650 VOLTS—TWO-WIRE CIRCUITS



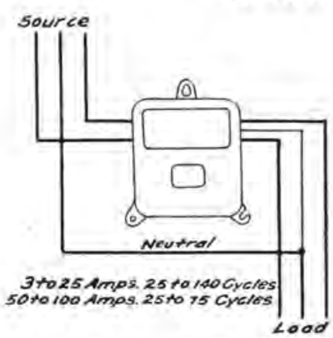
3 TO 100 AMPERES
25 CYCLES AND ABOVE

Front View



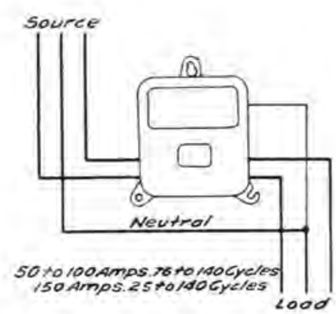
150 TO 300 AMPERES
25 CYCLES AND ABOVE

200 TO 650 VOLTS—THREE-WIRE CIRCUITS



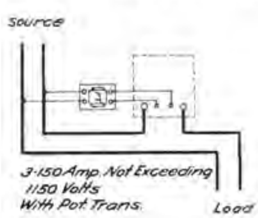
3 TO 25 AMP., 25 TO 140 CYCLES
50 TO 100 AMP., 25 TO 75 CYCLES

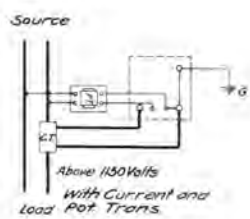
Front View



50 TO 100 AMP., 76 TO 140 CYCLES
150 AMP., 25 TO 140 CYCLES

CONNECTIONS OF TWO-WIRE THOMSON WATTHOUR METERS SWITCHBOARD PATTERN—TYPES IS-2 AND IS-3





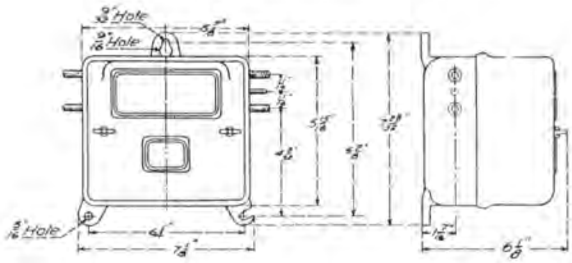
Back View

3 TO 150 AMP., NOT EXCEEDING 1150 VOLTS—WITH POTENTIAL TRANSFORMERS

5 TO 150 AMP., ABOVE 1150 VOLTS—WITH CURRENT AND POTENTIAL TRANSFORMERS

DIMENSIONS OF THOMSON WATTHOUR METERS—TYPE I

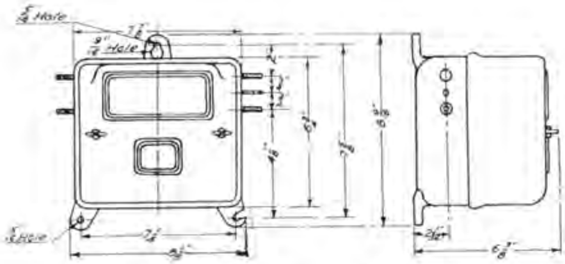
100 TO 650 VOLTS—TWO-WIRE CIRCUITS
200 TO 650 VOLTS—THREE-WIRE CIRCUITS



THREE-WIRE

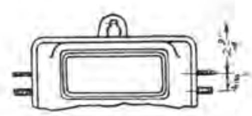
TWO-WIRE

3 TO 25 AMPERES, ALL FREQUENCIES



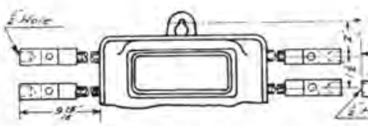
50 AND 75 AMP., THREE-WIRE, 75 CYCLES AND BELOW

Without Potential Transformer

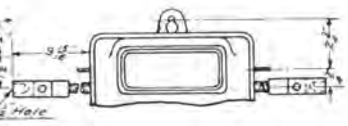


With Potential Transformer

50 AND 75 AMP., TWO-WIRE, ALL FREQUENCIES

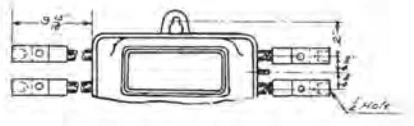


Without Potential Transformer

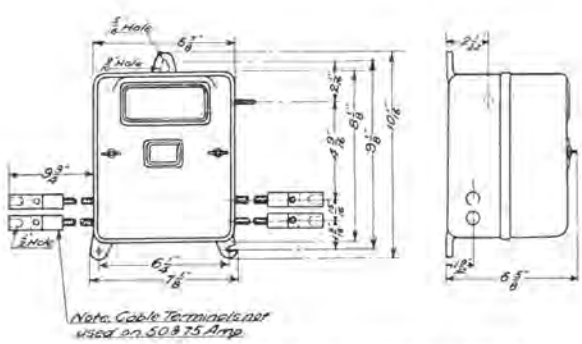


With Potential Transformer

100 AMP., TWO-WIRE, ALL FREQUENCIES



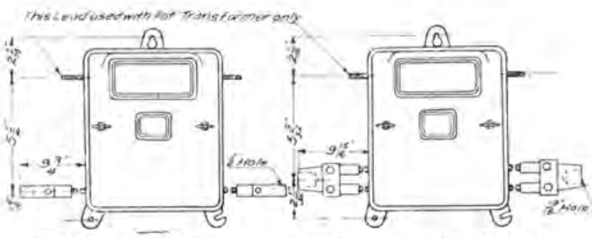
100 AMP., THREE-WIRE, 75 CYCLES AND BELOW



50-75-100 AMP., THREE-WIRE, ABOVE 75 CYCLES
150 AMP., THREE-WIRE, ALL FREQUENCIES

DIMENSIONS OF THOMSON WATTHOUR METER—TYPE I—(Continued)

100 TO 650 VOLTS

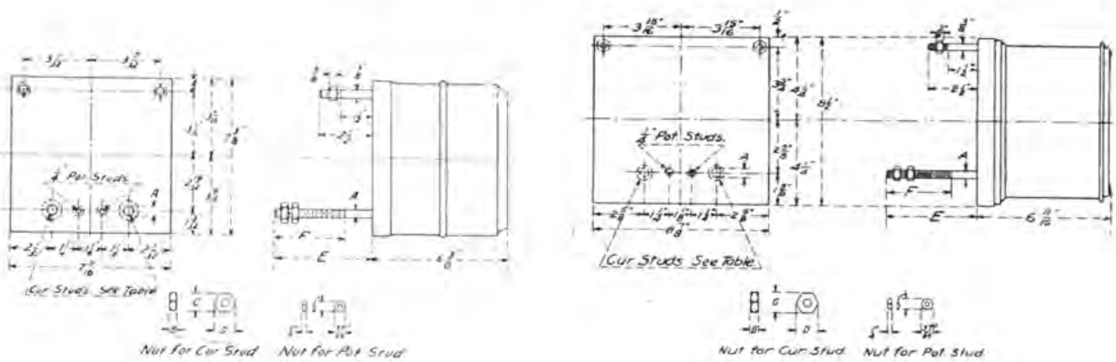


2-WIRE, 150 AMP. 2-WIRE, 200 AND 300 AMP.

150 TO 300 AMP., TWO-WIRE, ALL FREQUENCIES

DIMENSIONS OF TWO-WIRE THOMSON WATTHOUR METERS SWITCHBOARD PATTERN—TYPES IS-2 AND IS-3

100 TO 650 VOLTS—TWO-WIRE



CAPACITY	A	B	C	D	E	F
5-50 AMP.	3/4"	7/8"	13/32"	27/64"	3"	2 1/2"
100 AMP.	3/4"	1/2"	13/32"	27/64"	3"	1 1/4"
150 AMP.	1/2"	1/2"	1 1/16"	1 7/32"	3 1/2"	2 1/4"

TYPE IS–2

3 TO 150 AMP., ALL FREQUENCIES

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:

(Address nearest office.)

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 30 Church Street.
SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Building.
BALTIMORE, MD., Electrical Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Bldg.
PITTSBURG, Pa., Park Building.
RICHMOND, VA., 712 Mutual Building.
ROANOKE, VA., Strickland Building.
ATLANTA, GA., Empire Building.
MACON, GA., Grand Building.
NEW ORLEANS, LA., Maison-Blanche Building.
CINCINNATI, OHIO, Provident Bank Building.
COLUMBUS, OHIO, Columbus Savings & Trust Building.
CLEVELAND, OHIO, Citizens Building.
CHATTANOOGA, TENN., James Building.
MEMPHIS, TENN., Randolph Building.
NASHVILLE, TENN., Stahlman Building.
INDIANAPOLIS, IND., Terminal Traction Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.)
ST. LOUIS, MO., Wainwright Building.
KANSAS CITY, MO., Dwight Building.
BUTTE, MONTANA, Phœnix Building.
MINNEAPOLIS, MINN., 410-412 Third Avenue, North.
DENVER, COLO., Kittredge Building.
SALT LAKE CITY, UTAH, Newhouse Building.
SAN FRANCISCO, CAL., Union Trust Building.
LOS ANGELES, CAL., Delta Building.
PORTLAND, ORE., Electric Building.
SEATTLE, WASH., Colman Building.
SPOKANE, WASH., Paulsen Building.

For TEXAS and OKLAHOMA Business refer to
General Electric Company of Texas,
Dallas, Tex., Praetorian Building
El Paso, Tex., Chamber of Commerce Building.
Oklahoma City, Okla., Insurance Building.

FOREIGN:

FOREIGN DEPARTMENT,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
LONDON OFFICE, 83 Cannon St., London, E. C., England.

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

General Electric Company
Schenectady, N.Y.
SUPPLY DEPARTMENT

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MAZDA ECONOMY DIFFUSERS

In the past the Incandescent lamp has found its greatest field of usefulness in the lighting of small areas. The high efficiency of the Mazda lamp, however, makes it a competitor for lighting of larger areas and in order to equip it so as to meet these conditions most effectively, the Mazda Economy Diffuser has been designed.

It is obvious that the capacity of the lighting unit should bear a proportionate relation to the size of the room in which it is installed. For example, in small rooms, small units are necessary in order to produce an even illumination economically. In large rooms, large units are more effective and give a directive effect to the lighting which avoids flatness in the illumination. The maintenance of this proportion produces a much better appearance, and should not be disregarded, especially in stores and other places where pleasing effects are desirable.

Practically all lighting units have a high intrinsic brilliancy. By properly diffusing the light and reducing this brilliancy the light is not only easier on the eyes but experience shows that it is possible to see equally well with a lower intensity of illumination.

Fig. 1. 26 IN. MAZDA ECONOMY DIFFUSER FOR STORE LIGHTING

The Mazda Economy Diffuser is placed on the market after considerable study and practical experimentation, as a unit particularly adapted for the illumination of large and medium sized rooms.

The especial advantages are as follows:

Wide range of capacity which can be obtained by using different sizes of lamps or by different steps in the switch combination.

Relatively low intrinsic brilliancy with excellent diffusion.

An economical distribution of light in which the maximum intensity is emitted at oblique angles in the lower hemisphere so as to illuminate the intermediate spaces. A small amount of light is sent above the horizontal so as to avoid darkness in the upper part of the room.

The appearance of the diffuser is particularly neat and attractive by daylight as well as when in use.

It is mechanically convenient, being arranged for suspension from a chain, gas pipe or ordinary hook, and is very easily kept clean.

The Mazda lamps are operated in a vertically pendant position, which is most favorable to long life.

* Supersedes Bulletin No. 4660.

GENERAL DESCRIPTION

The structure of the Mazda Economy Diffuser is built around a central pipe. Rigidly attached to this pipe at its lower end is a nickel-plated reflector which supports the diffuser proper. A heavy sheet metal platform carrying the lamp sockets, which are permanently wired in various standard combinations, is also attached to this reflector by means of three screws. This platform is so arranged that it can be raised or lowered to accommodate lamps varying in size from 16 candle-power carbon to 100-watt Mazda. The various parts of the fixture are supported by a hook, which screws into a hickey attached to the upper end of the central pipe. The mechanism is enclosed in a neat spun metal casing held in place by the suspension hook at the top. This hook is cast with a hollow shank providing a convenient and inconspicuous means of leading in the conducting wires. Provision is made for supporting the globe by means of a suitable globe holder, which screws onto a rod hinged to the lower end of the central pipe and forces the upper rim of the globe against spring clips fastened to the under side of the reflector.

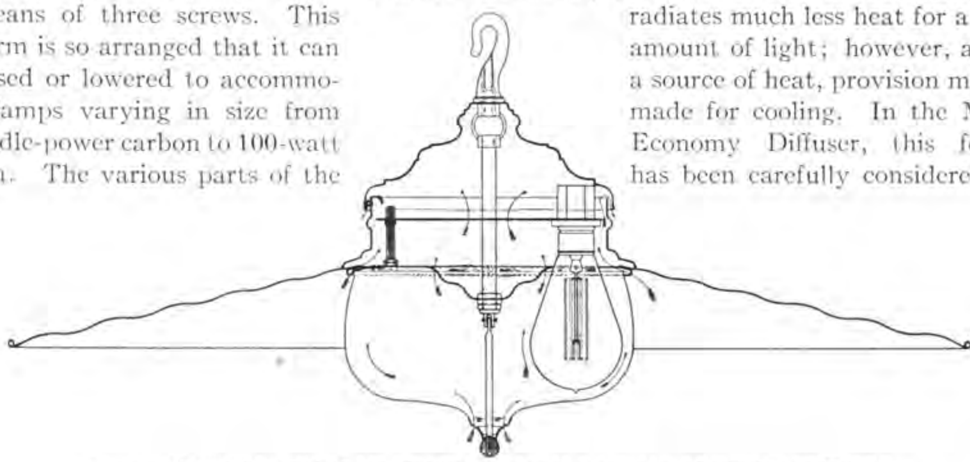


Fig. 2. SECTIONAL DIAGRAM SHOWING PASSAGE OF AIR THROUGH DIFFUSER

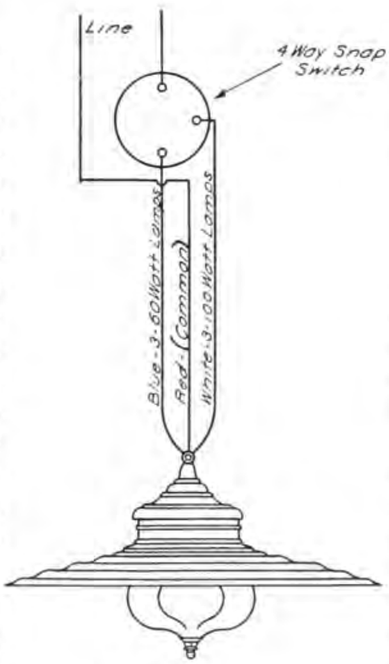


Fig. 3
CONNECTIONS FOR ECONOMY DIFFUSER

LAMPS

Only clear bulb lamps with Edison bases should be used with this diffuser. Lamps are not included with the fixtures and should be ordered separately.

VENTILATION

The Mazda lamp, being more efficient than any previous form of incandescent lamp, radiates much less heat for a given amount of light; however, as it is a source of heat, provision must be made for cooling. In the Mazda Economy Diffuser, this feature has been carefully considered and ample provision has been made to avoid undue heating. The method of ventilation is illustrated in Fig. 2.

WIRING

The Five-light Diffuser is wired for a single multiple circuit and is intended to be used as a five-light fixture only. The six-light diffuser is wired for two circuits and is provided with three leads, one of which is common to both circuits. It may be wired permanently as a three-light or six-light fixture, or it may be used with a four-way snap switch which will light first one group of three lamps, then the other group of three lamps and finally all six lamps. For example, a Mazda Economy Diffuser equipped with three 60-watt and three 100-watt Mazda lamps will have a capacity of 180, 300 and 480 watts by simply turning the switch handle. A four-way snap switch especially adapted for this service has been developed and can be furnished on order.

WATTS CONSUMPTION FOR EQUIPMENTS

FIVE-LIGHT DIFFUSER—SINGLE CIRCUIT

Number of Lamps	Watts per Lamp	Watts Consumed
5	40	200
5	60	300
5	100	500

SIX-LIGHT DIFFUSER—SINGLE CIRCUIT

Number of Lamps	Watts per Lamp	Watts Consumed
3	40	120
3	60	180
3	100	300
6	40	240
6	60	360

SIX-LIGHT DIFFUSER—DOUBLE CIRCUIT

Number of Lamps	Watts per Lamp	Watts Consumed, Switch Positions, No. 2	No. 3	No. 4
6	40	120	120	240
6	60	180	180	360
3 3	40 60	120	180	300
3 3	40 100	120	300	420
3 3	60 100	180	300	480

PLAIN TYPE

There are two principal types of Mazda Economy Diffusers known as Plain and Ornamental Type. The plain type may be subdivided into store type and mill type. The store type is equipped with a 26″ porcelain enameled steel diffuser, and the Mill Type Diffuser is equipped with 39″ paint enameled diffuser, the latter being slightly more efficient than the store type as a larger proportion of the light is concentrated below the horizontal.

For use in rooms with high ceilings the store type can be furnished with an upper canopy hook and ornamental link as illustrated on the front page, the type shown in Fig. 4 being more satisfactory for low ceiling work.

The dimensions of store type diffuser as illustrated on front page are the same as for Cat. No. 64375 shown on page 4.

Fig. 4. 26 IN. MAZDA ECONOMY DIFFUSER FOR STORE LIGHTING

SHOCK ABSORBER

Since the life of the Mazda lamp is considerably decreased where it is subjected to excessive vibration, a helically wound spring is shipped with these diffusers so that when the lamps are installed this vibration is overcome; thus prolonging the life of the lamp.

FINISH

The standard finish of the Plain Type Diffuser is streaked oxidized copper, although streaked oxidized silver or verde antique finishes can be supplied when specially ordered.

Fig. 5. 39 IN. MAZDA ECONOMY DIFFUSER FOR MILL LIGHTING

The standard finish of the Ornamental Type Mazda Economy Diffuser is Brushed Brass, although other finishes can be furnished on order.

GLOBE

The lamps in the Mazda Economy Diffuser are enclosed in a glass globe made in attractive five- and six-globe designs which give a finished appearance to the fixture and insure a large diffusing surface of relatively low intrinsic brilliancy. The globes furnished with the plain type diffuser are plain moulded glass sand-blasted on the inside, while the globes furnished with the ornamental type diffuser are of leaded sections of a specially selected opal art glass.

Plain frosted globes can be supplied with ornamental diffusers if required.

SINGLE LIGHT MAZDA ECONOMY DIFFUSER (MILL TYPE)

Where it is necessary to install individual lights over machines, a diffuser as illustrated in Fig. 6 will be found especially suitable.

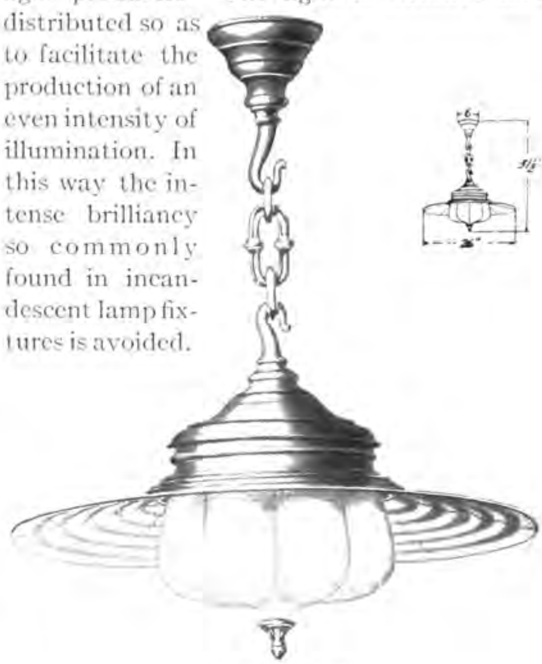
It consists of a sheet iron reflector 16 inches in diameter with a porcelain enameled reflecting surface and a paint finished upper surface. It can be used with standard Mazda lamps up to and including the 250 watt size. Where a soft diffused light is required a frosted outer globe can be furnished.

Fig. 6. SINGLE LIGHT MAZDA ECONOMY DIFFUSER
Cat. No. 108565, With Globe
Cat. No. 108566, Without Globe

This globe will enclose the 100 watt Mazda lamp or smaller sizes. The diffuser itself can be attached to the standard shadeholder socket, or it can be attached to the standard socket by means of the "O" holder.

ORNAMENTAL TYPE

The Ornamental Mazda Economy Diffusers comprise a number of fixtures which have been designed for the purpose of combining a scientific lighting unit with an ornamental fixture. They are not only attractive in appearance but highly efficient as light producers. The light is softened and distributed so as to facilitate the production of an even intensity of illumination. In this way the intense brilliancy so commonly found in incandescent lamp fixtures is avoided.



CAT. NO. 64375

The various types of Ornamental Mazda Economy Diffusers, together with a detailed description of each, are shown on pages 5 to 8. Both plain and ornamental types are manufactured in five- and six-light units.

CAT. NO. 64503

In addition to the five- and six-light sizes, single light fixtures as shown on page 8 can be supplied.

The following is a brief description of the various ornamental types.

Cat. No. 64375 has a spun brass casing and

CAT. NO. 64376

upper canopy with Gothic link and Amboy hooks, leaded glass diffuser and globe and simple cast brass knob.

CAT. NO. 64377

Cat. No. 64503 has a cast brass canopy and Elizabethan hooks and link. The upper part of the spun brass casing is ornamented in scroll and leaf designs of cast brass. The diffuser and globe are of leaded glass and the bottom knob is a simple brass casting.

Cat. No. 64376 has a cast bronze upper canopy, Renaissance hooks and links, cast bronze husk ornaments on spun brass casing, leaded glass diffuser and globe, and simple cast brass bottom knob. It is suitable for use in rooms where the architectural ornamentation is simple, and suggestive of the Renaissance.

Cat. No. 64377 has a cast bronze canopy, Renaissance hooks and link, cast brass scroll ornaments applied to spun brass casing, leaded glass diffuser and globe, and ornamental cast brass bottom knob. It is adapted to a scheme of decoration where the ornamentation is of Renaissance style.

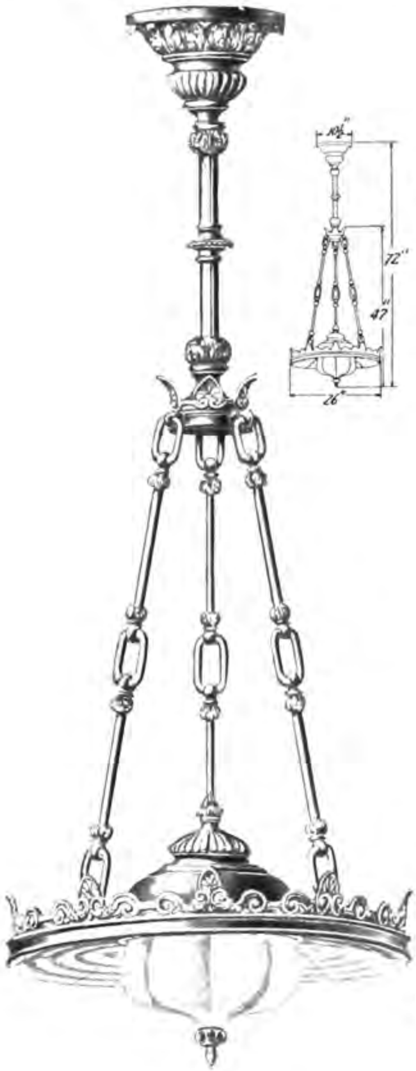
Cat. No. 64378 has a cast bronze canopy, hooks and ink; cast bronze crown. and hood covering the spun brass casing; leaded glass

CAT. NO. 64378

diffuser and globe, and ornamental cast brass bottom knob. This fixture is particularly adapted for use with Elizabethan schemes of interior decoration.

4729-6 Mazda Economy Diffusers

Cat. No. 64379 has an ornamental cast brass leaf and melon form canopy, Elizabethan hooks and links, leaded glass globe surmounted by a cast brass leaf cresting and closed in at the top by a spun brass hood with melon form of ornamentation; leaded glass globe and ornamental cast



CAT. NO. 64381

brass bottom knob. This fixture will harmonize with architectural decoration of modern French style.

CAT. NO. 64379

CAT. NO. 64380

Cat. No. 64380 is particularly adapted to the pure Renaissance style of decoration. It consists of a heavy cast bronze canopy, Renaissance hooks and links, leaded glass globe surmounted by cast brass ring with spun corona which has cast brass ornaments applied and finished around the edge, and rich oak leaf border of cast brass; the heavy ornamental bottom knob is of cast brass. This fixture is very effective in rich gilt and warm bronze finishes.

CAT. NO. 64382

Cat. No. 64381 is designed for rooms decorated in Renaissance style and having high ceilings. It consists of leaded glass diffuser with an ornamental cresting around the edge, which is used as a base on which to build up the fixture. Above the diffuser is a spun brass casting, bearing a melon ornament, and a knob of cast brass. The diffuser is suspended from the central stem of the fixture by three ornamental rod and link supports. This fixture has a heavy cast brass canopy with cast brass breaks and ornaments. The leaded glass globe is supported by an ornamental cast brass bottom knob.

Cat. No. 64382 is particularly adapted for use in rooms decorated in rich Renaissance style or the Modern French style where the decorations are of a massive character. In this fixture the leaded glass diffuser is used as a motive upon which the design is laid out. The ornament consists of a series of consol forms tied together by festoons, supporting a large ornamental cast top. The lighting unit proper is suspended from four heavy plain chains, which in turn are carried by four heavy consols attached to the central stem of the fixture. The canopy and other ornamental parts of the fixture are of cast brass and the leaded glass globe is supported by a heavy ornamental cast bronze knob.

Cat. No. 64383 is a simple single-light fixture consisting of cast brass leaf form canopy, socket covers and leaded glass shades.

CAT. NO. 64505

CAT. NO. 64506

CAT. NO. 64388

Cat. Nos. 64386 and 64384 are simple, single light fixtures of a classic type consisting of cast brass canopy and socket covers, cast brass hooks and chain of Elizabethan style, and leaded glass shades.

†Cat. No. 64387 is treated as a ceiling fixture for rooms having low ceilings. This fixture consists of a spun copper corona with cast brass ornaments applied, leaded glass globe, and simple brass bottom knob.

Cat. No. 64504 is treated as a highly ornamental ceiling fixture. In this fixture the leaded glass diffuser is surmounted by a corona of brass and leaded glass. The ornamentation around the corona is composed of festoons of roses executed in leaded glass and by means of the light transmitted through the diffuser gives the effect of a band of soft harmonious color, in pleasing contrast to the more brilliantly lighted surfaces of the globe and diffuser. The globe is of leaded

† Cut shows plain frosted globe and bottom knob.

glass supported by an ornamental cast brass knob.

*Cat. No. 64505 is designed for use in rooms having low or medium height ceilings. The leaded glass globe is surmounted by a cresting leaded glass globe and simple cast brass bottom knob.

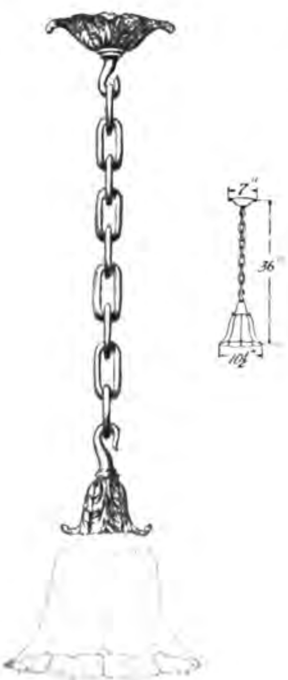
Cat. No. 64388 is designed for use in rooms decorated in Renaissance style having low or medium height ceilings. The leaded glass

CAT. NO. 64504

made up of cast brass conventional leaf forms while the casing and canopy are of spun brass. The bottom knob is a simple brass casting.

*Cat. No. 64506 is provided with Amboy hooks and plain brass chain, and a spun brass casing with cast brass ornaments applied, globe is surmounted by an ornamental cast brass cresting. The casing is of spun brass with cast ornaments applied and the canopy is a combination of spun and cast brass. The ornamental bottom knob is of cast brass.

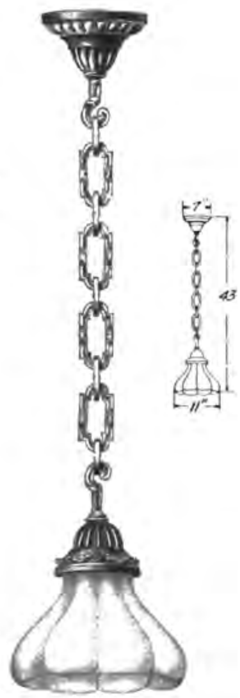
* Cut shows plain frosted globe.



CAT. NO. 64384

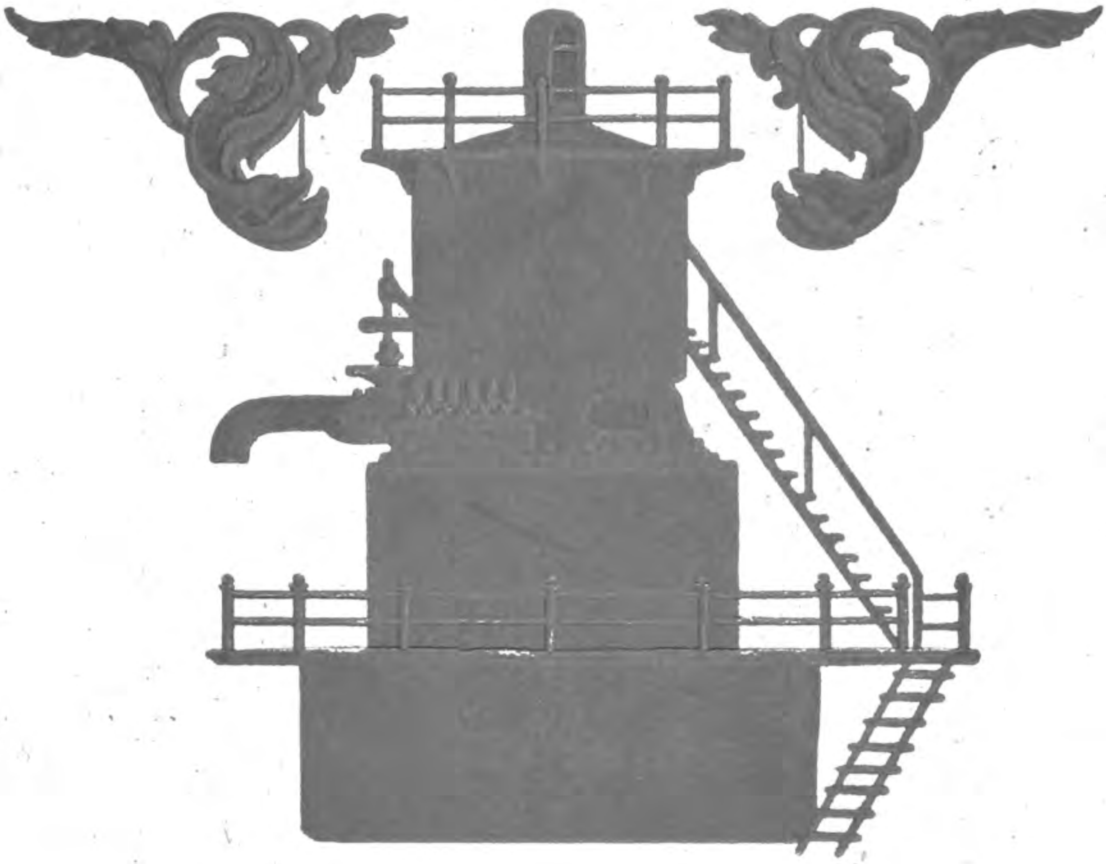
CAT. NO. 64387

CAT. NO. 64383



CAT. NO. 64386

CURTIS TURBINE INSTALLATIONS



GENERAL
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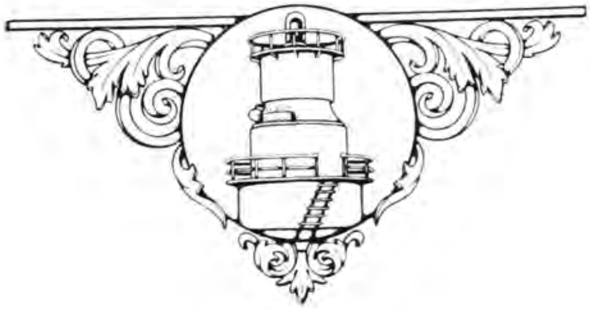
COMPANY

Curtis Steam Turbine-Generator Installations



General Electric Company

Schenectady, New York

April, 1910

No. 4732

Curtis Steam Turbine-Generators

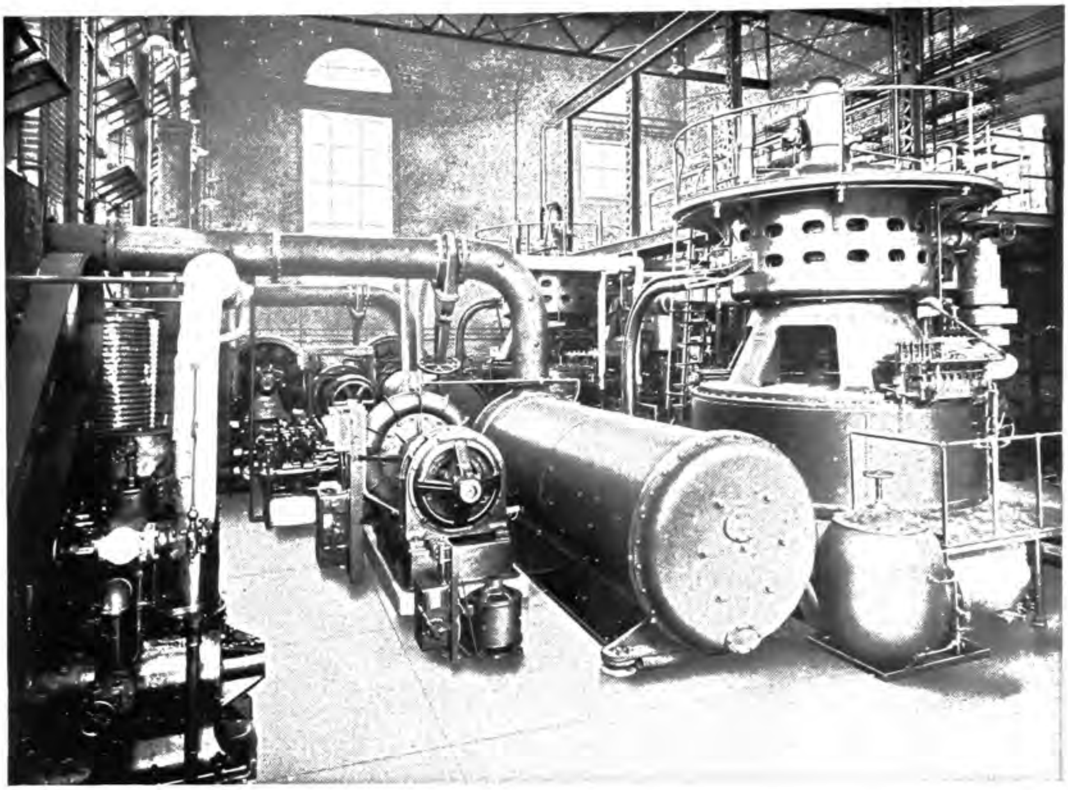
ALTHOUGH Curtis Steam Turbine-Generators were introduced less than ten years ago, the capacity sold in America alone now exceeds one and one-quarter million of kilowatts. These turbines have been installed in the electric lighting plants of nearly every large city, because of their

High steam economy at all loads;
Economy in floor space and building materials required;
Moderate initial cost and low maintenance expense;
Simplicity of construction; absence of all small clearances; absence of thrust balancing pistons with their heavy and uncertain leakages;
Maintenance of efficiency and general durability;
Ability to effectively utilize the large increase of available energy incident to the use of high steam pressure and high vacuum;
Ability to use high superheat without mechanical difficulties.

Large Lighting Railway and Power Plants equipped with Curtis Steam Turbines have shown the highest economy ever obtained, and the output of industrial and manufacturing plants has been materially increased. These turbines are built with vertical and horizontal shafts for high, low and mixed pressures. The latter types may be applied to existing plants using reciprocating engines, and in many cases will double the available capacity with very slight increase in steam consumption.

The illustrations of Curtis Steam Turbine Plants in this pamphlet indicate the enormous generating capacity which can be maintained in a building of comparatively moderate dimensions. They also illustrate some of the other advantages peculiar to a Curtis Turbine Station, for example, ample floor space available for auxiliary apparatus; easy accessibility to all machinery; perfect provision for cleanliness and ventilation.

A pamphlet describing the construction and performance of the Curtis Steam Turbine-Generator in detail will be sent on request.



1500 Kw. Curtis Steam Turbine-Generators Installed for the Dallas Electric Light and Power Company, Dallas, Texas

(AQB 8-1500-900, 2300 Volts)

Curtis Steam Turbine-Generators

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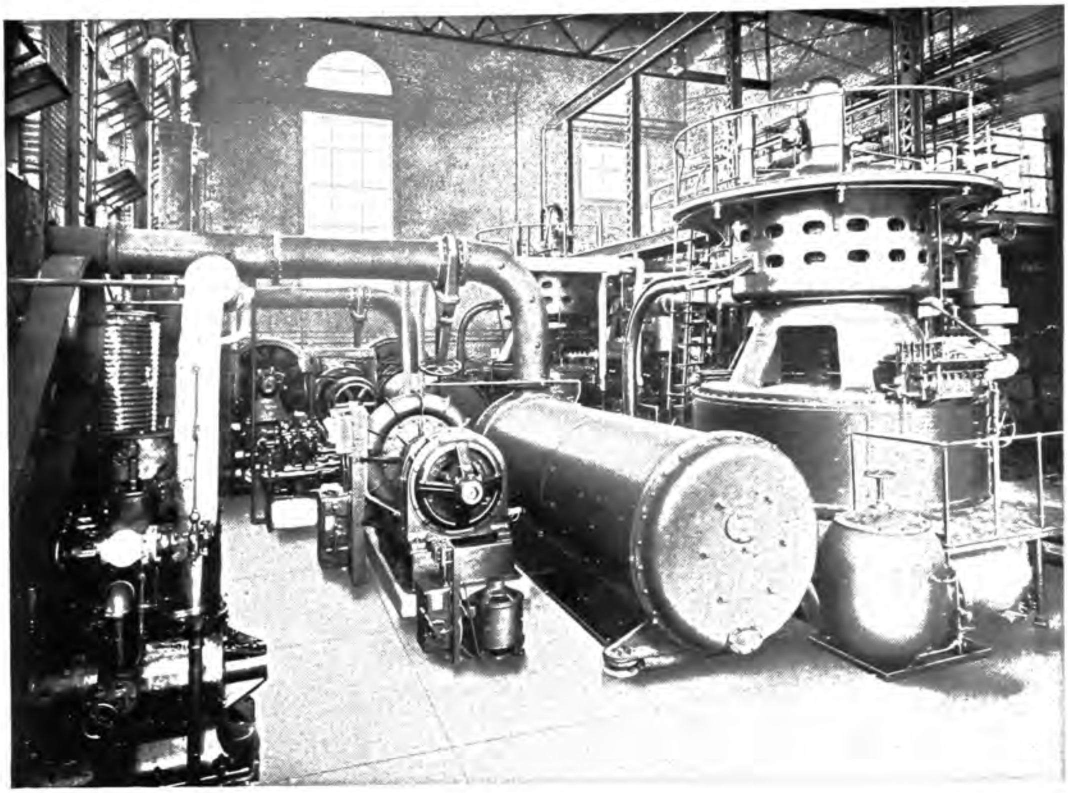
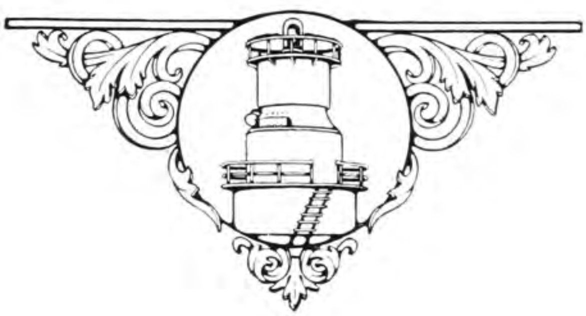
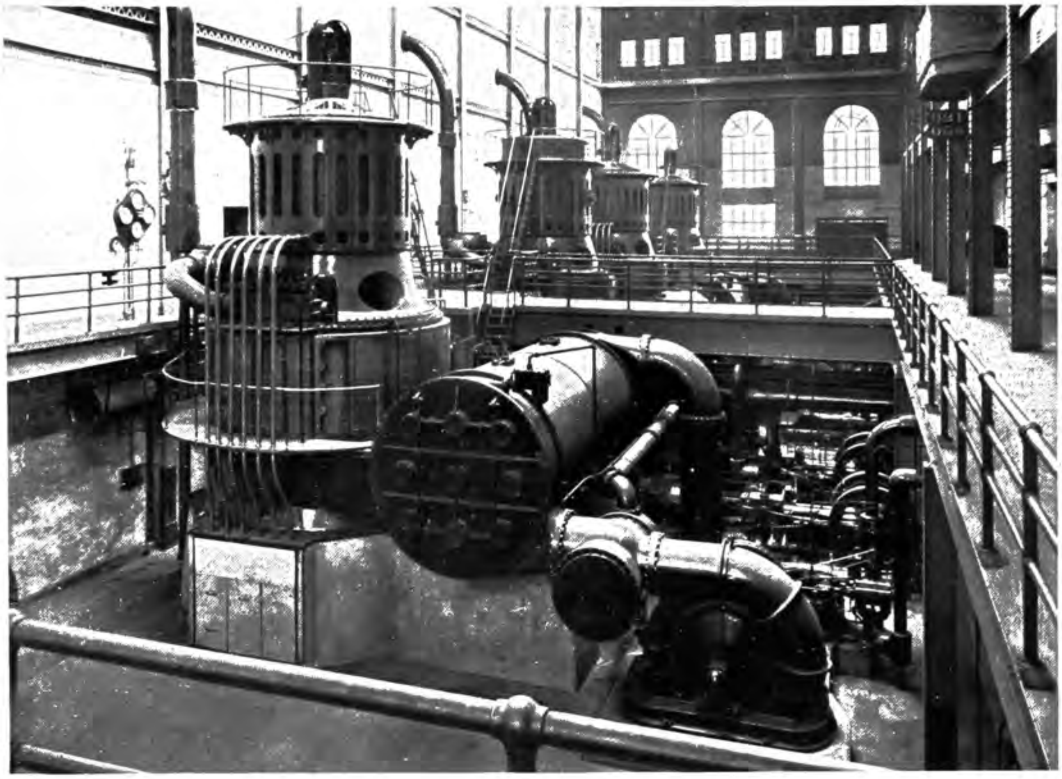


1500 Kw. Curtis Steam Turbine-Generators Installed for the Dallas Electric Light and Power Company, Dallas, Texas

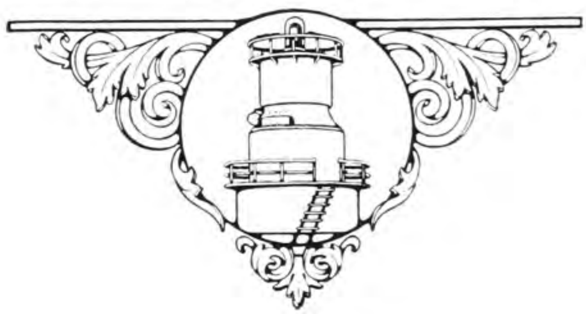
(AQB 8-1500-900, 2300 Volts)

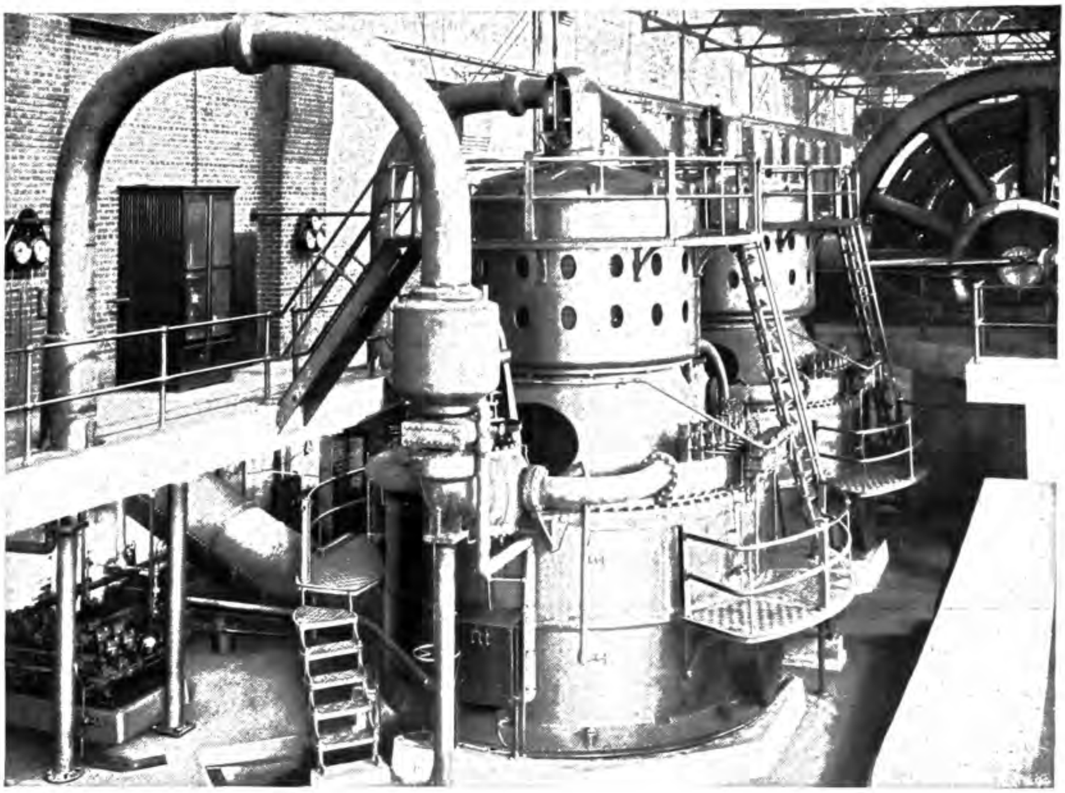




5000 Kw. Curtis Steam Turbine-Generators Installed for the N. Y. C. & H. R. R. R. at Yonkers, N. Y.

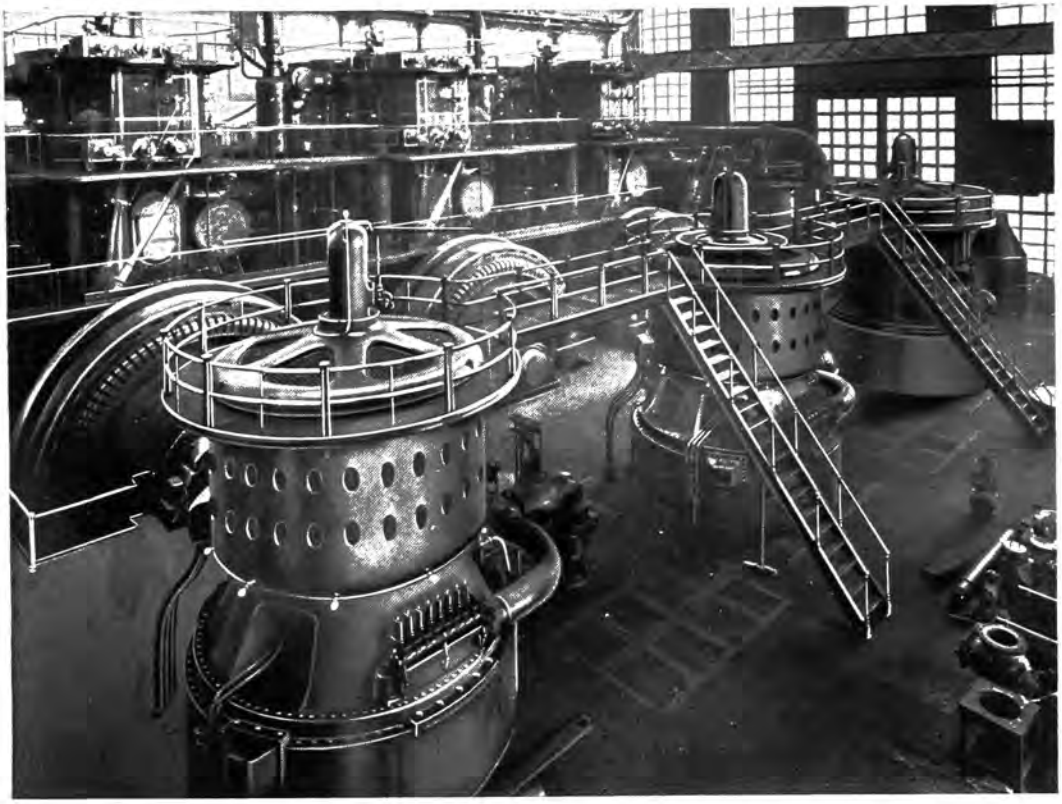
(ATB 4-5000-750, 11000 Volts)





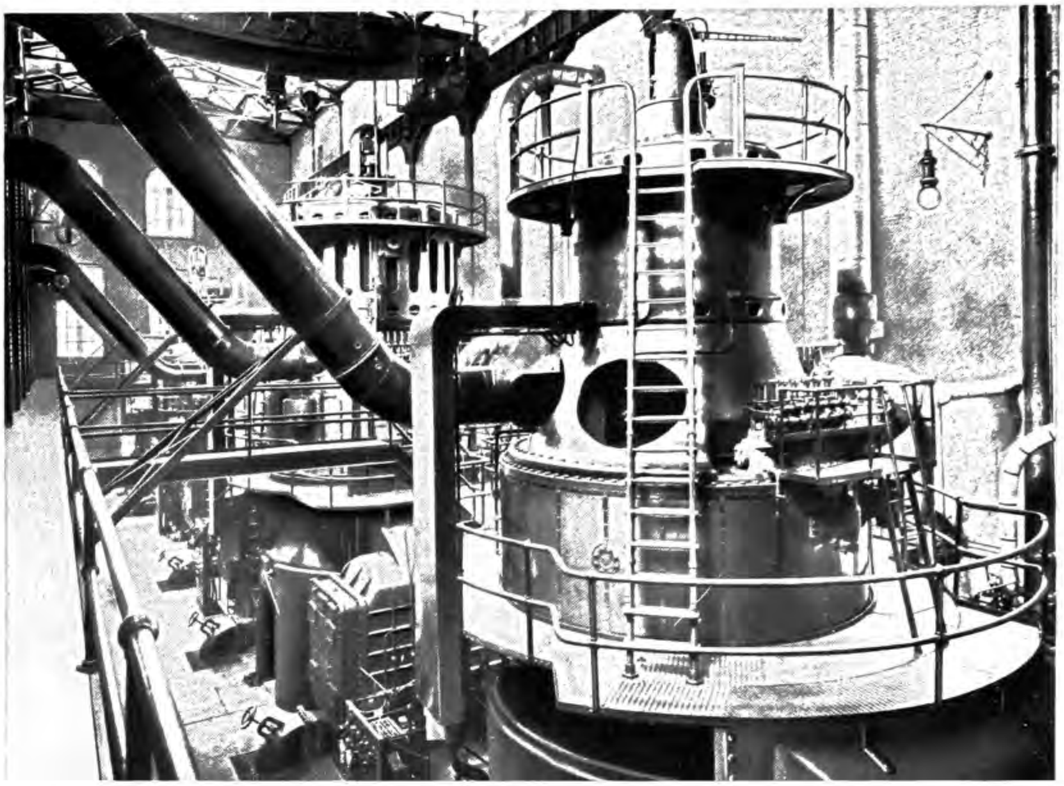
3000 Kw. Curtis Steam Turbine-Generator Installed for the Birmingham Railway Light and Power Company, Birmingham, Ala.

(ATB 12-3000-600, 2300 Volts)



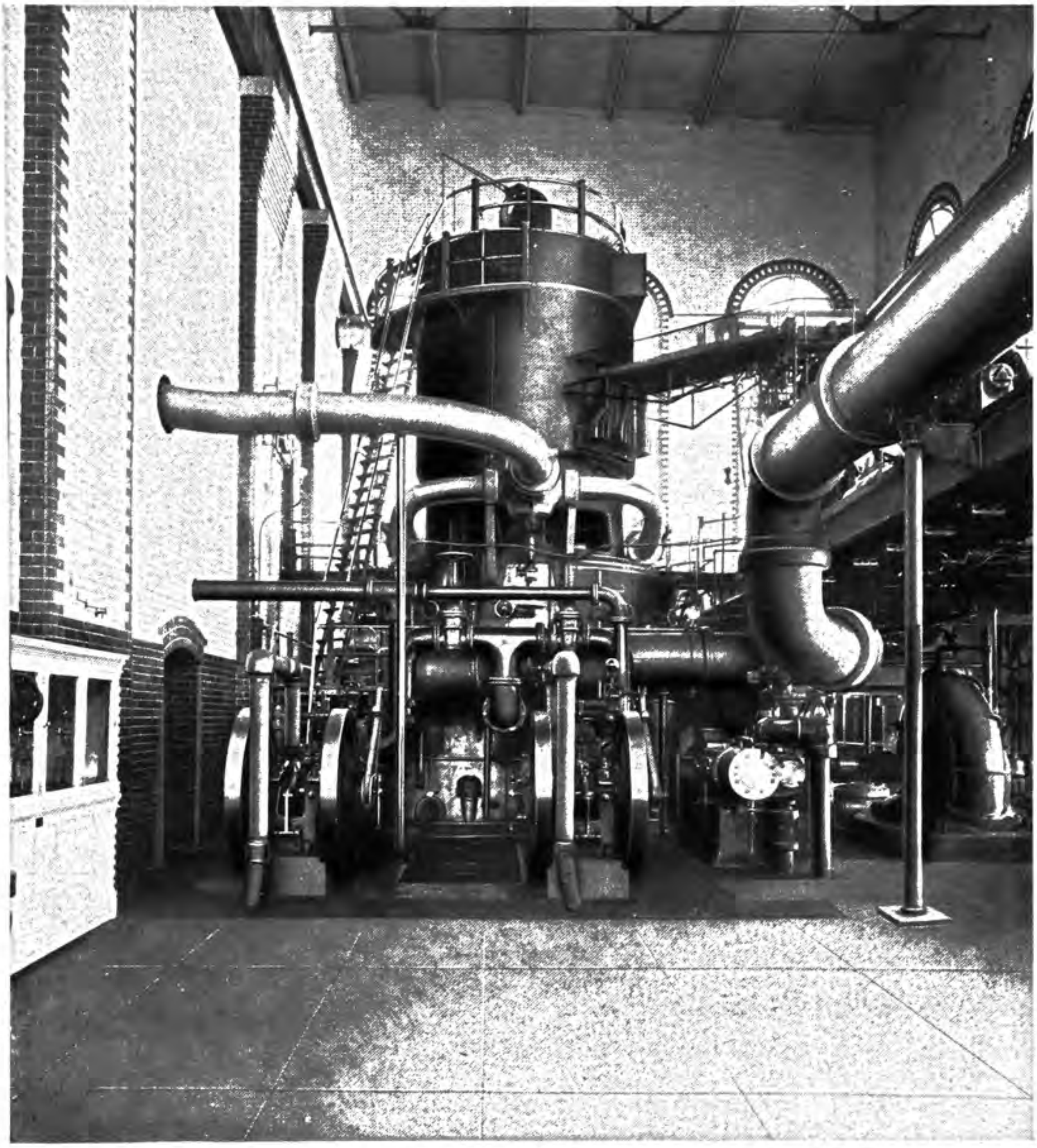
5000 Kw. Curtis Steam Turbine-Generators Installed for New York Edison Company (Waterside Station No. 1)

(ATB 6-5000-500, 6600 Volts and ATB 10-5000-720, 7600 Volts)



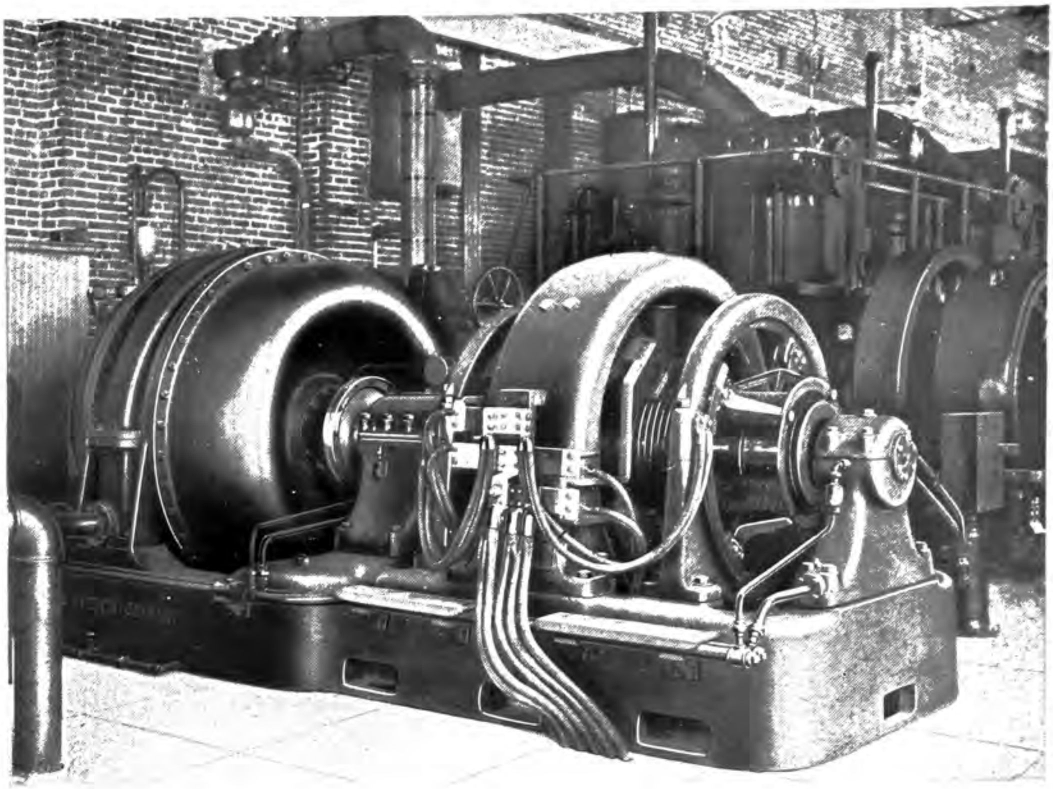
3000 Kw. and 5000 Kw. Curtis Steam Turbine-Generators Installed for Public Service Corporation, Marion, N. J.

(ATB 6-5000-500, 13200 Volts, ATB 12-3000-600, 13200 Volts and ATB 10-3000-720, 13200 Volts)



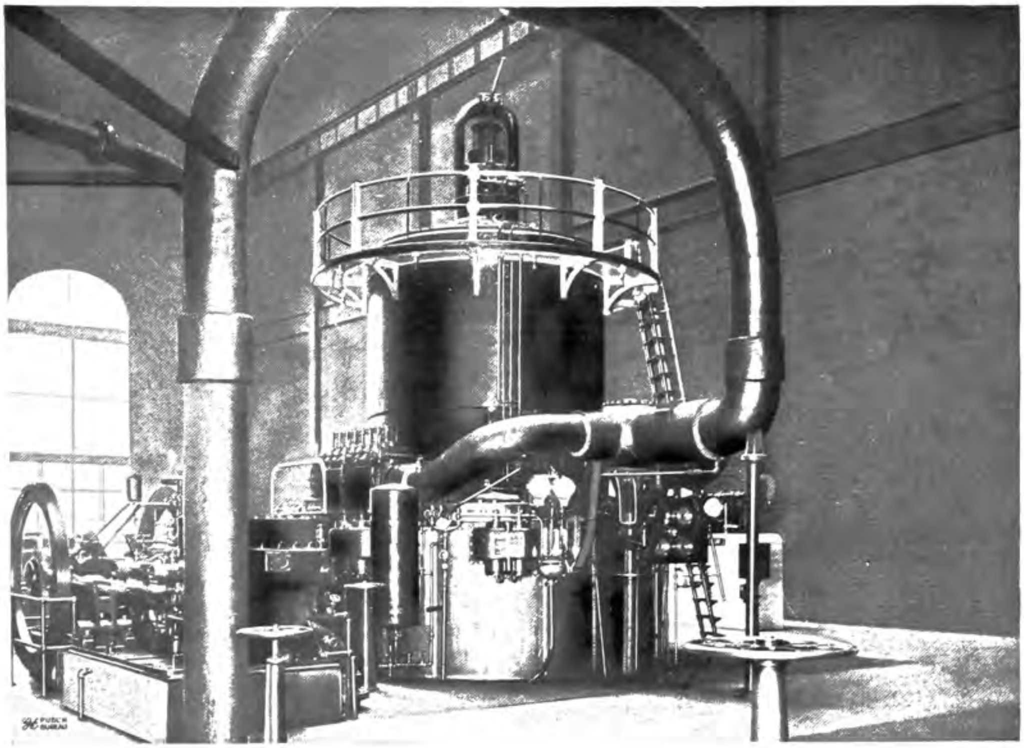
5000 Kw. Curtis Steam Turbine-Generator Installed for Arlington Mills, Lawrence, Mass.

(ATB 6-5000-800, 600 Volts)



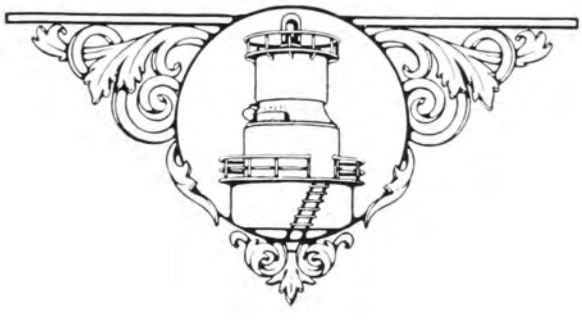
500 Kw. Low Pressure Curtis Steam Turbine-Generator Installed for the American Car and Foundry Co., Detroit, Mich.

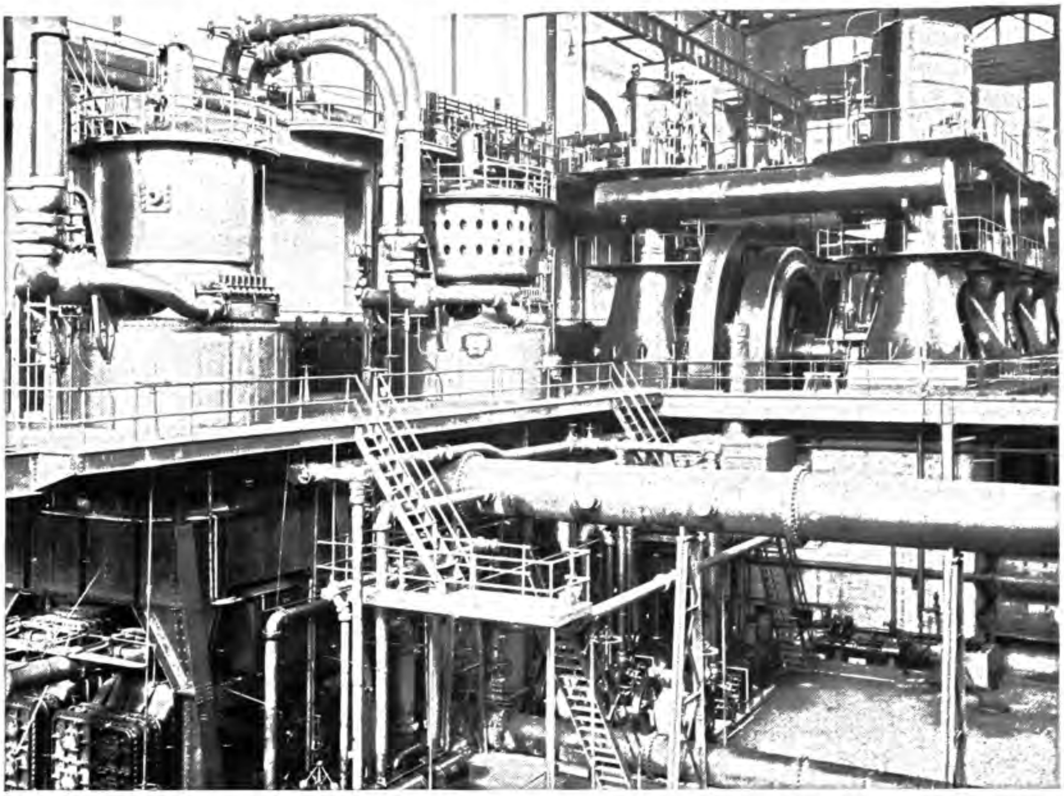
(CC 4-500-1500, 250 Volts)



5000 Kw. Curtis Steam Turbine-Generator Installed for the Union Gas and Electric Co., Cincinnati, Ohio

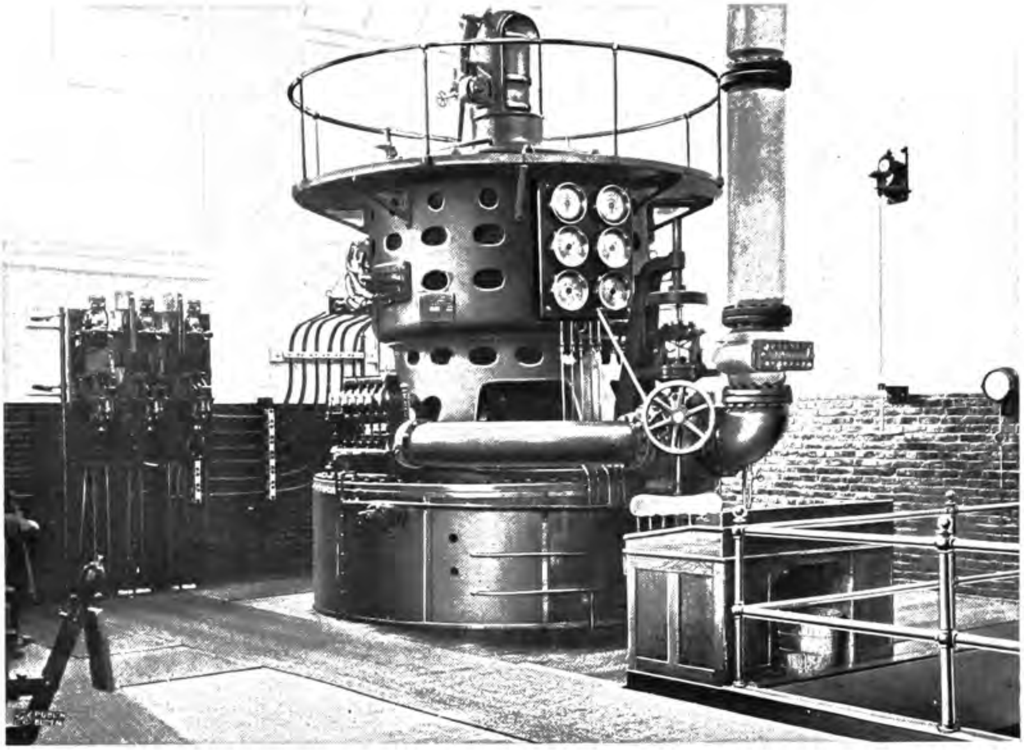
(ATB 10-5000-720 4500 Volts)





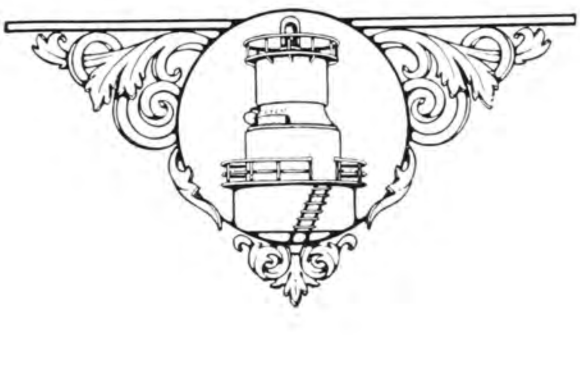
5000 Kw. Curtis Steam Turbine-Generators Installed for the Kansas City Metropolitan Street Railway Company

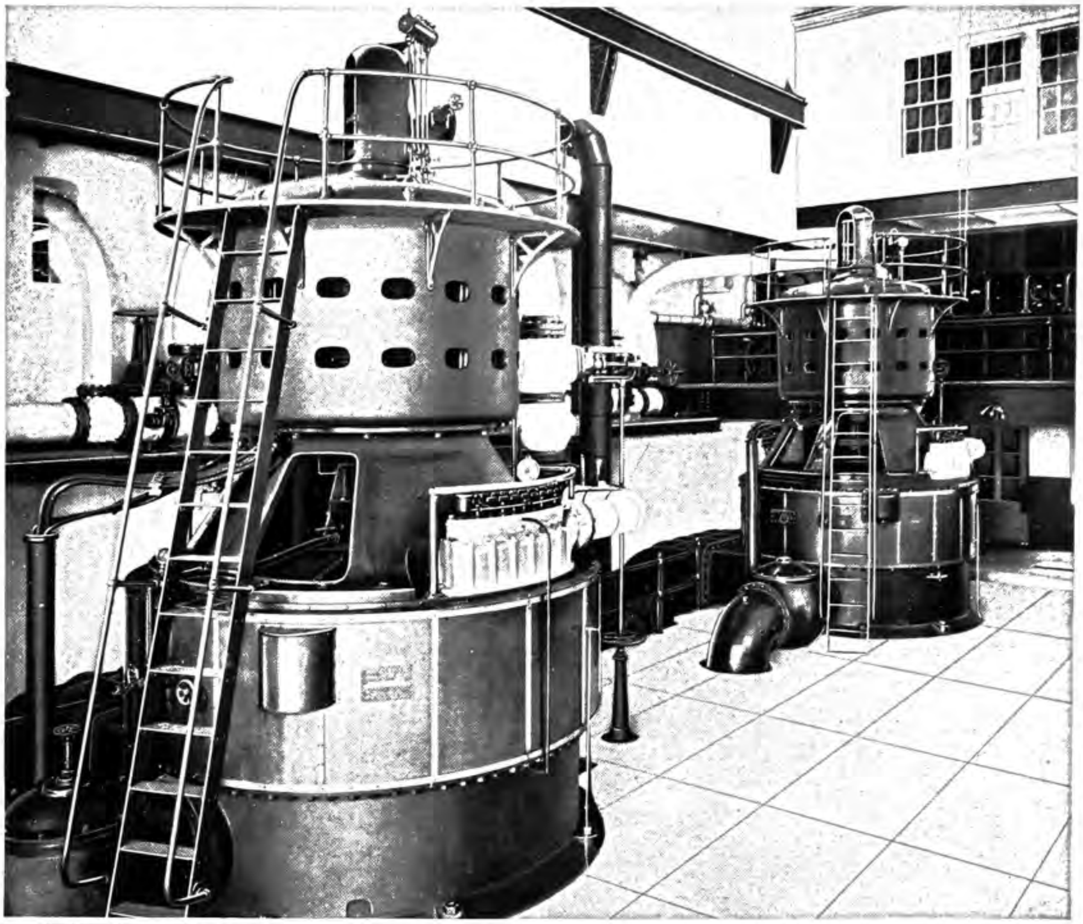
(ATB 6-5000-500, 6600 Volts)



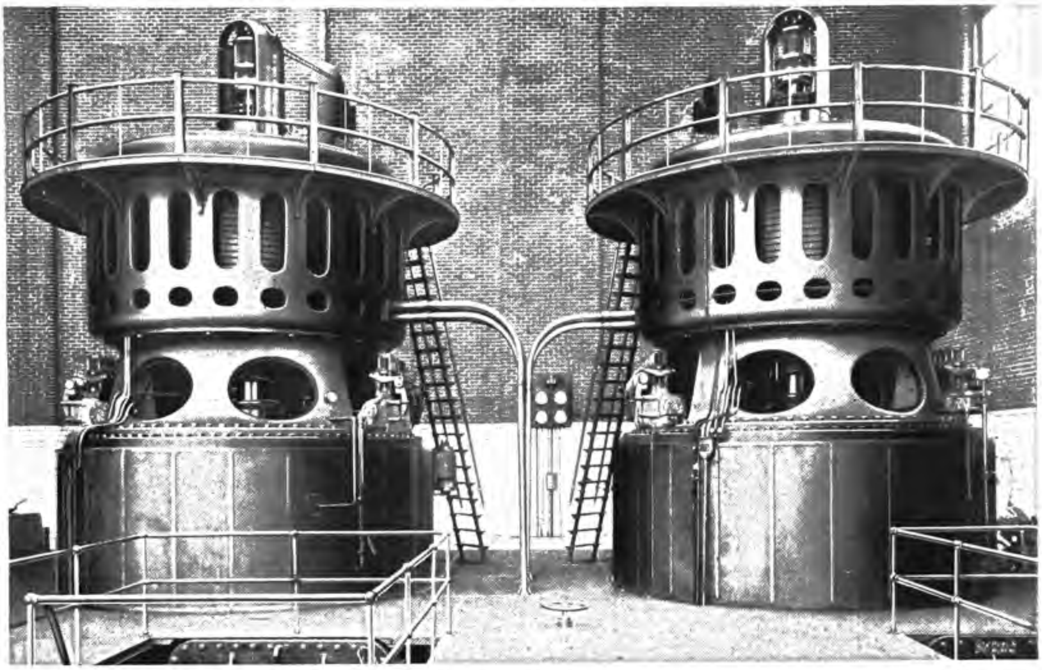
1500 Kw. Curtis Steam Turbine-Generator Installed for Pacific Mills, Dover, N. H.

(ATB 8-1500-900, 600 Volts)



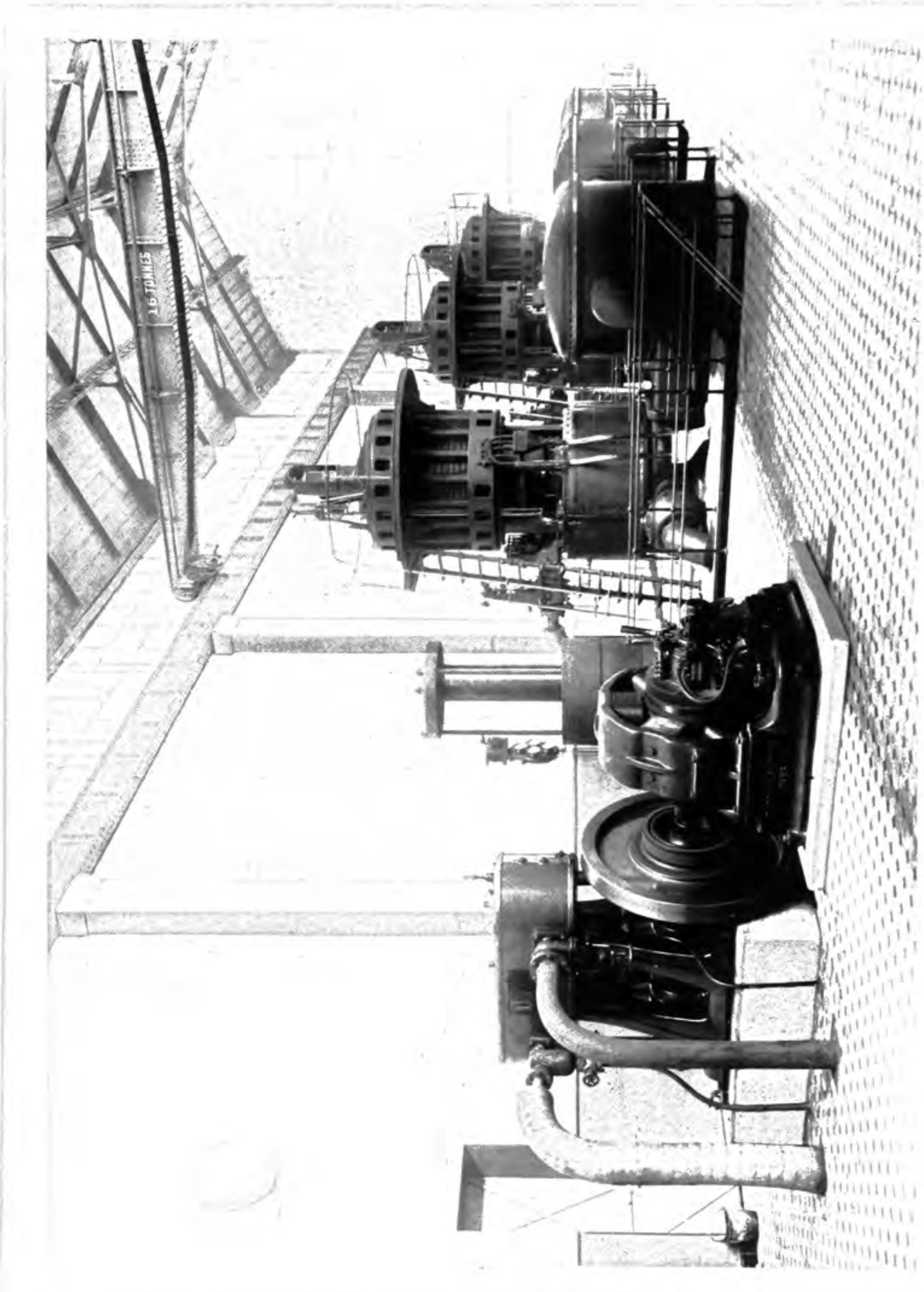


2000 Kw. Four-stage Curtis Steam Turbine direct connected to ATB 8-2000-750, 2300 Volt Generators, Installed for the Edison Electric Co., Los Angeles, Cal.



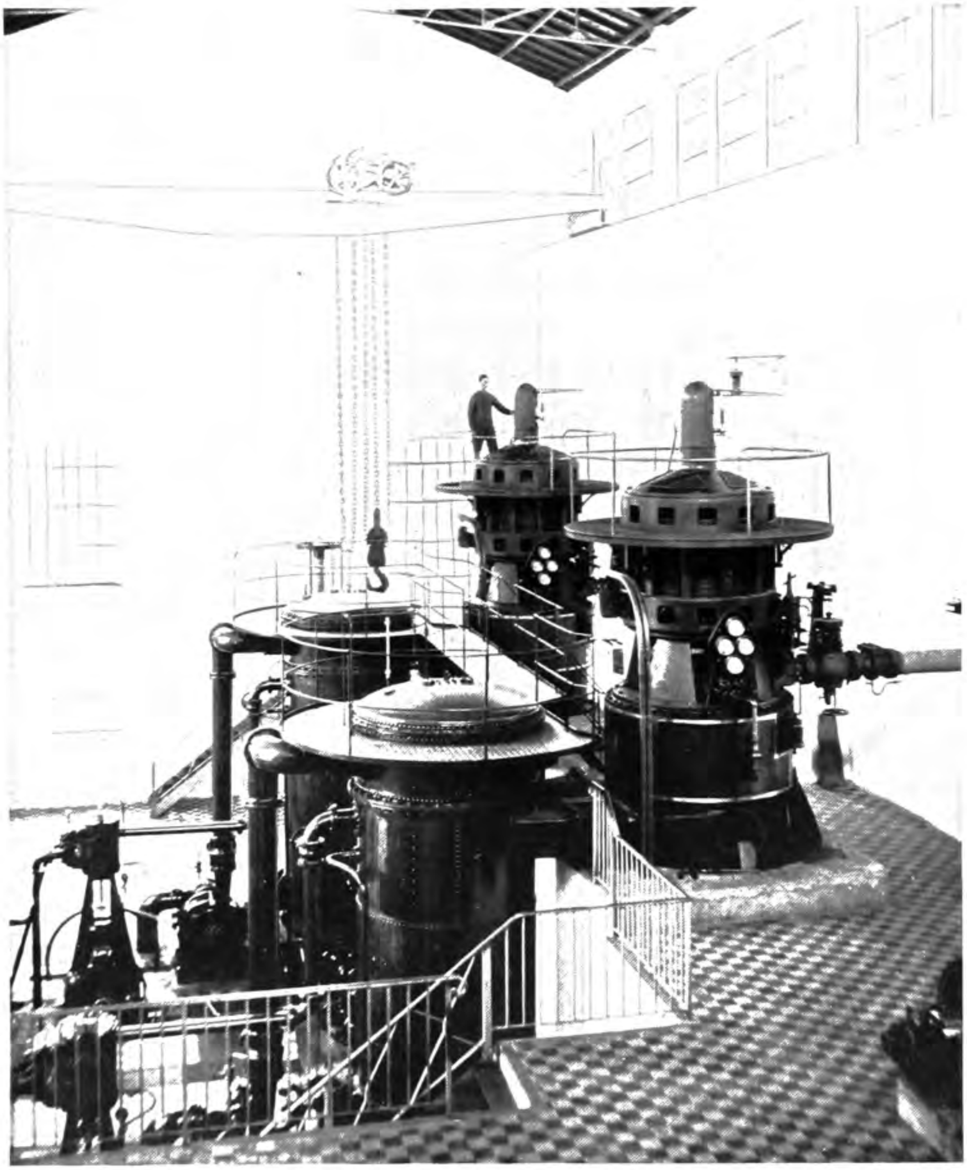
5000 Kw. Curtis Steam Turbine-Generator Installed for the Twin City Rapid Transit Co., Minneapolis, Minn.

(ATB 6-5000-750, 13200 Volts)



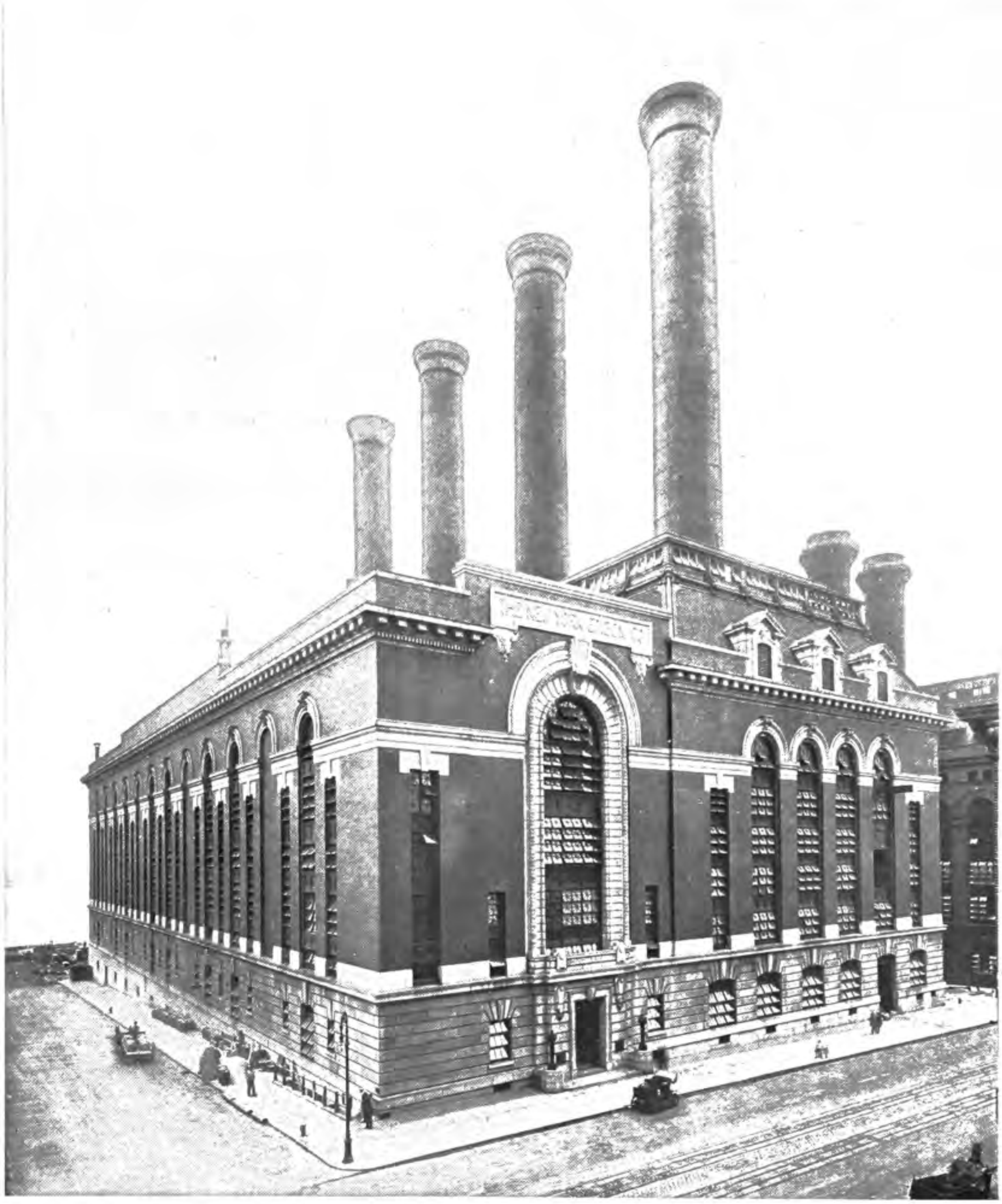
1000 Kw. Curtis Steam Turbine-Generator Installed for Usine de la Société du Gaz, Marseille, France

(ATB 2-1180 KV.-A.-1500, 5500 Volts)

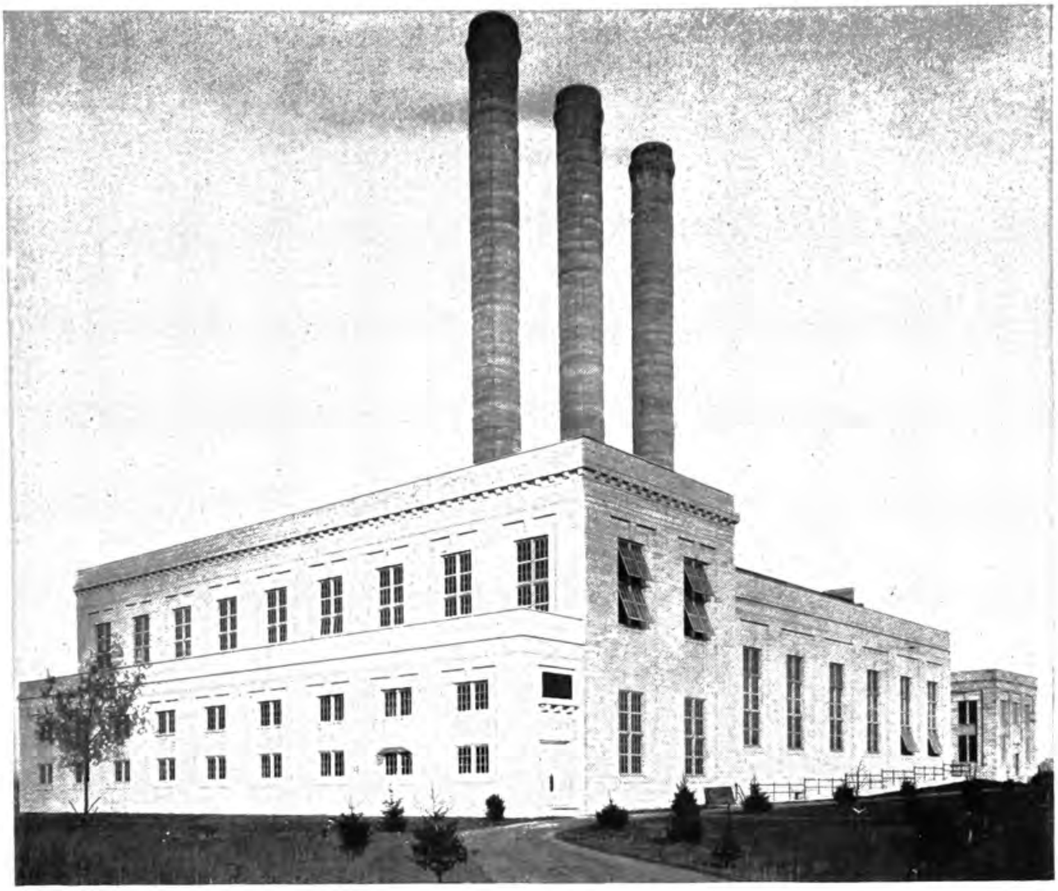


1000 Kw. Curtis Steam Turbine-Generator Installed for Usine de l' Harrach, Algiers, North Africa

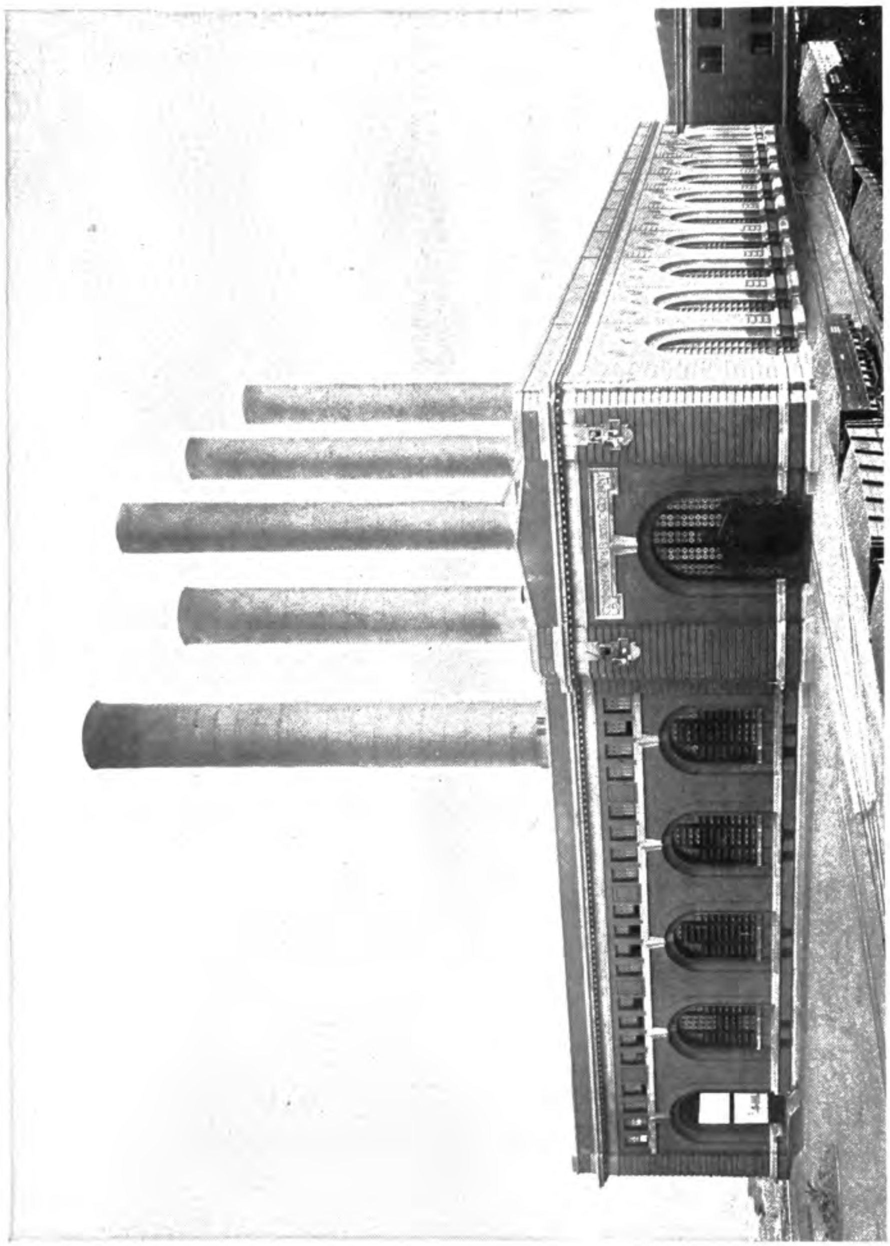
(ATB 4-1000-1500, 10000 Volts)



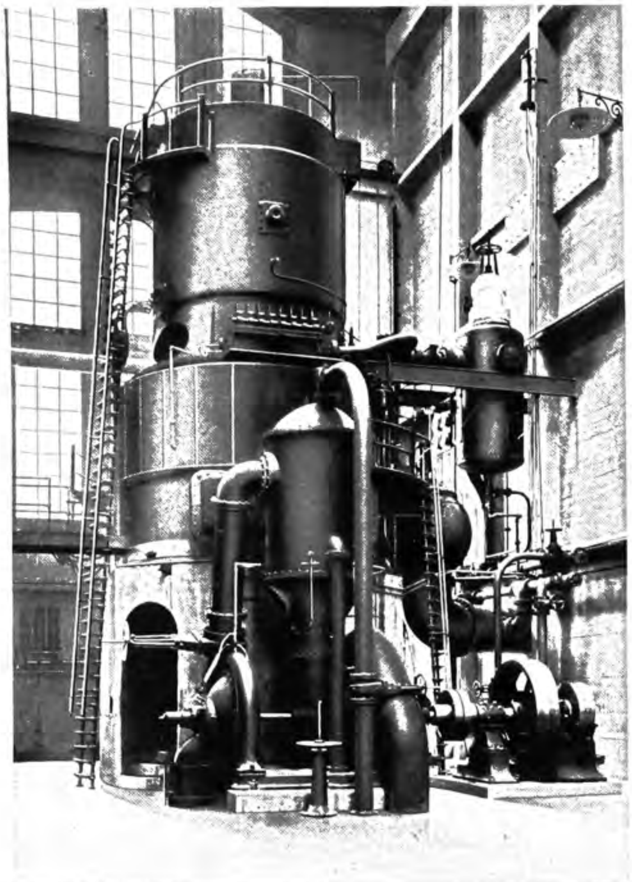
New York Edison Company's Waterside Station No. 2



Generating Station of Potomac Electric Light and Power Company, Washington, D. C.

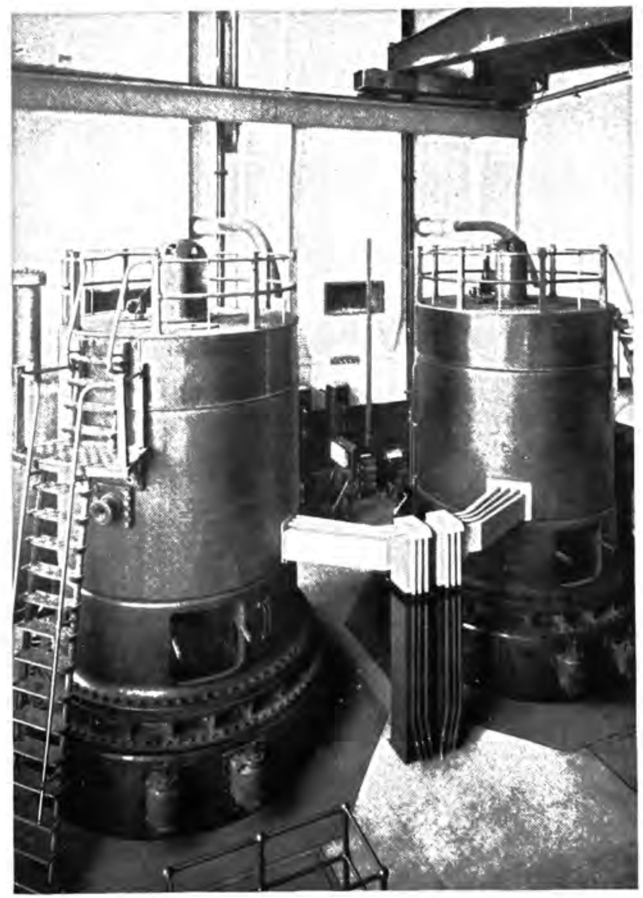


Commonwealth Edison Company's Fisk Street Station, Chicago, Ill.



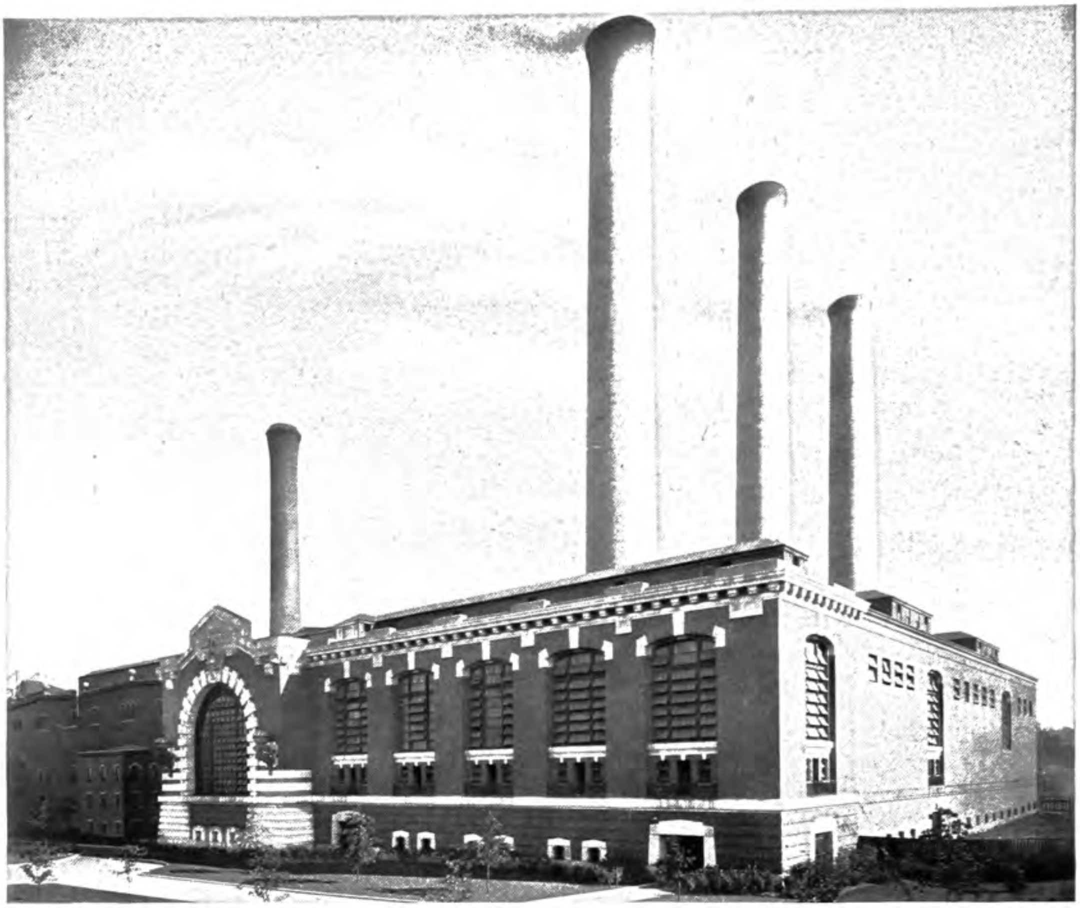
5000 Kw. Curtis Steam Turbine-Generator Installed for the Consolidated Electric Steam and Power Company, Baltimore, Md.

(ATB 4-5000-750, 13000 Volts)

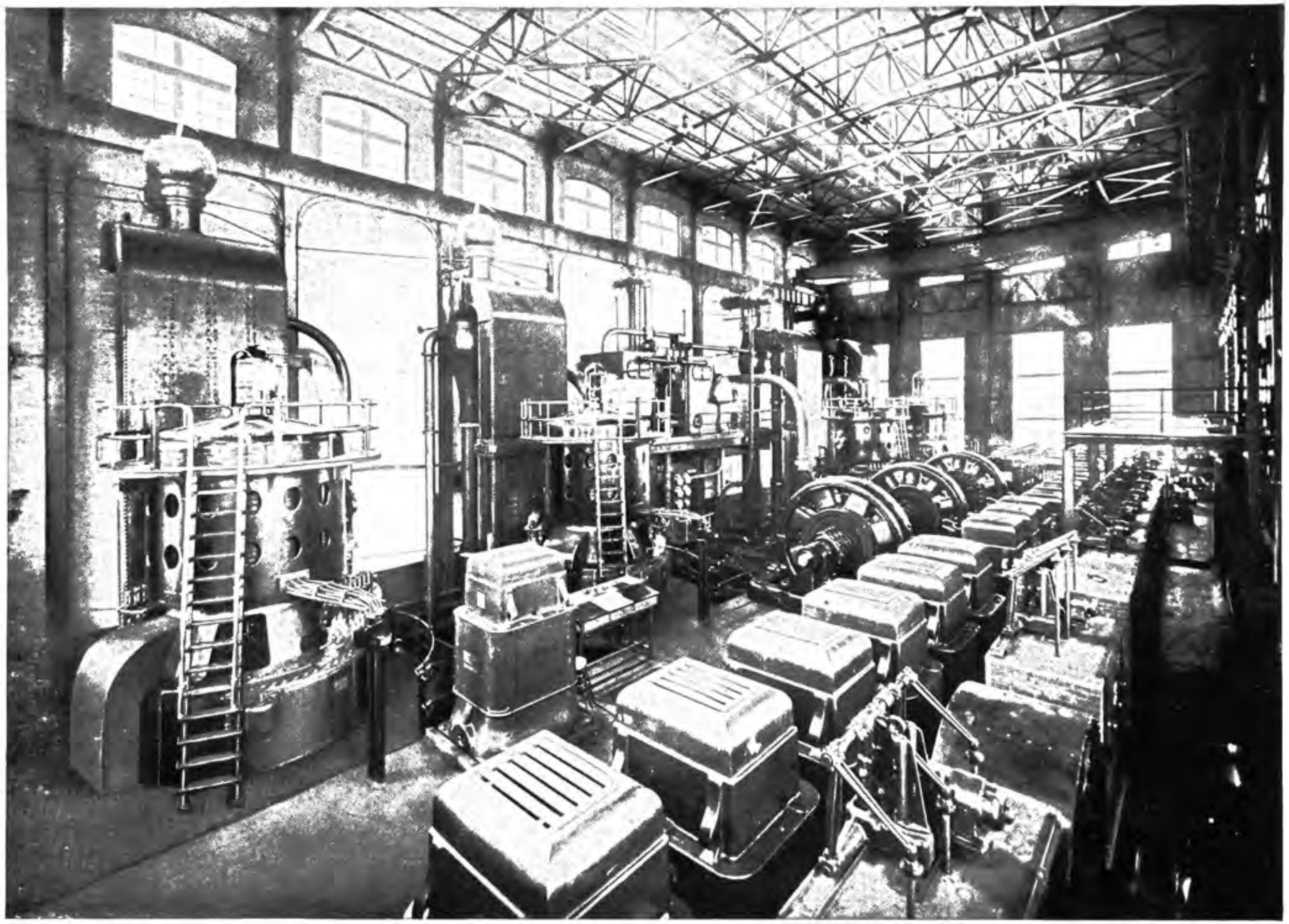


2000 Kw. Curtis Steam Turbine-Generator Installed for the Coney Island & Brooklyn Railroad Company

(ATB 4-2000-750, 11000 Volts)

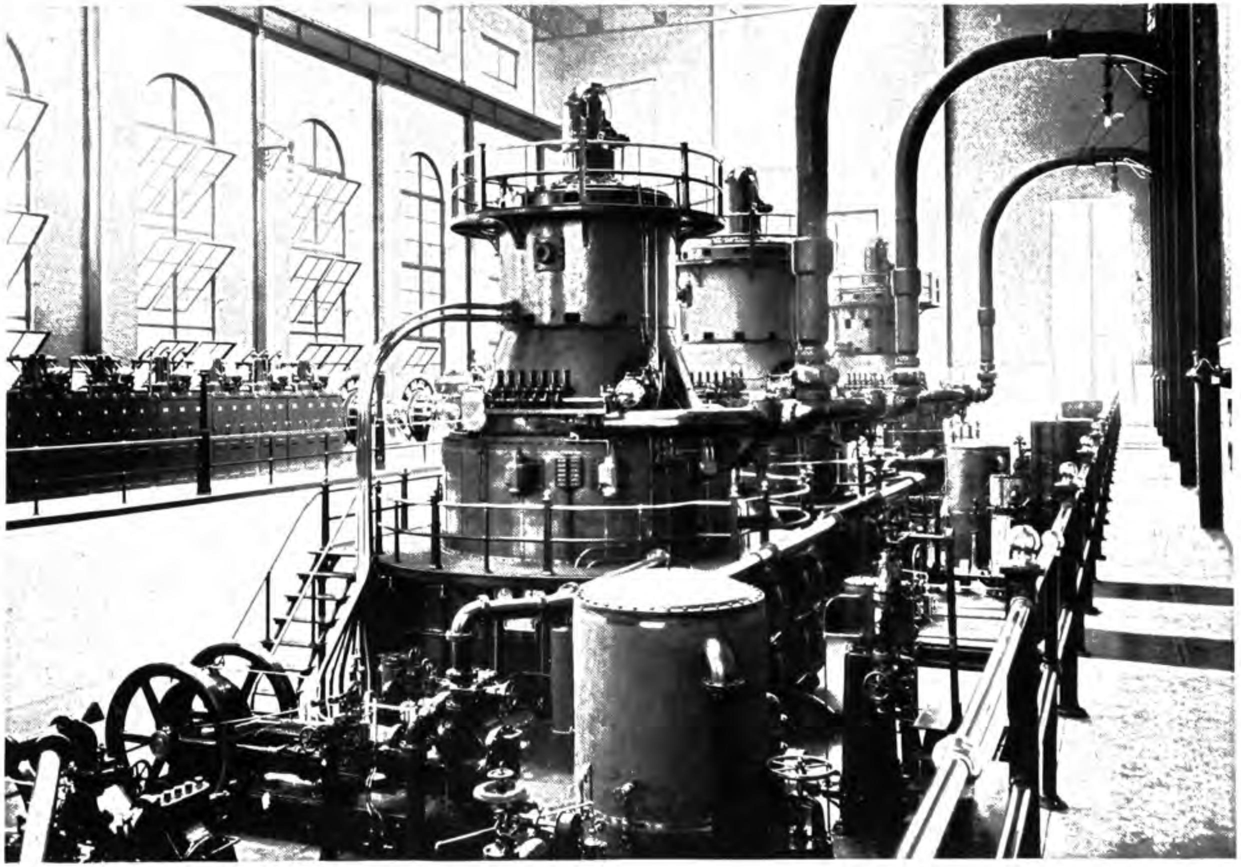


Power House of the Edison Electric Illuminating Company, Boston, Mass.



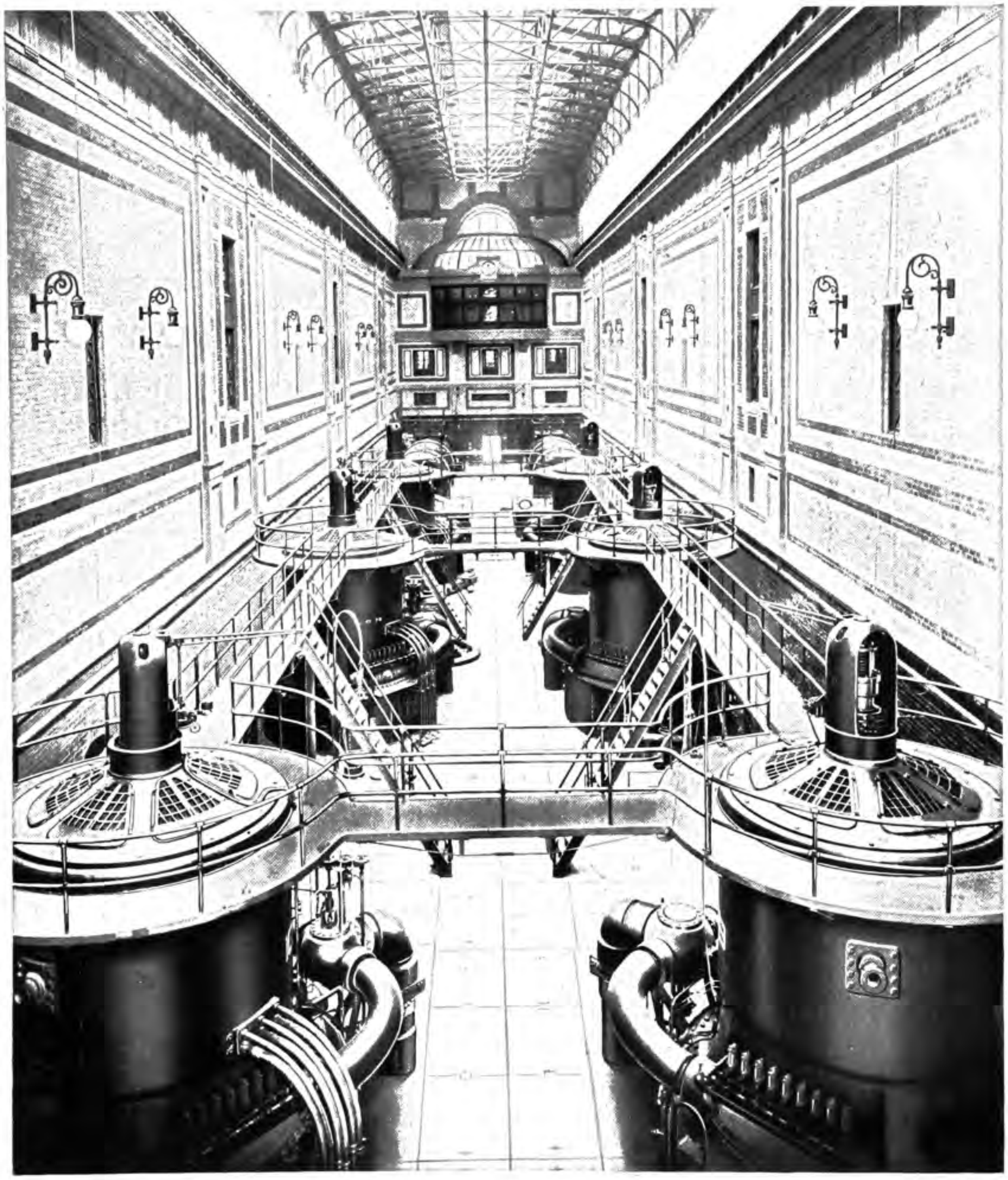
2000 Kw. Curtis Steam Turbine-Generators Installed for the West Jersey Sea Shore R. R. Co. (Westville Power House)

(ATB 4-2000-750, 6600 Volts)



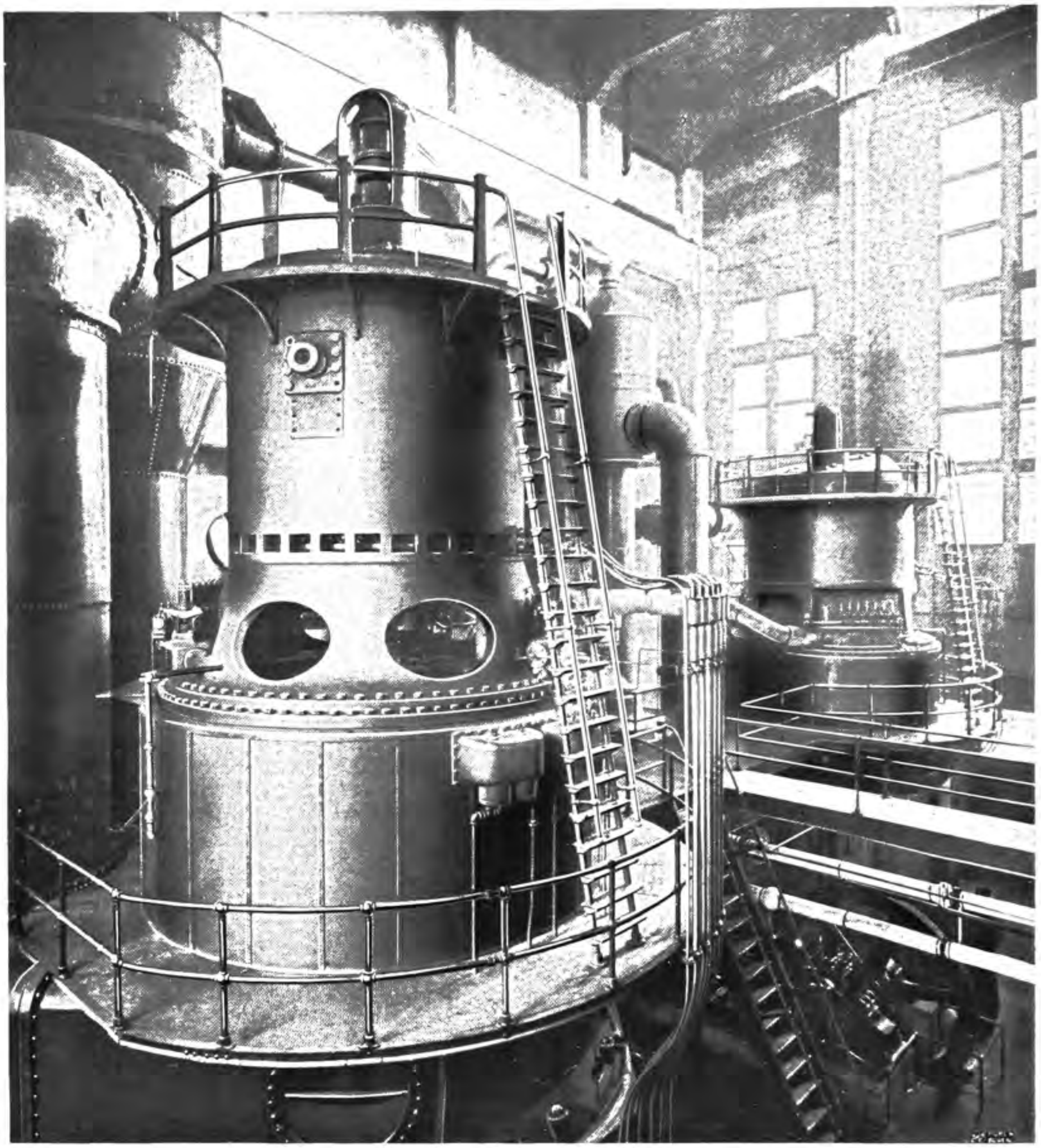
3000 Kw. Curtis Steam Turbine-Generators Installed in Generating Station
of the Norfolk & Portsmouth Railway Co.

(ATB 10-3000-720, 11000 Volts)



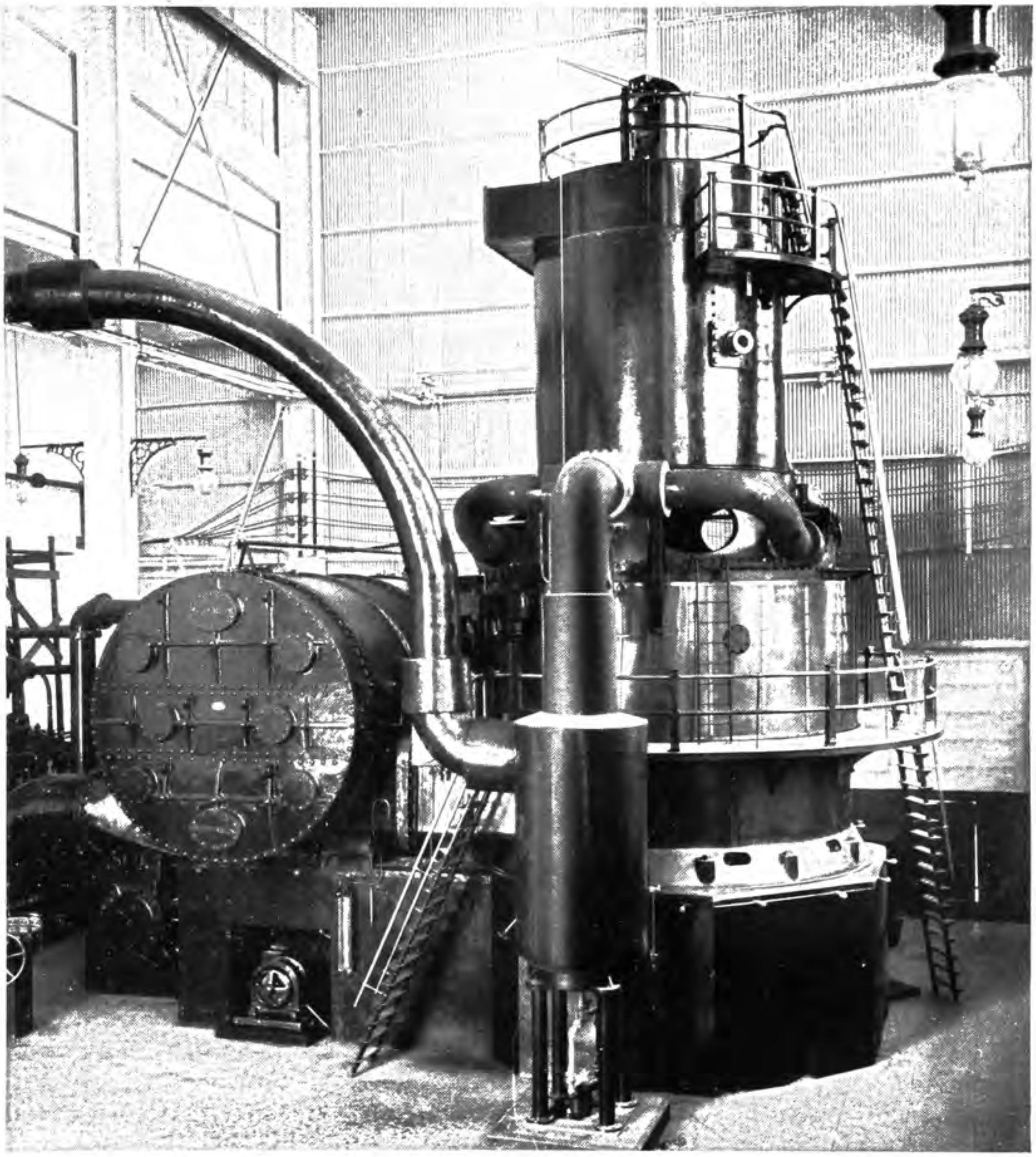
8000 Kw. and 14000 Kw. Curtis Steam Turbine-Generators in New York Edison Company's Waterside Station No. 2

(ATB 10-14000-720, 7500 Volts and ATB 4-8000-750, 6600 Volts)



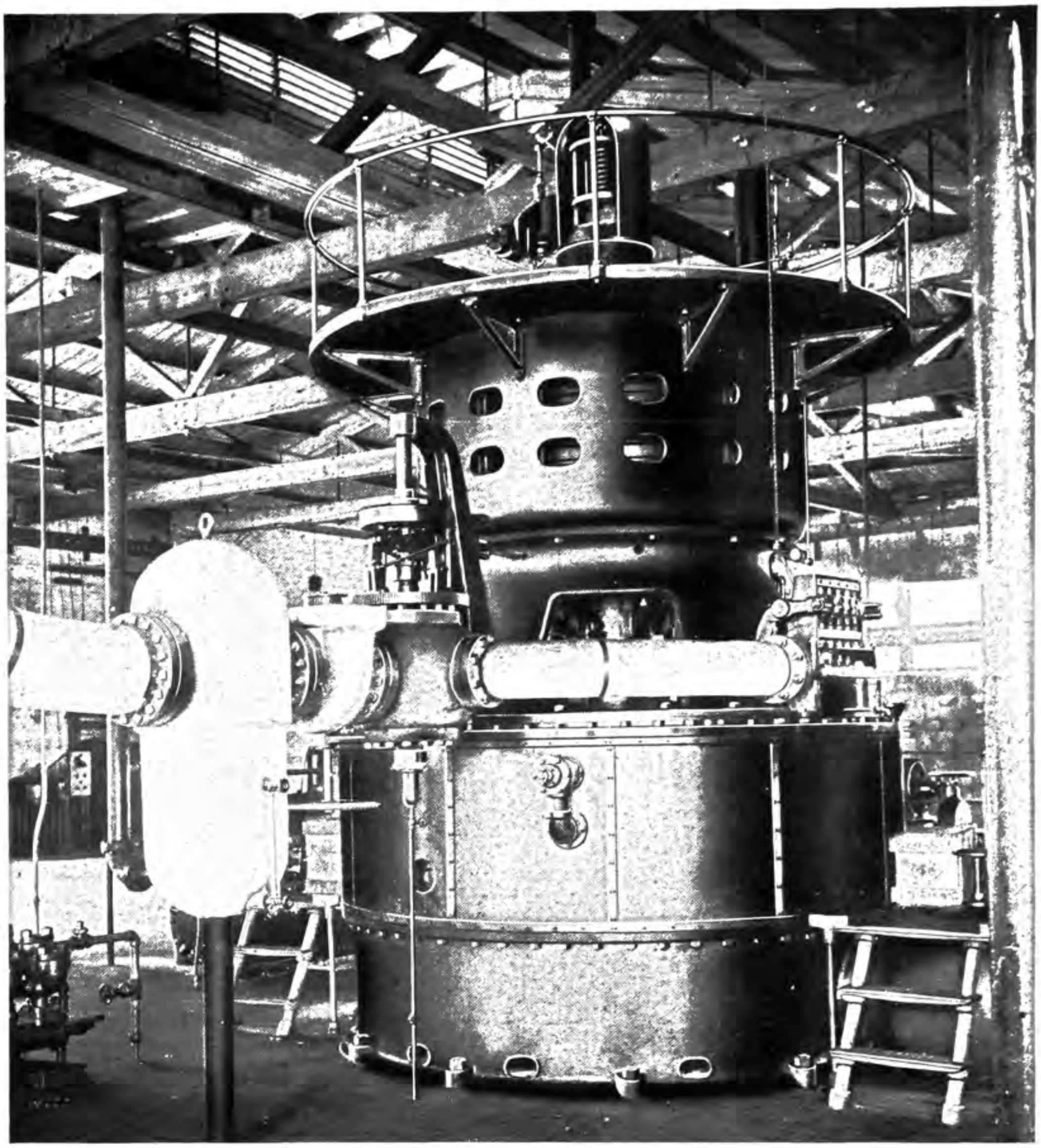
8000 Kw. and 3000 Kw. Curtis Steam Turbine-Generators Installed for the Seattle Electric Company, Seattle, Wash.

(ATB 10-8000-720, 13200 Volts and ATB 10-3000-720, 13800 Volts)



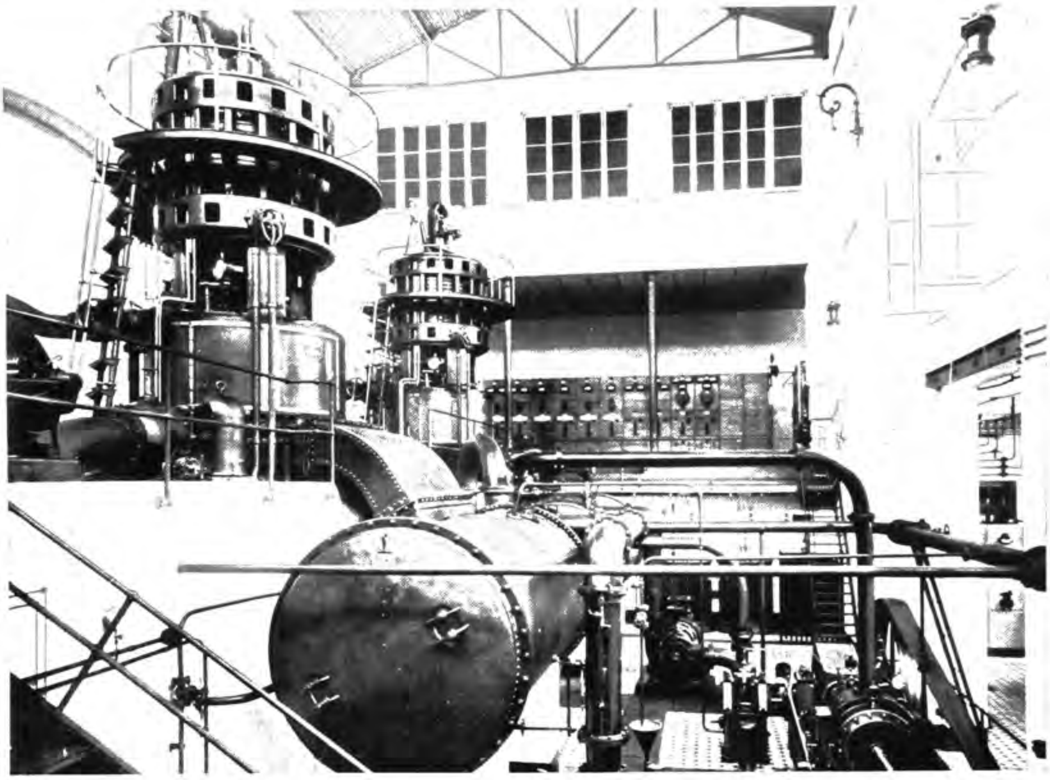
9000 Kw. Curtis Steam Turbine-Generator Installed for the Pacific Gas and Electric Co., Station "C," Oakland, Cal.

(ATB 10-9000-M-720, 4150 Volts)



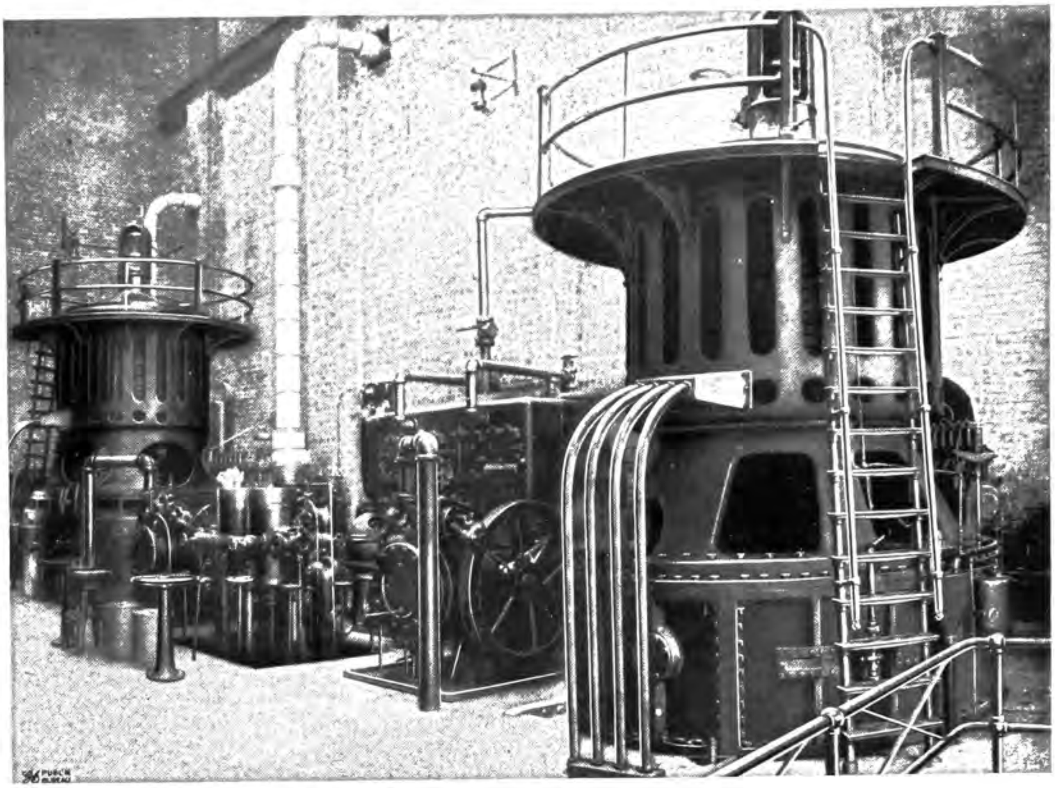
1500 Kw. Curtis Steam Turbine-Generator Installed for the Macon Railway and Light Co., Macon, Ga.

(ATB 8-1500-900, 2300 Volts)



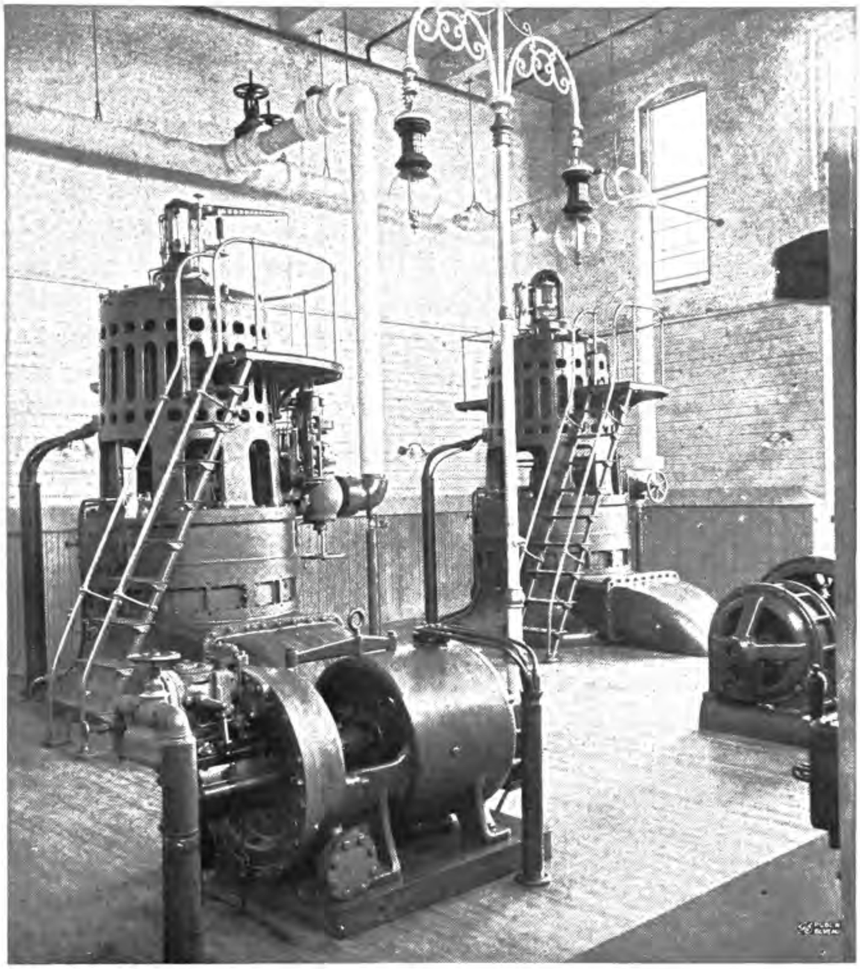
800 Kw. Curtis Steam Turbine-Generator Installed for Usine de la Societe du Gaz, Nice, France

(ATB 2-800-1500, 10000 Volts)



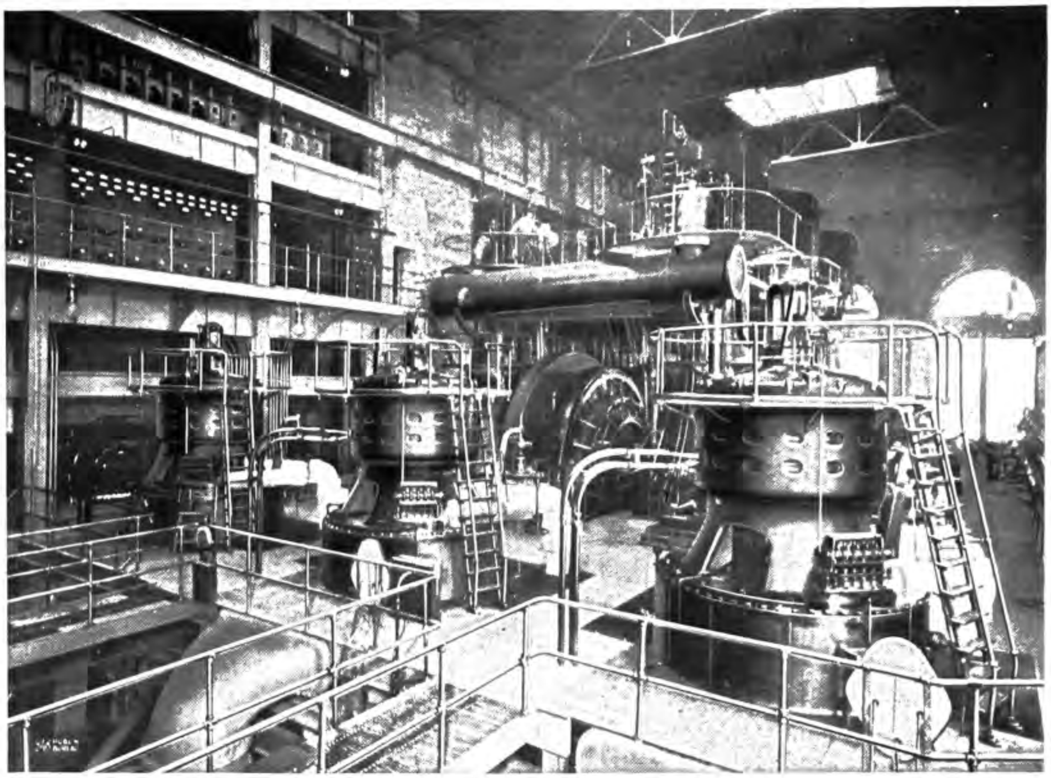
2000 Kw. Curtis Steam Turbine-Generator Installed for the Illinois Traction System, Peoria, Ill.

(ATB 4-2000-750, 2300 Volts)



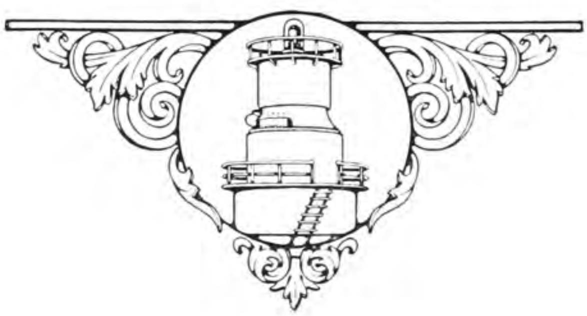
25 Kw. Horizontal and 500 Kw. Vertical Curtis Steam Turbine-Generators
Installed for the Nashua Manufacturing Co., Nashua, N. H.

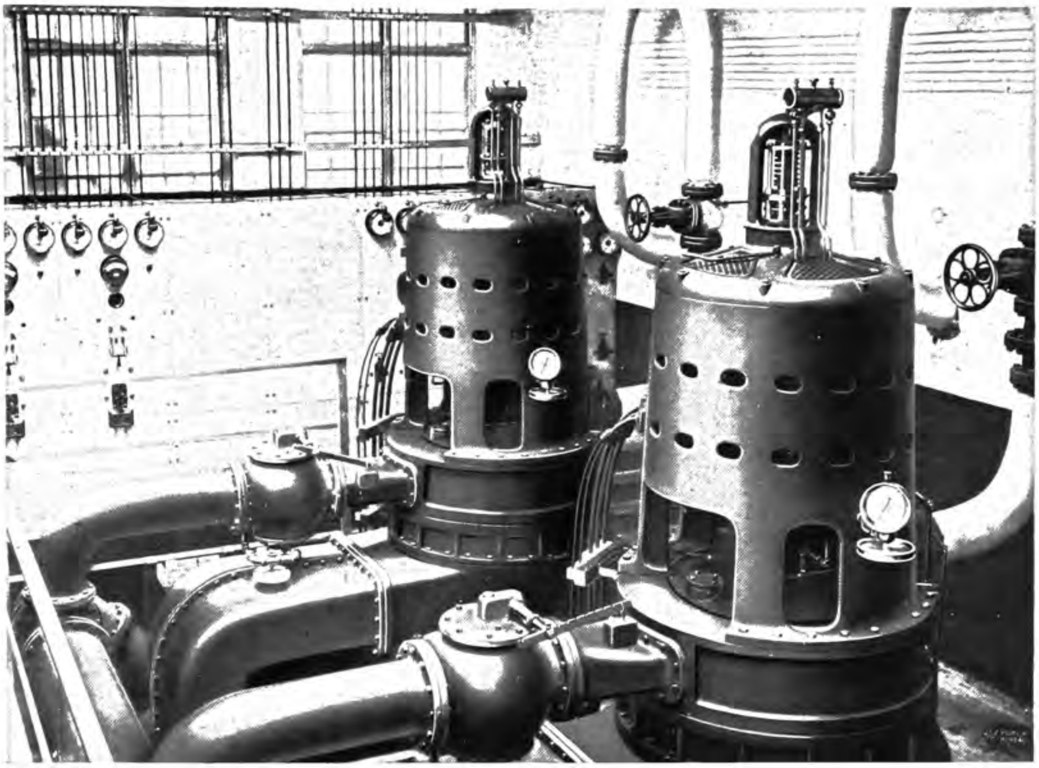
(C 25 Kw. 3600, 125 Volts and ATB 4-500, 600 Volts)



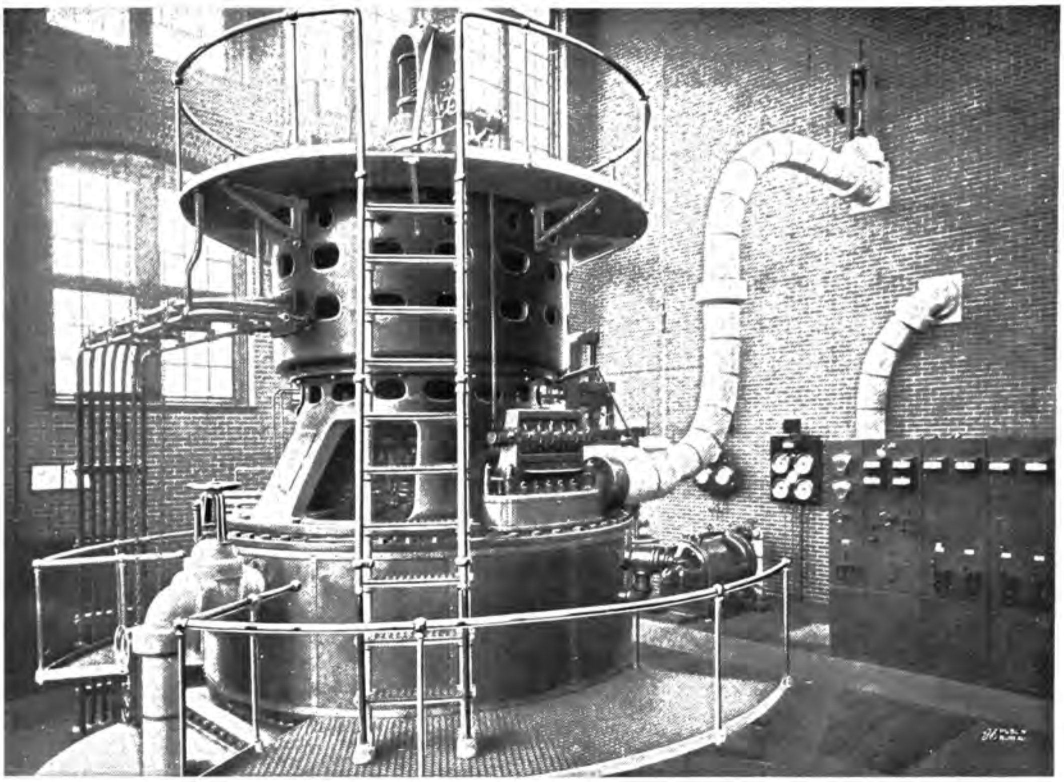
1500 Kw. Curtis Steam Turbine-Generator Installed for the New Orleans Railway and Light Company, New Orleans, La.

(ATB 8-1500-900, 2300 Volts)



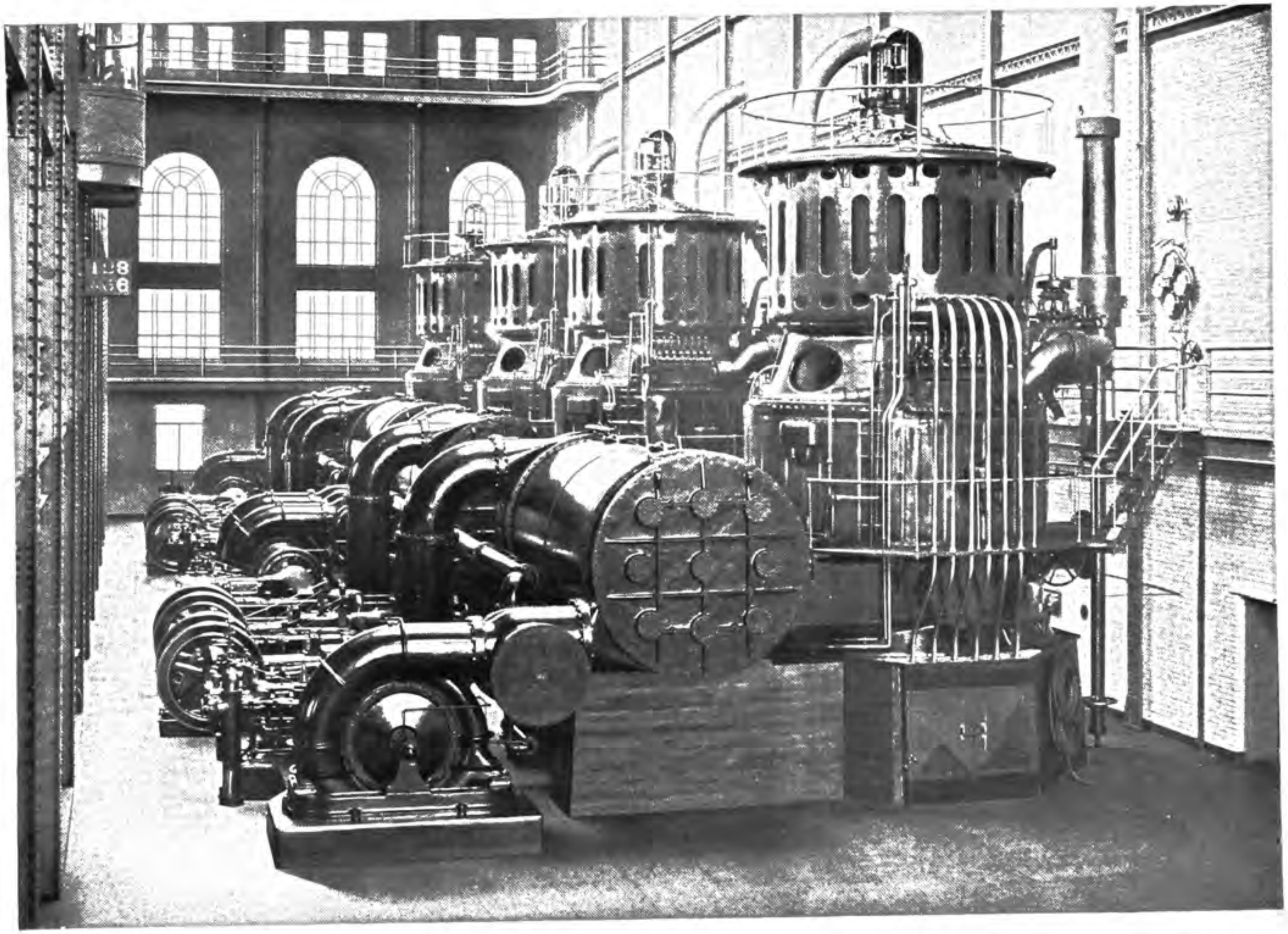


500 Kw. Two-Stage Curtis Steam Turbine direct connected to ATB 4-500-1800, Form T, 600 V. Generator, Installed at Fulton Bag and Cotton Mills Station, Atlanta, Ga.



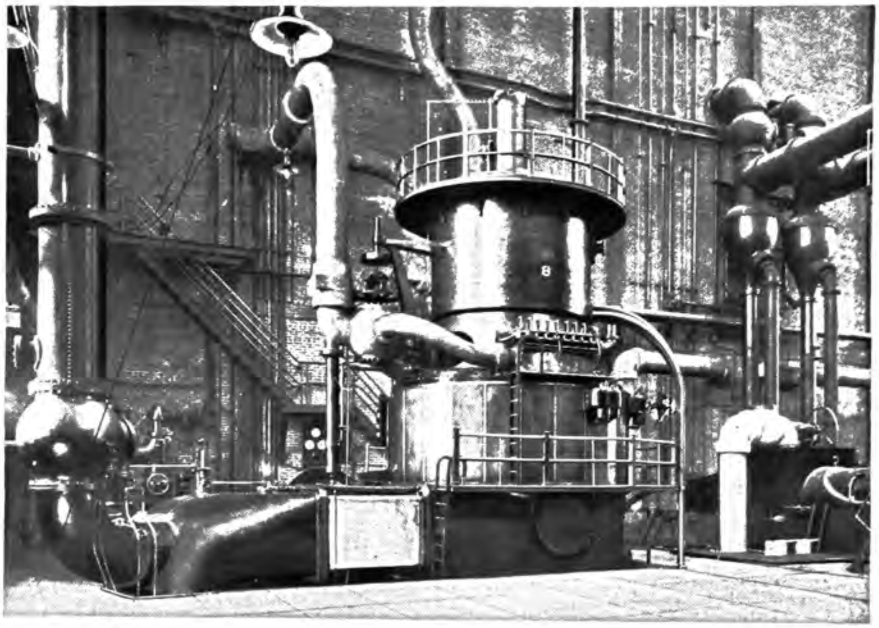
1500 Kw. Turbo-Alternator with 25 Kw. Turbine Exciter and Switchboard,
Installed for Louis DeJonge Co., Fitchburg, Mass.

(ATB 8-1500-900, 600 Volts)



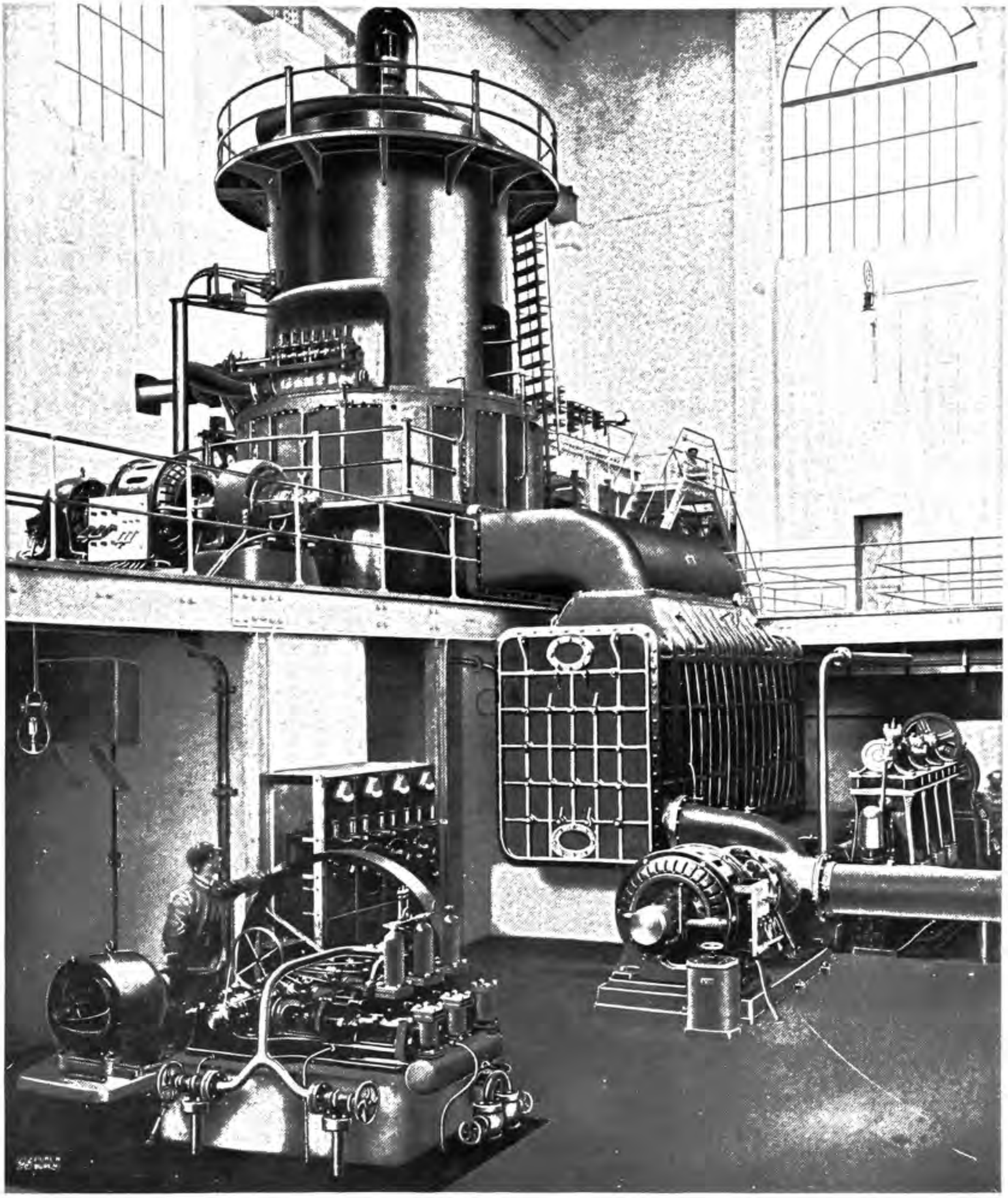
5000 Kw. Curtis Steam Turbine-Generators Installed for the N. Y. C. & H. R. R. R. at Port Morris, N. Y.

(ATB 6-5000-500, 6600 Volts)



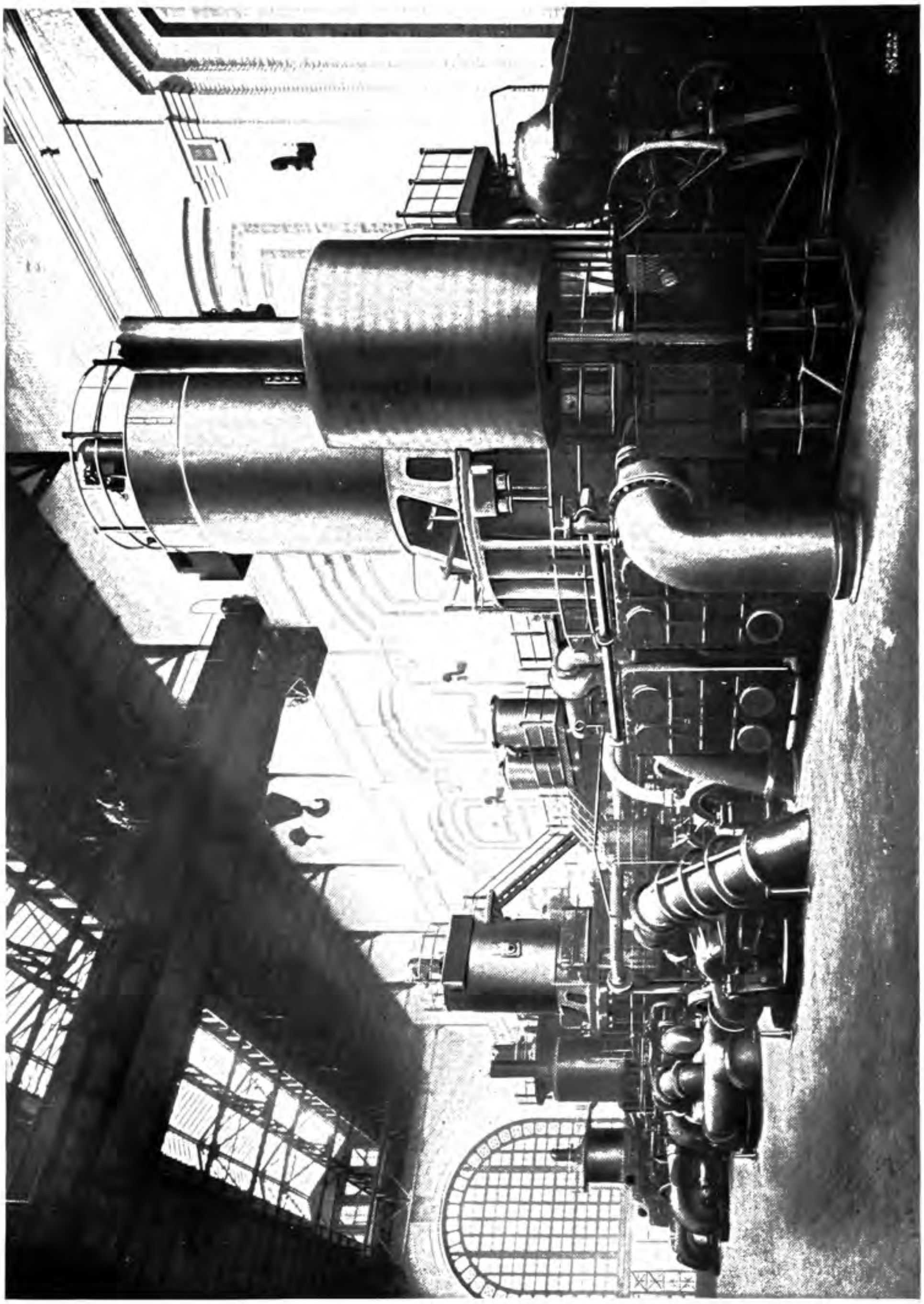
5000 Kw. Curtis Steam Turbine-Generator Installed for the United Railways and Electric Company (Pratt Street Station), Baltimore, Md.

(ATB 4-5000-750, 13000 Volts)



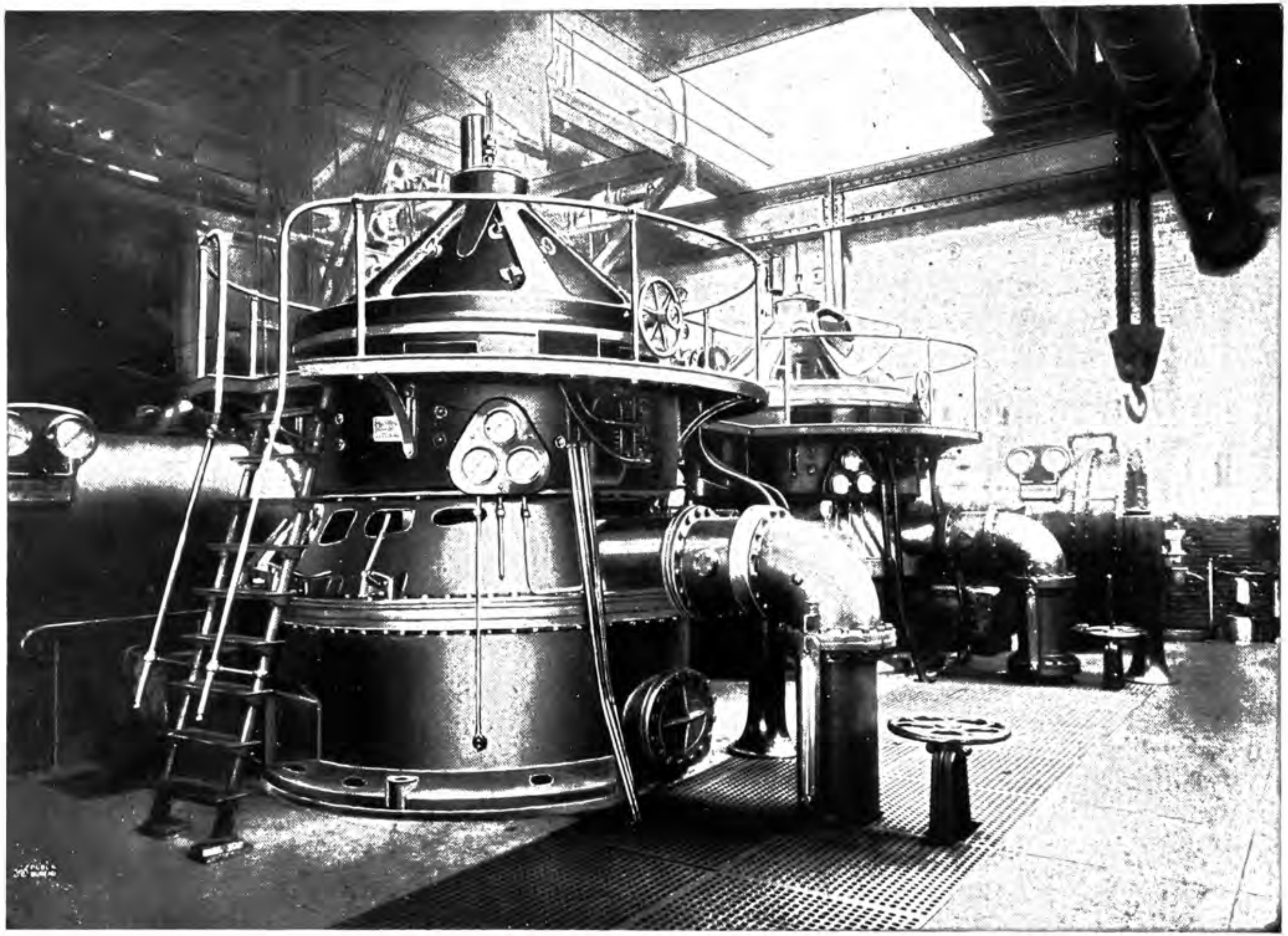
5000 Kw. Curtis Steam Turbine-Generator Installed for Usine á Gaz de Marseilles

(ATB 4-5000 Kw. 750, 13200 Volts)



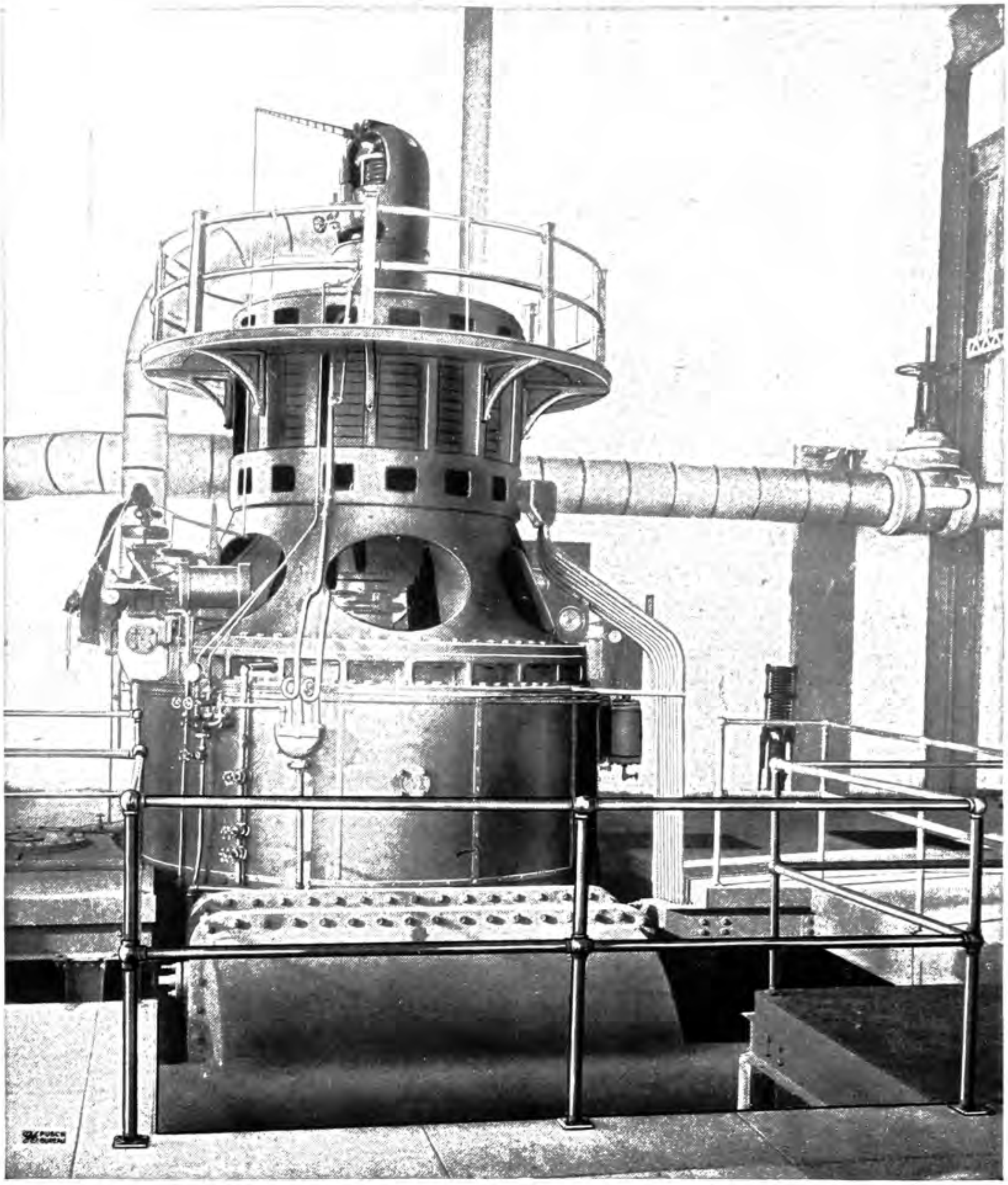
12000 Kw. Curtis Steam Turbine-Generators Installed for Boston Edison Company

(ATB 10-12000-720, 6900 Volts)



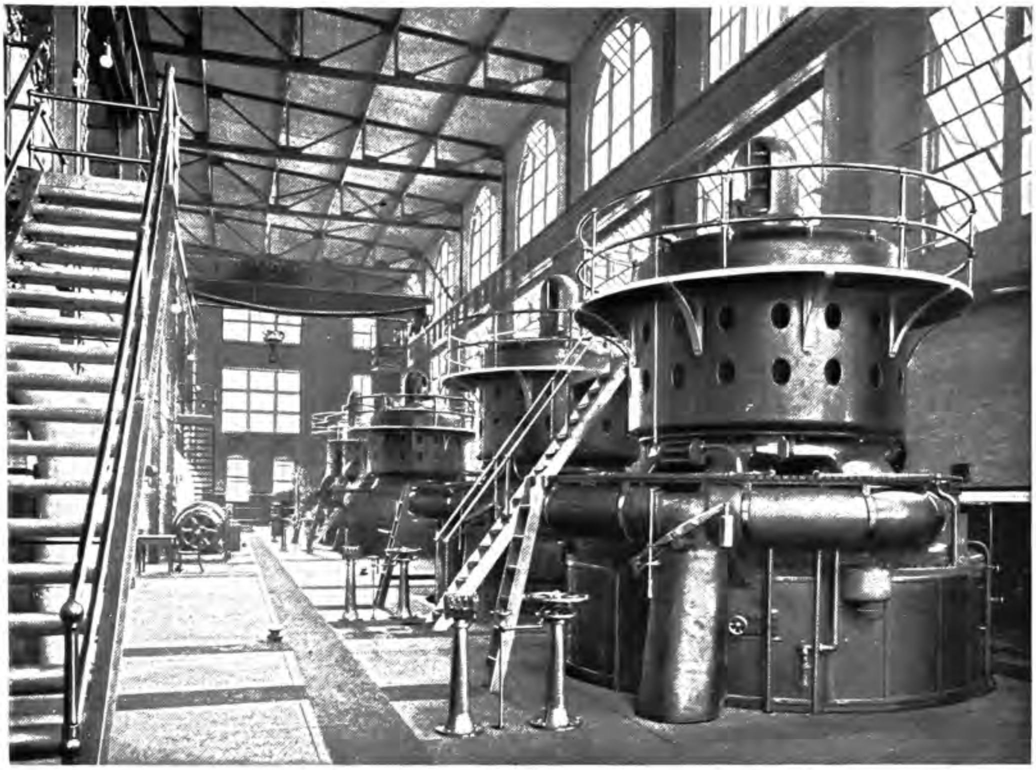
800 Kw. Low Pressure Curtis Steam Turbines Installed for the Philadelphia Rapid Transit Co., Phila., Pa.

(Direct Current, 6 Poles, 800 Kw., 1200 r.p.m., 600 Volts)



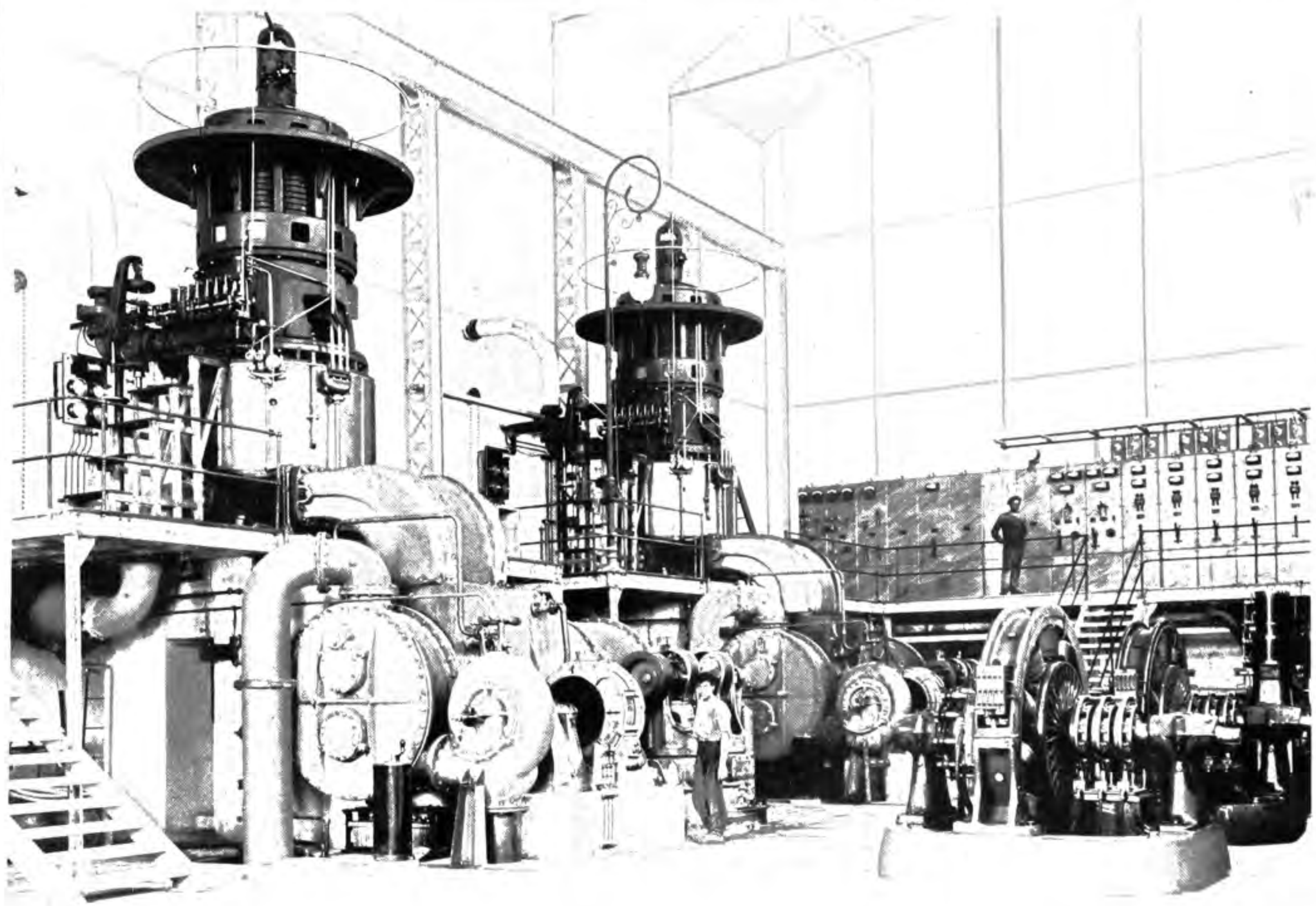
2250 Kw. Curtis Steam Turbine-Generator Installed for the Union Light, Heat and Power Company, Newport, Ky.

(ATB 8-2250-900, 4500 Volts)



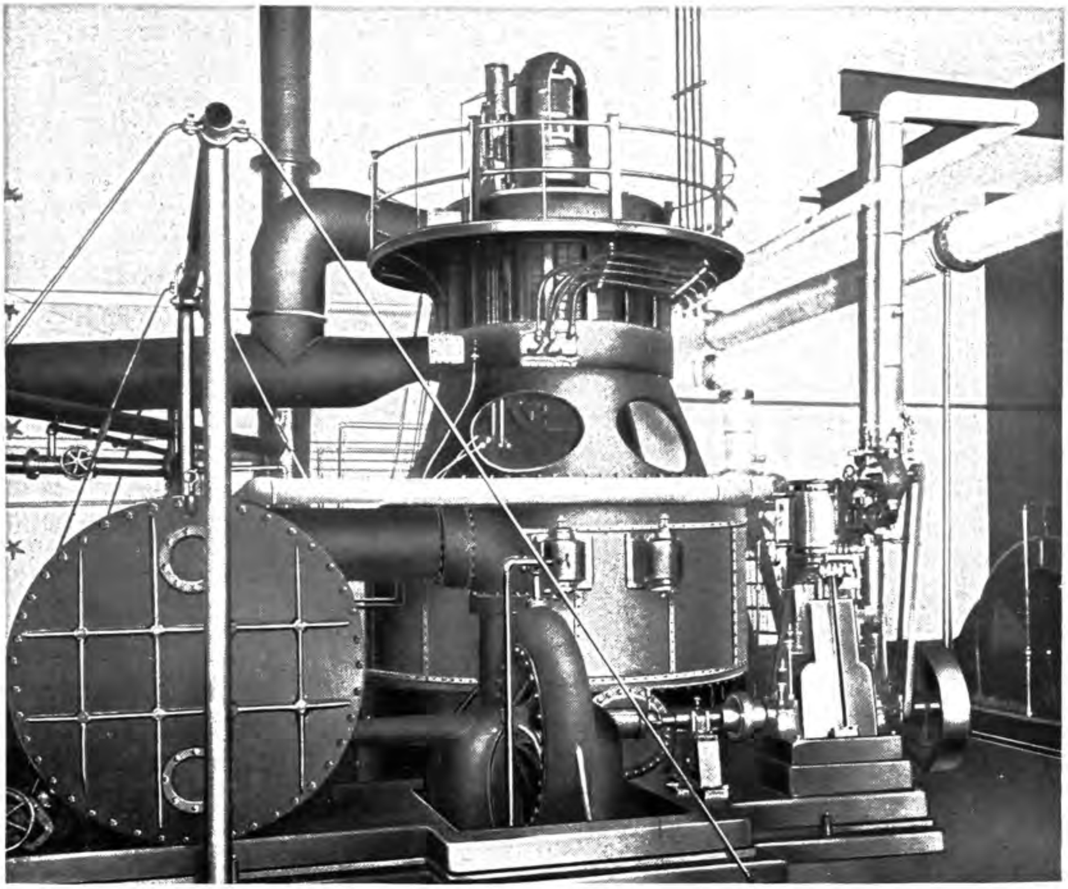
3000 Kw. Curtis Steam Turbine-Generators Installed for the Edison Electric and Illuminating Company, Detroit, Mich.

(ATB 12-3000-600, 4600 Volts and ATB 10-3000-720, 4600 Volts)



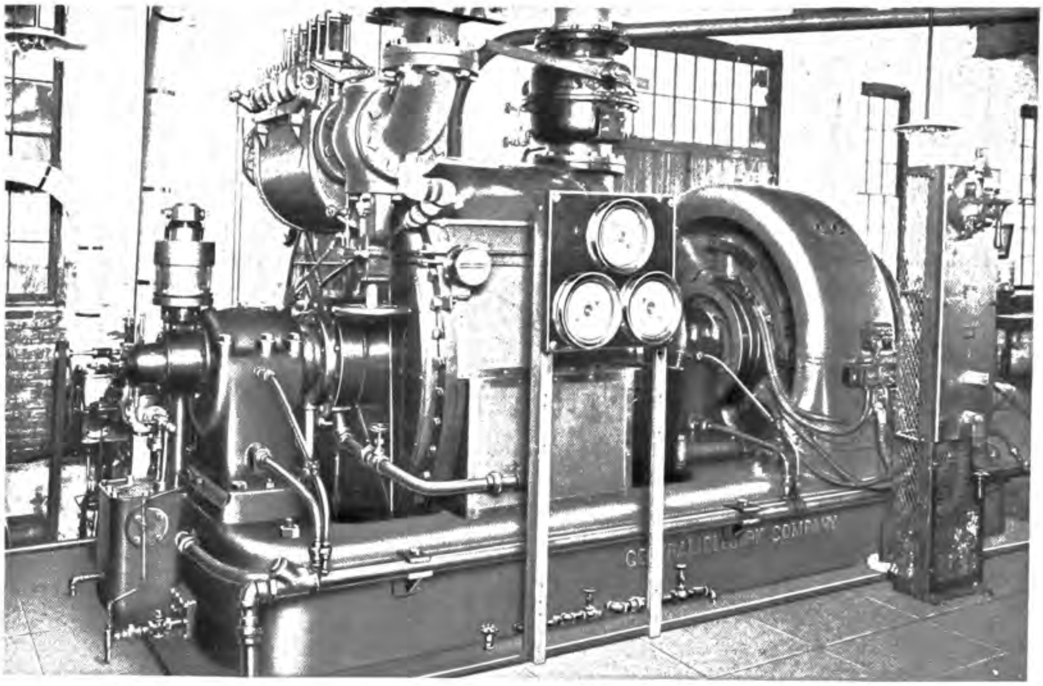
1000 Kw. Curtis Steam Turbine-Generator Installed for Usine de la Goulette
Tunis, Africa

(ATB 4-1000-1500, 10000 Volts)



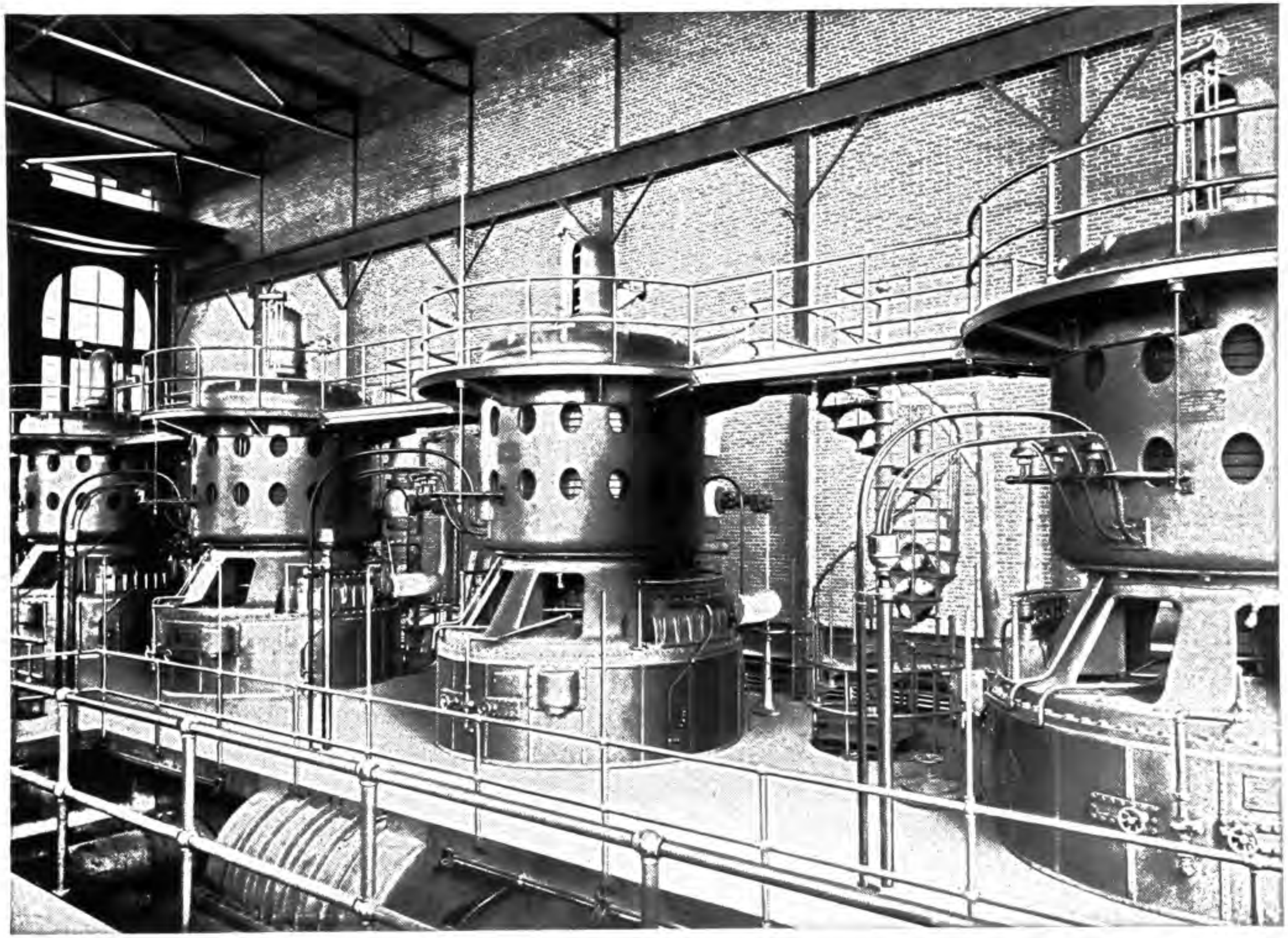
2250 Kw. Curtis Steam Turbine-Generator Installed for the Denver Gas and Electric Company, Denver, Colo.

(ATB 8-2250-900, 2300 Volts)



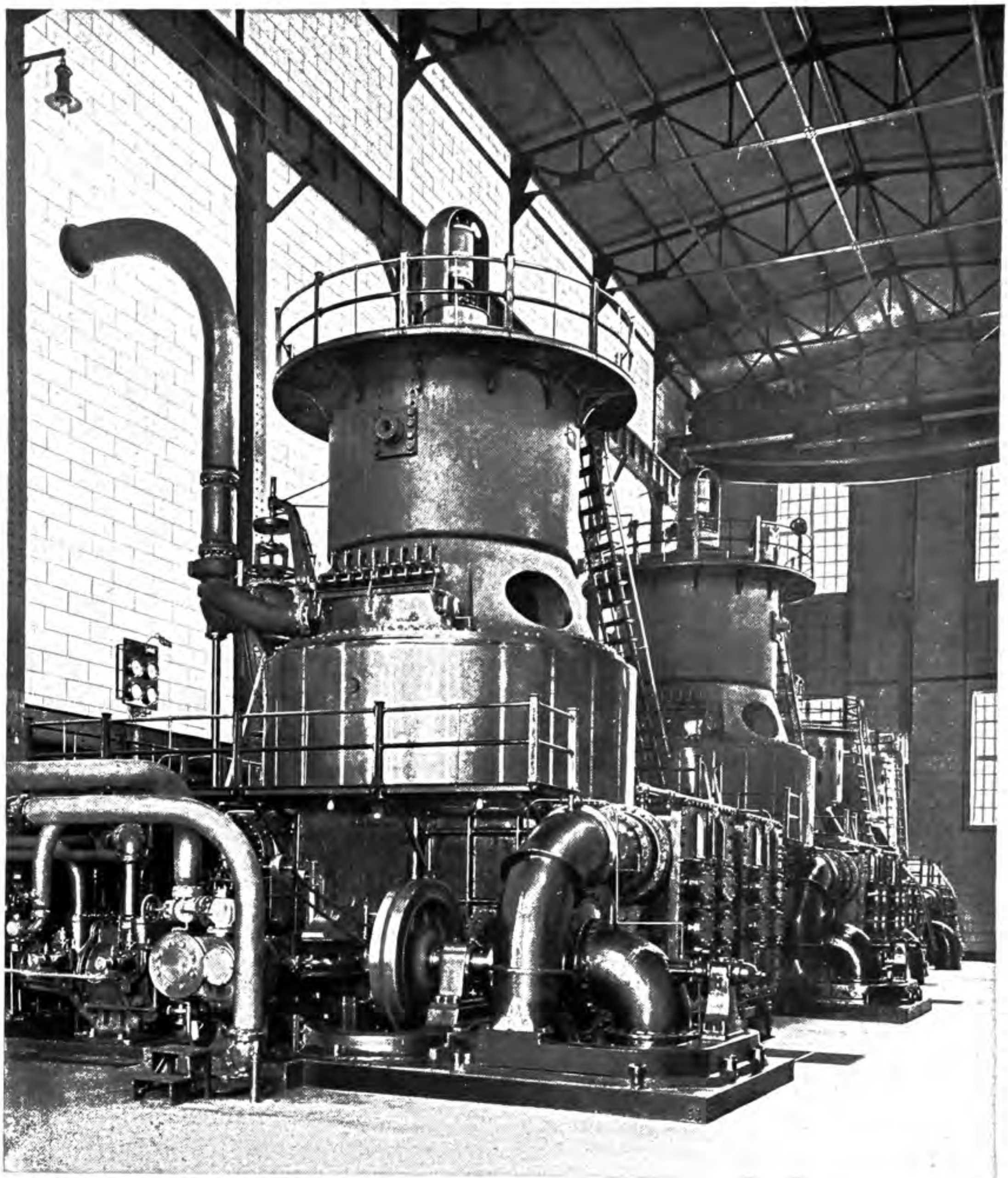
500 Kw. Curtis Steam Turbine-Generator Installed for the Danbury & Bethel Street Railway Company, Danbury, Conn.

(CC 4-500-1800, 575 Volts)



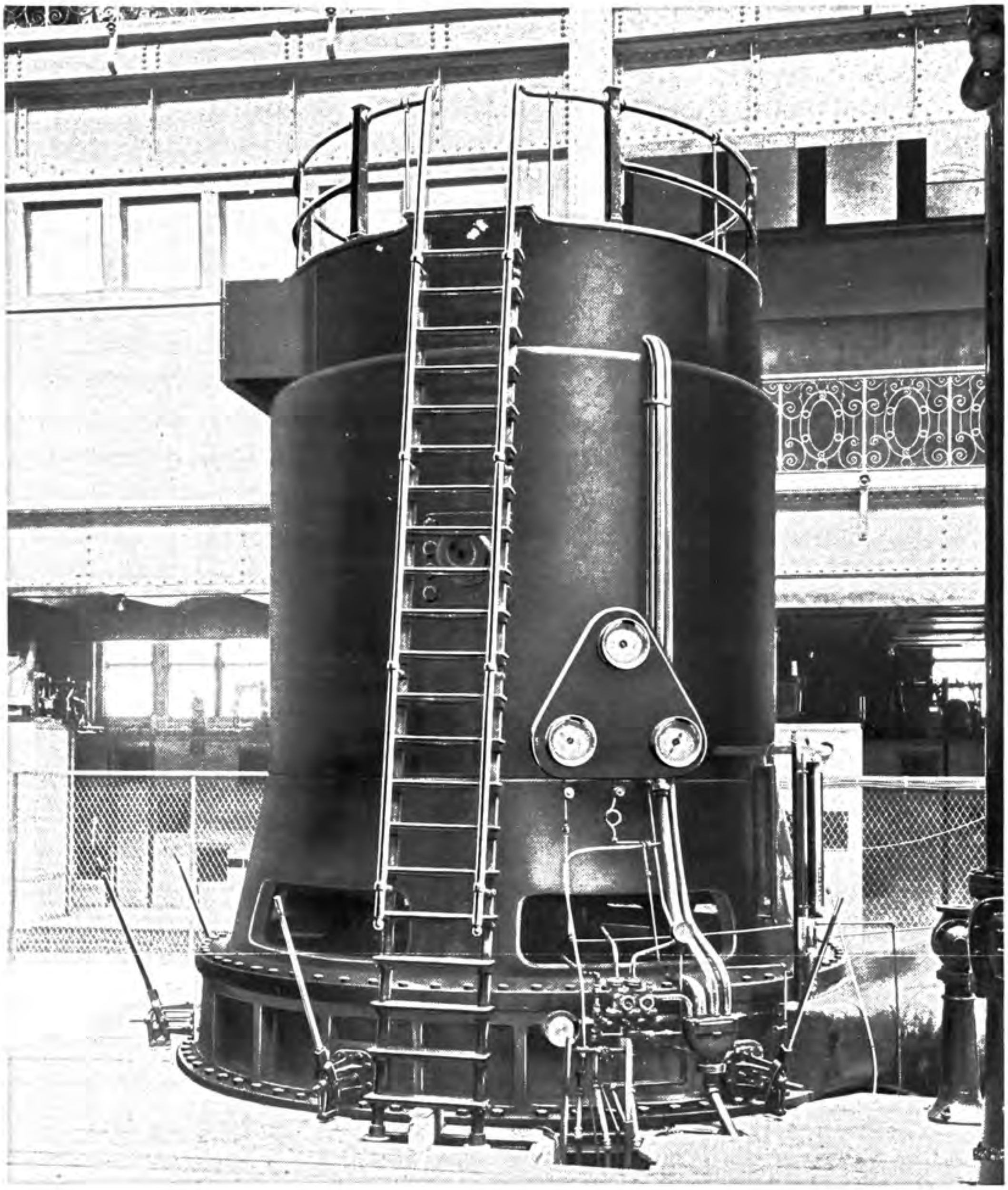
2000 Kw. Curtis Steam Turbine-Generator, Installed for Old Colony Street Railway Company, Quincy Point, Mass.

(ATB 4-2000-750, 13200 Volts)

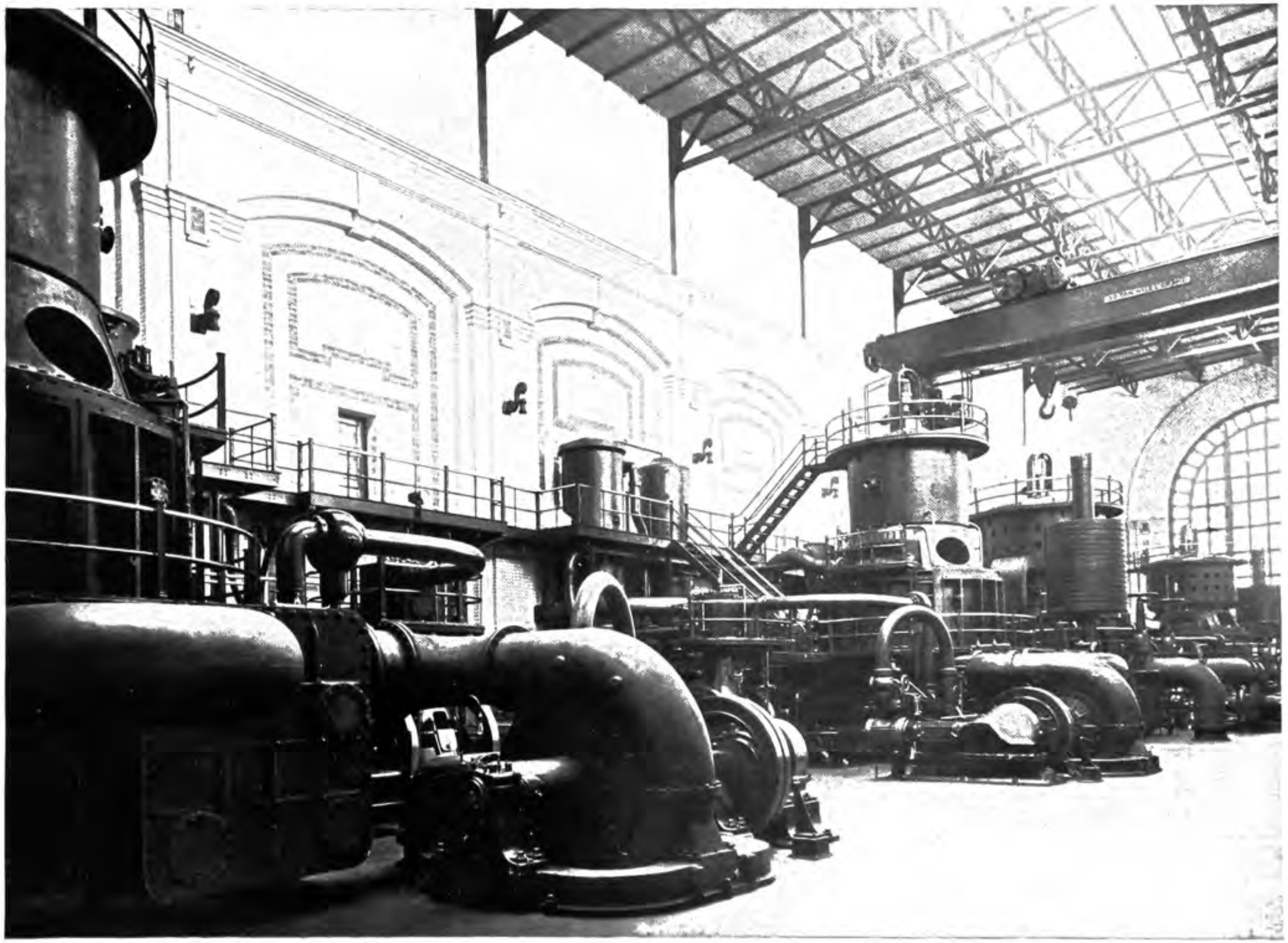


5000 Kw. and 9000 Kw. Curtis Steam Turbine-Generators Installed for the Potomac Electric Light and Power Company, Washington, D. C.

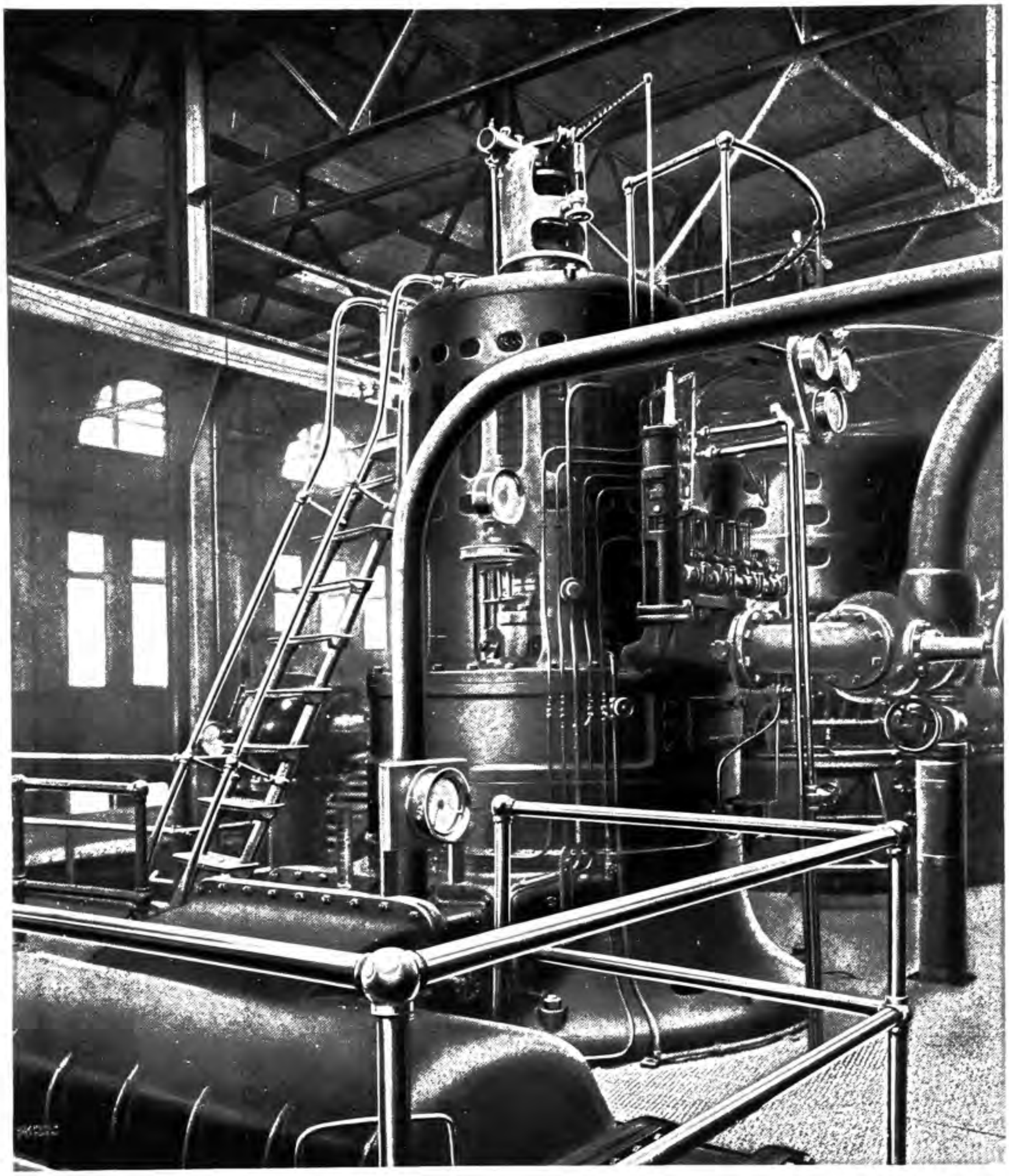
(ATB 4-5000-750, 6600 Volts and ATB 4-9000-750, 6600 Volts)



7500 Kw. Low Pressure Curtis Steam Turbine-Generator Installed for the Interborough Rapid Transit Co., 59th Street Station, New York City

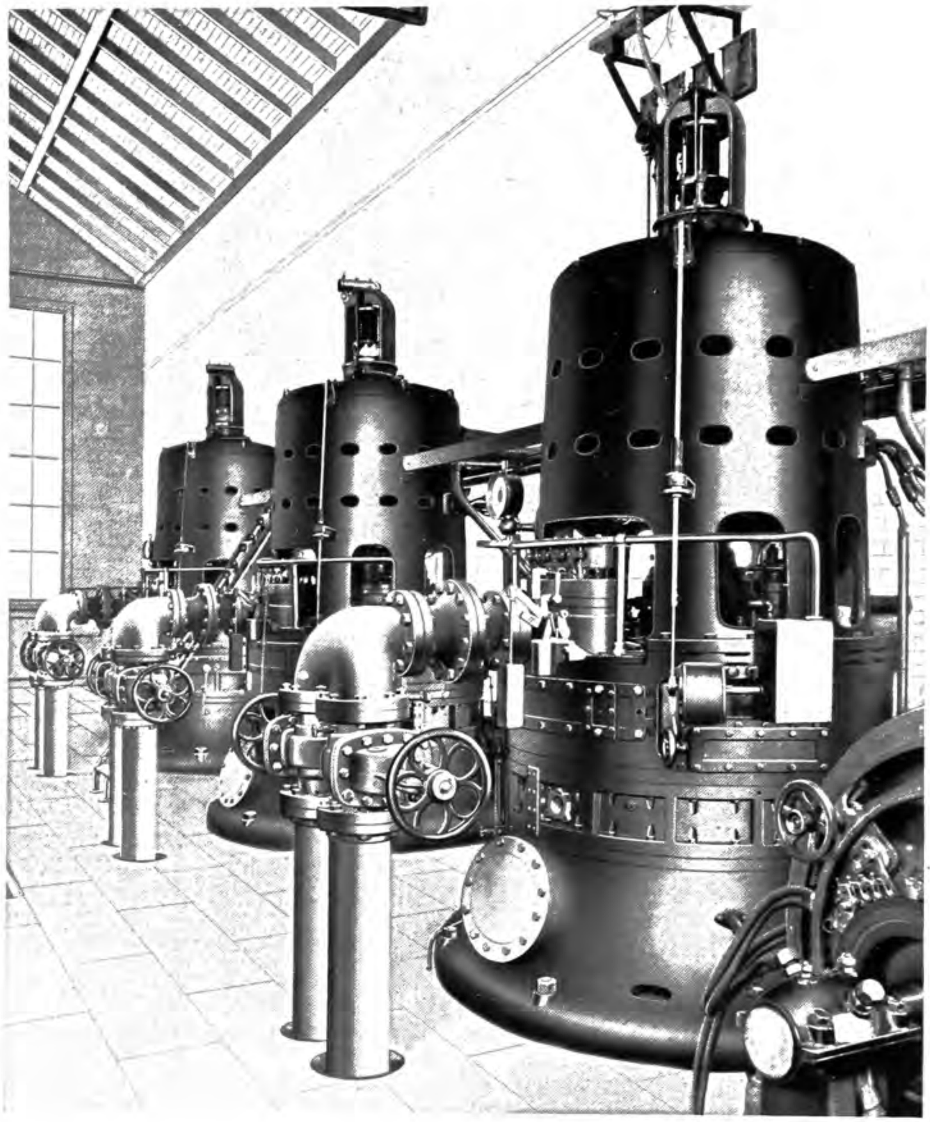


5000 Kw. and 8000 Kw. Curtis Steam Turbine-Generators Installed for the
Edison Electric Illuminating Company, Boston, Mass.

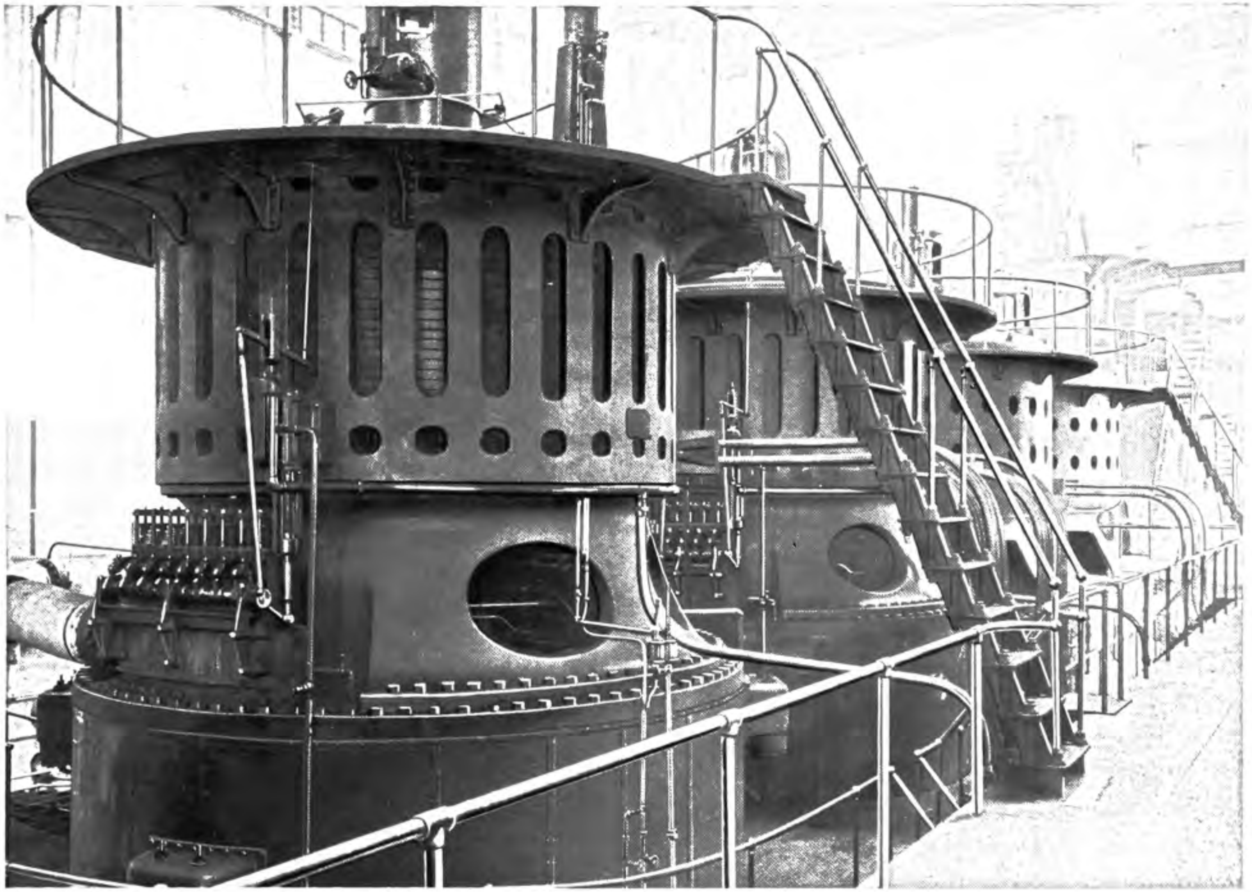


500 Kw. and 1500 Kw. Curtis Steam Turbine-Generators installed for the Philadelphia Electric Co., Tacony, Pa.

(AQB 4-500-1800, 2500 Volts and AQB 8-1500-900, 2300 Volts)

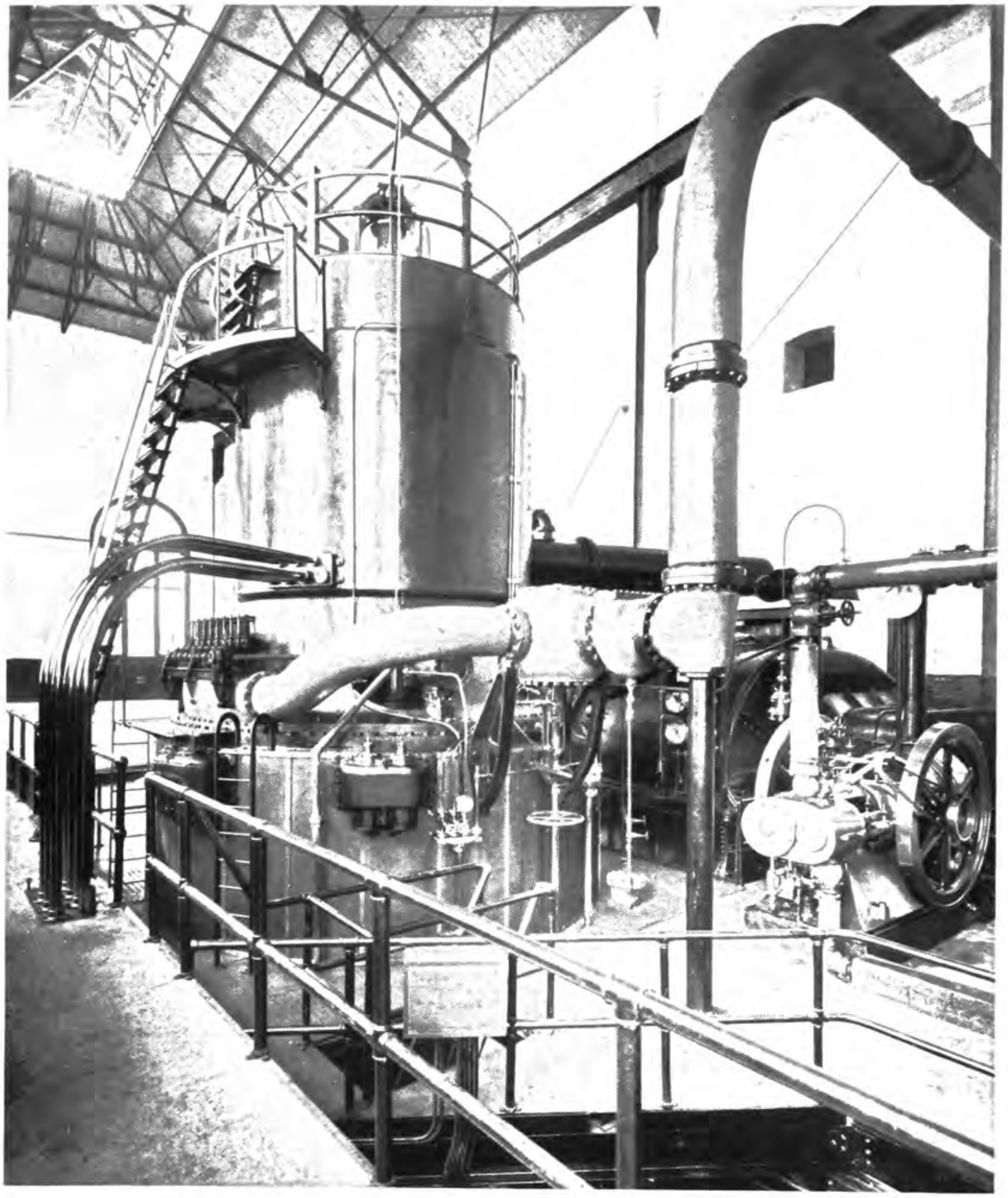


Three 500 Kw. Curtis Turbines direct connected to ATB 4-500-1800, 2300 Volt Generators Installed for D. L. & W. R. R. Co's Shop, Scranton, Pa.



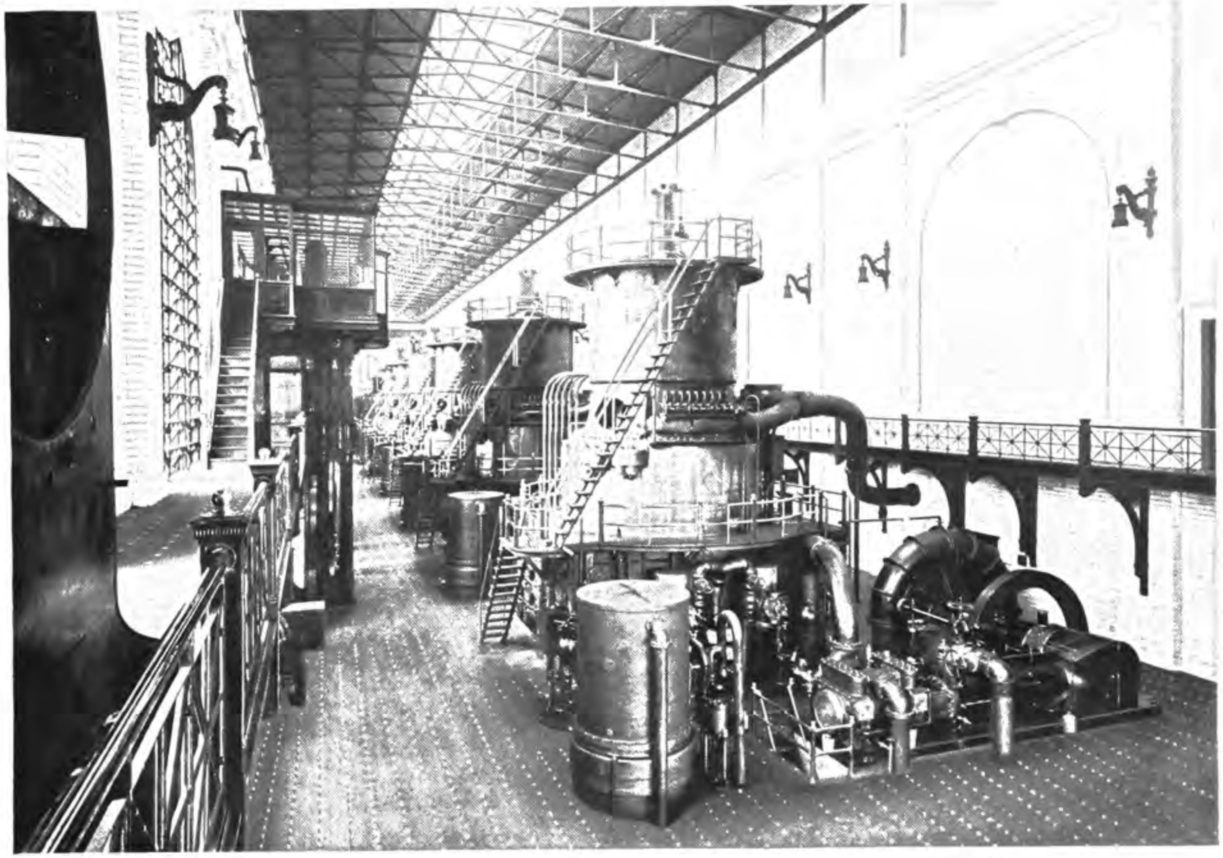
5000 Kw. Curtis Steam Turbine-Generators Installed for the Union Electric Light and Power Company, St. Louis, Mo.

(ATB 14-5000-514, 4000 Volts and ATB 6-5000-500, 6600 Volts)

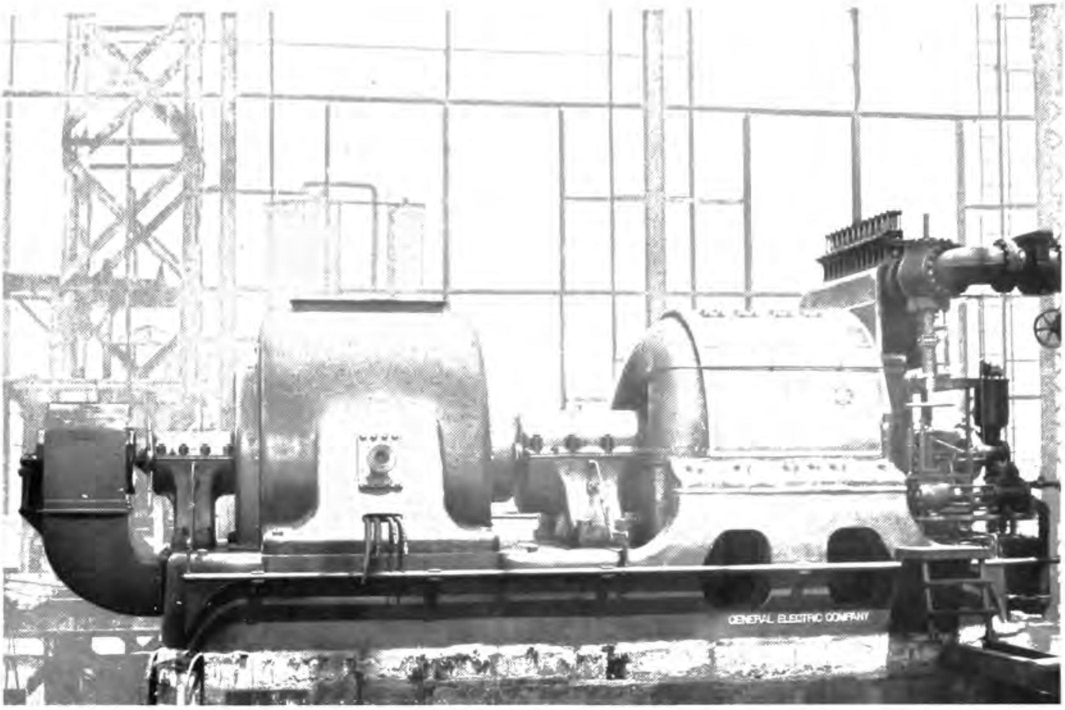


5000 Kw. Curtis Steam Turbine-Generator Installed for the United Railways of San Francisco

(ATB 4-5000-750, 13,200 Volts)



Ten 12000 Kw. Curtis Steam Turbine-Generators in Commonwealth Edison Company's Fisk Street Station, Chicago, Ill.



3500 Kw. Curtis Steam Turbine-Generator Installed for the Great Western Power Co., Oakland, Cal.

(ATB 6-3500-M-1200, 11000 Volts)

General Electric Company

Principal Offices, Schenectady, New York

Sales Offices

Address nearest office

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Schenectady, N.Y.

April, 1910

**Bulletin No. 4736*

LIGHTNING ARRESTERS

In Designing Lightning Arresters, the Engineers of the General Electric Company Have Considered the Great Variety of Conditions and Phenomena Produced by Lightning, Including All Effects of Abnormal Voltage.

MULTIGAP LIGHTNING ARRESTERS FOR ALTERNATING CURRENTS

THE lightning arresters described in this publication were designed after careful consideration of the great variety of conditions and phenomena produced by lightning, including all effects of abnormal voltage. These arresters, designed upon an elaboration of Prof. Elihu Thomson's fundamental patents, consist of a series of spark gaps shunted by graded resistances but without series resistance. The advantages possessed by them are:

1. Uniform voltage discharge over a wide range of frequency due to graded resistance.
2. Shunting the dynamic current through resistance.
3. The "breaking back" action on low frequency surges.
4. Fuse in ground leg of non-grounded neutral systems.
5. Adjustable gap in each leg shunted by a fuse.
6. Metallic resistance rods of improved composition.
7. Durable knurled cylinders of special alloy.
8. General Electric standard multiplex connection.

When properly installed they will perform the following functions:

First. Prevent excessive rises of potential of a transitory nature between lines as well as between lines and ground.

Second. Restrain the flow of the dynamic current across the gaps and extinguish the arc when normal potential is restored.

Third. Discharge high potentials covering a wide range of frequency.

The essential elements of the arrester are a number of cylinders spaced with a small air gap between them and placed between line and ground, and between line and line. In operation the multigap arrester discharges at a much lower voltage than would a single gap having a length equal to the sum of the small gaps.

In explaining the action of multigaps, there are three things to consider:

1. The transmission of the static stress along the line of cylinders.
2. The sparking of the gaps.
3. The action and duration of the dynamic current which follows the spark, and the extinguishment of the arc.

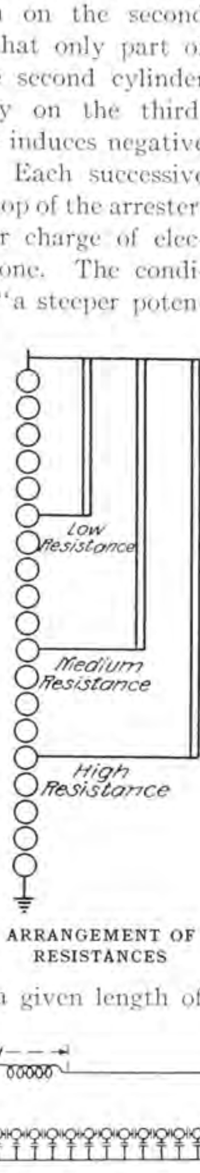
A spark may be defined as conduction of electricity by the air, and an arc as conduction of electricity by vapor of the electrode.

Distribution of Static Stress along Cylinders. The cylinders of the multigap arrester act like plates of condensers in series. This condenser function is the essential feature of its operation. When a static stress is applied to a series of cylinders between line and ground, the stress is instantly carried from end to end. If the top cylinder is positive it will attract a negative charge on the face of the adjacent cylinder and repel an equal positive charge to the opposite face, and so on down the entire row. The second cylinder has a definite capacity relative to the third cylinder and also to the ground; conse-

*Supersedes No. 4663.

quently the charge induced on the third cylinder will be less than on the second cylinder, due to the fact that only part of the positive charge on the second cylinder induces negative electricity on the third, while the rest of the charge induces negative electricity to the ground. Each successive cylinder, counting from the top of the arrester, will have a slightly smaller charge of electricity than the preceding one. The condition has been expressed as "a steeper potential gradient near the line."

Sparking of the Gaps. The quantity of electricity induced on the second cylinder is greater than on any lower cylinder and its gap has a greater potential strain across it as shown by the illustration below. When the potential across the first gap is sufficient to spark, the second cylinder is charged to line potential and the second gap receives the static strain and breaks down. The successive action is similar to overturning a row of nine-pins by pushing the first pin against the second. This phenomenon explains why a given length of air gap concentrated in one gap requires more potential to spark across it than the same total length made up of a row of multigaps. As the spark crosses each successive gap, the potential gradient along the remainder readjusts itself.



ARRANGEMENT OF RESISTANCES

How the Dynamic Arc is Extinguished. When the sparks extend across all the gaps the dynamic current will follow if, at that instant, the dynamic potential is sufficient. On account of the relatively greater current of the dynamic flow, the distribution of potential along the gaps becomes equal, and has the value necessary to maintain the dynamic current arc on a gap. The dynamic current continues to flow until the potential of the generator passes through zero to the next half cycle, when the arc-extinguishing quality of the metal cylinders comes into action. The alloy contains a metal of low boiling point which prevents the reversal of the dynamic current. It is a rectifying effect, and before the potential again reverses, the arc vapor in the gaps has cooled to a non-conducting state.

BASIC PRINCIPLES OF GENERAL ELECTRIC MULTIGAP LIGHTNING ARRESTERS

Rectification. The greater the value of the dynamic current, the greater the number of gaps required to extinguish the arcs.

Shunting by Resistance. Any arc is unstable and can be extinguished by placing a properly proportioned resistance in parallel with it.

Effect of Frequency. The higher the frequency of the lightning oscillation, the more readily will the multigap respond to the potential.

Briefly stated, the problem is to properly limit the dynamic current so that the arc may be extinguished; to arrange a shunt circuit so that the series resistance will be automatically cut out if safety demands it on account of a heavy lightning stroke and, while retaining these properties, to make the arrester sensitive to a wide range of frequencies. It should be noted that

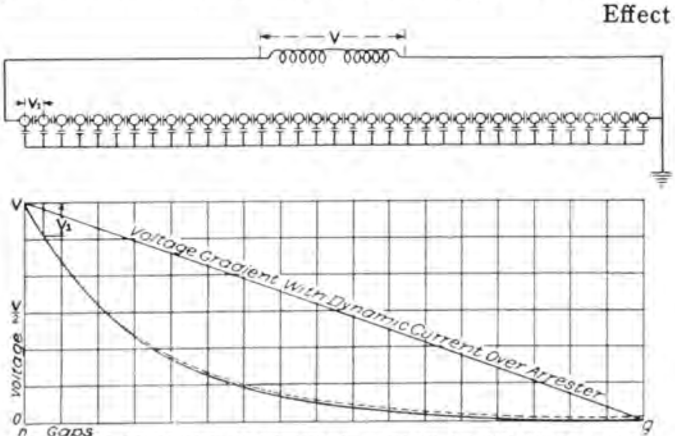
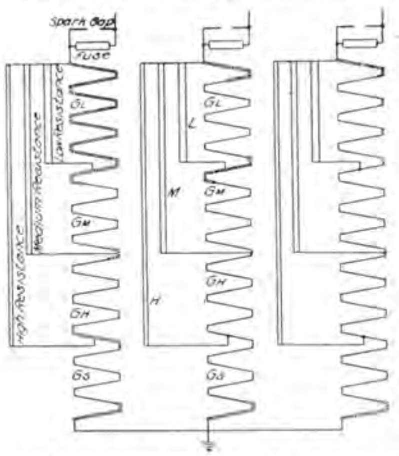


DIAGRAM SHOWING CONDENSER ACTION OF CYLINDERS AND POTENTIAL GRADIENT FOR STATIC STRESS series resistance limits the rate of discharge of the lightning as well as of the dynamic current.

GRADED SHUNT RESISTANCE

The desired result is obtained in the General Electric Multigap Lightning Arresters by the use of **graded shunt resistance.** Without regarding the "cumulative" or "breaking back" effect of the graded resistance, described later, this type of arrester may be considered as four arresters in one. First, for small discharges there are a few gaps in series with a high shunt resistance. This part of the arrester will safely discharge accumulated static and also all disruptive discharges of small ampere capacity. In the figure below this path is shown through *H*,



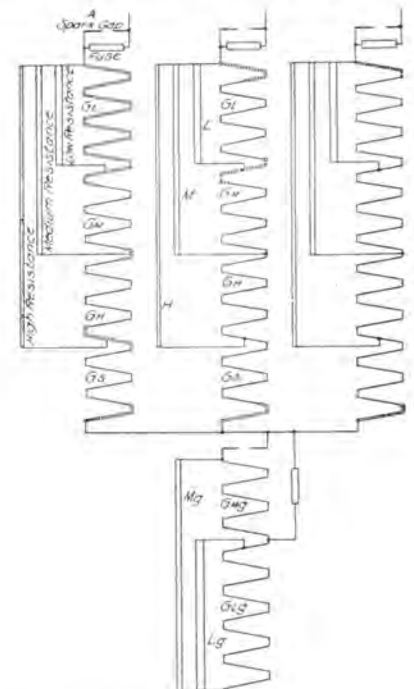
CONNECTIONS FOR 33000-VOLT Y SYSTEM WITH GROUNDED NEUTRAL

(resistance) and *GS* (gaps). Second, there are a number of gaps in series with a medium shunt resistance which will discharge disruptive strokes of medium ampere capacity; in the figure this path is shown through *M* (resistance) and *GH* plus *GS* (gaps). Third, there are a greater number of gaps in series with a low shunt resistance which will discharge heavy disruptive strokes. In the figure this path is shown through *L* (resistance) and *GM* plus *GH* plus *GS* (gaps). Fourth and last, the total number of gaps has no series resistance, thus enabling the arrester to freely discharge the heaviest induced strokes. In the figure this path is shown through zero resistance and *GL* plus *GM* plus *GH* plus *GS* (gaps).

In each of the above circuits the number of gaps and the resistance are so proportioned as to extinguish the dynamic arc at the end of the half cycle in which the lightning discharge takes place.

THE "CUMULATIVE" OR "BREAKING BACK" EFFECT

The graded shunt resistances give a valuable effect not brought out in the previous description, where the arrester is considered as four separate arresters. This is the "cumulative" or "breaking back" action.



CONNECTIONS FOR 33000-VOLT DELTA OR UNGROUNDED Y SYSTEMS

When a lightning strain between line and ground takes place, the potential is carried down the high resistance, *H*, to the series gaps, *GS*, and the series gaps spark over. Although it may require several thousand volts to spark across an air gap, it requires relatively only a few volts to maintain the arc which follows the spark. In consequence, when the gaps *GS* spark over, the lower end of the high resistance is reduced practically to ground potential. If the high resistance can carry the discharge current without giving an ohmic drop sufficient to break down the shunted gaps *GH*, nothing further occurs —the arc goes out. If, on the contrary, the lightning stroke is too heavy for this, the potential strain is thrown across the shunted gaps, *GH*, equal in number to the previous set. In other words, the same voltage breaks down both of the groups of gaps, *GS* and *GH*, in succession. The lightning discharge current is now limited only by the medium resistance, *M*, and the potential is concentrated across the gaps, *GM*. If the medium resistance cannot discharge the lightning, the gaps *GM* spark, and the discharge is limited only by the low resistance. The low resistance should take care of most cases but with extraordinarily heavy strokes and high frequencies, the discharge can "break back" far enough to cut out all resistance. In the last step the resistance is relatively low in proportion to the number of shunt gaps, *GL*, and is designed to cut out the dynamic current instantly from the gap, *GL*. The illustration of the 2200 volt arrester on page 8 shows that the low resistance actually performs this function. This "breaking back" effect is valuable in discharging lightning of low frequency, in a manner better than has been obtained before.

After the spark passes, the dynamic arcs are extinguished in the reversed order. The low resistance, *L*, is proportioned so as to draw the dynamic arcs instantly from the gaps, *GL*. The dynamic current continues in the next group of gaps, *GM*, until the end of the half cycle of the generator wave. At this instant the medium resistance, *M*, aids the rectifying quality of the gaps, *GM*, by shunting out the low frequency dynamic current of the generator. On account of this shunting effect the current dies out sooner in the gaps, *GM*, than it otherwise would. In the same manner, but to a less degree, the high resistance, *H*, draws the dynamic current from the gaps, *GH*. This current now being limited by the high resistance, the arc is easily extinguished at the end of the first one-half cycle of the generator wave.

"V" UNIT OF MULTIGAP LIGHTNING ARRESTERS

Therefore the superiority of the General Electric High-voltage Arrester is due largely to the proper shunting of its gaps, resulting in an arrester with the following properties: first, it will relieve the line of either light or heavy lightning disturbance, throughout a wide range of frequency; and, second, the groups of gaps are so proportioned to the shunt resistance that the rectifying quality of the cylinders readily extinguishes the arc.

"V" UNIT FOR MULTIGAP ARRESTERS

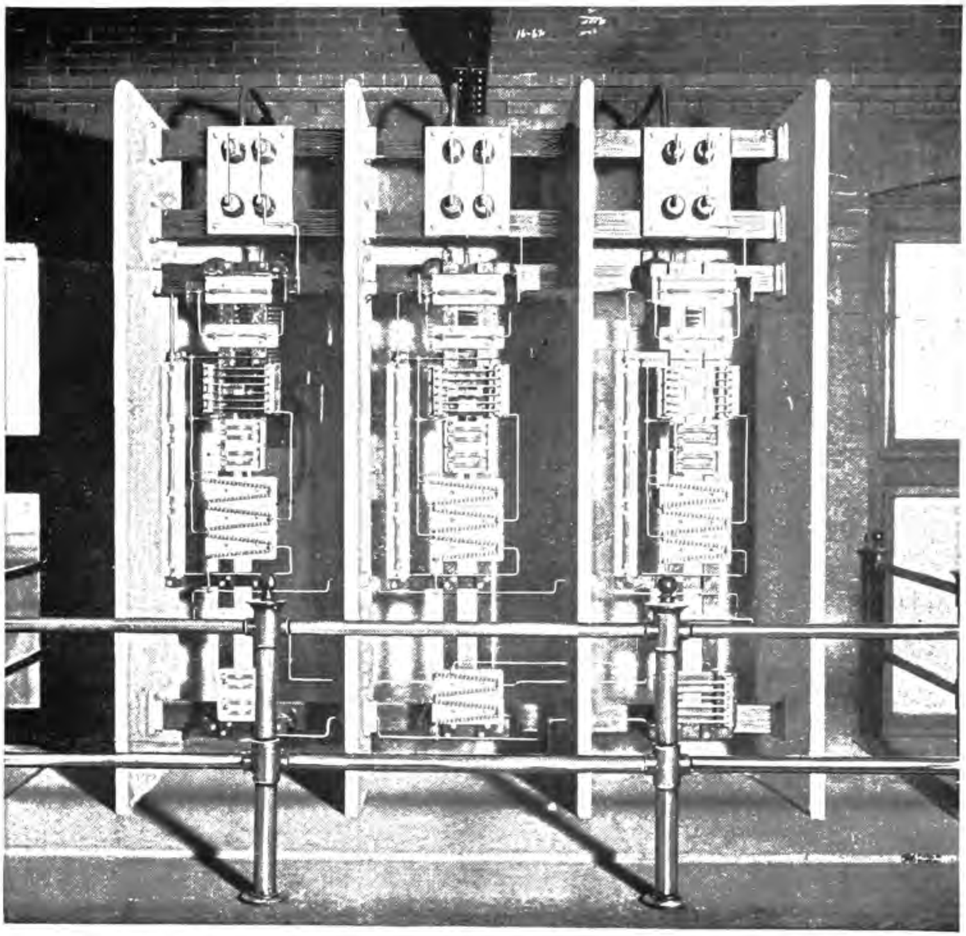
The High-voltage Multigap Arrester is made up of "V" units consisting of gaps between knurled cylinders and connected together at their ends by short metal strips. The base is of porcelain, which thoroughly insulates each cylinder, and insures the proper functioning of the multigaps.

CYLINDERS

The cylinders are made of an improved alloy that contains metal of low boiling point which gives the rectifying effect, and metals of high boiling point which cannot vaporize in the presence of the one of low boiling point. The cylinders are heavily knurled. As the arc plays on the point of a knurl it gradually burns back and when the metal of low boiling temperature is used up, the gap is increased at that particular point. The knurling, therefore, insures longer life to the cylinder by forcing successive arcs to shift to a new point. When worn along the entire face the cylinder should be slightly turned.

RESISTANCE RODS

The low resistance section of the graded shunt is composed of rods of a new metallic alloy. These rods have large current-carrying capacity, and practically zero temperature coefficient up to red heat.



INSTALLATION OF A 12500-VOLT, THREE-PHASE, MULTIGAP LIGHTNING ARRESTER IN THE GARFIELD PARK SUB-STATION OF THE WEST CHICAGO PARK COMMISSION

The medium and high resistance rods are of the same standard composition previously used. The contacts are metal caps shrunk on the ends; the resistances are permanent in value and the inductance is reduced to a minimum. The rods are designed with a large factor of safety, and have sufficient heat absorbing capacity to take the dynamic energy following transitory lightning discharges. They are glazed to prevent absorption of moisture and surface arcing.

DIFFERENCE BETWEEN ARRESTER FOR GROUNDED Y AND NON-GROUNDED NEUTRAL SYSTEMS

The connections for a three-phase arrester, 33,000 volts between lines, are shown in the illustrations on page 3. One illustration shows the design for a thoroughly grounded Y system and the other for a non-grounded neutral system. The latter includes delta, ungrounded Y, and Y systems grounded through a high resistance.

The difference in design lies in the use of a fourth arrester leg between the multiplex connection and ground on ungrounded systems. The reason for introducing the fourth leg is evident. The arrester is designed to have two legs between line and line. If one line became accidentally grounded, the full line potential would be thrown across one leg if the fourth or ground leg were not present. On a Y system with a grounded neutral the accidentally grounded phase causes a short circuit of the phase and the arrester is relieved of the strain by the tripping of the circuit breaker. Briefly stated, the fourth or ground leg of the arrester is used when, for any reason, the system could be operated, even for a short time, with one phase grounded.

MULTIPLEX CONNECTION

The multiplex connection has been a distinctive feature of the General Electric Company's arresters for several years. It consists of a common connection between the phase legs of the arrester above the earth connection and provides an arrester better adapted to relieve high potential surges between lines than would otherwise be possible. Its use also economizes greatly in space and material for delta and partially grounded or non-grounded Y systems.

FUSE AUXILIARIES

The practice of introducing an auxiliary adjustable gap between each line wire and its corresponding leg of the arrester has been modified in the new design with marked increase in the *sensitiveness* of the arrester. As the gap is necessary, under certain abnormal conditions, it is left on the arrester but short circuited by a fuse so that it comes into service only when the fuse blows on account of an arc between phase and ground or some similar extremely severe continued strain. The sensitiveness is also greatly increased by the addition of a similar shunting fuse around the adjustable gap in the ground leg of the arrester. The ground leg is necessary only when there is an accidental ground of a phase; ordinarily the increased sensitiveness is maintained continually.

LOCATION—INSTALLING—SPACING SETTING OF ADJUSTABLE GAP

Ample wall space should be provided and plenty of room in front should be left for the operator. The arresters should be installed as near as possible to where the lines enter the building. The following minimum separation distances, recommended by the General Electric Company for the past few years, have proved entirely satisfactory.

TABLE GIVING PROPER SPACE BETWEEN LIGHTNING ARRESTERS AND FOR SETTING ADJUSTABLE GAP

Max. Volts	Distance in Inches Between Live Parts of Adjacent Phases	Minimum Distance Between Centers (See Note)	Inches of Gap
7600	8″	28″	$\frac{1}{4}$
12250	8″	28″	$\frac{3}{8}$
13500	8″	33″	$\frac{3}{8}$
17000	10″	35″	$\frac{3}{8}$
22000	12″	37″	$\frac{1}{2}$
27000	18″	48″	$\frac{1}{2}$
32000	22″	52″	$\frac{5}{8}$
37000	26″	56″	$\frac{3}{4}$

NOTE—If barriers are used the width of barriers should be added to distances given.

It is advisable to install arresters in a dry place, and before assembling them the wooden supports, insulators, etc., should be thoroughly dried to expel all moisture which may have collected during transportation.

The adjustable spark gap on these arresters is shunted by a fuse as explained on page 6. This fuse blows under certain conditions and cuts in the added protection of the gap. The settings of this gap for the various arresters should be as given on preceding page.

VOLTAGE RANGE OF ARRESTERS

Lightning arresters of the form described have been designed for voltages from 5700 to 37000. For lower voltages, down to 300 volts, alternating current, the arresters are of slightly different design, having only two resistance rods. A view of the 300-volt arrester is shown on page 9. For 300 volts and less no resistance is necessary, as the voltage is so low that the arc cannot hold. These arresters, therefore, consist simply of spark gaps.

LOW VOLTAGE ARRESTERS—FORMS F1 AND F2
300 TO 5700 VOLTS

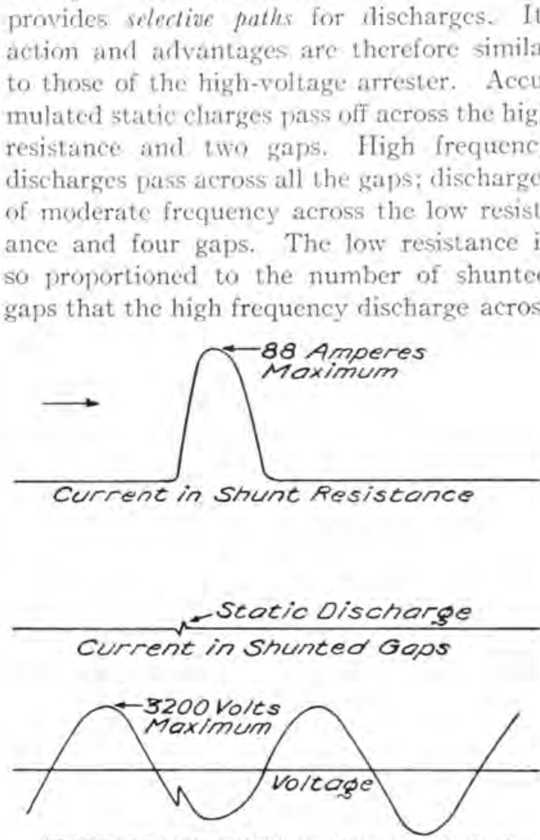
The 2200-volt arrester consists of one unit having fourteen cylinders, nine of which are shunted by a low resistance and eleven by a

LINE

GROUND

FORM F1, 2200-VOLT MULTIGAP ARRESTER FOR STATION INSTALLATION

high resistance. As in the case of the high voltage arresters, the grading of resistance provides *selective paths* for discharges. Its action and advantages are therefore similar to those of the high-voltage arrester. Accumulated static charges pass off across the high resistance and two gaps. High frequency discharges pass across all the gaps; discharges of moderate frequency across the low resistance and four gaps. The low resistance is so proportioned to the number of shunted gaps that the high frequency discharge across



OSCILLOGRAPH CURVES SHOWING LIGHTNING ARRESTER ACTION

these gaps is not followed by the dynamic current, the dynamic shunting at once to the low resistance. The discharge, as illustrated on the following page, takes place over all the gaps, but the arcs between the gaps shunted by the low resistances are very small compared with the bright arcs between the last four gaps. The static discharge passes through all the gaps, while the half wave of dynamic current following the static is shunted part of the way by the resistance.

An oscillogram of this phenomenon is shown above. The only current in the shunted gaps is the current of static discharge. It should be noted, however, that the current shown is not a measure of the true current, as the oscillograph cannot respond to currents of such high frequency.

This arrester is designed to operate across 2200 volts. It is used, however, from each line to ground, giving, thus connected, sufficient protection and being always able to handle a discharge when one line is grounded. It is built to be used single-pole,

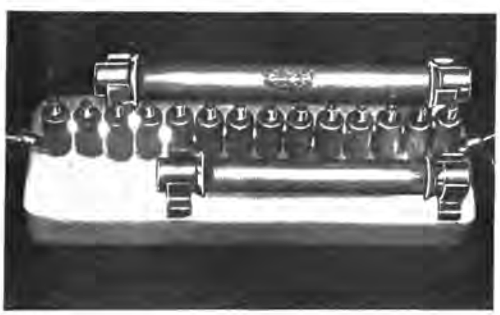
LINE

GROUND

FORM F2, 3000-VOLT MULTIGAP ARRESTER FOR STATION INSTALLATION

but by placing two or three in the same box, becomes double-pole or triple-pole.

The 1000-volt arrester is the same in design but has only one gap between the high resistance rod and line.



2200-VOLT, FORM F1, LIGHTNING ARRESTER DISCHARGING AND SHUNTING THE DYNAMIC CURRENT

The 3000-volt arrester shown above is based on the same general principle as the 2200-volt arrester, differing from it mainly in having two additional gaps to take care of the higher voltage.

The 2200-volt arrester, Form F1, is used in various combinations to form arresters of higher voltage. The complete line is catalogued on pages 13 and 14.

LOW-VOLTAGE LIGHTNING ARRESTERS

300 VOLTS OR LESS

For low-voltage, alternating current circuits up to 300 volts the Form D lightning arresters are used. This type has been sold

SINGLE-POLE FORM D ARRESTER

by the General Electric Company for several years, and in its present form meets the requirements for the protection of low voltage circuits such as transformer secondaries, motors, series arc lamps, etc. The arresters are made in single, double and triple-pole units mounted in compact iron boxes; various forms are shown in the accompanying illustrations.

PROTECTION OF MIXED OVERHEAD AND CABLE SYSTEMS

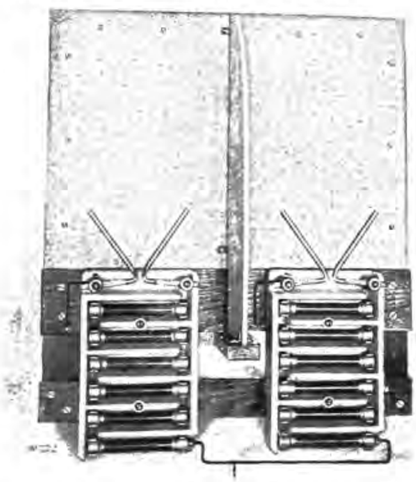
It is frequently necessary and desirable for circuits to dip underground when passing through cities, under rivers, etc., and in these cases some form of metal covered cable is generally used. Resonance invariably produces high potentials at the junction of overhead and underground lines, and these potentials are often of sufficient value to break down the insulation of the cables and also the insulation of apparatus installed on the system.

Whenever lines contain both inductance and capacity in appreciable quantities, high voltages which endanger the insulation of the whole system and which it is impossible to detect on ordinary switchboard instruments may exist. Abnormal voltages are therefore often found in circuits containing a combination of underground and overhead circuits and in underground transmission lines.

For the protection of underground cables, arresters should be installed at all points where a cable joins overhead construction.

DOUBLE-POLE AND TRIPLE-POLE FORM D 300-VOLT ARRESTERS

It is difficult, however, to determine the proper arresters for such circuits on account of the various conditions to be met. Recommendations will gladly be made on receipt of information as to accessibility, ease of inspection, voltage and power of system, and length of overhead and underground circuits.



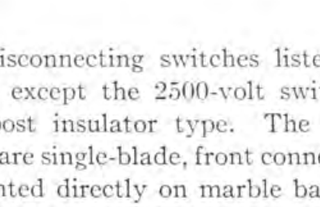
HORN ARRESTER FOR CONSTANT CURRENT CIRCUITS FOR STATION USE

CONSTANT CURRENT ARRESTERS

For constant current lighting circuits, horn arresters with resistances are recommended. It is advisable to place these arresters in the station on each outgoing line. When cables are used, the arrester should be placed on the pole where the cable joins the overhead wires. The accompanying illustration shows the appearance of one of the General Electric horn lightning arresters for station use.

DISCONNECTING SWITCHES

Lightning Arresters are listed in this Bulletin without disconnecting switches. The use of such switches, however, is strongly recommended in order that the lightning arresters may be disconnected from the line for proper inspection, adjustment, cleaning, etc., without opening the line circuit.



POST TYPE INSULATOR DISCONNECTING SWITCH

The disconnecting switches listed in this Bulletin, except the 2500-volt switches, are of the post insulator type. The 2500-volt switches are single-blade, front connected, and are mounted directly on marble bases. The post insulator switches are arranged for mounting on flat surfaces.

CHOKE COILS

The proper selection and installation of choke coils is an important feature of lightning protection. Choke coils should be used with lightning arresters except when the arresters are used to protect cable systems.

HOUR GLASS TYPE—CHOKE COIL
15000-35000 VOLTS

Three types of General Electric choke coils are shown in the accompanying illustrations.

6600 VOLTS

4600 VOLTS

LOW VOLTAGE CHOKE COILS

The 4600-volt coil is made of insulated wire wound on wooden core supported by iron feet. The 6600-volt coil is made of insulated wire and is mounted on marble base. For voltages above 6600 the "hour glass" type with air insulated turns is used. With this type the coil is mounted on a wooden, slate or marble base.

The "hour glass" type has the following advantages on high voltages.

1. Should there be any arcing between adjacent turns, the coils will reinsulate themselves after the discharge.

2. They are mechanically strong; and sagging is prevented by tapering the coils toward the center turns.

3. The insulating supports can best be designed for the strains that they have to withstand.

INSTRUCTIONS FOR ORDERING HIGH-VOLTAGE LIGHTNING ARRESTERS

All high-voltage arresters listed are for three-phase circuits. Information on those for single- or two-phase circuits will be furnished on request.

All lightning arresters are listed *without choke coils or disconnecting switches*, but the use of both is recommended. Choke coils, however, should not be used with cable systems.

When it is impossible to order a lightning arrester equipment by Cat. No., the data called for in the following list should accompany the requisition.

1. What is the normal line to line voltage?

2. How many sets of transmission lines are there?

3. Is the system single-phase, two-phase or three-phase, or three-phase, four wire?

4. Is the system delta connected; Y connected, neutral non-grounded; or Y connected, neutral grounded?

5. If single-phase, is the neutral grounded?

6. Are switches to be furnished with the arrester?

7. If so, are they to be double-blade or single-blade?

8. If double-blade switches are required, state the current-carrying capacity of the line switch.

9. Are choke coils to be furnished? If so, state their ampere capacities and the number desired.

10. The number of switch hooks to be furnished.

11. If the line is partly overhead and partly underground, submit a rough sketch that shows where the underground portion is located with reference to the stations and the remainder of the line.

DIRECT CURRENT LIGHTNING ARRESTERS

The Type M Form D-2 arrester has been the standard for direct current circuits for several years, and is furnished for lighting and power circuits of from 60 to 375 volts, and for railway and power circuits of from 250 to 1800 volts.

DIRECT CURRENT ARRESTER
TYPE M, FORM D-2

The present form of arrester is somewhat longer and narrower than the earlier types, and the spark gap and non-inductive resistance are in a straight line, thus forming a direct path for the discharge and reducing to a minimum the possibility of short circuit in the box in case of excessively heavy lightning discharges. One of the valuable features of the MD-2 arrester is the fact that all parts can be readily inspected on removing the cover of the porcelain enclosing box and a glance will show if the arrester is in proper condition for the next storm. The gap is surrounded by a strong electro-magnet which immediately blows out the dynamic arc through the chute after the lightning discharge has passed.

The gaps on arresters up to 850 volts are adjusted to .025 inch, and on higher voltages to .094 inch. These arrangements have been found to afford excellent protection to the insulation of the equipments, due to the ow breakdown points.

The spark gap terminals are threaded and attached to the lid of the box, thus affording a ready method of adjustment, positive grip on the terminals, and easy access for examination.

DIRECT CURRENT LIGHTNING ARRESTER—INTERIOR

GROUND CONNECTIONS

In all lightning arrester installations it is of the utmost importance to make perfect ground connections, as a large majority of lightning arrester troubles can be traced to the lack of this precaution. It has been customary to ground a lightning arrester by means of a large metal plate buried in a bed of charcoal at a depth of six or eight feet in the earth.

A more satisfactory method of making a ground is to drive a number of 1 in. iron pipes six or eight feet into the earth at several points about the station, connecting all these pipes together by means of copper wire or preferably copper strip. A quantity of salt should be placed around each pipe at the surface of the ground and the ground thoroughly moistened with water. It is advisable to connect the pipes to the iron frame work of the station, and also to any water mains, metal flumes, or trolley rails that are available.

For the station of ordinary size the following recommendation is made. Place three earth-pipes equally spaced near each outside wall, making twelve altogether, and place three extra pipes spaced about 6 feet apart at a point nearest the arrester.

When plates are placed in streams of running water, it is much better for them to be buried in the mud along the bank than to lie in the stream. Streams with rocky bottoms are to be avoided except as a last resort.

Whenever plates are placed at any distance from the arrester it is advisable to drive a pipe in the earth directly beneath the arrester, thus making the ground connections as short as possible. Earth plates at a distance cannot be depended upon. Long ground wires in a station cannot be depended upon unless a lead is carried to the multiple pipe earths described above.

In view of the fact that it is advisable occasionally to examine the ground connections to see that they are in proper condition, it is desirable to lay out the exact plans of the location of the ground plates, ground wires, or pipes, with a brief description of them, so that at any time the data may be referred to.

From time to time the resistance of the ground connections should be measured to determine their condition. This is very easily done when pipe grounds are installed, as the resistance of one pipe can be accurately determined when three or more pipes are used. The resistance of a single pipe ground in good condition has an average value of about 15 ohms. A simple and satisfactory method of keeping account of the condition of the earth connections is to divide the pipe-earths into two groups and connect each group to the 110-volt lighting circuit with an ammeter in series. If there is a flow of about 20 amperes the conditions are satisfactory provided the pipe-earths are properly distributed around the station.

For grounding pole lightning arresters on low voltage distribution circuits, a simple but satisfactory method is to drive a single $\frac{3}{4}$ inch or 1 inch pipe into the ground at the foot of the pole, and connect it to the arrester, preferably with the copper wire. The wire should be well soldered to the top of the pipe. The pipe should be driven to a depth of six to eight feet and should extend up the pole about 8 feet to avoid interference with the ground wire.

GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS FOR ALTERNATING CURRENT CONSTANT POTENTIAL CIRCUITS—UP TO 5700 VOLTS

Voltage of System Line to Line	Class of System	CAT. NO. ARRESTER	
		Line	Station
Up to 301	3-phase △ or ungrounded Y . . .	3413 single-pole 38126 double-pole 38127 triple-pole	
301–1200	3-phase △ or ungrounded Y . . .	46710 single-pole 77007 double-pole 77008 triple-pole	46711 single-pole 77022 double-pole 77023 triple-pole
1201–2300	3-phase △ or ungrounded Y . . .	46712 single-pole 46714 double-pole 46716 triple-pole	45477 single-pole 46713 double-pole 46715 triple-pole
2301–3000	3-phase △ or ungrounded Y . . .	75947 single-pole 78472 double-pole 78474 triple-pole	75946 single-pole 78473 double-pole 78475 triple-pole
3001–4150	3-phase △ or ungrounded Y . . .	46981 single-pole	46980 single-pole 46753 triple-pole
4151–5700	3-phase △ or ungrounded Y . . .	78490 triple-pole	78489 triple-pole
Up to 301	3-phase grounded Y	3413 single-pole 38126 double-pole 38127 triple-pole	
301–2000	3-phase grounded Y	46710 single-pole 77007 double-pole 77008 triple-pole	46711 single-pole 77022 double-pole 77023 triple-pole
2001–3500	3-phase grounded Y	46712 single-pole 46714 double-pole 46716 triple-pole	45477 single-pole 46713 double-pole 46715 triple-pole
3501–4500	3-phase grounded Y	75947 single-pole 78472 double-pole 78474 triple-pole	75946 single-pole 78473 double-pole 78475 triple-pole
4501–5700	3-phase grounded Y	46981 single-pole	46980 single-pole 46753 triple-pole
Up to 301	Single-phase ungrounded	3413 single-pole 38126 double-pole	
301–1200	Single-phase ungrounded	46710 single-pole 77007 double-pole	46711 single-pole 77022 double-pole
1201–2300	Single-phase ungrounded	46712 single-pole 46714 double-pole	45477 single-pole 46713 double-pole
2301–3000	Single-phase ungrounded	75947 single-pole 78472 double-pole	75946 single-pole 78473 double-pole
3001–4150	Single-phase ungrounded	46981 single-pole	46980 single-pole
4151–5700	Single-phase ungrounded	78480 double-pole	78479 double-pole
Up to 301	Single-phase grounded neutral . . .	3413 single-pole 38126 double-pole	
301–2000	Single-phase grounded neutral . .	46710 single-pole 77007 double-pole	46711 single-pole 77022 double-pole
2001–3500	Single-phase grounded neutral . . .	46712 single-pole 46714 double-pole	45477 single-pole 46713 double-pole
3501–4500	Single-phase grounded neutral . . .	75947 single-pole 78472 double-pole	75946 single pole 78473 double-pole
4501–5700	Single-phase grounded neutral . . .	46981 single-pole	46980 single-pole
1200–2000	Single-phase, one line grounded . .	46712 single-pole	45477 single-pole
2001–2600	Single-phase, one line grounded . .	75947 single-pole	75946 single-pole
2601–3500	Single-phase, one line grounded . .	46981 single-pole	46980 single-pole
*2300–*3300	Quarter-phase, three wire	See page 17	
*3301–*4300	Quarter-phase, three wire	See page 17	

Quarter-phase, four wire—treat as single-phase ungrounded.

*Voltage across outside wires.

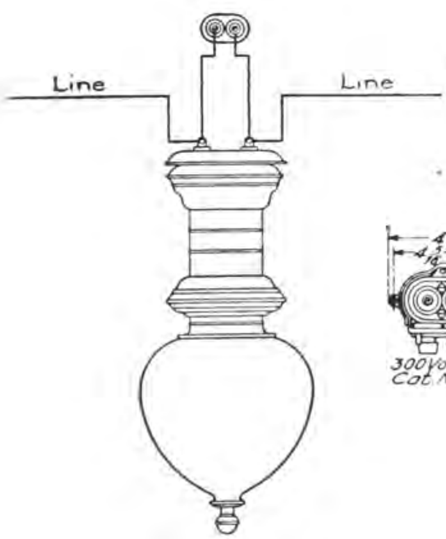
LOW VOLTAGE ALTERNATING CURRENT LIGHTNING ARRESTERS

APPROXIMATE SHIPPING WEIGHTS

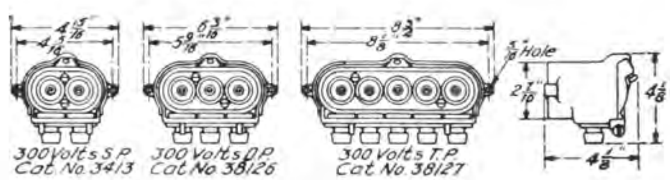
Cat. No.	Description. (For Voltage Rating see Page 13.)	Approx. Shipping Weight in Lb.
3413*§	Single-Pole Form D, Line Arrester in iron box	6
38126*	Double-Pole Form D, Line Arrester in iron box	8.5
38127*	Triple-Pole Form D, Line Arrester in iron box	11
45477	Single-Pole Form F1, Station Arrester	7.5
46710	Single-Pole Form F1, Line Arrester in wooden box	15
46711	Single-Pole Form F1, Station Arrester	7.5
46712	Single-Pole Form F1, Line Arrester in wooden box	15
46713	Double-Pole Form F1, Station Arrester	15
46714	Double-Pole Form F1, Line Arrester in wooden box	28
46715	Triple-Pole Form F1, Station Arrester	22
46716	Triple-Pole Form F1, Line Arrester in wooden box	42
46753	Triple-Pole Form F1, Station Arrester	28
46980	Single-Pole Form F1, Station Arrester	15
46981	Single-Pole Form F1, Line Arrester in wooden box	24
75946	Single-Pole Form F2, Station Arrester	10
75947	Single-Pole Form F2, Line Arrester in wooden box	20
77007	Double-Pole Form F1, Line Arrester in wooden box	28
77008	Triple-Pole Form F1, Line Arrester in wooden box	42
77022	Double-Pole Form F1, Station Arrester	15
77023	Triple-Pole Form F1, Station Arrester	22
78472	Double-Pole Form F2, Line Arrester in wooden box	35
78473	Double-Pole Form F2, Station Arrester	20
78474	Triple-Pole Form F2, Line Arrester in wooden box	50
78475	Triple-Pole Form F2, Station Arrester	30
78479	Double-Pole Form F1, Station Arrester	71
78480	Double-Pole Form F1, Line Arrester in wooden box	95
78489	Triple-Pole Form F1, Station Arrester	96
78490	Triple-Pole Form F1, Line Arrester in wooden box	135

*Not of graded shunt resistance type. For Transformer secondaries. § Also for individual arc lamp.

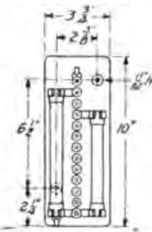
CONNECTIONS OF LIGHTNING ARRESTER CAT. NO. 3413 FOR INDIVIDUAL A.C. ARC LAMP



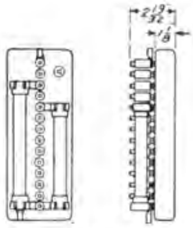
DIMENSIONS OF LOW VOLTAGE ALTERNATING CURRENT LIGHTNING ARRESTERS



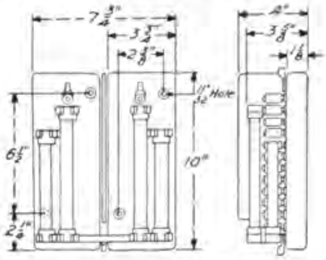
DIMENSIONS OF LOW-VOLTAGE ALTERNATING CURRENT LIGHTNING ARRESTERS



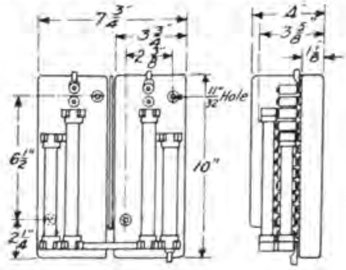
S.P. STATION ARRESTER
CAT. NO. 46711



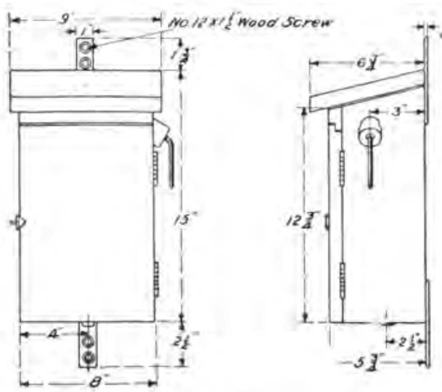
S.P. STATION ARRESTER
CAT. NO. 45477



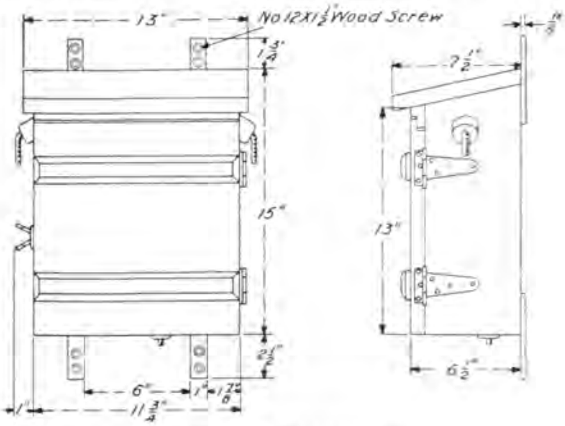
D.P. STATION ARRESTER
CAT NO. 77022



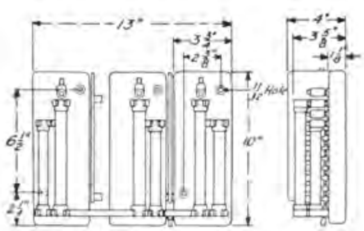
D.P. STATION ARRESTER
CAT. NO. 46713



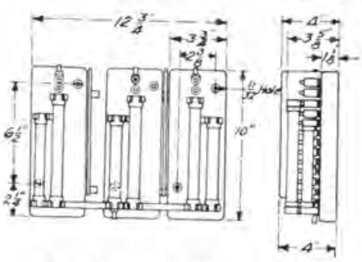
S.P. LINE ARRESTERS
CAT. NOS. 46710 AND 46712



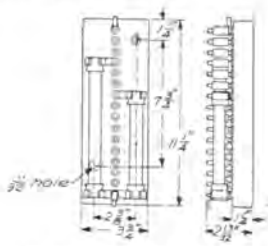
D.P. LINE ARRESTERS
CAT. NOS. 46714 AND 77007



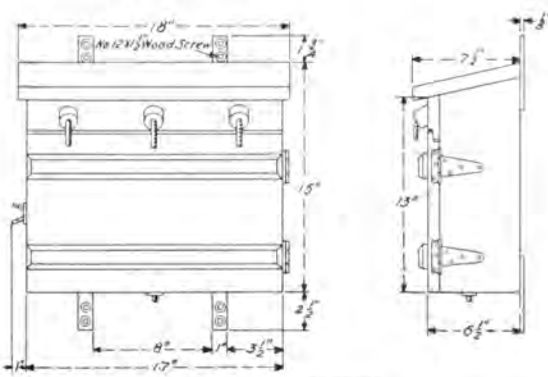
T.P. STATION ARRESTER
CAT. NO. 77023



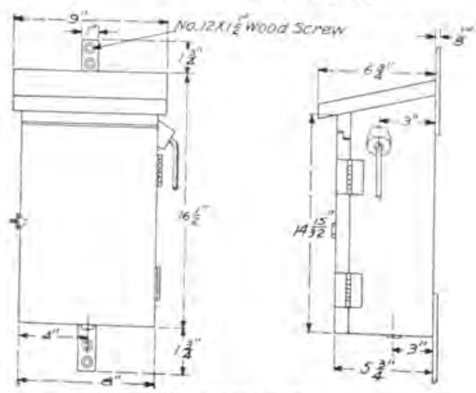
T.P. STATION ARRESTER
CAT. NO. 46715



S.P. STATION ARRESTER
CAT. NO. 75946

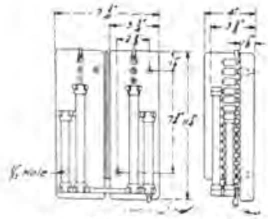


T.P. LINE ARRESTERS
CAT. NOS. 46716 AND 77008

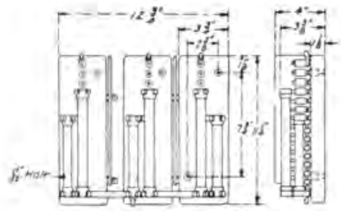


S.P. LINE ARRESTER
CAT. NO. 75947

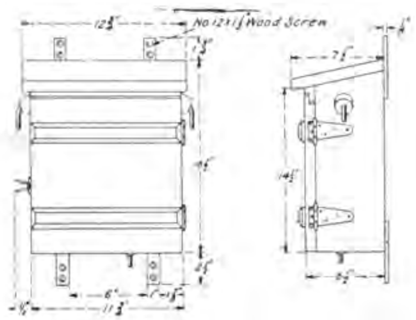
DIMENSIONS OF LOW-VOLTAGE ALTERNATING CURRENT LIGHTNING ARRESTERS



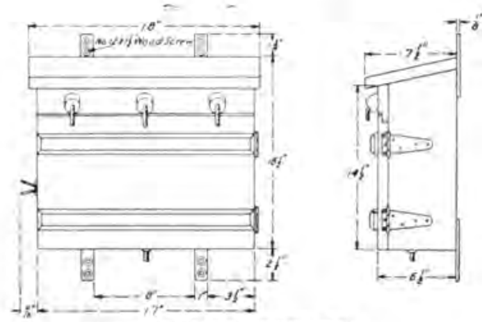
D.P. STATION ARRESTER
CAT. NO. 78473



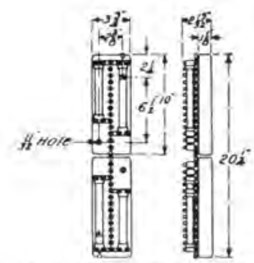
T.P. STATION ARRESTER
CAT. NO. 78475



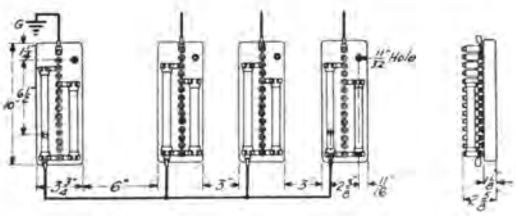
D.P. LINE ARRESTER
CAT. NO. 78472



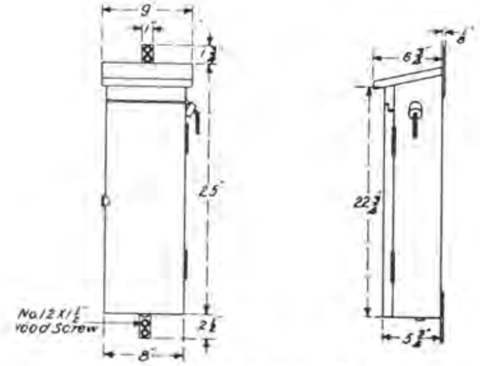
T.P. LINE ARRESTER
CAT. NO. 78474



S.P. STATION ARRESTER
CAT. NO. 46980

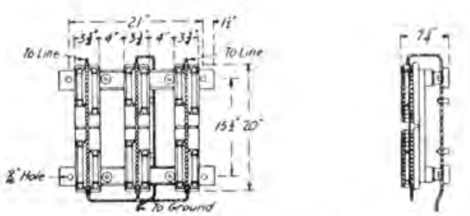


T.P. STATION ARRESTER
CAT. NO. 46753

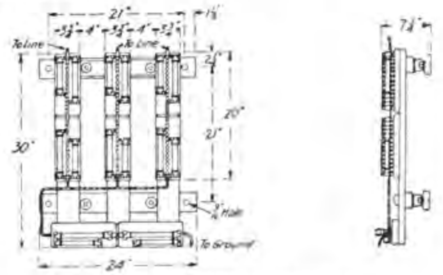


S.P. LINE ARRESTER
CAT. NO. 46981

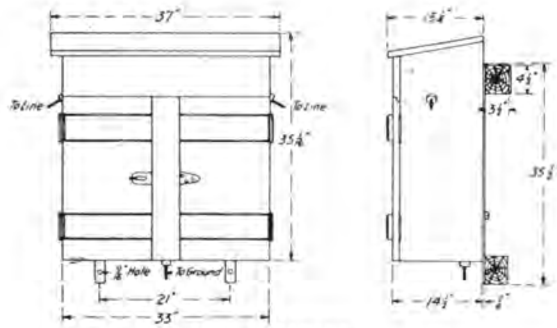
DIMENSIONS OF LOW-VOLTAGE ALTERNATING CURRENT LIGHTNING ARRESTERS



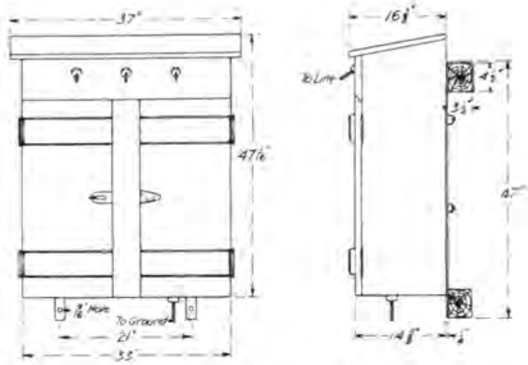
D.P. STATION ARRESTER
CAT. NO. 78479



T.P. STATION ARRESTER
CAT. NO. 78489

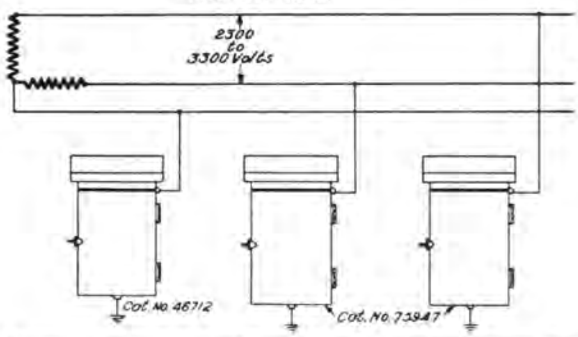


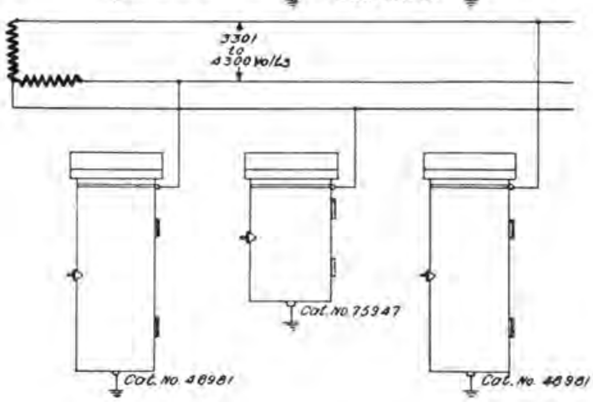
D.P. LINE ARRESTER
CAT. NO. 78480



T.P. LINE ARRESTER
CAT. NO. 78490

CONNECTIONS OF LIGHTNING ARRESTERS FOR TWO-PHASE THREE-WIRE CIRCUITS





Arresters shown in opposite diagram are for line service.

For station service use corresponding single-pole station type as follows:

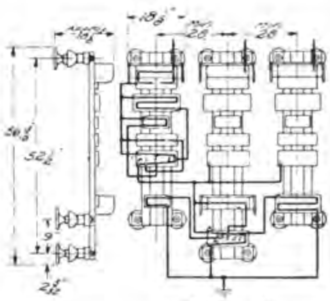
LINE	STATION
Cat. No. 46712	Cat. No. 45477
Cat. No. 46981	Cat. No. 46980
Cat. No. 75947	Cat. No. 75946

ALTERNATING CURRENT GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS

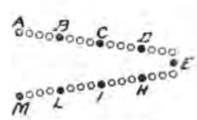
THE FOLLOWING CAT. NOS. DO NOT INCLUDE DISCONNECTING SWITCHES

THREE-PHASE FOR "DELTA" OR UNGROUNDED "Y" CIRCUITS			THREE-PHASE FOR GROUNDED "Y" CIRCUITS		
Cat. No.	Min. and Max. Voltage on which Arresters should be Installed	Approx. Shipping Weight in Lb.	Cat. No.	Min. and Max. Voltage on which Arresters should be Installed	Approx. Shipping Weight in Lb.
46991	5700– 7600	353	46992	5700– 7600	325
46993	7601–12250	465	46994	7601–12250	420
46995	12251–13500	550	46996	12251–13500	500
46997	13501–17000	650	46998	13501–17000	575
46999	17001–22000	805	47000	17001–22000	715
47001	22001–27000	980	47002	22001–27000	870
47003	27001–32000	1245	47004	27001–32000	1115
47005	32001–37000	1430	47006	32001–37000	1320

DIMENSIONS OF ALTERNATING CURRENT GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS FOR 3-PHASE DELTA OR UNGROUNDED "Y" CIRCUITS

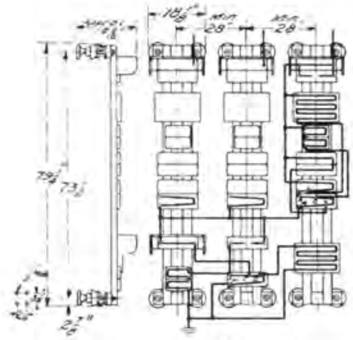


6600 Volts
Cat. No. 46991

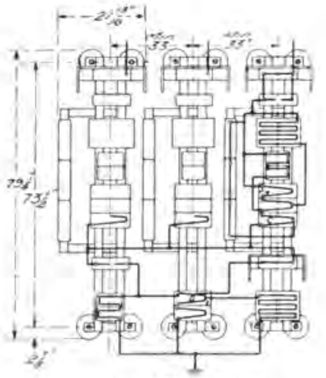


V UNIT

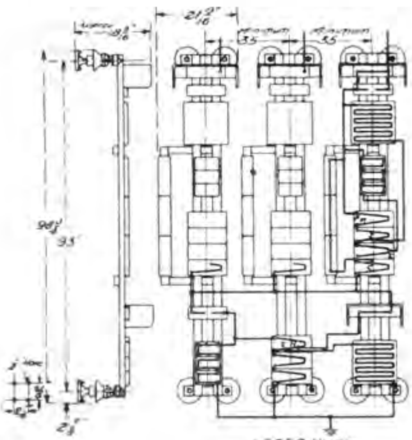
LETTERS ON DIAGRAMS SHOW WHICH CYLINDER OF EACH UNIT IS CONNECTED



10000 Volts
Cat. No. 46993

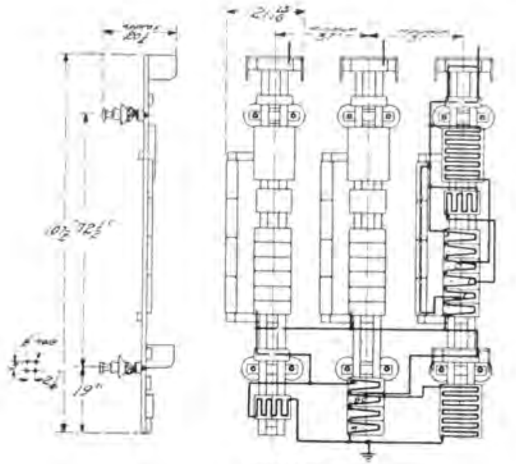


12500 Volts
Cat. No 46995

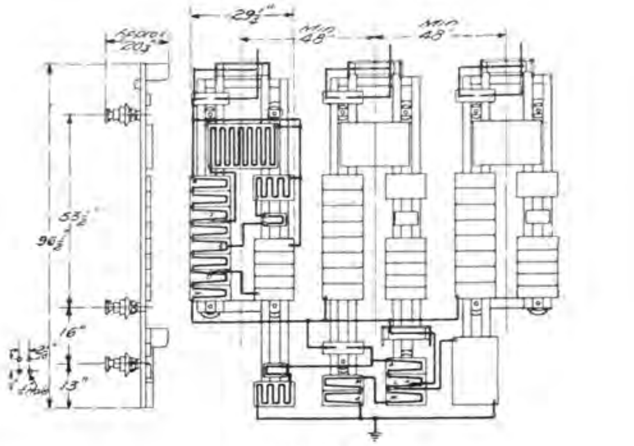


15000 Volts
Cat. No 46997

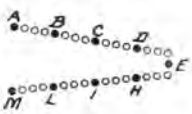
DIMENSIONS OF ALTERNATING CURRENT GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS FOR 3-PHASE DELTA OR UNGROUNDED "Y" CIRCUITS—Continued



20000 Volts
Cat. No. 46999

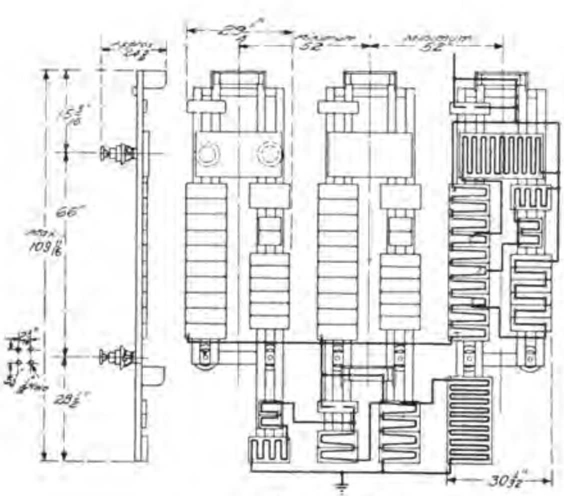


25000 Volts
Cat. No. 47001

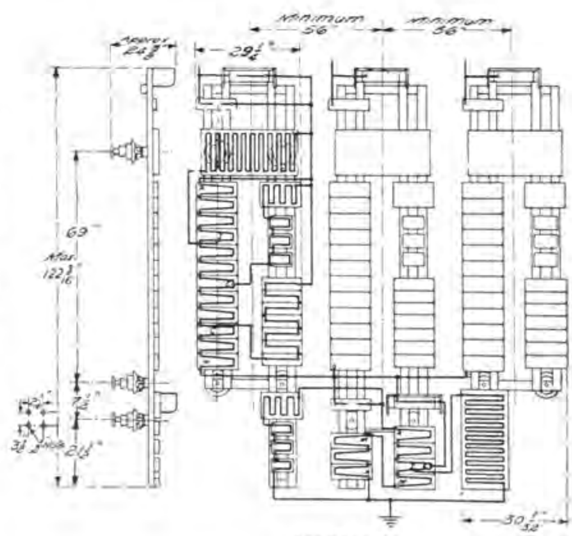


V UNIT

LETTERS ON DIAGRAMS SHOW WHICH CYLINDER OF EACH UNIT IS CONNECTED

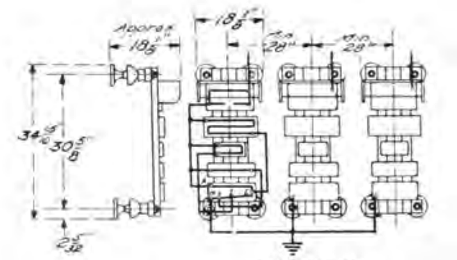


30000 volts
Cat. No. 47003

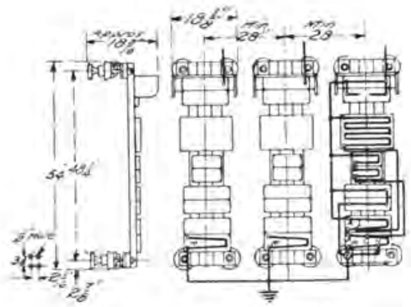


35000 Volts
Cat. No. 47005

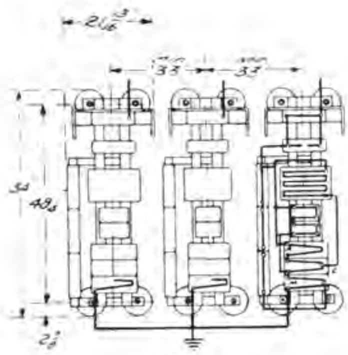
DIMENSIONS OF ALTERNATING CURRENT GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS FOR 3-PHASE GROUNDED "Y" CIRCUITS



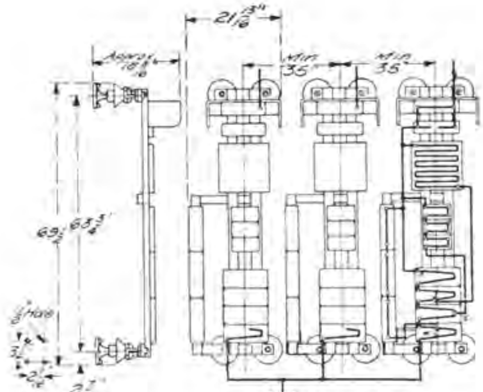
6600 Volts
Cat. No. 46992



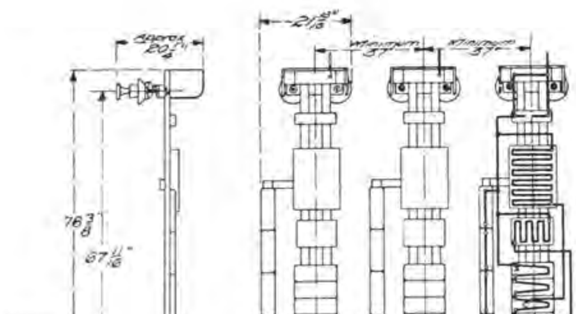
10000 Volts
Cat. No. 46994



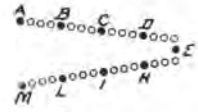
12500 Volts
Cat. No. 46996



15000 Volts
Cat. No. 46998



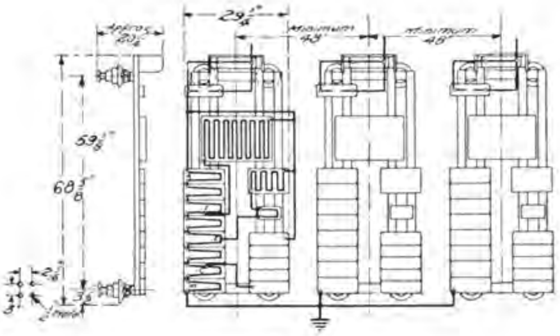
20000 Volts
Cat. No. 47000



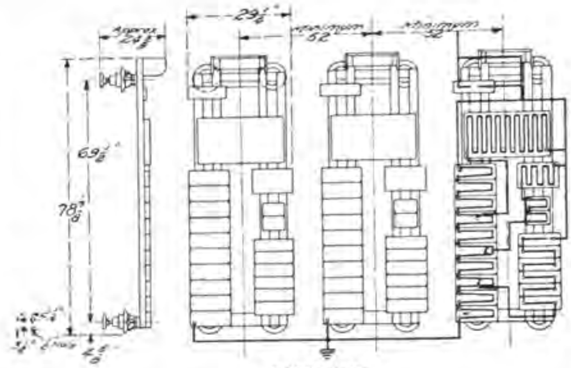
V UNIT

LETTERS ON DIAGRAMS SHOW WHICH CYLINDER OF EACH UNIT IS CONNECTED

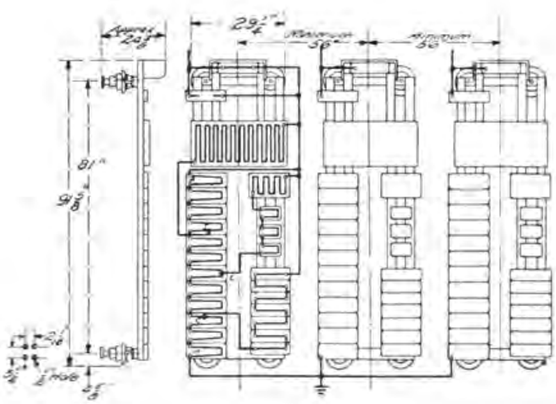
DIMENSIONS OF ALTERNATING CURRENT GRADED SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS FOR 3-PHASE GROUNDED "Y" CIRCUITS—Continued



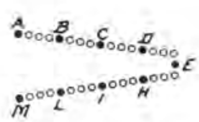
25000 Volts
Cat. No. 47002



30000 Volts
Cat. No. 47004



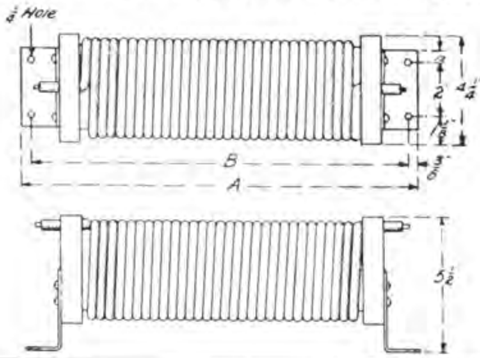
35000 Volts
Cat. No. 47006

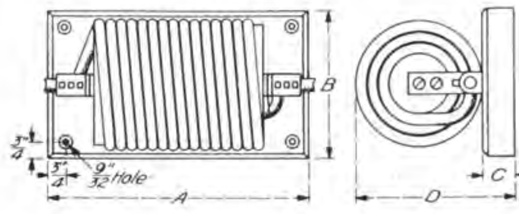


V UNIT

LETTERS ON DIAGRAMS SHOW WHICH CYLINDER OF EACH UNIT IS CONNECTED

CHOKE COILS FOR USE WITH ALTERNATING CURRENT LIGHTNING ARRESTERS



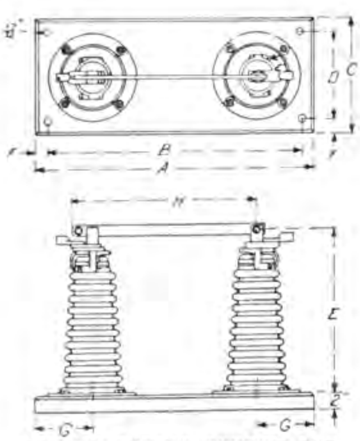


Cat. No.	Volts	Amp.	A	B	Cat. No.	Volts	Amp.	A	B	C	D
76339	4600	25	$15\frac{3}{4}$	$14\frac{5}{8}$	25401	6600	25	$10\frac{1}{2}$	$5\frac{1}{2}$	$1\frac{1}{4}$	$5\frac{13}{16}$
76340	4600	50	$17\frac{5}{8}$	$16\frac{7}{8}$	3416	6600	100	$12\frac{1}{2}$	7	$1\frac{1}{2}$	$7\frac{3}{4}$
					36882	6600	200	$12\frac{1}{2}$	7	$1\frac{1}{2}$	7

DIMENSIONS OF CHOKE COILS, HOUR GLASS TYPE 15000 TO 35000 VOLTS

CAT. NO.			Volts	Amp.	A	B	C	D
Marble Base	Slate Base	Wood Base						
77704	77699	76859	15000	200	$7\frac{15}{16}$	$8\frac{1}{2}$	$5\frac{3}{4}$	$19\frac{11}{16}$
77705	77700	76860	25000	200	$10\frac{5}{8}$	13	$10\frac{1}{4}$	$22\frac{3}{8}$
77706	77701	76861	35000	200	$13\frac{3}{8}$	13	$10\frac{1}{4}$	$25\frac{1}{8}$

DISCONNECTING SWITCHES FOR USE WITH ALTERNATING CURRENT LIGHTNING ARRESTERS

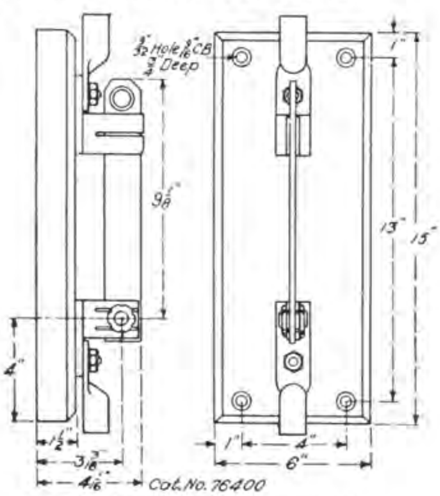


DISCONNECTING SWITCH FOR 5000 TO 35000 VOLTS—300 AMPS.

Cat. No.	Volts	A	B	C	D	E	F	G	H
76433	15000	18	15	9	6	$9\frac{13}{32}$	$\frac{9}{16}$	$4\frac{1}{2}$	$11\frac{1}{4}$
76666	25000	24	21	12	9	$12\frac{1}{4}$	$\frac{11}{16}$	6	$14\frac{1}{4}$
76668	35000	30	27	13	10	15	$\frac{11}{16}$	$6\frac{1}{2}$	$19\frac{1}{4}$

HOOKS AND HANDLES FOR USE WITH DISCONNECTING SWITCHES

Cat. No.	Max. Volts	Length in Feet
65849	15000	4
65850	45000	8



DISCONNECTING SWITCH FOR 2500 VOLTS—300 AMPS.

LIGHTNING ARRESTERS FOR CONSTANT CURRENT CIRCUITS—HORN TYPE

DOUBLE POLE STATION ARRESTERS

FOR USE ON SECONDARIES OF CONSTANT CURRENT TRANSFORMERS FOR ARC LIGHTING SYSTEMS

Cat. No.	Rating of Transformers	No. Required
47558	25 light	1
47559	35 light	1
47560	50 light single-circuit	1
47561	75 light single-circuit	1
47562	100 light single-circuit	1
47577	100 light multi-circuit	2

FOR USE ON SECONDARIES OF MERCURY ARC RECTIFIERS AND BRUSH ARC SYSTEMS

Cat. No.	MERCURY ARC RECTIFIERS		BRUSH ARC MACHINES
	Lights Capacity	Volts	Volts †
58959	12	1100	1100
58960	25	2300	3200
58961	50	4600	4600
58962	75	6900	9200
58961	100*	4600	

*Multi-circuit—two arresters required.

†This voltage rating is the voltage of the individual circuit to which the arrester is connected. It does *not* refer to the generator voltage as governed by the single-circuit rating.

FOR USE ON CONSTANT CURRENT INCANDESCENT SERIES SYSTEMS

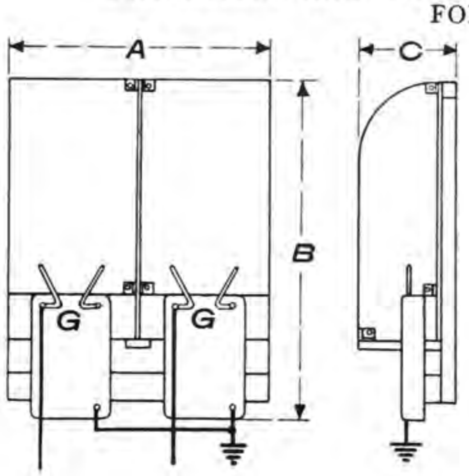
Cat. No. Arrester	Kw. Capacity of Trans.	Secondary Amperes
47558	4	1.75
47563	4	3.5
47563	4	4.0
47563	4	5.5
47563	4	6.6
47563	4	7.5
47560	8	1.75
47558	8	3.5
47558	8	4.0
47563	8	5.5
47563	8	6.6
47563	8	7.5
47562	16	1.75
47560	16	3.5
47560	16	4.0
47559	16	5.5
47558	16	6.6
47558	16	7.5
47559	*22	4.0
47558	*22	5.5
47558	*22	6.6
47563	*22	7.5
47577	*32	4.0
47559	*32	5.5
47558	*32	6.6
47558	*32	7.5

*Multi-circuit transformers—two arresters required

RECOMMENDATIONS FOR ADJUSTING THE GAP OF HORN ARRESTERS

Voltage of Circuit	1100	1500	2300	3200	4600	6900	9200
Each Gap in Inches G	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$

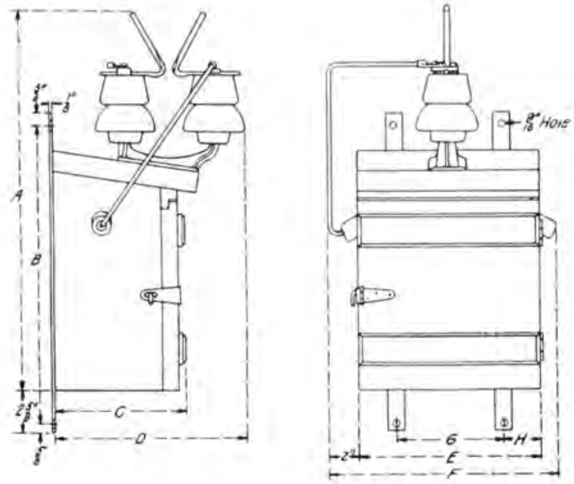
DIMENSIONS AND WEIGHTS OF HORN LIGHTNING ARRESTERS FOR STATION USE



CAT. NO.		APPROX. WT. IN LB.		DIMENSIONS IN INCHES		
Direct Current	Alternating Current	Net	Shipping	A	B	C
	47558	20	35	24	$8\frac{1}{4}$	$3\frac{3}{4}$
58960	47559	42	125	$23\frac{7}{8}$	$28\frac{7}{8}$	$8\frac{1}{2}$
	47560	47	135	$23\frac{7}{8}$	$29\frac{5}{8}$	$8\frac{1}{2}$
58961	47561	44	130	$23\frac{7}{8}$	28	$8\frac{1}{2}$
58962	47562	78	180	$23\frac{7}{8}$	32	17
58959	47563	15	25	24	$13\frac{9}{16}$	$3\frac{3}{4}$
	47577	70	170	$23\frac{7}{8}$	$29\frac{5}{8}$	17

LIGHTNING ARRESTERS FOR CONSTANT CURRENT CIRCUITS—HORN TYPE

SINGLE POLE LINE ARRESTERS



SINGLE POLE HORN LIGHTNING ARRESTER
FOR OUTDOOR SERVICE

DIMENSIONS

FOR A.C. ARC AND INCANDESCENT CIRCUITS

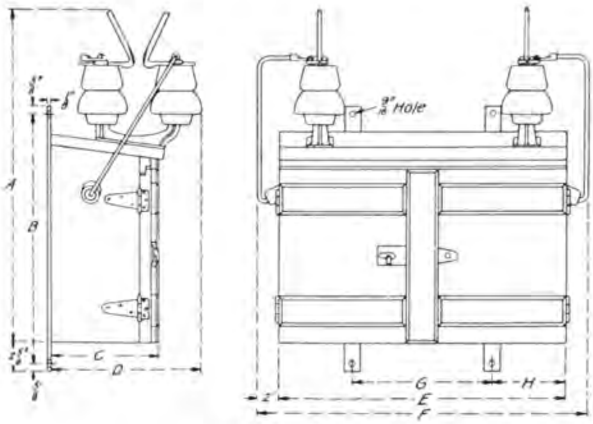
Cat. No.	Volts	Gap Setting	A	B	C	D	E	F	G	H
78253	2500	$\frac{1}{8}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	$9\frac{3}{4}$	$12\frac{3}{4}$	7	$1\frac{3}{8}$
78256	3200	$\frac{3}{16}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	$14\frac{3}{8}$	$17\frac{3}{8}$	9	$2\frac{11}{16}$
78260	4600	$\frac{1}{4}$	$23\frac{1}{4}$	$18\frac{1}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$15\frac{3}{8}$	$18\frac{3}{8}$	9	$3\frac{3}{16}$
78263	9200	$\frac{1}{2}$	$27\frac{1}{2}$	$22\frac{3}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$14\frac{7}{8}$	$17\frac{7}{8}$	9	$2\frac{15}{16}$

FOR RECTIFIER AND BRUSH ARC CIRCUITS

Cat. No.	Volts	Gap Setting	A	B	C	D	E	F	G	H
78258	3200	$\frac{3}{16}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	$14\frac{3}{8}$	$17\frac{3}{8}$	9	$2\frac{11}{16}$
78283	4600	$\frac{1}{4}$	$23\frac{1}{4}$	$18\frac{1}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$15\frac{3}{8}$	$18\frac{3}{8}$	9	$3\frac{3}{16}$
78264	9200	$\frac{1}{2}$	$27\frac{1}{2}$	$22\frac{3}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$14\frac{7}{8}$	$17\frac{7}{8}$	9	$2\frac{15}{16}$

LIGHTNING ARRESTERS FOR CONSTANT CURRENT CIRCUITS—HORN TYPE

DOUBLE POLE LINE ARRESTERS



DOUBLE POLE HORN LIGHTNING ARRESTER
FOR OUTDOOR SERVICE

DIMENSIONS

FOR A.C. ARC AND INCANDESCENT CIRCUITS

Cat. No.	Volts	Gap Setting	A	B	C	D	E	F	G	H
78252	1500	$\frac{1}{8}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	14	18	7	$3\frac{1}{2}$
78254	2500	$\frac{1}{8}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	$14\frac{3}{8}$	$18\frac{3}{8}$	9	$2\frac{11}{16}$
78255	3200	$\frac{3}{16}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	19	23	10	$4\frac{1}{2}$
78259	4600	$\frac{1}{4}$	$23\frac{1}{4}$	$18\frac{1}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$24\frac{5}{8}$	$28\frac{5}{8}$	14	$5\frac{5}{16}$
78261	9200	$\frac{1}{2}$	$27\frac{1}{2}$	$22\frac{3}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	25	29	15	5

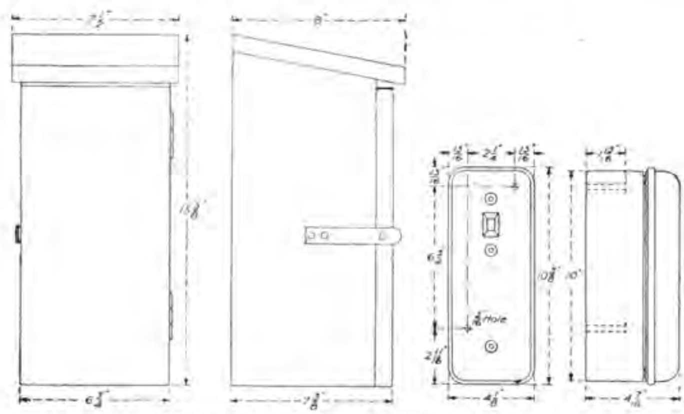
FOR RECTIFIER AND BRUSH ARC CIRCUITS

78251	1100	$\frac{1}{8}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	14	18	7	$3\frac{1}{2}$
78257	3200	$\frac{3}{16}$	$23\frac{5}{16}$	$17\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{5}{8}$	19	23	10	$4\frac{1}{2}$
78282	4600	$\frac{1}{4}$	$23\frac{1}{4}$	$18\frac{1}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	$24\frac{5}{8}$	$28\frac{5}{8}$	14	$5\frac{5}{16}$
78262	9200	$\frac{1}{2}$	$27\frac{1}{2}$	$22\frac{3}{8}$	$9\frac{1}{8}$	$12\frac{5}{8}$	25	29	15	5

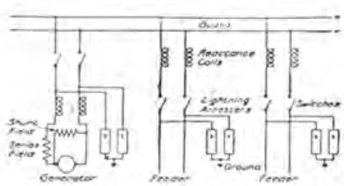
LIGHTNING ARRESTERS FOR DIRECT CURRENT CIRCUITS
TYPE M FORM D-2

Cat. No.	Description	Voltage	Approx. Shipping Weight in Lb.
33619	For station use	60 to 200	15
33620	In wooden box for line use	60 to 200	25
33867	Extra resistance	60 to 200	...
33621	For station use	125 to 375	15
33622	In wooden box for line use	125 to 375	25
33868	Extra resistance	125 to 375	...
33623	For station use	250 to 850	15
33625	In wooden box for line use	250 to 850	25
33869	Extra resistance	250 to 850	...
78508	For station use	600 to 1800	30
78509	In wooden box for line use	600 to 1800	50
59925	Extra resistance	600 to 1800	...

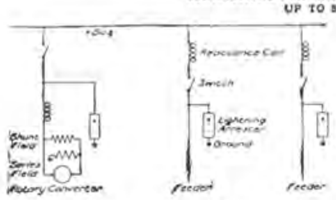
DIMENSIONS AND CONNECTIONS OF LIGHTNING ARRESTERS FOR DIRECT CURRENT CIRCUITS



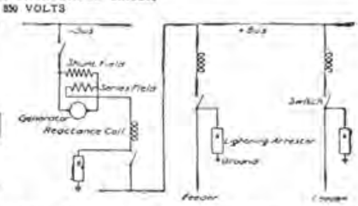
DIMENSIONS OF TYPE M FORM D-2 LIGHTNING ARRESTER
UP TO AND INCLUDING 850 VOLTS



CONNECTIONS FOR D.C. UNGROUNDED CIRCUIT
UP TO 850 VOLTS



CONNECTIONS FOR D.C. GROUNDED RETURN CIRCUIT
UP TO 850 VOLTS
MACHINE EQUALIZING ON NEGATIVE SIDE



CONNECTIONS FOR D.C. GROUNDED RETURN CIRCUIT
UP TO 850 VOLTS
MACHINE EQUALIZING ON POSITIVE SIDE

INDEX

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POWER AND MINING DEPARTMENT

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ELECTRIC HARDENING FURNACE

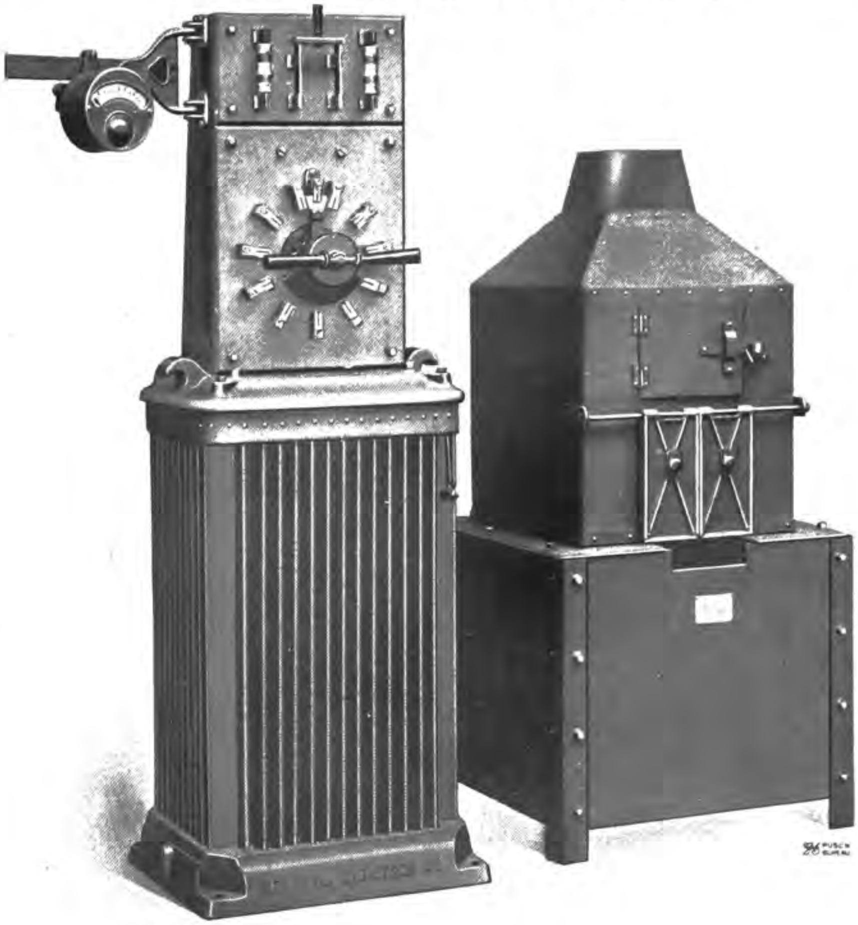

Fig. 1. 25 KW. ELECTRIC HARDENING FURNACE OUTFIT

THE rapid development of the tool steel industry from the old-time carbon to the self hardening, then to the sweating process, and finally to the high speed steels, demanded a corresponding development in the methods of hardening the finished product, and in order to meet this requirement the open fire or coal furnace gave way to the muffle furnace and the externally heated lead and metallic salt baths. These furnaces while being a great improvement are, however, more or less unsatisfactory on account of unequal heating and the consequent cracking and checking of the tools hardened, the

NOTE.—The data in this publication are for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication Subject to change without notice.

inability of the operator to quickly and properly regulate the temperature, the oxidation of tools due to air contact, resulting in large quantities of unsatisfactory work, and in the lead bath the forming of dross on the surface of the bath, the sticking of lead to the tool, the formation of poisonous gases and the floating of the steel on the bath due to the greater specific weight of the lead.

The number of manufactured articles that depend for their economical production on efficient and durable tools has become so large that any further improvement in the hardening or tempering of tool steel is of vital importance, and a notable advance in this direction has been made, not only by the development of high speed steel but also by the introduction of the electric furnace in which metallic salts are brought to a liquid state by passing current through them and in which the heating of the tool to be hardened can be exactly controlled and kept uniform throughout over a wide range of temperature. By its use, hardening and tempering can be carried out on scientific lines and steel of the proper hardness and temper for any class of work can be obtained readily and economically. Furthermore, a more durable and uniform product can be obtained in this type of electric furnace than with any other method heretofore employed.

The process of hardening necessitates the maintenance of a constant and uniform temperature in the furnace in order to obtain the best possible results, this requirement being by no means fulfilled by the ordinary coal, gas, oil, nor in fact by any muffle or pack furnace, nor by the lead or salt baths which are externally heated. It is also often necessary to adjust the temperature of the furnace, which cannot be done with precision with the ordinary furnaces, but owing to the flexibility of electric control the adjustment of the temperature in the electric furnace is easily accomplished, and with a source of constant power it is possible to maintain the furnace at a uniform temperature for any desired length of time.

CONSTRUCTION OF FURNACE

The electric furnace manufactured by the General Electric Company is operated from an alternating current, single-phase supply, and the outfit consists of a crucible and a regulating transformer as shown in Fig. 1, and includes the necessary connecting cables, cleaning scoops and starting electrode.

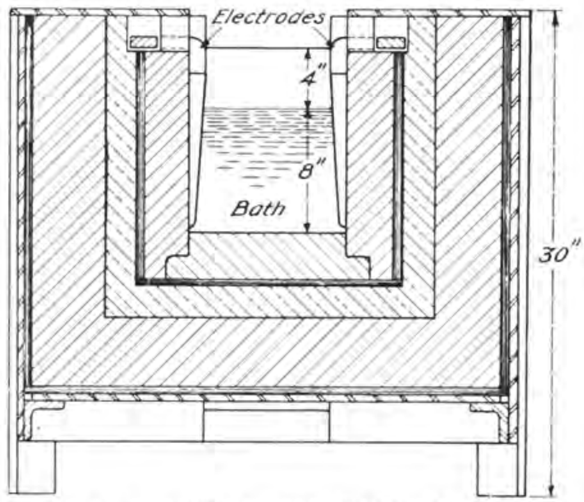

Fig. 2. SECTIONAL ELEVATION OF FURNACE

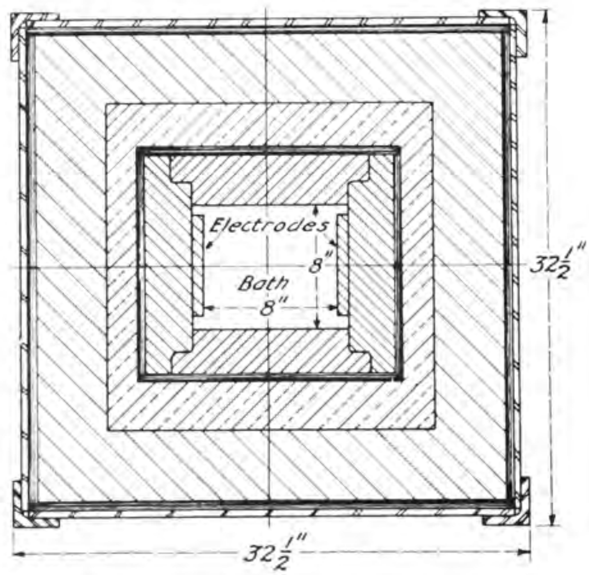

Fig. 3. SECTIONAL PLAN OF FURNACE

The crucible is built up of slabs of refractory material cemented together and surrounded by heat insulating material in a substantial sheet iron case. Two soft iron electrodes, located on opposite sides of the crucible, direct the current, from the transformer, through the bath. They are arranged so as to be readily renewable. The life of the electrodes is approximately 3000 hours when operated at 1400 degrees F., and 400 hours when operated at 2200 degrees F. A hood, containing a warming oven as shown, is furnished and must be connected to a suitable pipe to conduct the vapors to the outer air. The construction of the crucible is shown in detail in the sectional plan view and in the sectional elevation Figs. 2 and 3. Attention is called to the fact that the heat insulation provided is sufficient so that with the bath at a temperature of 2400 degrees F., the sheet iron case is not uncomfortable to the touch. This feature not only reduces fire risk, but also allows the quenching bath to be placed very close to the crucible, thus saving time and avoiding the cooling of the tool in air.

The regulating transformer consists of the transformer core and coils which are oil immersed in a substantial iron tank and a regulating switch, line switch, fuses and ammeter mounted on a panel supported on the tank cover. The transformer winding and the connections of the transformer, switches, fuses and furnace are shown diagrammatically in Fig. 4. As will be noted, one section of the primary winding is sub-divided into a number of steps, taps from which are brought to the dial switch. The range in the voltage applied to the furnace is obtained by cutting this section in or out of circuit by steps in either a positive or negative direction with respect to the main winding. The dial switch is provided with 11 points corresponding to 10 steps either way so that a total of 21 adjustments are obtainable, corresponding to a range in the voltage applied to the furnace terminals of from that necessary to keep the bath just above the freezing point to that necessary to start the furnace by the use of the starting electrode. By means of this variable voltage, it is possible to produce and maintain any temperature in the furnace, depending on the kind of salt used and on the range for which the outfit is designed.

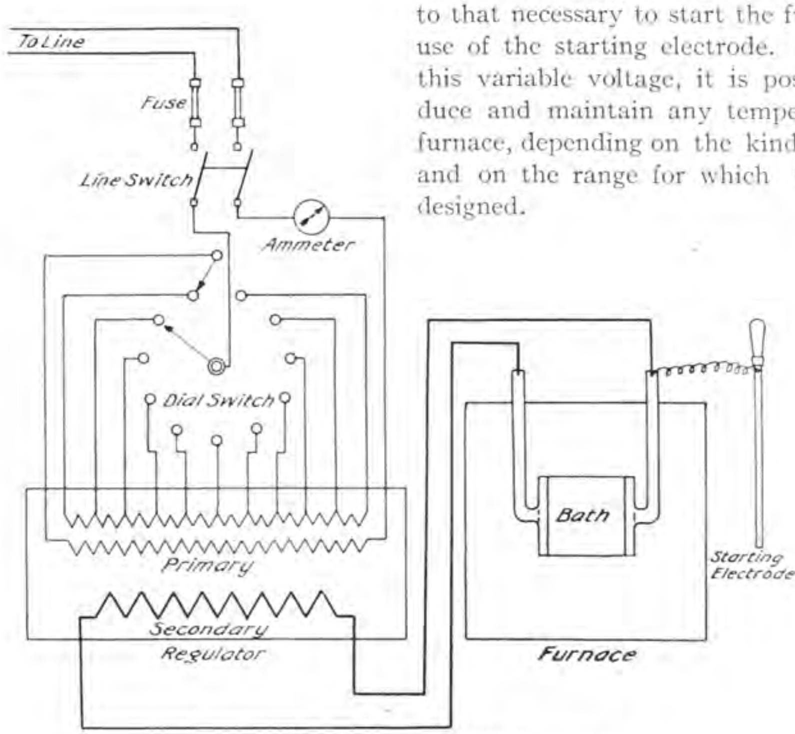

Fig. 4. DIAGRAM OF ELECTRIC CIRCUITS

OPERATION OF FURNACE

As the salt used for the bath solidifies and becomes a non-conductor of current when cold, it is necessary to start the melting of the bath by means of an auxiliary electrode provided for the purpose. Before closing the line switch on the panel, a small channel of approximately 1 sq. in. in section should be cut in the solidified bath and extending from one electrode to the other, the chips remaining in the channel. Two or three pieces of any standard lamp carbon approximately 7 in. long and ½ in. in diameter should then be laid on top of the chipped portion. The line switch should be closed and the dial switch rotated to the extreme right in which position the minimum obtainable voltage is applied to the furnace terminals. By means of the auxiliary electrode, the carbons should be tightly pressed against the furnace electrode at the left, and as shown in Fig. 5, until the chipped salt directly under the carbons is melted. The auxiliary electrode should then be drawn slowly to the right, allowing the salt in the channel to melt, until it reaches the right-hand furnace terminal, after which the starting electrode is removed from the bath and the switch rotated to the extreme left, in which position the maximum voltage is obtained. The molten channel together with the carbons is sufficient to maintain the circuit which will gradually increase the molten bath till the entire mass is in a liquid state, after which the starting carbons are removed.

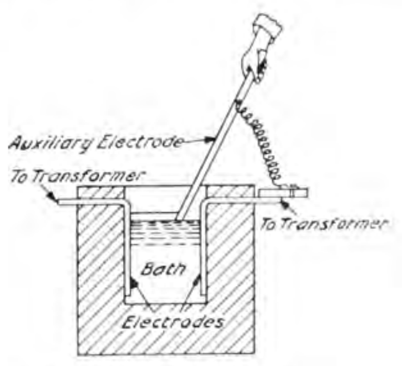

Fig. 5. STARTING THE FURNACE

As the melting of the bath progresses its resistance decreases and to prevent an excess current being taken from the line the furnace voltage should be lowered by rotating the dial switch to the right a sufficient amount to keep the line current within normal. After the bath has been entirely liquefied, it is automatically maintained at a constant temperature by heat convection, and the uniform distribution of current through it and any desired temperature can be indefinitely maintained by the proper adjustment of the dial switch, this temperature being practically uniform throughout the bath except at the surface for a depth of about ⅝ in. The time necessary to establish the circuit in the channel varies from 5 to 10 minutes and that required to bring the entire bath to the desired temperature from 1 to 1½ hours, but after all the salt has been melted any desired change in the temperature can be quickly obtained by adjusting the voltage. For measuring the temperature the General Electric Company recommend and will furnish a special thermoelectric pyrometer calibrated so that the temperature can be read directly.

When any desired temperature has been obtained by the proper adjustment of the dial switch, that portion of the tool to be hardened is immersed in the bath and allowed to remain until it attains the same color as the bath, when it is removed and hardened in water or oil as required. When the tool is removed from the bath, it is coated with a thin film of the salt which prevents contact with the air and effectually prevents oxidation, but as soon as the tool is immersed in the cooling medium the salt chips off, leaving the steel absolutely clean, except that in the case of high speed steel hardened in oil there is apt to be a slight coating of burnt oil which is, however, easily removed. As far as can be determined, the salt has absolutely no effect on the composition of carbon steel, but there seems to be a tendency to produce a film of soft metal of a few mils in thickness on the surface of high speed steels. This appears, however, to be true only for certain temperatures and in case the tool is kept too long in the bath; and it is, of course, in no way detrimental if the tools are ground after being hardened. In operating the furnace care should be taken that water or wet tools do not come in contact with the bath, as it will cause the hot salt to sputter and may burn the operator.

CAPACITY OF FURNACE

Fig. 1 illustrates the standard 25 kw., 60 cycle furnace for the hardening of high speed steel, and the crucible has a section of 8 in. x 8 in. x 12 in. deep, being designed for a bath 8 in. deep.

Steel is a much better electrical conductor than the bath and special precautions are therefore necessary not only to prevent the tool coming in contact with the electrodes but also to insure an ample clearance between them, so as to avoid diverting sufficient current from the bath through the tool to heat it to detrimental temperature. This clearance should be equal to one-half of the total diameter or thickness of the piece to be heated, and allowing 1 in. clearance top and bottom and on the remaining sides the maximum size of tool which can be successfully heated in a bath of the dimensions given is 6 in. x 6 in. x 4 in. In heating a number of small pieces simultaneously the useful area of bath is, of course, increased in proportion to the decrease in the size of the individual pieces. For the reason given above, all tools of whatever shape should always be immersed in the bath with their greatest length parallel to the electrodes. The rate at which work can be done with the electric furnace depends on the shape and on the contact surface of the piece to be heated, and on the manipulation of the regulating switch by the operator, and an approximate idea can be obtained by referring to the following tabulation which gives the time required to raise the temperature of round stock from room temperature to 1400 degrees F.

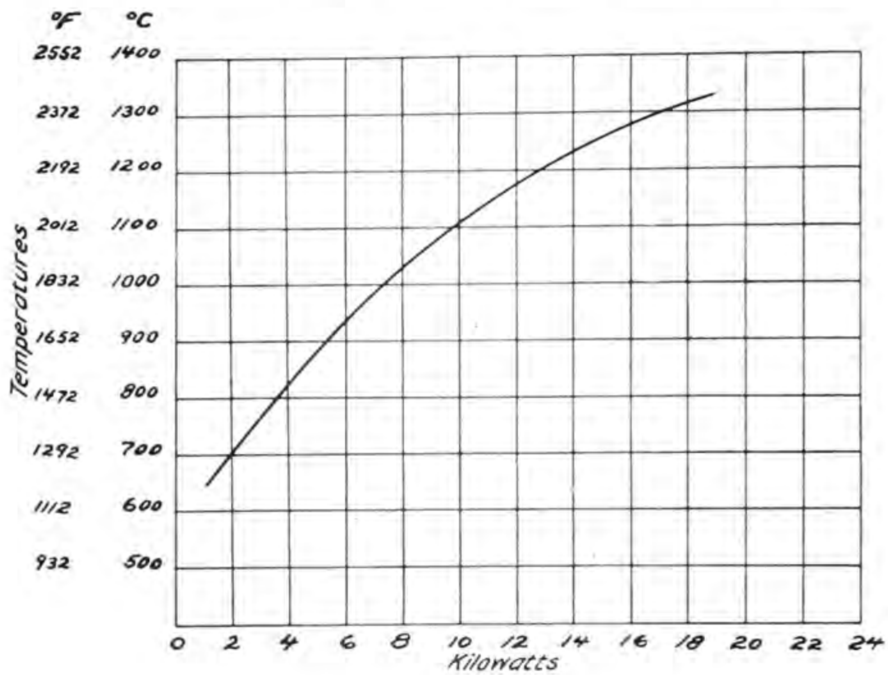

Fig. 6. POWER REQUIRED BY ELECTRIC FURNACE

Size of Stock	No. of Pieces	Weight in Lb.	Time in Min.
½" diam. 6" long	1	.32	¾
½" diam. 6" long	6	1.92	3
¾" diam. 6" long	1	.71	1½
¾" diam. 6" long	6	4.26	6
1" diam. 6" long	1	1.27	2½
1" diam. 6" long	6	7.62	8

When heating a single piece the switch was not changed, but when heating six pieces simultaneously the voltage was increased as soon as the steel was immersed and again lowered as the proper temperature was obtained.

The curve (Fig. 6) shows the power required by this furnace to maintain the bath constant at various temperatures, and in general the amount of power varies approximately as the surface so that from the figures given the power required at any temperature for any size of crucible can be estimated. From the curve it will be noted that the power required for temperatures necessary for hardening carbon steel is approximately one-fourth that required for hardening high speed steel and two sizes of regulating transformers have therefore been designed for each size of crucible, so that if a given crucible is to be used for carbon steel only a much smaller transformer can be supplied. Both carbon and high speed steel can be treated in the crucible when controlled by the larger transformer, but as a different salt mixture is required for obtaining the necessary temperatures, it is preferable, in case both kinds of steel are to be hardened, to have two crucibles, one containing a mixture of barium chloride and potassium chloride in which a temperature range of from 1200 degrees F. to 1800 degrees F. for the hardening of carbon steel can be obtained, and the other containing barium only and in which a range of from 1800 degrees F. to 2400 degrees F. can be obtained for the heating of high speed steel. In furnishing two crucibles with one transformer, it should, however, be noted that they cannot be operated simultaneously, but two crucibles are recommended for economy and for convenience in avoiding the necessity of changing the bath with a consequent loss of time and labor and more or less of the salt.

ADVANTAGES OF THE ELECTRIC FURNACE

THE Electric Furnace reduces hardening and tempering to an exact process and therefore produces uniformly superior results. The important advantages of the electric furnace will be evident to the practical worker who has read the preceeding pages. These advantages may be summarized as follows:

1. The production and maintenance of constant and uniform temperature for hardening any class of steel.
2. The exact knowledge of the temperature of the steel in its heated condition.
3. The equal and even heating of the material, and therefore the prevention of strains with consequent checks and cracks or the burning off of sharp edges and points.
4. The prevention of air from striking the heated tool, thereby avoiding oxidation.
5. The prevention of foreign matter entering the bath, thereby avoiding the pitting of the steel.
6. The obtaining of clean surfaces after hardening, thus to a considerable extent making unnecessary any cleaning.
7. The practicability of placing the cooling bath close to the furnace.
8. Easy operation of the furnace.
9. Reduction of fire risk.
10. Cleanliness.

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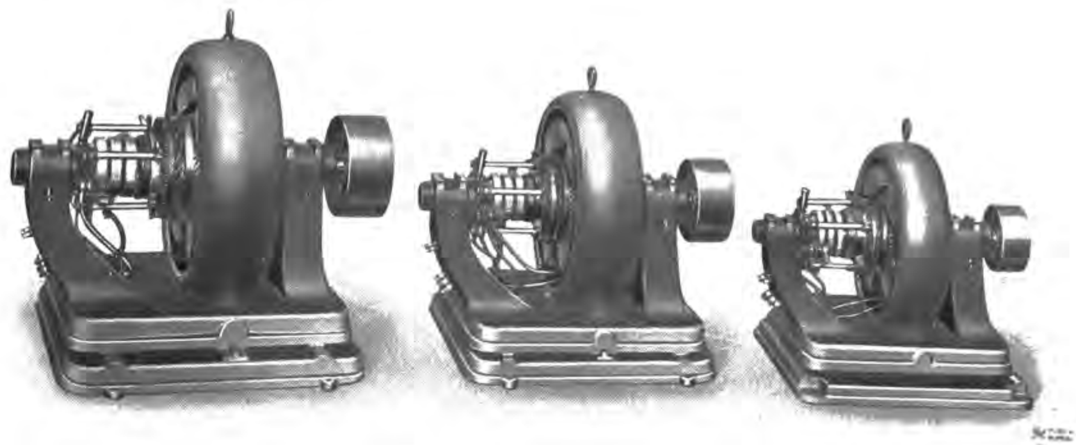
BELT DRIVEN REVOLVING ARMATURE ALTERNATORS

The General Electric Company has developed three sizes of polyphase, 60 cycle generators for use in small isolated plants. These generators are of the revolving armature, self-excited type and are designed for service at any power factor between .8 and 1.0.

Arrangement

The Type AT generators as shown in the illustrations are for belt drive, but can be readily used for direct connection by omitting the pulley and sliding base.



AT 4 (7½-15-25)-1800 ALTERNATORS

Phases and Voltages

The Type AT alternator can also be wound for two-phase, and when so wound is designated Type AQ. For single-phase service, standard three-phase windings with a load carried by any two of the three legs is recommended. Such generators are good for 70 per cent. of their three-phase capacity when run single-phase. These machines can be furnished for the following voltages: 120, 240, 480 and 600.

Armature

The armature is of the revolving type and contains two distinct windings. The main generator armature winding is connected to the three collector rings, while the exciter armature winding is connected to the commutator.

Field

The field structure consists of laminated pole pieces cast into a rigid stationary frame.

The pole pieces contain field coils which have a common flux for both generator and exciter. When machine is furnished as a synchronous motor, grids are placed on the poles.

Bearings

The bearing housing is carefully cleaned, and painted inside, thus insuring a flow of oil free from grit. The bearings are of suitable dimensions to give ample cooling surface, and are self-oiling, each bearing having two oil rings.

Exciter

No external excitation is required for these machines. The armature winding is independent of the armature winding of the exciter. The exciter winding, therefore, is not similar to a rotary converter where taps are taken off the main armature winding, nor does it depend on rectifying commutators or series transformers for stepping down part of the armature current. This arrangement has been thoroughly tried out, both in test and practice, and has proven thoroughly reliable in every way.

ARMATURE OF TYPE AT ALTERNATOR

Temperatures

These machines will operate under full rated k.v.a. load continuously, at any power factor between .8 and 1.0 with a temperature rise of any part not exceeding 40° C. above the surrounding air. They will carry 25 per cent. overload in k.v.a. under the same power factor conditions for two hours without the temperature rising more than 55° C. The rise in temperature is based on the temperature of the surrounding atmosphere being 25° C. and the recorded temperature must be corrected by one-half of 1 per cent. for each degree that this temperature differs from 25° C. in accordance with the standardizing rules of the A.I.E.E.

Load

These machines were primarily designed for lighting loads; and when used on inductive loads, the best results are obtained by avoiding sudden change of load.

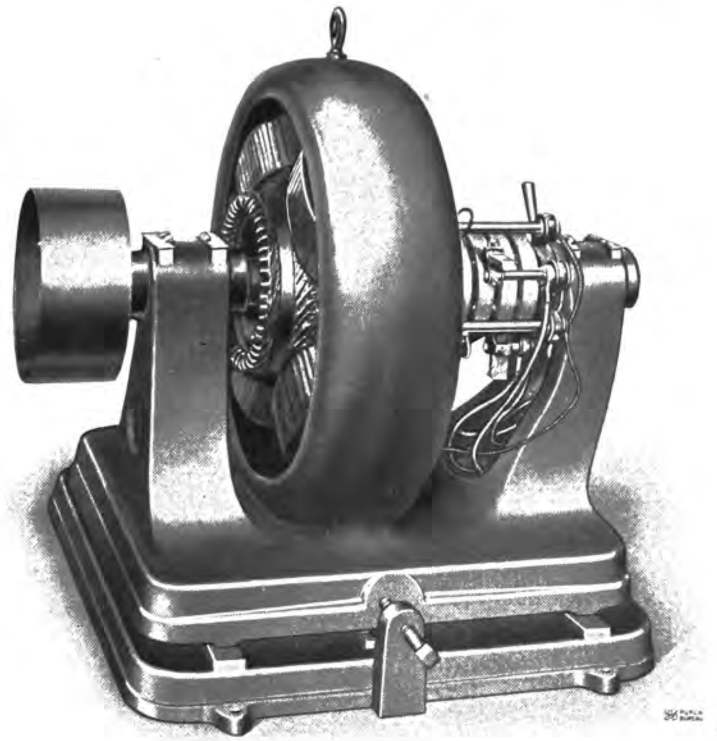
As Synchronous Motors

When operated as synchronous motors these machines are rated 10 h.p., 20 h.p. and 35 h.p. respectively. The field winding should be connected through switches on the field frame in order that the field circuit may be broken up to eliminate any danger that might arise from induced voltage. This precaution is advisable in addition to the grids mentioned under the heading of field. It is not advisable to throw on full rated voltage and a compensator should, therefore, be provided to reduce it.

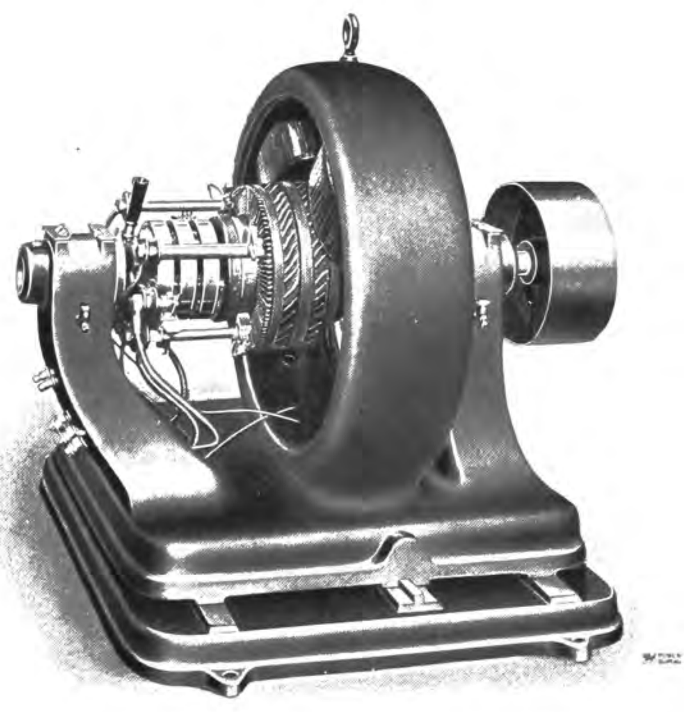
When 50 per cent. of normal voltage is applied, the starting torque will be approximately 25 per cent. full load torque.

As Rotary Condensers

When operating as rotary condensers, these machines are rated 6 k.v.a., 12 k.v.a and 20 k.v.a.



25 KW. BELT DRIVEN
ALTERNATOR
(AT 4-25-1800)

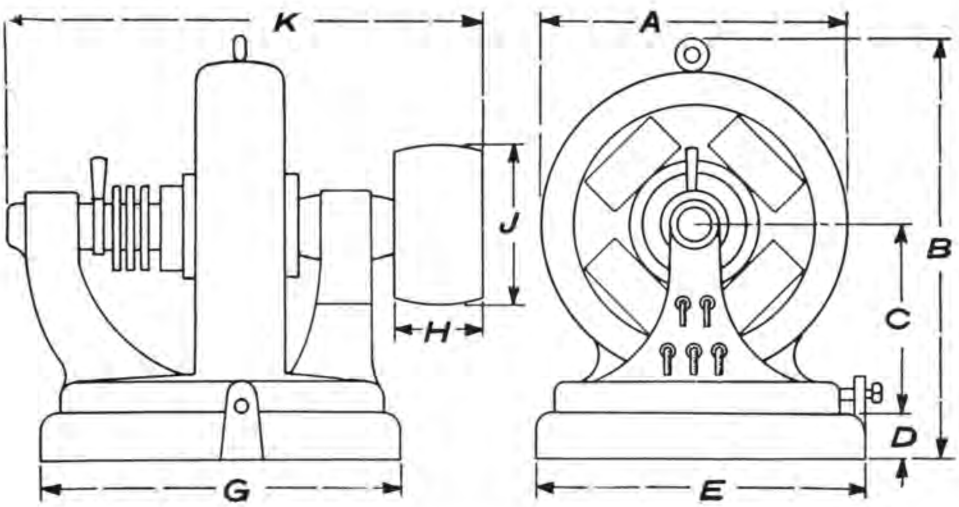


ANOTHER VIEW OF THE
25 KW. ALTERNATOR

RATINGS, WEIGHTS AND OUTPUTS

TYPE AT 60 CYCLE, BELT DRIVEN ALTERNATOR

Rating	KW.		NET WEIGHTS, LBS.			
	1.0 P.F.	0.8 P.F.	Rotor	Stator	Sub-Base	Total
AT-4-7½-1800 *	7½	6	120	500	95	715
AT-4-15-1800 *	15	12	165	810	95	1070
AT-4-25-1800 *	25	20	235	1160	140	1535



DIMENSIONS (Inches)

Type	Poles	KW.		Speed R.P.M.	A	B	C	D	E	G	H	J	K
		1.0 P.F.	0.8 P.F.										
AT	4	75	6	1800 *	$22\frac{3}{8}$	$29\frac{3}{4}$	$13\frac{1}{8}$	$2\frac{3}{16}$	$28\frac{13}{16}$	$26\frac{1}{2}$	$3\frac{1}{2}$	8	$32\frac{1}{2}$
AT	4	15	12	1800 *	$25\frac{3}{4}$	$33\frac{1}{16}$	$14\frac{1}{2}$	$2\frac{7}{16}$	$33\frac{1}{2}$	$29\frac{5}{8}$	$4\frac{1}{2}$	10	$37\frac{1}{4}$
AT	4	25	20	1800 *	$29\frac{3}{8}$	38	$16\frac{5}{8}$	$2\frac{3}{4}$	$38\frac{1}{2}$	$32\frac{5}{8}$	$5\frac{1}{2}$	12	$38\frac{7}{8}$

*120, 240, 480 and 600 volts.
Type "AQ" Quarter-Phase rating (same as above).
Type "AS" Single-Phase rating (70 per cent. of above)

General Electric Company

Schenectady, N.Y.

SUPPLY DEPARTMENT

May, 1910

Bulletin No. 4740

LINE DROP COMPENSATORS TYPE V4 FOR ALTERNATING CURRENT CIRCUITS

IT is extremely desirable, in any system of electrical distribution, to be able to read the actual voltage at the point of distribution by means of the voltmeters in the generating station. Various devices have been designed for accomplishing this result but while they are accurate on loads for which they are adjusted, they are not accurate on light loads, overloads, or loads of different power factors. It will be readily seen that unless a device of this kind is accurate on all loads with a single adjustment, it has no large field of usefulness.

The General Electric Company has now perfected a device which when once adjusted requires no further attention, and can be fully relied upon to indicate the variations of potential at the point of distribution under all conditions of load without appreciable error between no load and heavy overloads. This device is used in connection with the standard station voltmeter.

The compensator proper consists of three principal parts, a current transformer, a variable resistance and a variable reactance.

The secondary of the transformer is connected in series with the resistance and reactance, and the primary is connected to the secondary of an external current transformer.

The reactance and resistance are both so wound that any proportion of the winding can be cut in or out of the voltmeter circuit.

TYPE V4 LINE DROP COMPENSATOR

Both elements have 12 points of adjustment of one volt each, giving a total combined drop at maximum setting of about 17 volts.

The voltmeter, instead of being connected directly across the secondaries of the potential transformer, as is usual, has inserted in series with it portions of the reactance and resistance above mentioned. These are so connected that the drop in potential across them will be combined with that of the potential transformer, so that the voltmeter reading will indicate the potential at the center of distribution or end of the line.

If the amount of reactance and resistance is properly adjusted, we shall have produced a local circuit exactly corresponding in all its characteristics to that of the main circuit. Any change in the main circuit produces a corresponding change in the local circuit, and hence causes the voltmeter to always indicate the potential at the end of the line or center of distribution or at any point for which the adjustment is made.

Supersedes Bulletin No. 4868

4740-2 Voltmeter Compensating Device for Alternating Current Circuits

In making adjustment, it is advisable to calculate the ohmic drop for full load and set the resistance arm at the point which will give the required compensation and then adjust the reactance arm until the voltmeter reading corresponds to the voltage at the point on the line selected for normal voltage.

After the final adjustments have been made, no further attention to the device is required until some change is made in the construction of the circuit.

Type V4 Line Drop Compensators are manufactured for four frequencies as follows:

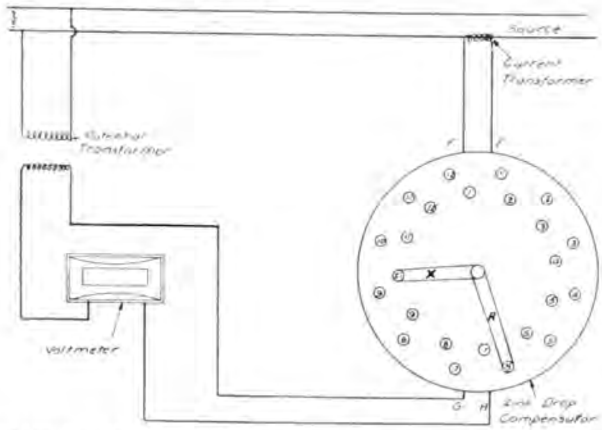


DIAGRAM OF CONNECTIONS OF TYPE V4 LINE DROP COMPENSATOR

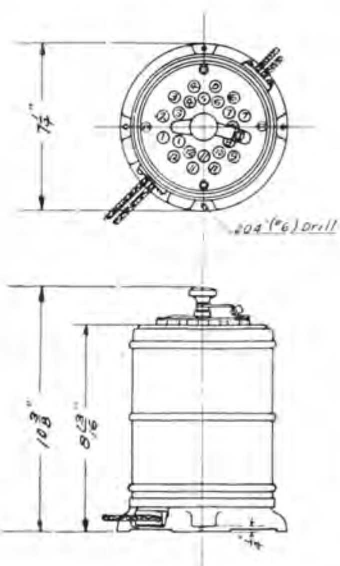
Cat. No.	Amperes	Frequency	*List Price
110041	5	25 cycles	**$75.00**
110042	5	40 cycles	**75.00**
110043	5	60 cycles	**75.00**
110044	5	125 cycles	**75.00**

*Price does not include external current transformer. When external current transformers are desired, the *continuous* ampere capacity of the circuit *must* be given.

ADAPTABILITY

It will be readily seen from the foregoing that a device so constructed can be applied to switchboards already installed without any radical changes in the existing panels and can be mounted at any convenient place behind the panel or on the wall, the small leads only being brought to the instrument on the panel.

The device includes a small current transformer, the primary of which is wound for 5 amperes *maximum* current. It is therefore necessary to install a standard current transformer in the main circuit for operating the device, unless current transformers are already installed for operating other instruments. When the compensating device is furnished with a switchboard, it is usually arranged to operate in series with current transformers operating other instruments and thus does not require an additional current transformer. In case it is to be used in connection with switchboards already installed, it may, or may not, be necessary to furnish an extra current transformer, depending entirely on the load already connected to the existing transformer. This question should be referred to the nearest district office before ordering.



DIMENSIONS OF TYPE V4 LINE DROP COMPENSATOR

General Electric Company
Schenectady, N.Y.
SUPPLY DEPARTMENT

May, 1910 — — *Bulletin No. 4741*

LUMINOUS ARC LAMPS FOR DIRECT CURRENT MULTIPLE CIRCUITS

The modern mill or factory operator is fully aware of the influence of the character of the artificial illumination provided, on the quality, speed and volume of production; the selection of lighting units will, therefore, be dependent on their efficiency, light distribution, first cost and maintenance costs.

The Multiple Luminous Arc Lamp is recommended for lighting areas where a large volume of light is desired and is especially well adapted for lighting machine shops, foundries, factory yards and places where the slight fumes given off by the lamp are not objectionable.

The Multiple Luminous Arc Lamp embodies such marked points of superiority over all other forms of arc lamps heretofore produced for mill and factory lighting that it should not only be selected for new lighting installations of this character, but can be made to economically supersede lighting systems already installed and which have heretofore been the best obtainable. This is made possible by the peculiar characteristics of this lamp, which are as follows:

High efficiency and low maintenance:

The Luminous Arc Lamp is one of the most efficient lighting units used for commercial service and, because of its long electrode life, the maintenance cost per candle-power is as low, if not lower, than that of any other unit.

Distribution:

The lamps give an ideal distribution of light which is maintained throughout the life of the electrodes.

Form 1. Multiple Luminous Arc Lamp for 4 Amp. Circuits

Special reflectors can be furnished to throw the maximum light in either a horizontal or a vertical direction. This makes it possible to install the lamps in low or high studded factories and secure a satisfactory light distribution on the floor.

SUPERIOR DESIGN

The Multiple Luminous Arc Lamp is patterned after the series luminous arc lamp invented by the General Electric Company, and approximately 50,000 of which are now in use. The most striking feature is the character of the arc used, this being formed between an upper electrode consisting of a short copper bar and the lower electrode which is composed of an iron composite called magnetite.

The design of the lamp is such that the upper electrode always remains in the same fixed position, the feeding and regulating

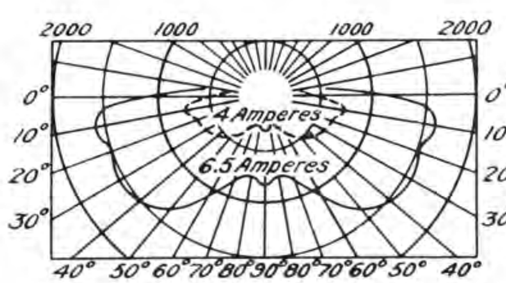
NOTE.—The data in this publication are for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication. Subject to change without notice.

being done through the lower electrode which moves in a vertical direction. Since the upper electrode remains stationary, the arc always remains in the same focal position.

Mechanism of 4 Amp. Lamp

EXCELLENT DIFFUSION

Inside the globe and directly above the arc is located a small reflector 11 in. diameter. This reflector is made of sheet steel and is of the well-known inverted concentric type. With the luminous arc most of the light is emitted by the arc stream proper in a horizontal direction, this being an important aid to good diffusion. By placing a reflector above the arc, part of the light is concentrated directly beneath the lamp so that the maximum light and a very even distribution is obtained on the working plane.



Distribution of Illumination for 4 and 6.5 Amp. Lamps

Another point of more than passing interest is its efficiency.

At 4 amperes, the efficiency is .758 watts per mean hemispherical candle-power, and at 6.5 amperes it is .493; this, it will be seen, is remarkably high efficiency for a lamp of this character.

Power Circuit Multiple Luminous Arc Lamp with External Cutout Resistance

The cost of maintenance is always an important item to users of electrical apparatus. With the Multiple Luminous Arc this has been reduced to a minimum. No inner enclosing globes are used, only one outer globe being required. The cost of the upper electrode can well be considered negligible, as it has a life of between 6000 and 8000 hours at 4 amperes, and 1000 to 2000 hours at 6.5 amperes with a comparatively small renewal cost. In trimming, only the lower electrode requires renewing, and as this has a life of from 175 to 200 hours at 4 amperes, and

100 to 130 hours at 6.5 amperes, the expense of trimming is relatively low.

The mechanism of the lamp itself is not only simple but very substantial. In feeding, the lower or negative electrode is drawn upward by a pair of shunt magnets until it strikes the positive electrode; the magnets are then short circuited by an automatic series cutout, and allow the lower electrode to fall back into normal position thereby forming the arc. It will thus be seen that when the lamp is operating, the steadying resistance and small series cutout only are in circuit with the arc, this being the most efficient mechanism possible. The steadying resistance is of the well-known edgewise wound type.

6.5 Amp. Multiple Luminous Arc Lamp

Mechanism of the 6.5 Amp. Lamp

The casing used is of solid copper with black oxidized copper finish. Flexible cables have been substituted in place of binding posts, so no trouble will be experienced with this lamp from metallic dust.

The Luminous Arc Lamp can be furnished for use on direct current circuits. For 110 volts, lamps adjusted for 4 or 6.5 amperes are available. The 4 ampere lamp is intended for use where only a moderate illumination is required. Where a greater amount of light is necessary the 6.5 ampere lamp will be found to give excellent results. With this lamp all the problems of factory and mill lighting, no matter how difficult, are solved, as it is particularly adapted for this work.

For 220-volt service, a single lamp adjusted for three amperes may be used. A more satisfactory way, however, is to operate the 4 or 6.5 ampere arc lamp two in series on 220 volts, thus obtaining twice the amount of light with but little more energy. The 4 and 6.5 ampere lamps can also be furnished for operating 5 in series on 550 volts. With the multiple series lamps, external cutout resistances are used so that if one lamp should fail to operate due to the electrode being entirely consumed, the operation of the other lamp will not be affected.

6.5 Amp. Lamp with Globe Lowered for Trimming

4741-4 *Luminous Arc Lamps for Direct Current Multiple Circuits*

CATALOGUE NUMBERS

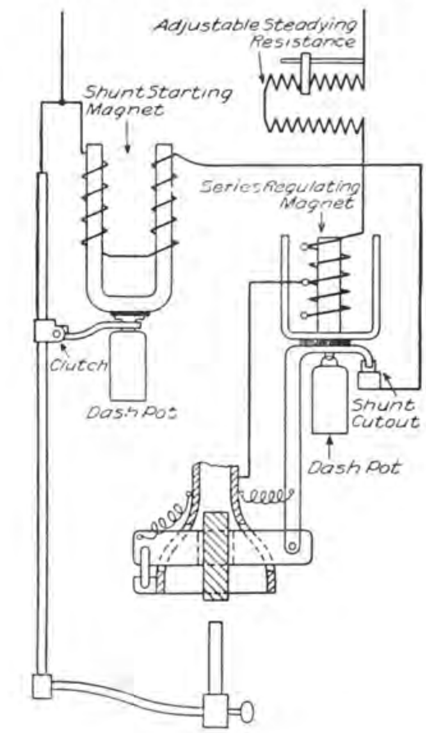
Amps.	Cat. No. Lamp	Cat. No. Casing	Descriptive	Ship. Wt. in Lb.
		100-125 VOLTS		
4	9592	111782	Black Ox. Copper	80
6.5	9594	111783	Black Ox. Copper	
		220 VOLTS		
3	9596	111782	Black Ox. Copper	80
		MULTIPLE-SERIES OR POWER-CIRCUIT { 2 IN SERIES ON 220 VOLTS, 5 IN SERIES ON 550 VOLTS		
4	*9593	111782	Black Ox. Copper	80
6.5	*9597	111783	Black Ox. Copper	

ACCESSORIES

Cat. No.	Description	Ship. Wt. in Lb.
*108467	External Cutout Resistance for 4 amp.	20
*108468	External Cutout Resistance for 6.5 amp.	
40527	Magnetite Electrode for 3 and 4 amp.	
108470	Magnetite Electrode for 6.5 amp.	

* One of these resistances must be used with each of the above Power Circuit lamps and is not included in the price of the lamp. No. 14 outer globe used.

DIAGRAM OF CONNECTIONS



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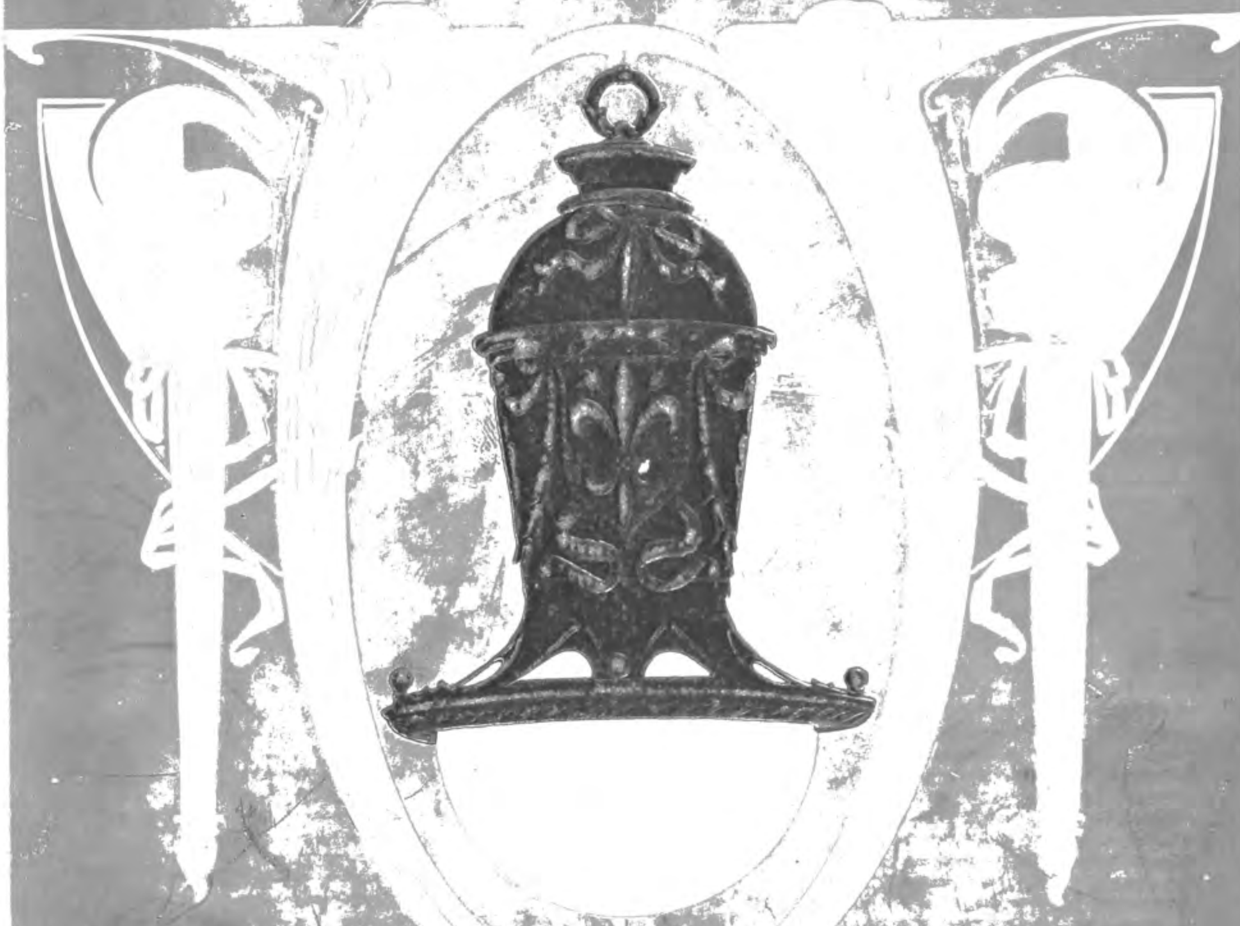
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

INTENSIFIED ARC LAMPS



Intensified Arc Lamps

General Electric Company

Schenectady, New York

June, 1910

No. 4743

INTRODUCTORY

To meet the growing demand for an economical, high efficiency lighting unit, the General Electric Company offers its Intensified Arc Lamp.

This lamp is pleasing in appearance, and the different forms are so designed as to harmonize with various styles of architectural ornamentation. Its illumination gives a closer approach to day-

Store Lighting with Intensified Arc Lamps, R. H. Stearns' Store, Boston, Mass.

light than any lamp yet placed on the market, and its simple mechanism insures reliability in operation, ease in trimming, and reduces the maintenance cost to a minimum.

The Intensified Arc Lamp provides a lighting unit of artistic design which embodies all of the essential characteristics demanded by present-day methods of illumination.

Mechanism

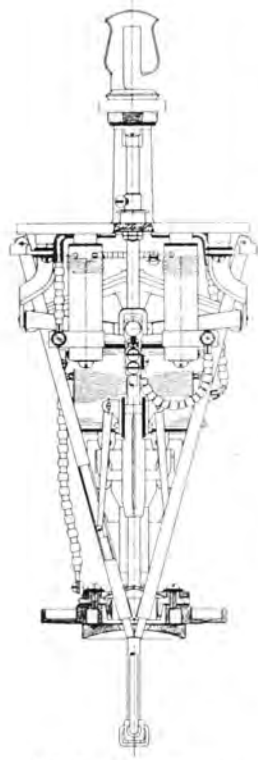


Fig. 1. Arrangement of Carbon

The mechanism of the Intensified Arc Lamp represents a radical departure from the type heretofore used for the operation of enclosed arc lamps. There are three carbons as shown in Fig. 1. The two upper or positive carbons are small in diameter, and are brought obliquely into contact, thereby maintaining an arc without the necessity of any regulating mechanism for the upper carbons. The lower negative carbon is somewhat larger in diameter than the upper ones and is regulated by means of the ordinary series magnet mechanism.

Fig. 2. Mechanism D.C. Intensified Arc Lamp

The construction is unusually rigid throughout and all sliding contacts have been eliminated. The magnets are wire wound with fireproof insulation and all modern improvements which tend to make a lamp reliable and effective, have been incorporated.

Globe Suspension

The simple and effective globe suspension system provided for this lamp is illustrated by Fig. 3, which shows the lamp with both outer and inner globes lowered for cleaning and trimming.

The outer globe is bowl shaped and held at its rim by a metal ring hinged to the lower edge of the lamp casing. A convenient locking device diametrically opposite the hinge serves to hold the globe in position.

For supporting the inner globe, a white enameled collar and elastic metal band are used.

The collar and enclosing globe (which may be considered as a unit) has two supporting pins placed diametrically opposite each other and resting firmly in two diagonal recesses in the neck of a supporting ring. This ring is provided with two flexible metal strips (see Fig. 4), one of which is hinged to the lamp casing, the other being fitted with a latch. By this arrangement it is obvious that when the ring is being latched into position the face

Fig. 3. View of Intensified Arc Lamp with Globes Lowered for Trimming

of the enclosing globe is free to seat itself firmly against the surface of the gas cap.

The wire netting which surrounds the enclosing globe is attached to the nickeled support and becomes part of the lamp. When the globe is either broken or discarded, the netting remains intact.

The outer globe is simply hinged and has a thumbscrew latch for holding it against the bottom of the lamp casing.

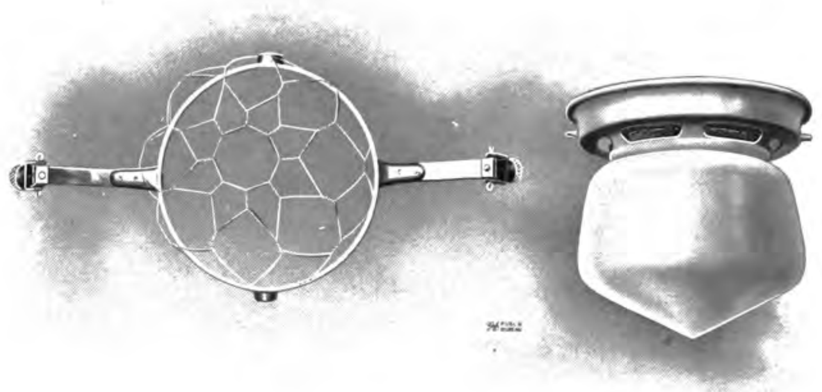


Fig. 4. Inner Globe, Holder and Net

Efficiency and Distribution

The high efficiency of the intensified arc is due primarily to the use of small diameter carbons. The position of the arc remains constant and permits the most effective use of globes and reflectors.

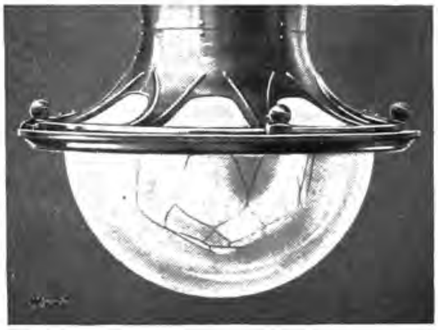


Fig. 5. Opal Inner and Clear Outer Globes and Reflector

While there are two cored positive carbons used, they are burned alternately; the current density therefore is relatively high and as the heat cannot readily pass off by conduction, as in the larger carbons, the end of the electrode is maintained in a state of high incandescence. Under these conditions, the end of the positive carbon is within the area of the crater, and prevents the wandering of the arc which is experienced with the larger diameter carbons ordinarily used in enclosed arc lamps.

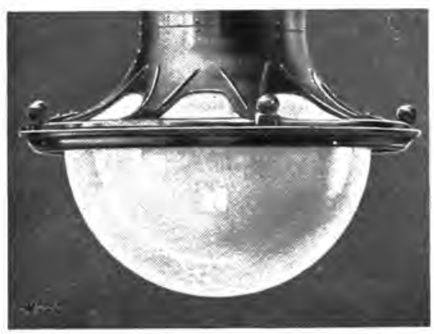


Fig. 6. Opal Inner and Outer Globes and Reflector

It has, however, been found that the diameter of the lower, or negative carbon, can be increased without materially affecting the arc efficiency or the steadiness of light distribution.

At standard arc adjustment (5 amp. 80 volts) the maximum radial efficiency of the D.C. intensified arc with clear inner globe (no outer) and small metal reflector is about .6 watts per candle-power. This unusually high efficiency permits the economical use of opal and other globes to insure proper diffusion. With light opal inner globe (no outer) the maximum radial efficiency is about .9 watts per candle and this globe is ordinarily recommended.

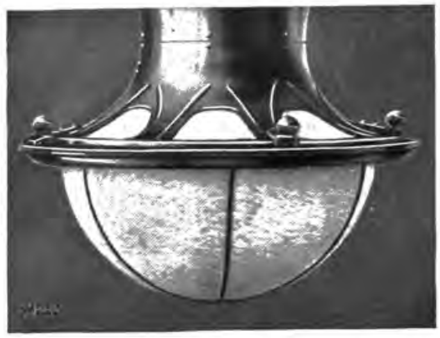


Fig. 8. Opal Inner and Art Glass Outer Globes and Reflector

The standard reflector is of opal glass, held in the lower part of the casing. Sufficient light is allowed to pass through the reflector and the openings in the lower part of the casing to prevent the appearance of a dark ceiling. For installations where ceiling illumination is of minor consideration a metal reflector which throws all the light in a downward direction is available. The shape of the enclosing globe (see Figs. 5, 6, 7 and 8) differs from that of the globes heretofore found in general use, the design being the result of a long series of experiments to determine a shape of enclosing globe which would give the most efficient distribution.

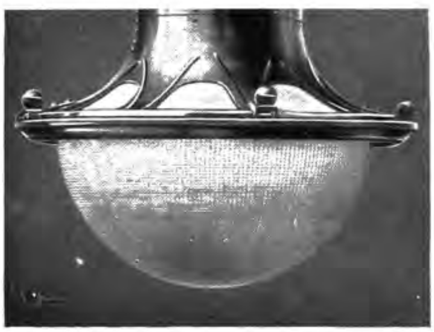


Fig. 7. Opal Inner and Holophane Outer Globes and Reflector

D.C. INTENSIFIED ARC LAMP

Design: French Renaissance Finish: Polished Brass

CATALOGUE NUMBERS

Lamp 9589 Casing 107722 Ornament 111950

D.C. INTENSIFIED ARC LAMP

Design: Fleur-de-lis Finish: Royal Copper

CATALOGUE NUMBERS

Lamp 9589	Casing 69076	Ornament 107672

Current Adjustment

The standard current adjustment for the direct current Intensified Arc Lamp is 5 amperes (80 V. arc). Lamps can, however, be furnished to consume as low as 3½ amperes (80 V. arc) and as high as 6 amperes (80 V. arc). Inasmuch as the efficiency is dependent, in a large measure, upon the current density of the positive carbon, adjustments lower than 5 amps. are not recommended. The 5 ampere lamp is recommended as a unit embodying both satisfactory carbon life and efficiency.

Electrode Life

Although small diameter carbons are used (two 6 m.m. upper, and one 9.5 m.m. lower) operating at high current densities, a life of from 80 to 100 hours is obtained from the 5 ampere (80 V. arc) direct current lamp.

Cost of Maintenance

An important factor with any lighting unit is the cost of maintenance. With the Intensified Arc Lamp this is reduced to a minimum. The cost of carbons is but slightly more than for an ordinary Enclosed Arc Lamp. The arrangement of inner and outer globes is such that the expense for globe breakage is practically negligible.

Important

When ordering give the catalogue number of the lamp and casing and ornament if desired. Also specify kind of outer globe wanted. Ceiling suspension canopies, chains, etc., are not furnished unless specified in order.

Outer and inner globes are interchangeable, and fit any style of casing.

It is, therefore, necessary when ordering to specify the catalogue numbers of both lamp and casing. When outer globes are required, they should also be designated by catalogue numbers.

Color

The correct color value of artificial illuminants should, in all cases, receive due consideration. When used to illuminate commercial interiors, especially where colored fabrics are displayed, the selection of an illuminant having the characteristics of diffused daylight is imperative. So many claims for whiteness of light are made for illuminants whose light is obviously tinted, that such claims have been to some degree discredited.

In order to illustrate the superiority of the Intensified Arc Lamp for color matching and selection, the lumichromoscope is available. With such an instrument the effect of daylight, together with various artificial light rays projected on the same fabric, can be simultaneously compared, and the superiority of the light from the Intensified Arc Lamp over other artificial illuminants, readily observed.

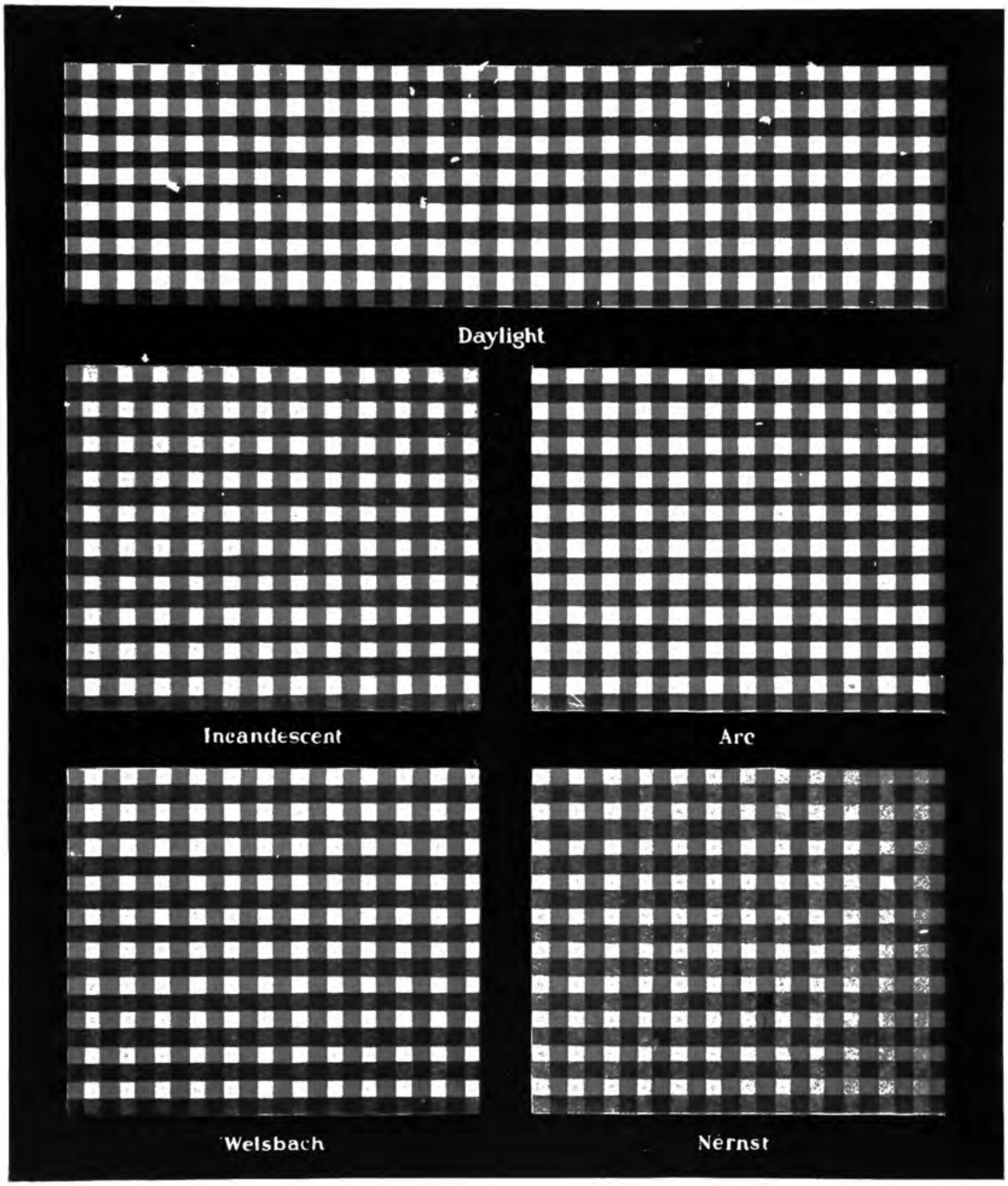
The illustration on page 12 shows the same fabric under four different light sources; *viz.*, Welsbach gas, D.C. Intensified Arc, Nernst and Incandescent light. The daylight color of the fabric is also shown and the effect is the same as when displayed under the Intensified Arc Lamp.

Summary

From the foregoing, it is evident that in the design of the Intensified Arc Lamp there is embodied all of the characteristic features desirable for the æsthetic and economical illumination of commercial interiors.

COLOR CHART

Showing the illuminating values of various forms of lighting compared with daylight



Inverted Diffuser for Intensified Arc Lamps

The Intensified Arc Lamp was primarily designed for store lighting in which field the demand for a new illuminant was most imperative. As soon as it was available, a considerable demand

Intensified Arc Lamp with Inverted Diffuser

for its use in mill lighting was evidenced. Mill lighting requirements being somewhat different from those of store lighting, it was found advisable to provide a different design of lighting unit.

The mill type Intensified Arc Lamp is shown on page 13. The mechanism is the same as for the regular store type lamp, the difference being in the casing, globe and diffuser. The casing is made dust proof, has flexible current leads and is arranged to take the 40 inch inverted diffuser, which made such a decided improvement in the former Enclosed Arc Lamp for mill lighting.

A special diffusing globe is used, which combines efficiency of light transmission with a high degree of diffusion. The lower part of the globe is frosted so as to prevent the direct image of the arc from shining in one's eyes. The upper part of the globe is clear so as to allow the maximum intensity of light to fall on the diffuser. There being but one globe a minimum amount of light is lost in absorption. As no upward light is required, the diffuser is so arranged as to reflect all light below the horizontal. Taken together the diffuser and globe cut out glare and concentrate a strong—yet well diffused—illumination on the working level. A special advantage of this combination is that the downward light is sent out at oblique angles so as to give even illumination over the spaces between lamps rather than being concentrated enough to cause a spotted effect.

The usefulness of the diffuser Intensified Arc Lamp is not limited to the field of mill lighting. It will be found suitable for all classes of factories, machine shops, armories, docks, warehouses, etc.

Not only is this lamp one of the most efficient as a light producer, but it can be maintained for a lower cost than almost any other illuminant.

INTENSIFIED ARC LAMPS—DIRECT CURRENT MULTIPLE—100-125 VOLTS—FORM 19

PLAIN TYPE

Globe	Amps.	Cat. No. Lamp	Cat. No. Casing	Casing Finish
			107722	Polished Brass
			69074	Royal Copper
Single	5	9589	107662	Verde Antique
Single	6	9590	107660	Streaked Ox. Copper
			69073	Black Ox. Copper
			107664	Polished Brass
Double	5	9589	69076	Royal Copper
Double	6	9590	107665	Verde Antique
			107663	Streaked Ox. Copper
			69075	Black Ox. Copper

ORNAMENTAL TYPE—FLEUR DE LIS DESIGN

Globe	Amps.	Lamp	Casing	Ornament	Casing Finish
			107722	107672	Polished Brass
			69074	107672	Royal Copper
Single	5	9589	107662	107672	Verde Antique
Single	6	9590	107660	107672	Streaked Ox. Copper
			69073	107672	Black Ox. Copper
			107664	107672	Polished Brass
Double	5	9589	69076	107672	Royal Copper
Double	6	9590	107665	107672	Verde Antique
			107663	107672	Streaked Ox. Copper
			69075	107672	Black Ox. Copper

ORNAMENTAL TYPE—WREATH DESIGN

Globe	Amps.	Lamp	Casing	Ornament	Casing Finish
			107722	107673	Polished Brass
			69074	107673	Royal Copper
Single	5	9589	107662	107673	Verde Antique
Single	6	9590	107660	107673	Streaked Ox. Copper
			69073	107673	Black Ox. Copper
			107664	107673	Polished Brass
Double	5	9589	69076	107673	Royal Copper
Double	6	9590	107665	107673	Verde Antique
			107663	107673	Streaked Ox. Copper
			69075	107673	Black Ox. Copper

ORNAMENTAL TYPE WREATH AND SHIELD DESIGN

Globe	Amps.	Lamp	Casing	Ornament	Casing Finish
			107722	107674	Polished Brass
			69074	107674	Royal Copper
Single	5	9589	107662	107674	Verde Antique
Single	6	9590	107660	107674	Streaked Ox. Copper
			69073	107674	Black Ox. Copper
			107664	107674	Polished Brass
Double	5	9589	69076	107674	Royal Copper
Double	6	9590	107665	107674	Verde Antique
			107663	107674	Streaked Ox. Copper
			69075	107674	Black Ox. Copper

ORNAMENTAL TYPE—RENAISSANCE DESIGN

Globe	Amps.	Lamp	Casing	Ornament	Casing Finish
			107722	111950	Polished Brass
			69074	111950	Royal Copper
Single	5	9589	107662	111950	Verde Antique
Single	6	9590	107660	111950	Streaked Ox. Copper
			69073	111950	Black Ox. Copper
			107664	111950	Polished Brass
Double	5	9589	69076	111950	Royal Copper
Double	6	9590	107665	111950	Verde Antique
			107663	111950	Streaked Ox. Copper
			69075	111950	Black Ox. Copper

The Cat. No. of casing covers plain type. In ordering any of the above lamps specify Cat. No. of lamp, casing and ornament for lamps with ornamental casings.

General Electric Company

Principal Offices, Schenectady, N. Y.

Sales Offices

(Address nearest office)

BOSTON, MASS.	84 State Street
NEW YORK, N. Y.	30 Church Street
Syracuse, N. Y.	Post-Standard Building
Buffalo, N. Y.	Ellicott Square Building
New Haven, Conn.	Malley Building
PHILADELPHIA, PA.	Witherspoon Building
Baltimore, Md.	Electrical Building
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Charleston, W. Va.	Charleston National Bank Building
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Cleveland, Ohio	Citizens Building
Chattanooga, Tenn.	James Building
Memphis, Tenn.	Randolph Building
Nashville, Tenn.	Stahlman Building
Indianapolis, Ind.	Traction Terminal Building
CHICAGO, ILL.	Monadnock Building
Detroit, Mich.	Majestic Building (Office of Soliciting Agent)
St. Louis, Mo.	Wainwright Building
Kansas City, Mo.	Dwight Building
Butte, Montana	Phœnix Building
Minneapolis, Minn.	410-412 Third Ave., North
DENVER, COLO.	Kittredge Building
Salt Lake City, Utah	Newhouse Building
SAN FRANCISCO, CAL.	Union Trust Building
Los Angeles, Cal.	Delta Building
Portland, Ore.	Electric Building
Seattle, Wash.	Colman Building
Spokane, Wash.	Paulsen Building

For Texas and Oklahoma Business refer to
General Electric Company of Texas,

Dallas, Tex.	Praetorian Building
El Paso, Tex.	Chamber of Commerce Building
Oklahoma City, Okla.	Insurance Building

FOREIGN

Foreign Department,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
London Office, 83 Cannon St., London, E. C., England

For all Canadian Business,
Canadian General Electric Company, Ltd., Toronto, Ontario

General Electric Company
Schenectady, N.Y.

SUPPLY DEPARTMENT

May, 1910 — *Copyright, 1910 by General Electric Company* — *Bulletin No. 4744*

METER TESTING RHEOSTATS FOR 110/120 VOLTS

TO make the periodical calibration of service wattmeters most efficiently and with the least possible annoyance to the customer, some form of artificial outfit for meter testing. The switches and resistances are designed to give loads varying from one-half an ampere to the full load rating of the rheostats in one-half ampere steps.

Meter Testing Rheostat, 15 Amperes, 110/120 Volts

Meter Testing Rheostat, 30 Amperes, 110/120 Volts

load for the meter is necessary. Of the various devices in use for this purpose, the most common is a bank of incandescent lamps. This arrangement is far from satisfactory on account of the size and weight of the bank, and is uneconomical because of the expense due to lamp renewals and breakage.

In the Meter Testing Rheostats, here described, these objectionable features are eliminated, and when used with a portable test meter the rheostats afford a very efficient

The switches on the 15 ampere box are mounted on a small terminal board which is separated from the base of the rheostat. In the 30 ampere size, this terminal board is omitted, the switches being mounted directly on the base. Each switch is marked with the value of the load which it controls. Suitable binding posts are provided into which the line wires are inserted and fastened by set screws.

The resistance units are similar in design to the well-known Form P units employed in

NOTE: The prices and data in this publication are for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication. Both prices and data are subject to change without notice.

General Electric motor-starting rheostats of small capacities. Those furnished with the 15 ampere rheostat are cylindrical in shape, and are securely fastened to the base of the box and reinforced by a small brass rod which passes through their center and absolutely prevents buckling due to extreme heat.

Flat units made of the same material are furnished with the 30 ampere rheostat and are made in this form in order to economize space.

The inductance of the units is also negligible, therefore the device can be used interchangeably on direct or alternating current circuits. The units may be readily removed in case of damage. In ordering units it is necessary only to state the drawing number of the capacity of the rheostat as marked on the name plate, and the rating of the switch to which the desired resistance is connected.

Meter Testing Rheostat, 15 Amperes, 110/120 Volts Ready for Use

Meter Testing Rheostat, 30 Ampere, 110/120 Volts Ready for Use

The resistance metal is non-corrosive and has a very low temperature coefficient. It is wound on a fireproof body and the complete unit is covered with a protecting compound which, unlike some forms, will not crack and peel off, nor will it melt or run like enamel, but will become harder when subjected to high temperatures.

As the units have a negligible temperature coefficient the load remains steady as the resistance heats up, thus permitting the rheostat to be used with satisfactory results in testing meters where portable indicating instruments are used as standards.

The rheostat is substantially made and neatly finished in black japan.

Cat. No.	Range	Wt. in Lb.	Dimensions in Inches	List Price
65294	½ to 15 amp.	7	14 x7½x1¾	$20.00
111708	½ to 30 amp.	14	12½x7½x4½	40.00

Spare Resistance Units for Cat. No. 65294, $0.50 list each.

Spare Resistance Units for Cat. No. 111708, $1.00 list each.

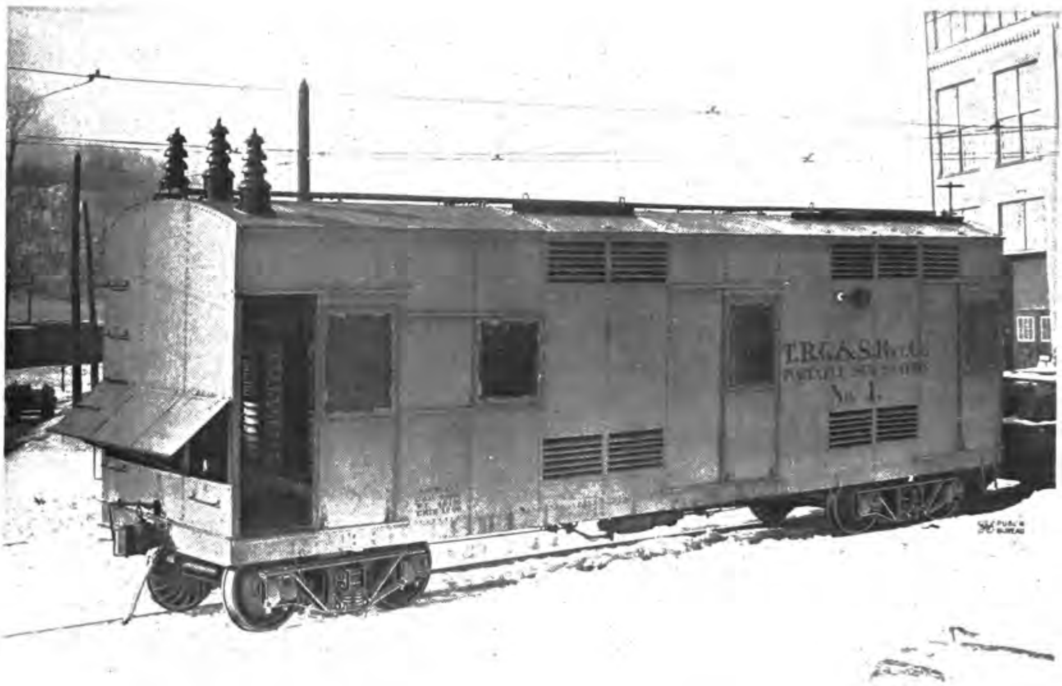
General Electric Company
Schenectady, N.Y.

RAILWAY DEPARTMENT

July, 1910 Bulletin No. 4746

PORTABLE SUB-STATIONS FOR ELECTRIC RAILWAYS

In modern street railway systems employing high tension alternating current power generators and distribution, permanent rotary converter sub-stations are usually located at such points on the line as are required to furnish 600 volt or 1200 volt direct current to the trolley wire with reasonable voltage regulation under the normal service conditions on the particular sections of the line which they feed. In many cases, the normal load on a sub-station can be carried by one rotary converter unit, and frequently no reserve equipment is provided in the sub-station for use in case of accident, or for supplying abnormal current demands.



PORTABLE SUB-STATION FOR THE T.B.G. & S. RAILWAY CO.
400 KW. CAPACITY AT 33,000 VOLTS

On the majority of electric roads, there are certain sections of the line on which abnormally heavy traffic must be handled at

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* *Supersedes Bulletin No. 4694.*

infrequent intervals or only during a certain portion of the year, as for instance, lines serving fair grounds, parks or summer resorts, where the heavy passenger traffic only lasts for a few weeks or even for a few days out of the entire year. Often such sections of line are not operated at all, except on those special occasions.

To meet these conditions, either the permanent sub-station equipment must be of much larger capacity than required for the average service and additional feeder copper installed (and even then the line drop may be excessive when under maximum service conditions), or a temporary sub-station must be installed.

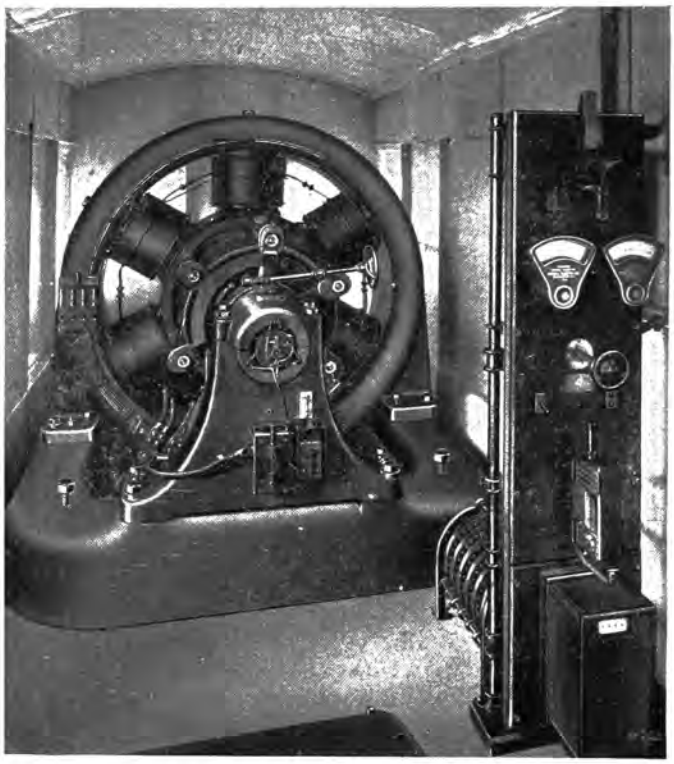
For the supply of intermittent power of the above character and to provide for a temporary supply of power in case of accidents at sub-stations equipped with only one rotary converter unit, the General Electric Company has developed Portable Sub-Stations consisting of specially arranged cars containing complete sub-station equipments, including a rotary converter or motor generator set of the required capacity, transformers, switchboard and accessories. These Portable Sub-Stations are provided with trucks adapted for short radius curves and may be conveniently moved to any section of the line requiring power temporarily, only necessitating making connections to the high

TRANSFORMER END OF PORTABLE SUB-STATION, 400 KW. CAPACITY, 33,000 VOLTS tension lines and direct current trolley or feeders, to render them ready for immediate service.

A considerable number of these Portable Sub-Stations have been built for various roads, and they have proved to be a most valuable adjunct to the modern street railway system.

LIMITATIONS OF SIZE

Owing to the limiting railroad clearance dimensions it is generally impracticable to provide for more than 500 kw. capacity in a single car and the large clearances required for high voltages will probably confine the use of portable sub-stations to transmission voltages of 60,000 volts and less. Even lower limits of capacity may be prescribed by the strength of bridges and culverts on the railway on which the car is to be used.



CONVERTER END OF PORTABLE SUB-STATION, 500 KW.
600 VOLT CONVERTER

1st. For ensuring continuity of power supply with a minimum investment in permanent sub-stations.

2nd. For saving large investment in copper and sub-station equipment on lines heavily loaded only on special days or seasons.

3rd. For providing additional power at any point where the traffic may be temporarily abnormally heavy.

4th. For furnishing power to extensions while under construction.

EQUIPMENT

Portable sub-stations are generally provided with a rotary converter equipment, interchangeable with that used in the permanent sub-stations. Such an equipment for either 25 or 60 cycles consists of the following principal items:

Rotary Converter.
Step-Down Transformer.
Reactive Coil.
Blower if Transformer is Air-Blast type.
Switchboard Equipment.
Lightning Arresters.

Special conditions may make motor generators more desirable in certain cases, when the equipment comprises:

Motor-Generator Set.
Step-Down Transformer if Line Voltage exceeds 13,200 Volts.
Blower if Transformer is Air-Blast type.
Switchboard Equipment.
Lightning Arrester.

Illumination at night is obtained from rows of incandescent lamps near the roof connected in groups of five in series either to the converter or the trolley by a single-pole double throw lighting switch on the D.C. panel.

CONVERTERS

The General Electric Company standard rotary converter with speed limit attachment is used with slight modifications. The commutator end of the base is provided with leveling bolts to facilitate leveling the converter for operating when the car is located on a grade. Special attention is given to the balancing of the converter armature to minimize vibration of the car.

The converter is securely fastened to the car floor framing to prevent shifting of the converter while the car is in transit. However, means are provided for leveling the converter without weakening this blocking.

The equalizer switch is mounted on the pillow block instead of the field frame on account of the limited width of the car, as shown in the illustrations.

TRANSFORMERS

Transformers are generally of the air blast type, this type being particularly suitable on account of its light weight per unit of output. They are usually made top connected for the high potential leads and bottom connected for the low potential leads which are carried through the air blast chamber to the reactive coil and starting panel. For potentials above 33,000 volts, oil cooled transformers must be used, and on account of the small clearances between the transformer and car walls, sometimes it is necessary to employ a blower to stimulate circulation.

The standard reactive coil with starting panel as designed for permanent sub-stations is used without any modifications. The reactive coil is of the air blast type when air blast transformers are employed.

LIGHTNING ARRESTERS

The use of lightning arresters in wooden cars is not recommended on account of the fire risk. However, for voltages up to 13,200 the lightning arresters are small and can readily be housed in asbestos lumber compartments or the car protected by lining that section of it with asbestos.

When a portable sub-station is located near a permanent sub-station equipped with effective lightning arresters, the portable sub-station may be protected thereby, but if the car is used some distance from any permanent sub-station for a considerable time, so that lightning protection is required, then lightning arresters should be installed outside and away from the car or a steel car provided equipped with lightning arresters.

SWITCHBOARD

The switchboard for a converter equipment consists of:

1 Incoming line and transformer panel.
1 D.C. converter and feeder panel.
1 Converter starting panel.

Panels are made of natural black slate and the instruments have a dull, black finish.

Three-Phase Incoming Line and Transformer Panel:

Size of panel 76 in. high, 16 in. wide.

Equipment:

1 Hand operated T.P.S.T. oil switch with transformer trip.

1 Ammeter.

1 Current transformer.

1 Low potential transformer (for 60 cycle converter only).

1 Integrating wattmeter.

1 S.P.S.T. main switch.

1 S.P.D.T. lighting switch.

2 Potential receptacles with 1 plug.

1 D.C. lightning arrester.

1 S.P.4T. starting switch (for 60 cycle converter only).

1 Starting resistance (for 60 cycle converter only).

1 S.P.S.T. equalizer switch (mounted on converter frame).

LIGHTNING ARRESTER COMPARTMENT OF PORTABLE SUB-STATION SHOWN ON PAGE 1

1 High potential transformer (for 60 cycle converter only).

1 Synchronism indicator (for 60 cycle converter only).

1 Synchronizing plug and receptacle (for 60 cycle converter only).

3 Enclosed fuses for blower motor.

D.C. Converter and Feeder Panel.

Equipment:

1 Carbon break circuit breaker with low voltage release.

1 Ammeter.

1 Voltmeter

1 Hand-operated field rheostat.

Three-Phase Converter Starting Panel Mounted on Reactance.

For 25 cycle converters up to 500 kw.

Equipment:

1 D.P.D.T. lever switch.

Six-Phase Converter Starting Panel Mounted on Reactance. For 500 kw. 25 cycle converters.

Equipment:

1 T.P.D.T. lever switch for fractional voltage taps.

1 T.P.D.T. lever switch for full voltage leads.

ARRANGEMENT OF APPARATUS

The positions of the switchboard panels are shown in the plan and elevation diagram on page 9. The oil switches are located at the end of the car, thus obtaining a short and direct run of high tension connections, and isolating them from the attendant whose operating position will be in the center of the car.

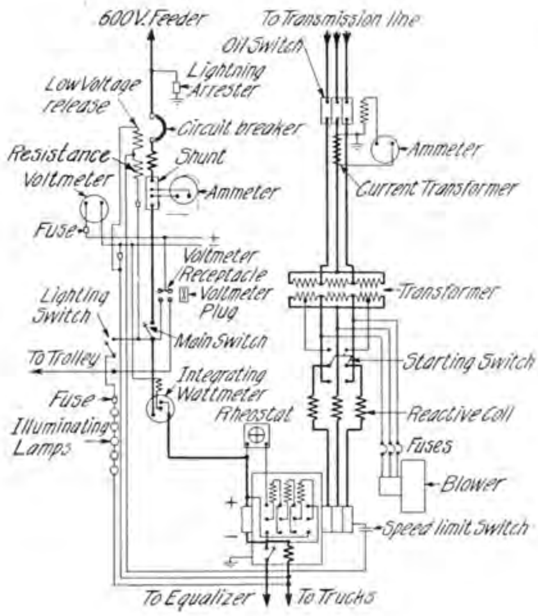


DIAGRAM OF CONNECTIONS

The incoming high tension lines may be connected directly to the transmission line, but if frequent or continued use of the portable sub-station in one locality is necessary, disconnecting switches should be mounted on the nearest pole to facilitate disconnecting the oil switch without having to cut off power from the transmission line.

The transformers and the converters which constitute the bulk of the weight are usually placed over the trucks to relieve the car body of heavy loads.

The car is protected above and at the side of the circuit breaker by asbestos lumber from any arcing which may result from the opening of the circuit breaker on short circuits or overloads.

The positive feeder cable is carried to a terminal block on the outside of the car near the roof for convenient connection to the trolley wire or feeder. The negative cable is securely grounded to both trucks. No connection is made to the equalizer switch on the converter, but if the converter does not take its share of the load when used near another sub-station, a temporary connection can readily be made to the equalizer bus in the station.

CAR CONSTRUCTION

The car bodies may be constructed of either wood or steel. The chief objection to the wood car is the possibility of fire which may result from electrical disturbances on the interior or be communicated from the outside.

The steel car body is heavier and more expensive but the small increase in cost should be well worth the insurance it provides. In general, a complete portable sub-station with a steel car will weigh about 10% more and cost about 10% more than a similar sub-station with a wood car body.

The design and construction of the steel car body is necessarily materially different from that of the wood body as explained in the following paragraphs.

WOOD CAR BODIES

The wood car body consists of an ordinary freight car with special provision for light, ventilation and accessibility. Ventilation is obtained from the windows and doors which can remain open on either side of the car, depending on the weather conditions, and through hatch covers in the roof immediately above the transformer and converter, which may be raised on either side independently. These hatch covers may be entirely removed for installing or dismantling the apparatus with a crane. They are provided with wide over-lapping edges to shield the apparatus from ordinary rain storms when open and to make a perfectly tight joint when closed.

These cars are generally wood lined inside but may instead be lined throughout with asbestos lumber.

Unless a more elaborate finish is desired, the outside is given three coats of paint and the interior is left unpainted.

The high tension entrance end of the car is specially constructed to form a weather protection over the line entrance bushings. The opposite end of the car is detachable to facilitate the removal of apparatus if no crane is available, and end doors as well as center doors are provided to give adequate ventilation on the ends of the car, to give access to oil switches and high tension insulators at one end and to the collector rings, etc., of the converter at the other end of the car without having to pass through the narrow aisles. All doors are fitted with wire glass sash in the upper panels.

STEEL CAR BODIES

The ventilation of steel cars is obtained by means of louvre panels at the top and bottom of each side of the car near the transformer and converter. These panels are provided with covers on the inside for protection against a driving storm or severe cold weather.

Hatch covers are provided above the transformer and converter for installing or dismantling the machines, but are bolted to the car body and are not intended for ventilation.

The sides and roof consist of heavy sheet steel plates riveted to a structural steel frame, all parts being made of non-combustible material except the running board and the window sashes which are of wood. The doors are of wood protected with a metal sheathing. The floor is of a composition cement laid on galvanized corrugated sheet iron or ferro-inclave plates securely fastened to the floor framing. This flooring is especially adapted for steel cars to withstand shocks received in transportation and is not cold or otherwise objectionable to walk on.

The under side of the roof is sheathed with thin galvanized iron so as to form air pockets between it and the roof plates to prevent any direct radiation of heat when the car is standing in the sun. This sheathing also acts as a protection against any possible condensation which might otherwise drop on the apparatus.

To further prevent the atmosphere in the car from getting too warm from radiation through the steel plates on the sides of the car, the exterior is painted a light grey color. The interior is painted white to reflect the light and give a more uniform illumination. The composition floor, although colored in its plastic state, is given two coats of paint to make it less susceptible to moisture.

The steel car shown in the illustration is provided with roof entrance bushings for the 33,000 volt incoming lines. This was done to keep the high voltage lines further from the ground and to allow more available space inside. These bushings can readily be removed when the car is to be transported.

CAR EQUIPMENT

As cars must be shipped over steam railroad lines to their destination, they are provided with MCB equipment throughout, including air brakes acting on all wheels. A hand brake shaft is usually provided at one end, operating the brakes on one truck only. If the car is required to pass around curves of very short radius, a special construction of the brake rigging to permit the trucks to swivel may be required, differing from the usual steam railroad brake rigging. Draft gear is of the MCB standard type with MCB standard couplers and hand levers at the side of car. Bodies should have the usual steps, ladders, etc.

The trucks are usually of the diamond frame arch bar type equipped with 33 in. wheels mounted on MCB standard steel axles and fitted with cast iron journal boxes.

SIZE AND WEIGHT

A portable converter sub-station for 13,200 volts and 300 kw. capacity will have an interior length of approximately 36 ft., width 7 ft. 6 in., and height 8 ft., and will weigh, complete, about 76,500 lbs. For 33,000 volts and 500 kw. capacity, the interior dimensions will be, approximately: length 40 ft., width 8 ft. 6 in., height 9 ft., and weight about 97,000 lbs. A 60,000 volt, 60 cycle portable sub-station with oil cooled transformer, Form K 10 oil switches and 500 kw. induction motor-generator installed in a steel car will have interior dimensions of 50 ft. length, 8 ft. 6 in. width, 9 ft. 3 in. height and a weight of approximately 150,000 lbs. On account of the size of high tension entrance bushings, they are designed for placing in the roof, and are lifted out before shipment on account of passage through tunnels, etc., the holes being temporarily closed.

INSTALLATION

The car body and trucks can be purchased directly according to the customer's own specifications or the car complete with equipment can be supplied by the General Electric Company. In either case, if the installation is done by the General Electric Company, the car should preferably be shipped to the Company's Schenectady Works for installing the apparatus.

In wooden cars, the high tension insulators are mounted on metallic pins fastened to steel or metal covered supports, the metal being thoroughly grounded to the trucks to reduce fire risk in case of a failure of the insulation. The entrance bushings are similarly supported and the supports are grounded to the framing. The small wires are run in iron pipe conduits under the car floor.

The heavy cables are supported on porcelain clamp insulators run in the air blast chamber, or when run under the car floor are protected against mechanical injury and wheel splash.

DATA FOR QUOTATIONS

Inquiries which require the car to be furnished by the General Electric Company should state:

Minimum Clearance on Local Tracks.

There may be less clearance on the Purchaser's local tracks than on the various lines over which the car would pass to its destination. This data should be given in the usual way, *i.e.*, the different permissible widths for various heights above the track.

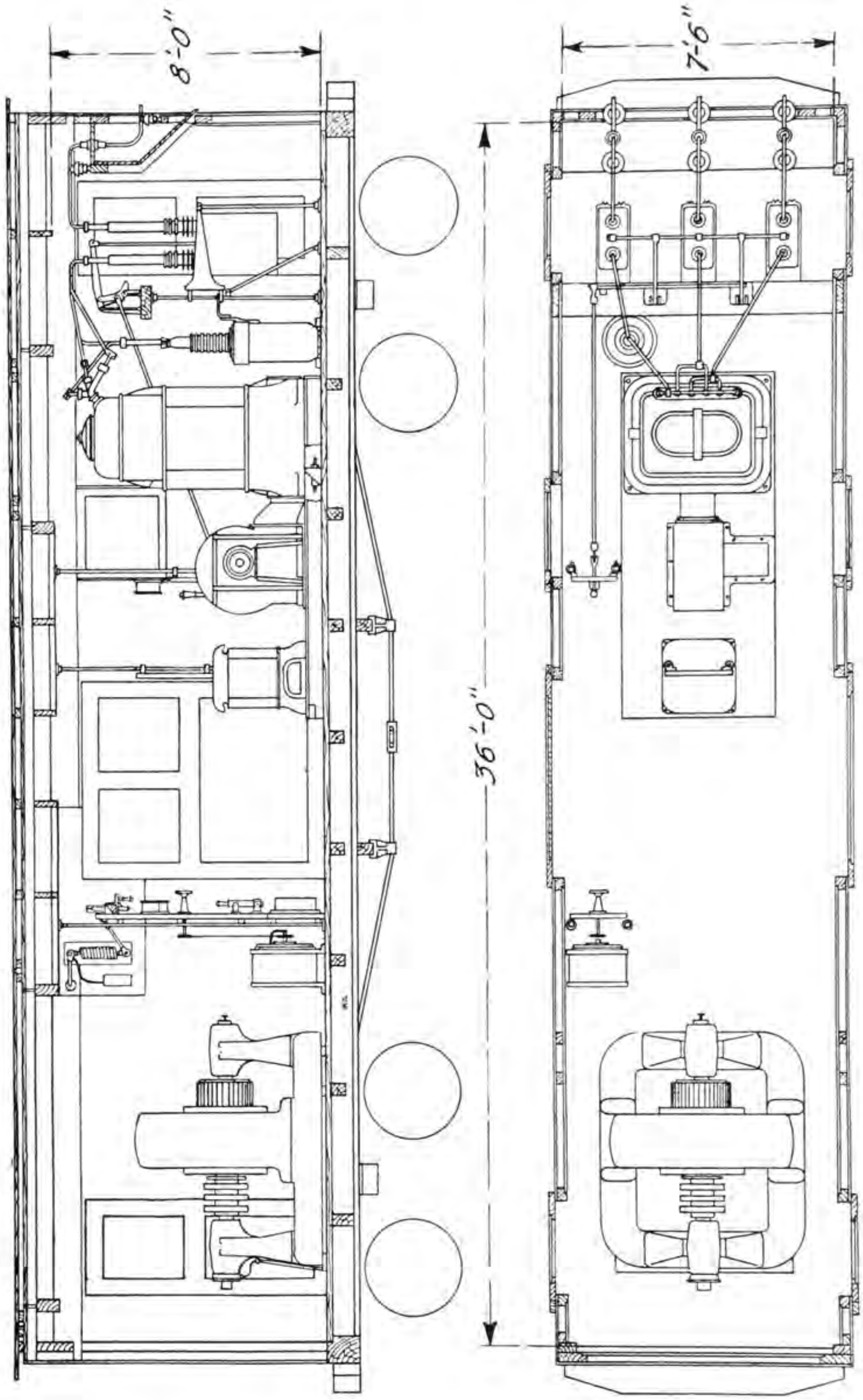
Minimum Radius of Curve around which Car must Pass.

Where the Apparatus will be Installed.

Steel or Wood Box Desired.

Special Requirements.

If the car is furnished by the customer and the installation is done by the General Electric Company, the inquiry should be accompanied by drawings of the car, indicating the interior dimensions and arrangements for line entrances and how the apparatus is to be placed in the car; that is, whether through hatches or removable end or side doors.



PLAN AND ELEVATION OF PORTABLE SUB-STATION, 300 KW. CAPACITY AT 33,000 VOLTS

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES

(Address nearest office)

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 30 Church Street.
SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Building.
BALTIMORE, MD., Electrical Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Bldg.
PITTSBURG, PA., Park Building.
RICHMOND, VA., 712 Mutual Building.
ROANOKE, VA., Strickland Building.
ATLANTA, GA., Empire Building.
BIRMINGHAM, ALA., Brown-Marx Building.
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MINNEAPOLIS, MINN., 410-412 Third Avenue, North.
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FOREIGN DEPARTMENT,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
LONDON OFFICE, 83 Cannon St, London, E. C., England

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

RAILWAY LINE MATERIAL FOR DIRECT SUSPENSION & CATENARY CONSTRUCTION

GENERAL ELECTRIC COMPANY

PRICE SUPPLEMENT

TO ACCOMPANY BULLETIN NO. 4747

RAILWAY LINE MATERIAL

No. Page		List Price
7798—110	per 1000	$10.00
8744—111	per 100	16.00
8747—110	per 1000 net	9.50
8749—110	per 1000 net	9.00
8750—110	per 1000 net	8.00
8751—110	per 1000 net	14.00
8841—110	per 1000 net	22.50
9312—116	price on app.	
9322—116	price on app.	
11294—41	per 100	66.50
11296—41	per 100	66.50
11297—67	per 100	700.00
11298—67	per 100	800.00
12900—46	per 100	125.00
15022—43	per 100	65.00
15026—15	per 100	375.00
15037—15	per 100	450.00
15120—44	per 100	95.00
15121—44	per 100	95.00
15138—46	per 100	125.00
15140—45	per 100	137.50
15147—45	per 100	137.50
15157—42	per 100	47.50
15901—48	per 100	35.00
15902—48	per 100	7.00
15903—48	per 100	10.00
15993—64	each	9.00
16034—42	per 100	47.50
16379—48	per 100	100.00
16380—41	per 100	75.00
16394—43	per 100	65.00
16395—64	each	12.50
16399—58	per 100	68.75
16400—58	per 100	78.75
16727—59	per 100	40.00
16762—124	price on app.	
16914—123	each	10.00
16915—124	each	2.50
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16926—32	per 100	18.50
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17338—48	per 100	50.00
17341—37	per 100	50.00
17400—48	per 100	40.00
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19407—70	per 100	150.00
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19484—47	per 100	225.00
19490—68	per 100	700.00

No. Page		List Price
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29131—63	each	6.50

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No. Page	List Price	No. Page	List Price	No. Page	List Price	No. Page	List Price
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88395—126....per 100 net	**270.00**	100028—110........price on app.		100133—8......per 100	**426.00**	100936—72........each	**2.00**
88396—126....per 100 net	**450.00**	100029—124.......each net	**3.50**	100134—8......per 100	**462.00**	105705—21.....per 100	**75.00**
88397—126....per 100 net	**675.00**	100030—124.... ..each net	**3.50**	100135—8......per 100	**462.00**	108530—120....per 100	**40.00**
88398—126....per 100 net	**900.00**	100031—123.......each net	**4.00**	100156—118....per 100 net	**17.10**	110706—126.......each net	**7.00**
88399—126....per 100 net	**331.50**	100032—125........price on app.		100157—118....per 100 net	**24.30**	110745—64.....per 100	**450.00**
88418—126....per 100 net	**390.00**	100033—125........price on app.		100158—118....per 100 net	**22.50**	110746—64.....per 100	**450.00**
88641—56.....per 100	**125.00**	100034—125........price on app.		100159—118....per 100 net	**31.50**	110747—64.....per 100	**450.00**
88651—56.....per 100	**137.50**	100035—125....per 100	**40.00**	100160—118....per 100 net	**28.80**	110748—64.....per 100	**800.00**
88672—56.....per 100	**200.00**	100036—125....per 100	**50.00**	100161—118....per 100 net	**31.50**	110749—65.....per 100	**525.00**
88785—56.....per 100	**250.00**	100037—125. ..per 100	**60.00**	100162—119....per 100 net	**49.50**	110750—65.....per 100	**525.00**
88894—51.....per 100	**130.00**	100038—125....per 100	**70.00**	100163—119....per 100 net	**47.70**	110751—65.....per 100	**525.00**
88895—51.....per 100	**130.00**	100039—125....per 100	**62.50**	100164—119....per 100 net	**43.20**	110752—65........each	**11.00**
88896—51.....per 100	**112.50**	100040—125....per 100	**87.50**	100165—112....per 100 net	**26.40**	110753—65.....per 100	**650.00**
88897—46.....per 100	**130.00**	100041—125....per 100	**100.00**	100166—112....per 100 net	**28.05**	110754—65.....per 100	**650.00**
88898—46.....per 100	**130.00**	100042—125....per 100	**112.50**	100167—112....per 100 net	**31.90**	110755—65.....per 100	**650.00**
88899—46 . ..per 100	**112.50**	100043—125....per 100	**125.00**	100168—112....per 100 net	**36.03**	110756—64,65..per 100	**35.00**
88955—46 ....per 100	**112.50**	100044—125....per 100	**137.50**	100169—112....per 100 net	**43.45**	110900—119...per 1000 net	**50.00**
88965—80...... each	**3.25**	100045—125....per 100	**150.00**	100170—112....per 100 net	**50.05**	110901—119...per 1000 net	**75.00**
89473—17.....per 100	**192.50**	100046—125....per 100	**165.00**	100171—112....per 100 net	**48.07**	111099—82.....per 100	**67.50**
89475—17.....per 100	**190.00**	100047—125....per 100	**180.00**	100172—112....per 100 net	**52.14**	112151—86........each	**40.00**
89477—28.....per 100	**215.00**	100048—125....per 100	**195.00**	100173—112....per 100 net	**59.51**	112152—86........each	**30.00**
89479—28 ....per 100	**205.00**	100049—126.......each net	**1.60**	100174—112....per 100 net	**64.35**	112153—86.....per 100	**75.00**
89481—24.....per 100	**172.50**	100074—125....per 100	**65.00**	100175—112....per 100 net	**72.52**		
89483—24.....per 100	**167.50**	100075—125....per 100	**60.00**	100176—74,85..per 100	**60.00**		
89485—18.....per 100	**140.00**	100076—125....per 100	**50.00**	100177—86.....per 100	**150.00**		

RAILWAY LINE MATERIAL

FOR

DIRECT SUSPENSION

AND

CATENARY CONSTRUCTION

GENERAL ELECTRIC COMPANY

Supply Department

SCHENECTADY, N. Y.

June, 1910 *Bulletin No. 4747*

ADVICE REGARDING THE PLACING OF ORDERS

1. Orders, and correspondence regarding orders, must always be sent to the nearest Sales Office. (See list of Sales Offices at end of this catalogue.)

2. Catalogue numbers should be used wherever possible.

3. Avoid ordering goods "same as last." If it is advisable to refer to a previous order the date and number of the order and the number of our invoice covering previous shipment should be specified to avoid delay and error in locating it.

4. In ordering, catalogue numbers should be accompanied by the name of the article. This insures complete identification, and lessens the danger of typographical errors in transmitting orders. Where it is impossible to give the catalogue number, a full description of the article required should be furnished.

5. State distinctly how goods are to be shipped—whether by freight, express or mail. If any special route is preferred, it should be mentioned on the order.

6. Careful attention is given to the proper packing of goods, especially glassware, and receipts are obtained from carriers for delivery in good condition. This Company cannot, therefore, be held responsible for goods damaged or lost in transportation. All possible precaution, however, will be used to prevent injury or delay, and, if required, shipments will be traced. All claims for breakage should be presented to transportation companies handling the freight. We will gladly co-operate with our customers in having such claims adjusted by the carriers.

7. All claims must be made within three days of the receipt of the goods and should be accompanied by the package slip which is forwarded with each shipment.

8. When referring to orders, always give the number or date of your order as well as the name of the consignee of the goods.

9. Do not return material of any kind without first communicating with the nearest Sales Office and obtaining—

   First: Approval for returning goods.

   Second: Returned Apparatus tag, giving proper shipping directions.

10. All returned goods must be plainly marked with the name and address of the sender, and proper notice of shipment and shipping receipt should be sent to the Sales Office.

11. Prices are subject to change without notice and it is understood that this Company will in no way be held responsible for such changes.

12. All prices are listed at point of manufacture. Charges for boxing and packing will be made in accordance with our regular custom.

SHERARDIZING, THE NEW PROTECTIVE FINISH FOR IRON AND STEEL

In place of galvanizing, enameling, or other processes heretofore employed, a process of finishing known as Sherardizing has been adopted as standard for the protection of iron and steel line material devices. In this process, which is comparatively new, zinc is deposited by distillation upon the surface to be protected, and this zinc coating not only adheres to the surface as in hot or electrolytic galvanizing, but forms with the iron an alloy extending considerably below the surface, which resists corrosion under the most adverse weather conditions, and is proof against the tendency to scale off exhibited by the best hot galvanizing, under prolonged exposure. It withstands successfully the Preece test of successive immersions in copper sulphate solution, which is the standard form of test specified and applied by practically all telegraph and telephone companies and other large users of galvanized materials.

Sherardizing has the additional advantage of furnishing efficient protection of threaded and other finished surfaces without materially altering their dimensions, whereas, in hot galvanizing, screw threads have to be recut and the steel surface is, therefore, liable to partial exposure. It is also free from the weakening effect caused by hot galvanizing on malleable iron in certain forms, which has to some extent limited the employment of galvanizing in line material manufacture, and has often seriously impaired the integrity of castings of irregular sections.

The adoption of Sherardizing marks the most important step in the art of line material manufacture since the design of Catenary Construction.

DIMENSIONS

In this catalogue descriptions of the overhead line devices contain detail dimensions which, it is believed, will assist intending purchasers. It must be understood, however, that the dimensions given are averages and therefore subject to reasonable variation in manufacture.

DIRECT SUSPENSION LINE MATERIAL

POLE BRACKETS

The following pole brackets represent the various forms called for in modern railway line construction and include the three styles of tube, the use of which has been approved in the best practice.

The wrought iron pipe referred to in the table is standard welded gas and water pipe, and the structural tubing is a special high carbon steel tube with butt joint, which, because of the great stiffness of the material does not require a welded seam.

All diameters given are the nominal inside diameters of standard wrought iron pipe.

All parts of these brackets are finished in black japan.

The following table gives dimensions and weights of the various tubes employed.

Material	Nominal Inside Diameter	Actual Outside Diameter	Thickness of Wall	Weight in Lbs. per Ft.
Wrought Iron Pipe	1¼"	1.66"	.140"	2.2
	1½"	1.90"	.145"	2.6
	2"	2.375"	.154"	3.6
"A" Tubing	1¼"	1.66"	.095"	1.5
	1½"	1.90"	.095"	1.87
	2"	2.375"	.107"	2.50
"C" Tubing	1¼"	1.66"	.140"	2.2
	1½"	1.90"	.145"	2.5
	2"	2.375"	.154"	3.5

Iron poles, such as are used in line construction, have actual outside diameters somewhat larger than their nominal listed diameters.

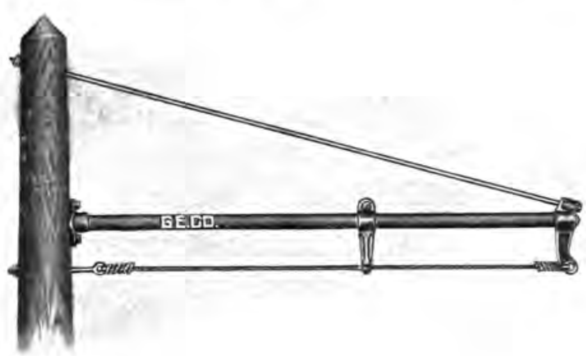
4" Standard Pipe Pole, actual outside diam. . . . 4½ inches
5" Standard Pipe Pole, actual outside diam. . . . 5 9/16 inches
6" Standard Pipe Pole, actual outside diam. . . . 6⅝ inches
7" Standard Pipe Pole, actual outside diam. . . . 7⅝ inches

FLEXIBLE BRACKETS

For Wood Poles

9 ft. long with Guy Rod and Galvanized Steel Cable

FORM A-1 BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40009	1½" "A" tubing	3250	40012	2" "A" tubing	3450
40010	1½" "C" tubing	3800	40013	2" "C" tubing	4000
40011	1½" Wrought iron pipe . .	3900	40014	2" Wrought iron pipe . . .	4100

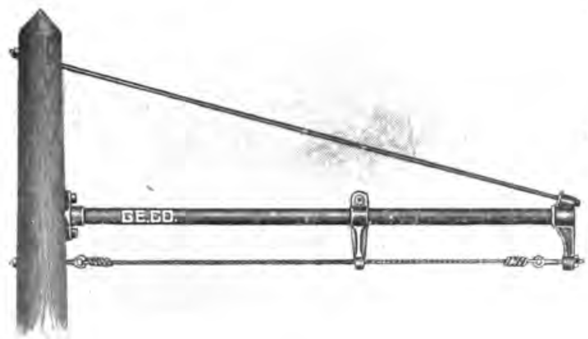
For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

POLE BRACKETS, FLEXIBLE

For Wood Poles

9 ft. long with Guy Rod and Galvanized Steel Cable

FORM A-2 BRACKETS



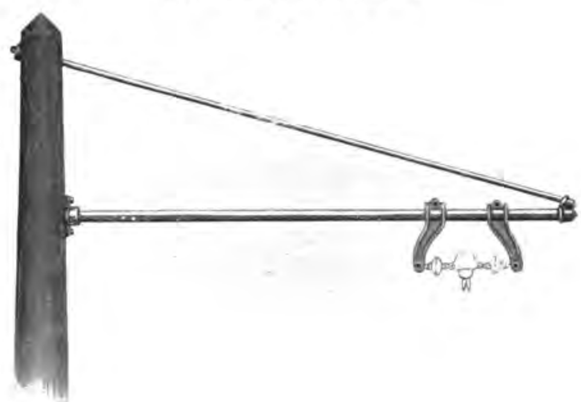
This bracket differs from the Form "A-1" only in that it has additional adjustment for tension of span wire.

Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40015	1½" "A" tubing	3300	40018	2" "A" tubing	3500
40016	1½" "C" tubing	3850	40019	2" "C" tubing	4050
40017	1½" Wrought iron pipe	3950	40020	2" Wrought iron pipe	4150

For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

9 ft. 6 in. long for 1200 Volt Form H Suspensions

FORM A-3 BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
100130	1½" "A" tubing	4500	100133	2" "A" tubing	4700
100131	1½" "C" tubing	5000	100134	2" "C" tubing	5200
100132	1½" Wrought iron pipe	5150	100135	2" Wrought iron pipe	5350

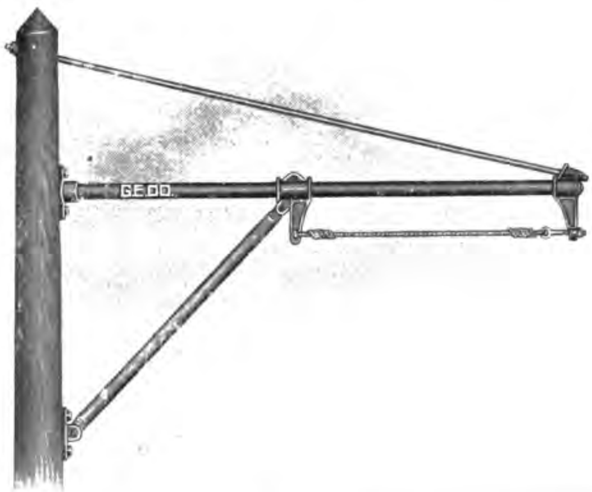
For Sherardized Brackets or brackets other than 9 ft. 6 in. in length, prices will be quoted on application.

POLE BRACKETS, FLEXIBLE

For Wood Poles

9 ft. long with Guy Rod and Galvanized Steel Cable

FORM B COMBINATION BRACKETS

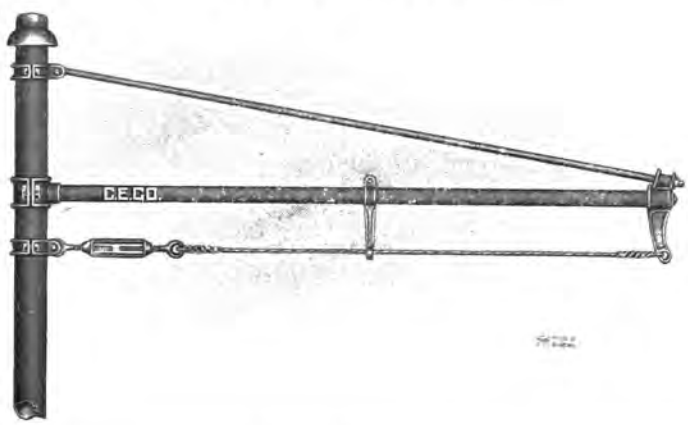


Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40021	"A" tubing, arm 1½", strut 1¼"	4150	40024	"A" tubing, arm 2", strut 1½" .	5050
40022	"C" tubing, arm 1½", strut 1¼"	5000	40025	"C" tubing, arm 2", strut 1½" .	6250
40023	Wrought iron pipe, arm 1½", strut 1¼"	5100	40026	Wrought iron pipe, arm 2", strut 1½"	6400

For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

For use with 5 in. Standard Pipe Poles

FORM A-1 BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40033	1½" "A" tubing	4100	40036	2" "A" tubing	4950
40034	1½" "C" tubing	4700	40037	2" "C" tubing	5800
40035	1½" Wrought iron pipe . .	4800	40038	2" Wrought iron pipe . . .	5900

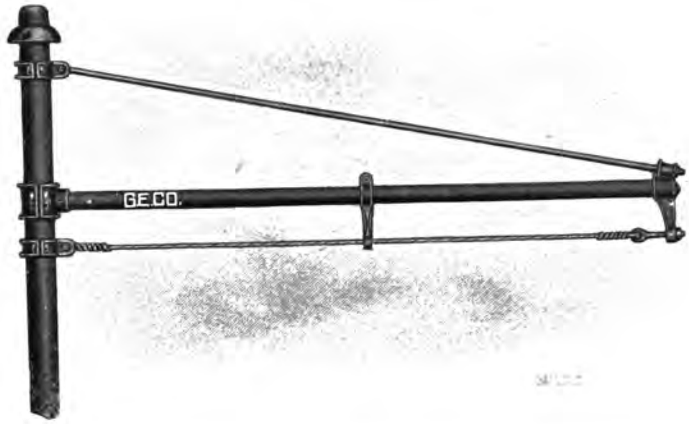
By changing pole clamps these brackets may also be used for 4", 6" or 7" poles.
For separate list of pole clamps see page 14.
For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

POLE BRACKETS, FLEXIBLE

For use with 5 in. Standard Pipe Poles

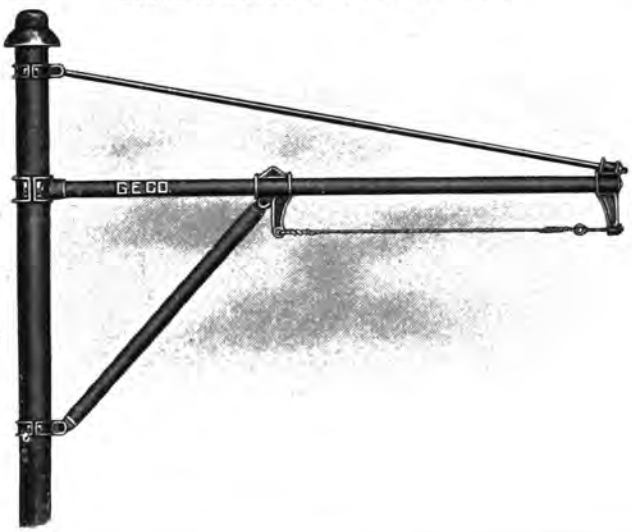
9 ft. long with Guy Rod and Galvanized Steel Cable

FORM A-2 BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40039	1½″ "A" tubing	3900	40042	2″ "A" tubing	4700
40040	1½″ "C" tubing	4500	40043	2″ "C" tubing	5600
40041	1½″ Wrought iron pipe	4600	40044	2″ Wrought iron pipe	5700

FORM B COMBINATION BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40045	"A" tubing, arm 1½″, strut 1¼″	5150	40048	"A" tubing, arm 2″, strut 1½″	6200
40046	"C" tubing, arm 1½″, strut 1¼″	6050	40049	"C" tubing, arm 2″, strut 1½″	7350
40047	Wrought iron pipe, arm 1½″ strut 1¼″	6150	40050	Wrought iron pipe, arm 2″, strut 1½″	7500

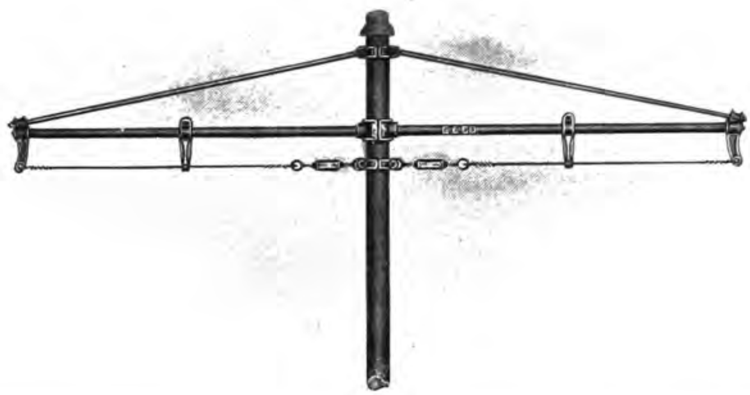
By changing pole clamps these brackets may also be used for 4″, 6″, or 7″ poles.
For separate list of pole clamps see page 14.
For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

POLE BRACKETS, FLEXIBLE

For use with 5 in. Standard Pipe Poles

9 ft. arms with Guy Rod and Galvanized Steel Cable

FORM A-1 BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40057	1½" "A" tubing	7550	40060	2" "A" tubing	8900
40058	1½" "C" tubing	8700	40061	2" "C" tubing	10700
40059	1½" Wrought iron pipe	8900	40062	2" Wrought iron pipe	10900

FORM A-2 BRACKETS

Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40063	1½" "A" tubing	7150	40066	2" "A" tubing	8500
40064	1½" "C" tubing	8300	40067	2" "C" tubing	10300
40065	1½" Wrought iron pipe	8500	40068	2" Wrought iron pipe	10500

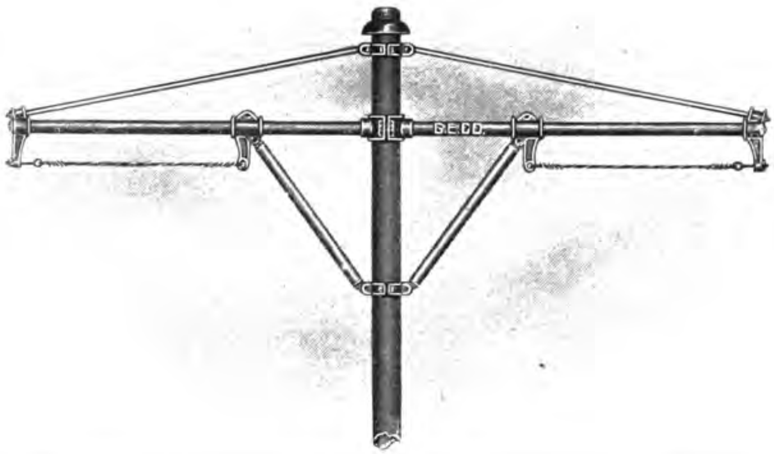
By changing pole clamps these brackets may also be used for 4", 6", or 7" poles.
For separate list of pole clamps see page 14.
For Sherardized Brackets or brackets with arms other than 9 feet in length, prices will be quoted on application.

POLE BRACKETS, FLEXIBLE

For use with 5 in. Standard Pipe Poles

9 ft. arms with Guy Rod and Galvanized Steel Cable

FORM B COMBINATION BRACKETS



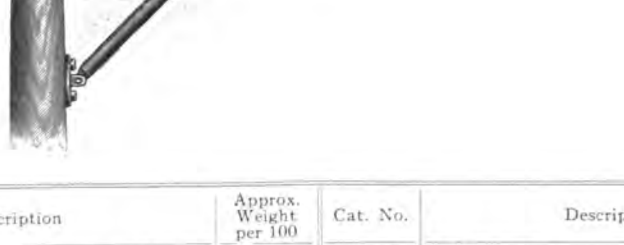
Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40069	"A" tubing, arm 1½", strut 1¼"	9650	40072	"A" tubing, arm 2", strut 1½"	11000
40070	"C" tubing, arm 1½", strut 1¼"	10800	40073	"C" tubing, arm 2", strut 1½"	12800
40071	Wrought iron pipe, arm 1½", strut 1¼"	11000	40074	Wrought iron pipe, arm 2", strut 1½"	13000

By changing pole clamps these brackets may also be used for 4", 6", or 7" poles.
For separate list of pole clamps see page 14.
For Sherardized Brackets or brackets with arms other than 9 feet in length, prices will be quoted on application.

RIGID BRACKETS—For Wood Poles

9 ft. long

FORM C BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40027	"A" tubing, arm 1½", strut 1¼"	2850	40030	"A" tubing, arm 2", strut 1½"	3800
40028	"C" tubing, arm 1½", strut 1¼"	3700	40031	"C" tubing, arm 2", strut 1½"	5000
40029	Wrought iron pipe, arm 1½", strut 1¼"	3800	40032	Wrought iron pipe, arm 2", strut 1½"	5100

For Sherardized Brackets or brackets other than 9 feet in length, prices will be quoted on application.

POLE BRACKETS—RIGID

For use with 5 in. Standard Pipe Poles

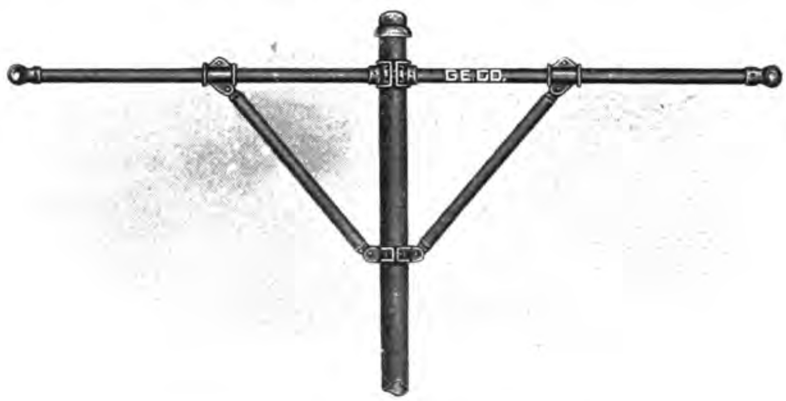
9 ft. long

FORM C BRACKETS

Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40051	"A" tubing, arm 1½", strut 1¼"	3750	40054	"A" tubing, arm 2", strut 1½"	4700
40052	"C" tubing, arm 1½", strut 1¼"	4650	40055	"C" tubing, arm 2", strut 1½"	5800
40053	Wrought iron pipe, arm 1½", strut 1¼"	4900	40056	Wrought iron pipe, arm 2", strut 1½"	6000

Two, 9 ft. arms

FORM C BRACKETS



Cat. No.	Description	Approx. Weight per 100	Cat. No.	Description	Approx. Weight per 100
40075	"A" tubing, arm 1½", strut 1¼"	6650	40078	"A" tubing, arm 2", strut 1½"	8200
40076	"C" tubing, arm 1½", strut 1¼"	8200	40079	"C" tubing, arm 2", strut 1½"	10400
40077	Wrought iron pipe, arm 1½", strut 1¼"	8500	40080	Wrought iron pipe, arm 2", strut 1½"	10700

By changing pole clamps these brackets may also be used for 4", 6", or 7" poles.
For separate list of pole clamps see page 14.
For Sherardized Brackets or brackets with arms other than 9 feet in length, prices will be quoted on application.

CLAMPS AND BANDS

For Brackets for Iron Poles

BRACKET CLAMPS

FOR HOLDING HORIZONTAL ARMS TO POLE

CAT. NO.		Description	APPROX. WT. PER 100	
Single	Double		Single	Double
40081	40097	For 4″ Standard Pipe Pole and 1¼″ Bracket Arms . . .	680	775
40082	40098	For 5″ Standard Pipe Pole and 1½″ Bracket Arms . . .	745	760
40083	40099	For 5″ Standard Pipe Pole and 2″ Bracket Arms . . .	745	760
40084	40100	For 6″ Standard Pipe Pole and 1¼″ Bracket Arms . . .	980	995
40085	40101	For 6″ Standard Pipe Pole and 2″ Bracket Arms . . .	980	995
40086	40102	For 7″ Standard Pipe Pole and 2″ Bracket Arms . . .	1360	1405

For Sherardized clamps prices will be quoted on application.

ANGLE CLAMPS

FOR HOLDING SUPPORTING STRUTS TO POLE

Cat. No. 40088

Cat. No. 40104

CAT. NO.		Description	APPROX. WT. PER 100	
Single	Double		Single	Double
40087	40103	For 4″ Standard Pipe Pole	645	745
40088	40104	For 5″ Standard Pipe Pole	655	755
40090	40106	For 6″ Standard Pipe Pole	860	960
40092	40108	For 7″ Standard Pipe Pole	1035	1135

For Sherardized clamps prices will be quoted on application.

POLE BANDS

FOR HOLDING GUY RODS AND SPAN WIRES TO POLE

CAT. NO.		Description	APPROX. WT. PER 100	
Single	Double		Single	Double
40093	40109	For 4″ Standard Pipe Pole	155	200
40094	40110	For 5″ Standard Pipe Pole	180	225
40095	40111	For 6″ Standard Pipe Pole	210	250
40096	40112	For 7″ Standard Pipe Pole	230	275

For Sherardized clamps prices will be quoted on application.

POLE BRACKETS—CAST IRON

FOR SUPPORTING PIPE BRACKET ARM

Cat. No. 15037

Cat. No.	Description	Approx. Weight per 100
15026	Short bracket for $1\frac{1}{2}''$ pipe, length $22\frac{9}{16}''$, height $28\frac{1}{2}''$, diam. of hole, $2\frac{1}{8}''$,	2400
15037	Long bracket for $1\frac{1}{2}''$ pipe, length $30\frac{9}{16}''$, height $28\frac{1}{2}''$, diam. of hole, $2\frac{1}{8}''$	3100

SUSPENSIONS—FORM H

In this section are listed all forms of suspensions demanded by the varying conditions of direct suspension construction.

In general there are five forms; the Form H suspensions, consisting of malleable iron shells into which the insulation holding the studs is permanently moulded; the Form S, consisting of malleable iron yokes with strain insulators of various forms shackled to them; the Form D, or cap and cone-suspensions; the Form G, in which insulation is provided by an insulated bolt; and Form T, feeder tap suspensions.

600 Volt Straight Line Suspension

Form H suspensions consist primarily of malleable iron shells into which the insulation holding the studs is permanently moulded. A load of over five tons is required to pull the stud from this form of suspension.

STRAIGHT LINE—600 VOLTS

These are made in two sizes 3¼ in. and 3½ in. in diameter, each of which is furnished with either ⅝ in. or ¾ in. stud. The 3½ in. suspension has extra heavy shell and arms and is designed especially for the heaviest construction.

Each of these suspensions, being in one piece, is held against turning by the span wire, and cannot, therefore, become unscrewed as a result of vibration in service.

600 Volt Straight Line Suspension

Overall length 6½ in.; arm yokes accommodate ⅜ in. span wire. Shell and stud have the standard sherardized finish.

Cat. No.	Shell		Diameter of Stud	Approx. Weight per 100
	Dia.	Height		
25980	3¼″	2″	⅝″	210
39688	3¼″	2¼″	¾″	215
39690	3½″	2¼″	⅝″	265
25979	3½″	2¼″	¾″	270

STRAIGHT LINE—1200 VOLTS

These suspensions and the 3½ in. straight line 600 volt suspensions are identical, except that the arms are replaced by clevises to which giant or wood strain insulators are shackled. A new bracket designed particularly for 1200 volt, Form H suspensions is listed on page 8.

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64425

1200 Volt Straight Line Suspension

Overall length between centers of outer eyes 12¼ in.; diameter of shell 3½ in. All metal parts including the stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
66624	⅝″	460
66622	¾″	465

SUSPENSIONS—FORM H

Straight Line—1200 Volts

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 16727

1200 Volt Straight Line Suspension

Overall length between centers of outer eyes 23¾ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
66620 66618	⅝" ¾"	565 570

WITH 1¼ IN. WOOD STRAIN INSULATORS, CAT. No. 37488

1200 Volt Straight Line Suspension

Overall length between centers of outer eyes 23¾ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
89475 89473	⅝" ¾"	635 640

SUSPENSION BODY WITH PINS

FOR 1200 VOLT STRAIGHT LINE AND 600 AND 1200 VOLT DOUBLE CURVE FORM H SUSPENSIONS

Suspension Body

Length between centers of clevis holes 4¾ in.; diameter of shell 3½ in.; diameter of pins ½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
66330 66326	⅝" ¾"	285 290

SINGLE CURVE

The Form H Single Curve Suspension consists of a 3½ in. body casting, into which the insulation holding the stud is moulded, with a clevis on one side to which the pull off arm is attached by means of a ½ in. steel pin and cotter. For 1200 volt work, strain insulators are shackled to the pull off arm.

SUSPENSIONS—FORM H

SINGLE CURVE

600 Volt Single Curve Suspension

600 VOLTS

Length between center line of stud and center of pull off eye 4½ in.; height above center of pull off eye 3½ in.; diameter of pull off eye $\frac{9}{16}$ in.; thickness of pull off arm at eye ½ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68953	⅝″	310
68955	¾″	315

1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATOR, CAT. No. 64417

1200 Volt Single Curve Suspension

Length between center line of stud and center of outer eye $8\frac{11}{16}$ in.; height above center of pull off eye 3½ in.; diameter of shell 3½ in. All metal parts including shell have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68965	⅝″	415
68967	¾″	420

WITH 1 IN. WOOD STRAIN INSULATOR, CAT. No. 43229

Length between center line of stud and center of outer eye 14⅜ in.; height above center of pull off eye 3½ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

1200 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
68945	⅝″	470
68947	¾″	475

WITH 1 1/4 IN. WOOD STRAIN INSULATOR, CAT. No. 43230

Length between center line of stud and center of outer eye 14⅜ in.; height above center of pull off eye 3½ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

1200 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
89485	⅝″	495
89487	¾″	500

SUSPENSIONS—FORM H

SUSPENSION BODY—WITH PIN

FOR 600 AND 1200 VOLT SINGLE CURVE FORM H SUSPENSIONS

Suspension Body

Distance between center line of stud and center of clevis hole $2\frac{3}{8}$ in.; diameter of shell $3\frac{1}{2}$ in.; height of shell $2\frac{1}{4}$ in.; diameter of pin $\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68961	$\frac{5}{8}$"	255
68963	$\frac{3}{4}$"	260

DOUBLE CURVE

The Form H double curve suspensions are like the single curve suspensions, except that there are two clevises and arms.

600 VOLTS

600 Volt Double Curve Suspension

Length between centers of pull off eyes 9 in.; height above center of pull off eyes $3\frac{1}{2}$ in.; diameter of shell $3\frac{1}{2}$ in.; diameter of pull off eyes $\frac{9}{16}$ in.; thickness of pull off arms at eyes $\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68957	$\frac{5}{8}$"	395
68959	$\frac{3}{4}$"	400

1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64417

1200 Volt Double Curve Suspension

Length between centers of pull off eyes $17\frac{5}{8}$ in.; height above centers of pull off eyes $3\frac{1}{2}$ in.; diameter of shell $3\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68969	$\frac{5}{8}$"	605
68971	$\frac{3}{4}$"	610

SUSPENSIONS—FORM H

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 43229

1200 Volt Double Curve Suspension

Length between centers of pull off eyes 28¾ in.; height above centers of pull off eyes 3½ in.; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68949	⅝"	715
68951	¾"	720

WITH 1 1/4 IN. WOOD STRAIN INSULATORS, CAT. No. 43230

1200 Volt Double Curve Suspension

Length between centers of pull off eyes 28¾ in; height above centers of pull off eyes 3½ in; diameter of shell 3½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
89489	⅝"	765
89491	¾"	770

BRIDGE OR CEILING—600 VOLTS

These suspensions have a total height of 2 inches above the ear seat. The supporting ears are slotted for ½ inch lag screws or bolts.

Ceiling Suspension

Distance between centers of screw slots 4¼ in.; thickness of slotted ears ⅜ in.; diameter of shell 3¼ in. Shell and stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
27370	⅝"	230
40961	¾"	245

LOW BRIDGE OR CEILING AND LOW MINING—600 VOLT

To produce a suspension of minimum height and a long creepage surface together with high mechanical strength, an entirely new feature has been introduced into the manufacture of both the Low Bridge or Ceiling Suspension and the Low Mining Suspension. The new feature is the "crimped cup" method of clamping the stud into the shell—the method being similar to that employed in the manufacture of Giant Strain Insulators. The insulation between the shell and the stud cap is sheet mica, ⅛ in. thick, with a fibre backing.

This design throws the entire mechanical load on to the malleable iron cup which is of ample strength to care for the greatest loads possible under operating conditions; thus the moulded insulation, used to give the long creepage surface, is entirely relieved of mechanical strains.

SUSPENSIONS—FORM H

LOW BRIDGE CEILING SUSPENSION

The Low Bridge or Ceiling Suspension is for use under bridges and elevated structures where head room is limited. The top of Cat. No. 64560 is designed to be countersunk in the supporting timber, bringing the top of the ear hub $\frac{1}{4}$ in. below the bottom of the timber. Cat. No. 105705 has the supporting arms at its top so that it may be attached to the overhead structure without countersinking, its total height above the ear seat is $1\frac{1}{4}$ in.; $\frac{1}{2}$ in. screws are required for the supporting arms. Shell and stud have standard sherardized finish.

Cat. No. 105705

Cat. No. 64560

Cat. No.	Description	Approx. Weight per 100
64560	Low bridge ceiling suspension Form H, $\frac{5}{8}''$ stud with arms at bottom	150
105705	Low bridge ceiling suspension Form H, $\frac{5}{8}''$ stud with arms at top	150

LOW MINING SUSPENSION

This mining suspension is like the Low Bridge Suspension in its internal design and will be found useful in many places where the suspension shown at the bottom of the page is too high. The Low Mining Suspension is adapted to use with the standard roof bolt and wedges or with the expansion bolts listed on page 22. Shell and stud have the standard sherardized finish.

Low Mining Suspension

Height from ear seat to top of shell $1\frac{1}{4}$ in.; diameter of shell at top 3 in.; height of boss above shell $\frac{5}{8}$ in.

Cat. No.	Description	Approx. Weight per 100
64561	Low Mining Suspension $\frac{5}{8}''$ stud	150

MINING

The height of the Form H Mining Suspension, from the ear seat to the top of the shell is 2 inches.

The extended flange at the top gives wide bearing surface against the mine roof to resist transverse stress on curves and the sides are grooved for the reception of a wrench with which the suspension can be set up tight on the roof bolt. The double petticoat provides ample leakage surface for voltages up to 600.

In the following tables mining suspensions are listed with several different arrangements for fastening into the mine roof, and for convenience in ordering repair parts, the insulating portion is listed also separately.

Mining Suspension

Diameter of top flange 4 in; diameter of shell $3\frac{1}{4}$ in.; height from ear seat to top of flange 2 in. Shell and stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
35688	$\frac{5}{8}''$	250
40965	$\frac{3}{4}''$	255

SUSPENSIONS—FORM H

MINING

Mining Suspension

WITH ROOF BOLT AND WEDGES

This suspension consists of the standard Form H mining suspension, with a 5 in. roof bolt and two expansion wedges. The bolt is slotted near the top and the upper wedge is arranged to engage it so as to prevent turning of the bolt in screwing up the suspension. When the suspension is removed from the bolt the whole device is loosened in the hole by a blow with a hammer and may thus be readily recovered.

The roof drilling should be 1⅜ in. in diameter and at least 5 in. deep. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
35686	Mining Suspension complete, ⅝″ stud	370
40963	Mining Suspension complete, ¾″ stud	375
35689	Roof bolt (⅝″–11, 5″ special)	40
35690	Upper roof wedge	45
35691	Lower roof wedge	35

Mining Suspension

WITH 4 IN. EXPANSION BOLT

The suspensions listed in the following table are made up of the standard Form H suspension, with a 4 in. expansion bolt consisting of a malleable iron shell, 1¼ in. in diameter, a roof bolt and a conical nut by means of which the shell is expanded when in position. The roof bolt being properly seated in the suspension boss, the shell is readily expanded in the roof hole by a few turns of the suspension.

The roof drilling should be 1¼ in. in diameter and at least 5 in. deep.

Expansion bolts Cat. Nos. 100409 and 100410 are furnished as alternatives for Cat. Nos. 66334 and 66336 when so desired. The whole difference consists in the addition of a hexagonal shaped shoulder on the roof bolt which is of service in recovering the expansion bolt from the hole. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
68941	Mining Suspension complete, ⅝″ stud	350
68943	Mining Suspension complete, ¾″ stud	355
66334	Expansion bolt, 4″ long, with stud (threaded ⅝″–11)	100
66336	Expansion bolt, 6″ long, with stud (threaded ⅝″–11)	110
100409	Expansion bolt, 4″ long, with stud (threaded ⅝″–11) having hexagonal shoulder	105
100410	Expansion bolt, 6″ long, with stud (threaded ⅝″–11) having hexagonal shoulder	115

SUSPENSIONS—FORM H

MINING

WITH LAG SCREW AND WOOD PLUG

This suspension consists of the standard Form H mining suspension, with a gimlet point lag screw threaded and rusted in the top and projecting 3 in. above the tapped boss.

Mining Suspension

It is used in connection with a wooden plug, Cat. No. 34137, which is drilled axially for the lag screw. The plug is driven into a hole drilled in the mine roof and the lag screwed into the plug, its taper splitting the wood and expanding it permanently in place.

The roof drilling should be 1½ in. in diameter and 4 in. deep.

This is also an excellent ceiling suspension for use in timbered entries, or in car-barn wiring as the lag can be screwed into the roof timbers.

The lag screw, shell and stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
34136	Mining Suspension complete, ⅝″ stud	275
40967	Mining Suspension complete, ¾″ stud	280
34137	Wooden plug (3″ x 1½″)	10
36310	Lag Screw (⅝″ x 3⅞″ special)	25

Bracket Suspension

BRACKET

The Form H bracket suspension consists of the standard 3¼ in. shell to which the bracket arm clamp is hinged, thus providing the flexibility required to care for vibration in the trolley wire.

For suspensions for 2 in. pipe the height from ear seat to center of bracket arm clamp is 5⅛ in.; for 1½ in. pipe the height is 4⅞ in; diameter of shell 3¼ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
25992	Bracket Suspension complete, ⅝″ stud for 2″ pipe	540
25993	Bracket Suspension complete, ⅝″ stud for 1½″ pipe	530
25994	Bracket Suspension, ⅝″ stud, without clamp	275
25996	Clamp for 2″ pipe, for use with Cat. No. 25992	265
25997	Clamp for 1½″ pipe, for use with Cat. No. 25993	255

The clamps for the Form H Bracket Suspensions are the same as those used with Form G Bracket Suspensions.

SUSPENSIONS—FORM S

These suspensions consist of liberally designed malleable iron yokes fitted with 2 in. giant strain insulators or wood strain insulators either 1 in. or $1\frac{1}{4}$ in. in diameter. If other insulators are desired, bodies and insulators should be ordered separately.

SINGLE TROLLEY

STRAIGHT LINE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64425

Length between centers of outer eyes $15\frac{3}{8}$ in. All metal parts including stud have standard sherardized finish.

600 Volt Straight Line Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
66648	$\frac{5}{8}''$	410
66646	$\frac{3}{4}''$	415

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 16727

Length between centers of outer eyes 27 in. All metal parts including stud have standard sherardized finish.

600 Volt Straight Line Suspension

Cat. No.	Diameter of Stud	Approx. Wt. per 100
66640	$\frac{5}{8}''$	515
66638	$\frac{3}{4}''$	520

WITH 1 1/4 IN. WOOD STRAIN INSULATORS, CAT. No. 37488

Length between centers of outer eyes 27 in. All metal parts including stud have standard sherardized finish.

600 Volt Straight Line Suspension

Cat. No.	Diameter of Stud	Approx. Wt. per 100
89483	$\frac{5}{8}''$	585
89481	$\frac{3}{4}''$	590

STRAIGHT LINE—1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. NOS. 64425 AND 64417

1200 Volt Straight Line Suspension

Length between centers of outer eyes 24 in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
100120	$\frac{5}{8}''$	620
100118	$\frac{3}{4}''$	625

SUSPENSIONS—FORM S

BODIES FOR STRAIGHT LINE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between pin centers 8 in.; clevis opening $\frac{9}{16}$ in.; diameter of pins $\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish.

Straight Line Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
66632	$\frac{5}{8}''$	235
66630	$\frac{3}{4}''$	240

SINGLE CURVE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATOR, CAT. No. 64425

Length between center line of stud to center of outer eye 9 in. All metal parts including stud have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
25987	$\frac{5}{8}''$	240
25983	$\frac{3}{4}''$	245

WITH 1 IN. WOOD STRAIN INSULATOR, CAT. No. 16727

Length between center line of stud to center of outer eye 14$\frac{7}{8}$ in. All metal parts including stud have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
33958	$\frac{5}{8}''$	295
33954	$\frac{3}{4}''$	300

WITH 1 1/4 IN WOOD STRAIN INSULATOR, CAT. No. 37488

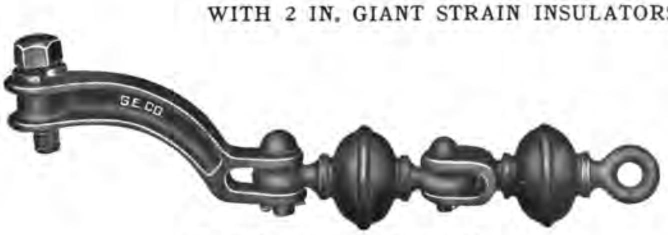
Length between center line of stud to center of outer eye 14$\frac{7}{8}$ in. All metal parts including stud have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
64252	$\frac{5}{8}''$	330
64251	$\frac{3}{4}''$	335

SINGLE CURVE—1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. NOS. 64425 AND 64417



1200 Volt Single Curve Suspension

Length between center line of stud and center of outer eye 13$\frac{1}{4}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68166	$\frac{5}{8}''$	345
68165	$\frac{3}{4}''$	350

SUSPENSIONS—FORM S

BODIES FOR SINGLE CURVE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between center line of stud and center of pin $5\frac{1}{4}$ in.; clevis opening $\frac{9}{16}$ in.; diameter of pin $\frac{1}{2}$ in. Standard sherardized finish throughout.

Single Curve Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
64244	$\frac{5}{8}''$	155
64243	$\frac{3}{4}''$	160

DOUBLE CURVE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64425

Length between centers of outer eyes 18 in. All metal parts including stud have standard sherardized finish.

600 Volt Double Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
25988	$\frac{5}{8}''$	410
25986	$\frac{3}{4}''$	415

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 16727

600 Volt Double Curve Suspension

Length between centers of outer eyes $29\frac{3}{4}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
33960	$\frac{5}{8}''$	515
33956	$\frac{3}{4}''$	520

WITH 1 1/4 IN. WOOD STRAIN INSULATORS, CAT. No. 37488

600 Volt Double Curve Suspension

Length between centers of outer eyes $29\frac{3}{4}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
64254	$\frac{5}{8}''$	585
64253	$\frac{3}{4}''$	590

SUSPENSIONS—FORM S

Single Trolley

DOUBLE CURVE—1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. NOS. 64425 AND 64417

1200 Volt Double Curve Suspension

Length between centers of outer eyes 26½ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68168 68167	⅝″ ¾″	620 625

BODIES FOR DOUBLE CURVE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between centers of pins 10½ in.; clevis opening $\frac{9}{16}$ in.; diameter of pins ½ in. Standard sherardized finish throughout.

Double Curve Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
64246 64245	⅝″ ¾″	235 240

Double Trolley

The stud bolts in all Form S double trolley suspensions are spaced 6½ in. between centers.

STRAIGHT LINE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64425

600 Volt Straight Line Suspension

Length between centers of outer eyes 22½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
66644 66642	⅝″ ¾″	555 565

SUSPENSIONS—FORM S

Double Trolley

STRAIGHT LINE

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 16727

600 Volt Straight Line Suspension

Length between centers of outer eyes 33½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
66636	⅝″	660
66634	¾″	670

WITH 1 1/4 IN. WOOD STRAIN INSULATORS, CAT. No. 37488

600 Volt Straight Line Suspension

Length between centers of outer eyes 33½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
89479	⅝″	730
89477	¾″	740

1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. NOS. 64425 AND 64417

1200 Volt Straight Line Suspension

Length between centers of outer eyes 30½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
100124	⅝″	765
100122	¾″	775

BODIES FOR STRAIGHT LINE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between pin centers 14½ in.; distance between stud centers 6½ in.; clevis opening $\frac{9}{16}$ in.; diameter of pins ½ in. Standard sherardized finish throughout.

Straight Line Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
66628	⅝″	380
66626	¾″	390

SUSPENSIONS—FORM S

Double Trolley

SINGLE CURVE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATOR, CAT. No. 64425

Length between center line of outer stud and center of outer eye 15½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
27377	⅝"	350
27374	¾"	360

WITH 1 IN. WOOD STRAIN INSULATOR, CAT. No. 16727

Length between center line of outer stud and center of outer eye 21⅜ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
33966	⅝"	405
33962	¾"	415

WITH 1 1/4 IN. WOOD STRAIN INSULATOR, CAT. No. 37488

Length between center line of outer stud and center of outer eye 21⅜ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

600 Volt Single Curve Suspension

Cat. No.	Diameter of Stud	Approx. Weight per 100
64256	⅝"	440
64255	¾"	450

SINGLE CURVE—1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATOR, CAT. NOS. 64425 AND 64417

Length between center line of outer stud and center of outer eye 19¾ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

1200 Volt Single Curve Suspension

Cat No.	Diameter of Stud	Approx. Weight per 100
68170	⅝"	455
68169	¾"	465

BODIES FOR SINGLE CURVE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between center line of outer stud and center of pin 11¾ in.; distance between stud centers 6½ in.; clevis opening 9/16 in.; diameter of pin ½ in. Standard sherardized finish throughout.

Single Curve Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
64248	⅝"	265
64247	¾"	275

SUSPENSIONS—FORM S

DOUBLE CURVE—600 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS, CAT. No. 64425

600 Volt Double Curve Suspension

Length between centers of outer eyes 24½ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
27376	$\frac{5}{8}''$	570
27375	$\frac{3}{4}''$	580

WITH 1 IN. WOOD STRAIN INSULATORS, CAT. No. 16727

600 Volt Double Curve Suspension

Length between centers of outer eyes 36¼ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
33968	$\frac{5}{8}''$	675
33964	$\frac{3}{4}''$	685

WITH 1 1/4 IN. WOOD STRAIN INSULATORS, CAT. No. 37488

600 Volt Double Curve Suspension

Length between centers of outer eyes 36¼ in.; distance between stud centers 6½ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
64258	$\frac{5}{8}''$	745
64257	$\frac{3}{4}''$	755

SUSPENSIONS—FORM S

DOUBLE CURVE—1200 VOLTS

WITH 2 IN. GIANT STRAIN INSULATORS CAT. NOS. 64425 AND 64417

1200 Volt Double Curve Suspension

Length between centers of outer eyes 33 in.; distance between stud centers $6\frac{1}{2}$ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Diameter of Stud	Approx. Weight per 100
68172	$\frac{5}{8}''$	780
68171	$\frac{3}{4}''$	790

BODIES FOR DOUBLE CURVE SUSPENSIONS

COMPLETE WITH BOLTS, WASHERS AND PINS

Length between centers of pins 17 in.; distance between stud centers $6\frac{1}{2}$ in.; clevis opening $\frac{9}{16}$ in.; diameter of pin $\frac{1}{2}$ in. Standard sherardized finish throughout.

Double Curve Suspension Body

Cat. No.	Diameter of Stud	Approx. Weight per 100
64250	$\frac{5}{8}''$	395
64249	$\frac{3}{4}''$	405

BOLTS, WASHERS AND PINS WITH STANDARD SHERARDIZED FINISH

FOR FORM S SUSPENSIONS—STRAIGHT LINE, SINGLE AND DOUBLE CURVE

Cat. No.	Description	Approx. Weight per 100
51890	Bolt, 2″ long, $\frac{5}{8}''$-11, hexagonal head	
51889	Bolt, 2″ long, $\frac{3}{4}''$-10, hexagonal head	
27442	Lock washer for $\frac{5}{8}''$ bolt	
27441	Lock washer for $\frac{3}{4}''$ bolt	
100216	$\frac{1}{2}''$ Round head pin with cotter	

SUSPENSIONS—FORM D

Section of Form D Suspension

The Form D Suspensions are recommended only for voltages up to and including 600.

In the Form D suspensions the cap, cone and malleable iron body casting (also the lock washer when ordered) are assembled as shown in the sectional view above. The cap and cone dovetail together in such a way as to prevent the formation of a film of moisture between them. The stud bolt head is made considerably larger than the opening in the body casting so that accidental breakage of the insulation will not allow the trolley wire to fall. A dead load of over six tons is required to crush the insulation between the stud cap and body.

The lock washer, which is supplied only when specially ordered, engages directly with the screw cap and the body and effectively prevents any tendency to unscrew from vibration.

CAP AND CONE INSULATORS

For convenience in ordering parts, caps, cones and lock washers are listed separately in the following table. They are interchangeable for all Form D suspensions having studs of corresponding diameter.

The bodies are listed separately in the tables of complete suspensions.

All studs, bodies and lock washers have standard sherardized finish.

Cap

Cone

Lock Washer

Cat. No.	Description	Approx. Weight per 100
16925	Screw cap insulator, $\frac{5}{8}''$ stud	70
16926	Cone for No. 16925	25
26143	Screw cap insulator, $\frac{3}{4}''$ stud	75
26144	Cone for No. 26143	25
19480	Lock washer for all Form D suspensions	3

SUSPENSIONS—FORM D

Single Trolley

STRAIGHT LINE

Overall length $6\frac{1}{2}$ in.; height above ear seat $2\frac{1}{8}$ in.; arm yokes accommodate $\frac{3}{8}$ in. span wire. Stud and body have standard sherardized finish.

Straight Line Suspension

Cat. No.	Description	Approx Weight per 100
37979	Straight line suspension, $\frac{5}{8}''$ stud	195
37981	Straight line suspension, $\frac{3}{4}''$ stud	200
39700	Straight line body	100

Single Curve Suspension

SINGLE CURVE

Distance between center line of stud and center of pull off eye $4\frac{5}{8}$ in.; diameter of pull off eye $\frac{9}{16}$ in.; thickness of arm at eye $\frac{1}{2}$ in. Stud and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
37983	Single curve suspension, $\frac{5}{8}''$ stud	245
37984	Single curve suspension, $\frac{3}{4}''$ stud	250
39701	Single curve body	150

DOUBLE CURVE

Double Curve Suspension

Length between centers of eyes $9\frac{1}{4}$ in.; diameter of pull off eye $\frac{9}{16}$ in.; thickness of arms at eyes $\frac{1}{2}$ in. Stud and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
37986	Double curve suspension, $\frac{5}{8}''$ stud	295
37988	Double curve suspension, $\frac{3}{4}''$ stud	300
39702	Double curve body	200

Ceiling Suspension

CEILING

Height above ear seat $2\frac{7}{16}$ in.; diameter of screw holes $\frac{9}{16}$ in. Stud and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
37991	Ceiling suspension, $\frac{5}{8}''$ stud	350
37993	Ceiling suspension, $\frac{3}{4}''$ stud	355
39703	Ceiling body	250

SUSPENSIONS—FORM D
SINGLE TROLLEY

STRAIN

Strain Suspension

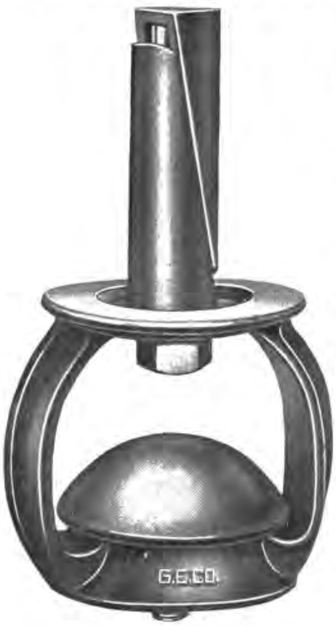
Overall length $7\frac{1}{2}$ in.; diameter of pull off eyes $\frac{7}{16}$ in.; arm yokes accommodate $\frac{3}{8}$ in. span wire. Stud and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
37997	Strain suspension, $\frac{5}{8}''$ stud	245
60015	Strain suspension, $\frac{3}{4}''$ stud	250
39705	Strain body	150

MINING

The height of the Form D mining suspension from the top of the ear seat to the top of the body is $4\frac{5}{16}$ inches.

The suspensions are listed with both roof bolt and wedges, and with the 4 in. expansion bolt; for the former the roof drilling should be $1\frac{3}{8}$ in. in diameter, and for the latter $1\frac{1}{4}$ in. in diameter; the depth of the hole being at least 4 in. in either case.



Mining Suspension With Roof Bolt and Wedges

Greatest diameter 5 in.; diameter of top body flange 4 in.; height of body $4\frac{5}{16}$ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
37995	Mining suspension, $\frac{5}{8}''$ stud with roof bolt and wedges	510
40969	Mining suspension, $\frac{3}{4}''$ stud with roof bolt and wedges	515
68937	Mining suspension, $\frac{5}{8}''$ stud with 4″ expansion bolt	490
68939	Mining suspension, $\frac{3}{4}''$ stud with 4″ expansion bolt	495
39704	Mining body	285
41069	Roof bolt ($\frac{5}{8}''$-11, 5″ special) with nut	50
35690	Upper roof wedge	45
35691	Lower roof wedge	35
68397	Expansion bolt, 4″ long with nut	110

Mining Suspension With Expansion Bolt

Bracket Suspension

BRACKET

For suspensions for 2 in. pipe the height from ear seat to center of bracket arm clamp is $3\frac{1}{2}$ in.; for $1\frac{1}{2}$ in. pipe the height is $3\frac{1}{4}$ in. All metal parts including studs have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
38005	Bracket Suspension, $\frac{5}{8}''$ stud, for 2″ pipe	400
60016	Bracket Suspension, $\frac{3}{4}''$ stud, for 2″ pipe	405
38008	Bracket Suspension, $\frac{5}{8}''$ stud, for $1\frac{1}{2}''$ pipe	375
60017	Bracket Suspension, $\frac{3}{4}''$ stud, for $1\frac{1}{2}''$ pipe	380
39706	Bracket Body, for 2″ pipe	305
39707	Bracket Body, for $1\frac{1}{2}''$ pipe	280

SUSPENSIONS—FORM D

DOUBLE TROLLEY

The Form D Double Trolley Suspensions are particularly suited for use where there is a difference of potential between the two wires, inasmuch as they insulate the wires from each other. This separate insulation of the wires is essential where they are fed from different sources, for example, where two companies operate over the same track.

The distance between centers is 6½ in. which allows ample space for frog and crossing devices where double trolley turnouts are installed.

The bodies are heavier throughout than the bodies of corresponding single trolley suspensions and are fully adequate to the stresses of the heaviest line construction.

STRAIGHT LINE

Straight Line Suspension

Overall length 13¼ in.; distance between centers of studs 6½ in.; arm yokes accommodate ⅜ in. span wire. Studs and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
38010	Straight Line Suspension, ⅝" stud	470
38012	Straight Line Suspension, ¾" stud	480
39708	Straight Line Body	280

SINGLE CURVE

Single Curve Suspension

Length between center line of outer stud and center of pull off eye 11⅛ in.; distance between centers of studs 6½ in.; diameter of pull off eye 9/16 in.; thickness of pull off arm at eye ½ in. Studs and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
38014	Double Trolley, Single Curve Suspension, ⅝" stud	500
38016	Double Trolley, Single Curve Suspension, ¾" stud	510
39709	Double Trolley, Single Curve Body	310

SUSPENSIONS—FORM D

DOUBLE CURVE

Double Curve Suspension

Length between centers of pull off eyes $15\frac{3}{4}$ in.; distance between centers of studs $6\frac{1}{2}$ in.; diameter of pull off eyes $\frac{9}{16}$ in.; thickness of pull off arms at eye $\frac{1}{2}$ in. Studs and body have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
39927	Double Trolley, Double Curve Suspension, $\frac{5}{8}''$ stud	565
39928	Double Trolley, Double Curve Suspension, $\frac{3}{4}''$ stud	575
39710	Double Trolley, Double Curve Body	375

SUSPENSIONS—FORM G

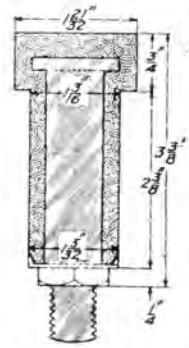
Section of Form G Suspension

The Form G Suspensions consist of malleable iron castings and insulated bolts assembled as indicated in the sectional view. The insulated bolt is held firmly in place by a cap casting threaded to the body casting. A dead load of over 6 tons is required to crush the insulation between the stud cap of the insulated bolt and the body casting. Particular attention is called to a new feature of the insulated bolt: The shoulder of the forged steel bolt is under cut providing a considerable recess into which the insulating compound is moulded. The effect of the undercut is to provide a flange which very effectively binds the compound to the bolt at the point which otherwise would be weakest.

INSULATED BOLTS

Insulated Bolts, Cat. Nos. 17207 and 62561 are interchangeable for all Form G suspensions, having studs of corresponding diameter, and fit all standard ears except the automatic ear, Cat. No. 17338, for which a special insulated bolt, Cat. No. 17341, with pointed stud is provided. All three insulated bolts are alike excepting in their studs. The studs have standard sherardized finish.

Cat. No. 17207



Cross Section of Insulated Bolts

Cat. No. 17341

Cat. No.	Description	Approx. Weight per 100
17207	Insulated Bolt, $\frac{5}{8}$" stud	90
62561	Insulated Bolt, $\frac{3}{4}$" stud	95
17341	Insulated Bolt, $\frac{5}{8}$" stud for Automatic Ear, Cat. No. 17338	95

SUSPENSIONS—FORM G

STRAIGHT LINE

Straight Line Suspension

Overall length across arms 6 in.; height above ear seat $3\frac{7}{8}$ in.; arm yokes accommodate $\frac{3}{8}$ in. span wire. All metal parts including studs have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
25976	Straight Line Suspension, $\frac{5}{8}''$ stud	245
66019	Straight Line Suspension, $\frac{3}{4}''$ stud	250
25977	Body	120
25978	Cap	35

SINGLE CURVE

Single Curve Suspension

Length from center line of stud to center of pull off eye 4 in.; height above ear seat $3\frac{7}{8}$ in.; diameter of pull off eye $\frac{9}{16}$ in.; thickness of pull off arm at eye $\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
25981	Single Curve Suspension, $\frac{5}{8}''$ stud	270
66022	Single Curve Suspension, $\frac{3}{4}''$ stud	275
25982	Body	145
25978	Cap	35

SUSPENSIONS—FORM G

DOUBLE CURVE

Double Curve Suspension

Length between centers of pull off eyes 8 in.; height above ear seat $3\frac{7}{8}$ in.; diameter of pull off eyes $\frac{9}{16}$ in.; thickness of pull off arm at eye $\frac{1}{2}$ in. All metal parts including stud have standard sherardized finish

Cat. No.	Description	Approx. Weight per 100
25984	Double Curve Suspension, $\frac{5}{8}''$ stud	310
66025	Double Curve Suspension, $\frac{3}{4}''$ stud	315
25985	Body	185
25978	Cap	35

CEILING

Ceiling Suspension

Height above ear seat $3\frac{9}{16}$ in.; diameter of screw holes $\frac{9}{16}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx Weight per 100
25998	Ceiling Suspension, $\frac{5}{8}''$ stud	225
66034	Ceiling Suspension, $\frac{3}{4}''$ stud	230
25991	Body	75
25999	Cap	60

SUSPENSIONS—FORM G

SOCKET CEILING

Socket Ceiling Suspension

Height above ear seat $3\frac{7}{16}$ in.; width of screw slots $\frac{9}{16}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
38690	Socket Ceiling Suspension, $\frac{5}{8}$" stud	170
68399	Socket Ceiling Suspension, $\frac{3}{4}$" stud	175
38691	Body	80

BRACKET

Bracket Suspension

For suspensions for 2 in. pipe the height from ear seat to center of bracket arm clamp is $6\frac{1}{2}$ in.; for $1\frac{1}{2}$ in.pipe the height is $6\frac{1}{4}$ in. All metal parts including stud have standard sherardized finish.

Cat. No.	Description	Approx. Weight per 100
25989	Bracket Suspension, $\frac{5}{8}$" stud for 2" pipe	480
66028	Bracket Suspension, $\frac{3}{4}$" stud for 2" pipe	485
25990	Bracket Suspension, $\frac{5}{8}$" stud for $1\frac{1}{2}$" pipe	460
66030	Bracket Suspension, $\frac{3}{4}$" stud for $1\frac{1}{2}$" pipe	465
25991	Body	75
25995	Cap	40
25996	Clamp for 2" pipe	275
25997	Clamp for $1\frac{1}{2}$" pipe	255

SUSPENSIONS—FORM T

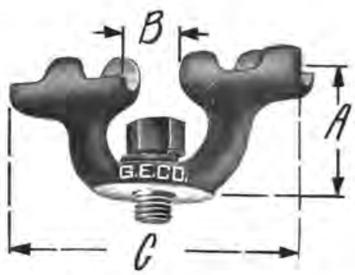
FEEDER TAP

The Feeder Tap Suspensions will fit any standard ear, except the automatic ear, Cat. No. 17338, and are used in place of the insulated suspensions, a tap from the feeder wire being substituted for the regular span wire. The bodies of these suspensions are composition with the lugs tinned for soldering to the span wire.

Straight Line Suspension

Overall length 6 in.; yokes accommodate $\frac{3}{8}$ in. span wire.

Cat. No.	Description	Approx. Weight per 100
11294	Straight Line Feeder Suspension, $\frac{5}{8}''$ stud comp.	85
11296	Straight Line Feeder Suspension, $\frac{3}{4}''$ stud comp.	90

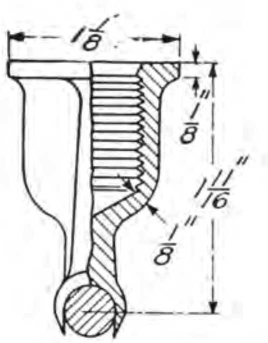


Feeder Clamp Suspension

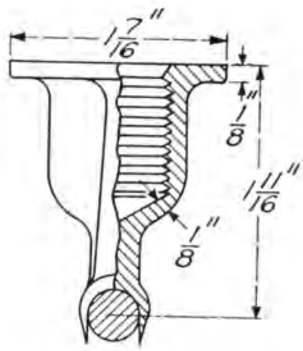
Cat. No.	Description	A	B	C	Approx. Weight per 100
16380	Feeder Clamp Suspension, $\frac{5}{8}''$ stud comp. for 1/0 feeder wire	$1\frac{15}{16}''$	$1\frac{1}{8}''$	$5\frac{1}{2}''$	90
48807	Feeder Clamp Suspension, $\frac{3}{4}''$ stud comp. for 1/0 feeder wire	$1\frac{15}{16}''$	$1\frac{1}{8}''$	$5\frac{1}{2}''$	95
61567	Feeder Clamp Suspension, $\frac{5}{8}''$ stud comp. for 4/0 feeder wire	$2\frac{1}{32}''$	$1\frac{3}{8}''$	$5\frac{3}{4}''$	225
48808	Feeder Clamp Suspension, $\frac{3}{4}''$ stud comp. for 4/0 feeder wire	$2\frac{1}{32}''$	$1\frac{3}{8}''$	$5\frac{3}{4}''$	230

EARS FOR ROUND WIRE

SOLDERED



Form H



Form H2

Soldered Ears for round wire are furnished in two Forms—the "H" and the "H2" which differ only in the diameter of the hub flange. The Form H with a $1\frac{1}{8}$ in. flange is particularly suitable for use with suspensions of the insulated bolt type, Form G. The Form H2 ears have a $1\frac{7}{16}$ in. hub flange and are especially suitable for suspensions presenting a large bearing surface at the base of their studs, such as the Forms H, S and D.

These ears have a groove depth equal to the diameter of the wire so that when the lips are peened down and soldered the bottom of the wire is exposed, allowing unobstructed passage of the trolley wheel.

In the design of these ears all angles are filled with generous fillets, and in their manufacture extreme care is exercised to maintain accurate dimensions of the milled grooves and of the lips which are tapered to a knife edge.

Grooves are milled to exact dimensions and, unless specially ordered, are tinned for soldering.

9 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
16034	Form H, for No. 0 wire, ⅝" tap	54
15157	Form H, for No. 00 wire, ⅝" tap	62
31666	Form H2, for No. 0 wire, ⅝" tap	57
31668	Form H2, for No. 00 wire, ⅝" tap	68

12 IN. PLAIN

32562	Form H, for No. 0 wire, ⅝" tap	63
32564	Form H, for No. 00 wire, ⅝" tap	72
32563	Form H2, for No. 0 wire, ⅝" tap	66
32565	Form H2, for No. 00 wire, ⅝" tap	85

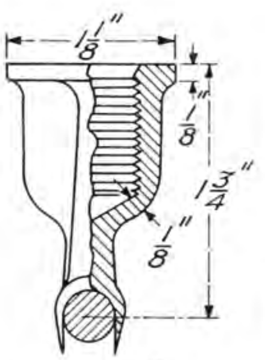
EARS FOR ROUND WIRE

SOLDERED

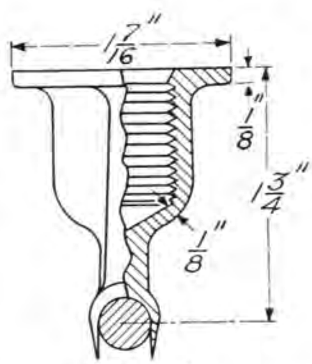
15 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
16394	Form H, for No. 0 wire, $\frac{5}{8}''$ tap	82
15022	Form H, for No. 00 wire, $\frac{5}{8}''$ tap	94
31665	Form H2, for No. 0 wire, $\frac{5}{8}''$ tap	88
31667	Form H2, for No. 00 wire, $\frac{5}{8}''$ tap	104
34111	Form H2, for No. 000 wire, $\frac{5}{8}''$ tap	122
26151	Form H2, for No. 000 wire, $\frac{3}{4}''$ tap	122
34112	Form H2, for No. 0000 wire, $\frac{5}{8}''$ tap	128
19492	Form H2, for No. 0000 wire, $\frac{3}{4}''$ tap	128

CLINCH



Form J



Form J2

Clinch Ears for round wire are furnished in two forms,—the "J" and the "J2" which differ only in the diameter of the hub flange. The Form J, with a $1\frac{1}{8}$ in. flange is particularly suitable for use with suspensions of the insulated bolt type, Form G. The Form J2 ears have a $1\frac{7}{16}$ in. hub flange and are especially suitable for suspensions presenting a large bearing surface at the base of their studs, such as the Forms H, S and D.

The Clinch Ears have an extra deep groove so that the lips approximately meet beneath the wire and are generally used without solder.

In the design of these ears all angles are filled with generous fillets, and in their manufacture extreme care is exercised to maintain accurate dimensions of the milled grooves and of the lips which are tapered to a knife edge.

Grooves are milled to exact dimensions and unless specially ordered are furnished untinned.

CLINCH

9 IN. PLAIN

Cat. No.	Description	Approx Weight per 100
32574	Form J, for No. 0 wire, $\frac{5}{8}''$ tap	57
32576	Form J, for No. 00 wire, $\frac{5}{8}''$ tap	63
32575	Form J2, for No. 0 wire, $\frac{5}{8}''$ tap	69
32577	Form J2, for No. 00 wire, $\frac{5}{8}''$ tap	74

EARS FOR ROUND WIRE

CLINCH

12 IN. PLAIN

Cat. No	Description	Approx. Weight per 100
32570	Form J, for No. 0 wire, 5/8" tap	72
32572	Form J, for No. 00 wire, 5/8" tap	82
32571	Form J2, for No. 0 wire, 5/8" tap	75
32573	Form J2, for No. 00 wire, 5/8" tap	85

15 IN. PLAIN

19424	Form J, for No. 0 wire, 5/8" tap	85
19425	Form J, for No. 00 wire, 5/8" tap	94
32568	Form J2, for No. 0 wire, 5/8" tap	88
32569	Form J2, for No. 00 wire, 5/8" tap	97
34113	Form J2, for No. 000 wire, 5/8" tap	124
32566	Form J2, for No. 000 wire, 3/4" tap	124
34114	Form J2, for No. 0000 wire, 5/8" tap	140
32567	Form J2, for No. 0000 wire, 3/4" tap	140

SOLDERED

All feeder, strain and splicing ears for use on round wire are of the deep groove form as denoted by the letter J. The 0 and 00 sizes have hub flanges $1\frac{1}{8}$ in. in diameter and the 000 and 0000 sizes have $1\frac{7}{16}$ in. flanges, the size of the flange being indicated by the absence or presence of the numerical exponent (2) after the form letter.

All these ears are designed for soldering and unless especially ordered are furnished with tinned lips.

15 IN. FEEDER

Cat. No.	Description	Approx. Weight per 100
15120	Form J, for No. 0 wire, 5/8" tap	95
15121	Form J, for No. 00 wire, 5/8" tap	100
34115	Form J2, for No. 000 wire, 5/8" tap	145
26152	Form J2, for No. 000 wire, 3/4" tap	145
34116	Form J2, for No. 0000 wire, 5/8" tap	155
26153	Form J2, for No. 0000 wire, 3/4" tap	155
39896	Set screw for above feeder ears, 14-24, 1/2" long, square head	

The feeder lug of the 0 and 00 ears is drilled to take 00 B. & S. solid wire. The 000 and 0000 ears take wire up to and including 0000 B. & S.

EARS FOR ROUND WIRE

SOLDERED

15 IN. STRAIN

Cat. No.	Description	Approx. Weight per 100
68446	Form J, for No. 0 wire, $\frac{5}{8}''$ tap	100
60348	Form J, for No. 00 wire, $\frac{5}{8}''$ tap	110
60349	Form J2, for No. 000 wire, $\frac{5}{8}''$ tap	150
60350	Form J2, for No. 0000 wire, $\frac{5}{8}''$ tap	190

19 IN. STRAIN

15140	Form J, for No. 0 wire, $\frac{5}{8}''$ tap	130
15147	Form J, for No. 00 wire, $\frac{5}{8}''$ tap	145
34117	Form J2, for No. 000 wire, $\frac{5}{8}''$ tap	205
26156	Form J2, for No. 000 wire, $\frac{3}{4}''$ tap	205
34118	Form J2, for No. 0000 wire, $\frac{5}{8}''$ tap	250
26157	Form J2, for No. 0000 wire, $\frac{3}{4}''$ tap	250

SINGLE END STRAIN

30459	8″, for No. 0 wire	40
30460	8″, for No. 00 wire	50
34121	9″, for No. 000 wire	60
34122	9″, for No. 0000 wire	70

EARS FOR ROUND WIRE

SOLDERED

13 1/4 IN. DOUBLE BOSS STRAIN FOR USE WITH STRAIN PLATES

Cat. No.	Description	Approx. Weight per 100
88955	Form J2, for No. 0 wire, ⅝″ tap	130
88899	Form J2, for No. 00 wire, ⅝″ tap	150
88898	Form J2, for No. 000 wire, ⅝″ tap	200
59206	Form J2, for No. 000 wire, ¾″ tap	200
88897	Form J2, for No. 0000 wire, ⅝″ tap	245
59205	Form J2, for No. 0000 wire, ¾″ tap	245

15 IN. SPLICING

15138	Form J, for No. 0 wire, ⅝″ tap	125
12900	Form J, for No. 00 wire, ⅝″ tap	130
34119	Form J2, for No. 000 wire, ⅝″ tap	210
26154	Form J2, for No. 000 wire, ¾″ tap	210
34120	Form J2, for No. 0000 wire, ⅝″ tap	250
26155	Form J2, for No. 0000 wire, ¾″ tap	250

19 IN. SPLICING EARS—MECHANICAL

Equipped with large clamping nuts for holding trolley wire. No solder needed.

41189	For Nos. 0 and 00 wire, ⅝″ tap	400
41190	For Nos. 0 and 00 wire, ¾″ tap	400
30458	For Nos. 000 and 0000 wire, ⅝″ tap	585
41186	For Nos. 000 and 0000 wire, ¾″ tap	585

EARS FOR ROUND WIRE

SOLDERED CLINCH

16 1/2 IN. FLEXIBLE

These ears have hinged hubs to afford flexibility when used with rigid suspensions such as the Form D Bracket, and the various Ceiling and Mining Suspensions.

Cat. No.	Description	Approx. Weight per 100
17302	For No. 0 wire, $\frac{5}{8}''$ tap	175
19484	For No. 00 wire, $\frac{5}{8}''$ tap	195

SCREW CLAMP—FORM A

The ease of installation and removal of the Screw Clamp Ears for round wire make them increasingly useful, not only for temporary installations in mine work but also for more permanent work where comparatively slow speeds are encountered.

5 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
41047	For Nos. 0 and 00 wire, $\frac{5}{8}''$ tap, mal. iron, sherardized	70
41443	For Nos. 0 and 00 wire, $\frac{5}{8}''$ tap, comp.	80
66042	For Nos. 0 and 00 wire, $\frac{3}{4}''$ tap, mal. iron, sherardized	70
66044	For Nos. 0 and 00 wire, $\frac{3}{4}''$ tap, comp.	80
41049	For Nos. 000 and 0000 wire, $\frac{5}{8}''$ tap, mal. iron, sherardized	75
41444	For Nos. 000 and 0000 wire, $\frac{5}{8}''$ tap, comp.	85
66043	For Nos. 000 and 0000 wire, $\frac{3}{4}''$ tap, mal. iron, sherardized	75
66045	For Nos. 000 and 0000 wire, $\frac{3}{4}''$ tap, comp.	85

EARS FOR ROUND WIRE

FORM B CLAMPING EAR

This ear is provided with a thin metal sheath surrounding the wire.

Overall length 8 in.; height from center of trolley wire to top of hub $1\frac{5}{8}$ in.

Cat. No.	Description	Approx. Weight per 100
16379	Clamping Ear, Form B, $\frac{5}{8}$" tap, for Nos. 0 and 00 wires, comp.	85
15901	Clamping Sheath, for Cat No. 16379, copper	15
15902	Clamping Block, for Cat. No. 16379, mal. iron, sherardized	12
15903	Clamping Screw, for Cat. No. 16379, steel, sherardized	6

6 IN. AUTOMATIC EAR

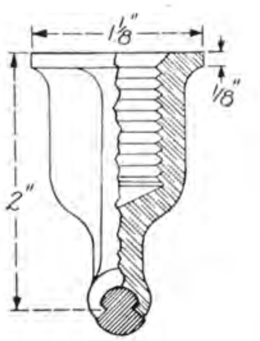
The Automatic Ear is clamped on the wire by the spreading action of a special pointed stud in the suspension, for which the special insulated bolt, Cat. No. 17341, is furnished with Form G suspensions.

This ear is often very useful for temporary work, and, together with the adapter, can be used with standard suspensions.

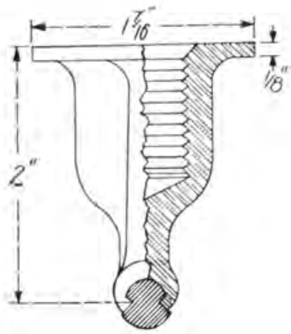
Cat. No.	Description	Approx. Weight per 100
17338	6" Automatic Ear, for Nos. 0 and 00 wires, $\frac{5}{8}$" tap, mal. iron, sherardized	125
17400	Adapter for No. 17338, $\frac{5}{8}$" tap and stud, comp.	50

EARS FOR GROOVED WIRE

SOLDERED CLINCH



Form P



Form P2

Clinch Ears for grooved wire are designed to be sprung on the wire by hand and the sides crimped together, making a snug fit. They are then usually soldered. The 00 ears are furnished with the hub flange either $1\frac{1}{8}$ in. or $1\frac{7}{16}$ in. in diameter; the difference being designated by the absence or presence of a numerical exponent after the form letter. Special attention is called to the fact that the grooves are formed to give an exact fit both at the groove bottom and the lips. The ears are furnished with lips tinned for soldering.

9 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
39876	Form P, for No. 00 wire, $\frac{5}{8}''$ tap	80
39879	Form P2, for No. 00 wire, $\frac{5}{8}''$ tap	85
40941	Form P2, for No. 000 wire, $\frac{5}{8}''$ tap	100
40942	Form P2, for No. 000 wire, $\frac{3}{4}''$ tap	100
40937	Form P2, for No. 0000 wire, $\frac{5}{8}''$ tap	120
40938	Form P2, for No. 0000 wire, $\frac{3}{4}''$ tap	120

12 IN. PLAIN

39877	Form P, for No. 00 wire, $\frac{5}{8}''$ tap	94
39880	Form P2, for No. 00 wire, $\frac{5}{8}''$ tap	100
40943	Form P2, for No. 000 wire, $\frac{5}{8}''$ tap	129
40944	Form P2, for No. 000 wire, $\frac{3}{4}''$ tap	129
40939	Form P2, for No. 0000 wire, $\frac{5}{8}''$ tap	140
40940	Form P2, for No. 0000 wire, $\frac{3}{4}''$ tap	140

EARS FOR GROOVED WIRE

SOLDERED CLINCH

15 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
39878	Form P, for No. 00 wire, $\frac{5}{8}$" tap	108
39881	Form P2, for No. 00 wire, $\frac{5}{8}$" tap	125
39882	Form P2, for No. 000 wire, $\frac{5}{8}$" tap	150
39883	Form P2, for No. 000 wire, $\frac{3}{4}$" tap	150
39884	Form P2, for No. 0000 wire, $\frac{5}{8}$" tap	170
39885	Form P2, for No. 0000 wire, $\frac{3}{4}$" tap	170

15 IN. FEEDER EARS

39891	Form P, for No. 00 wire, $\frac{5}{8}$" tap	140
39892	Form P2, for No. 000 wire, $\frac{5}{8}$" tap	185
39893	Form P2, for No. 000 wire, $\frac{3}{4}$" tap	180
39894	Form P2, for No. 0000 wire, $\frac{5}{8}$" tap	200
39895	Form P2, for No. 0000 wire, $\frac{3}{4}$" tap	200
39896	Set Screw for feeder ears, 14–24, $\frac{1}{4}$", square head	

The feeder boss on all 1/0 and 2/0 ears is drilled to take wire 2/0 and smaller. The 3/0 and 4/0 ears take feeder wires up to 4/0.

15 IN. STRAIN

60351	Form P, for No. 00 wire, $\frac{5}{8}$" tap	130
60352	Form P2, for No. 000 wire, $\frac{3}{4}$" tap	190

19 IN. STRAIN

39886	Form P, for No. 00 wire, $\frac{5}{8}$" tap	170
39887	Form P2, for No. 000 wire, $\frac{5}{8}$" tap	238
39888	Form P2, for No. 000 wire, $\frac{3}{4}$" tap	240
39889	Form P2, for No. 0000 wire, $\frac{5}{8}$" tap	290
39890	Form P2, for No. 0000 wire, $\frac{3}{4}$" tap	290

EARS FOR GROOVED WIRE

SOLDERED CLINCH

SINGLE END STRAIN

Cat. No.	Description	Approx. Weight per 100
68442	8″ Half Strain Ear for No. 00 wire	60
68444	9″ Half Strain Ear for No. 000 wire	75
68445	9″ Half Strain Ear for No. 0000 wire	90

13 1/4 IN. DOUBLE BOSS STRAIN EARS

FOR USE WITH STRAIN PLATES

88896	Form P2, for No. 00 wire, $\frac{5}{8}$″ tap	170
88894	Form P2, for No. 000 wire, $\frac{5}{8}$″ tap	225
59203	Form P2, for No. 000 wire, $\frac{3}{4}$″ tap	225
88895	Form P2, for No. 0000 wire, $\frac{5}{8}$″ tap	270
59204	Form P2, for No. 0000 wire, $\frac{3}{4}$″ tap	270

SPLICING EARS—SOLDERED

Designed for soldering in same manner as soldered splicing sleeves.

19436	19½″ Splicing Ear for No. 00 wire, $\frac{5}{8}$″ tap	225
21487	19½″ Splicing Ear for No. 00 wire, $\frac{3}{4}$″ tap	225
19437	21½″ Splicing Ear for No. 000 wire, $\frac{5}{8}$″ tap	250
21488	21½″ Splicing Ear for No. 000 wire, $\frac{3}{4}$″ tap	250
19438	23½″ Splicing Ear for No. 0000 wire, $\frac{5}{8}$″ tap	285
21454	23½″ Splicing Ear for No. 0000 wire, $\frac{3}{4}$″ tap	285

EARS FOR GROOVED WIRE

19 IN. SPLICING EARS—MECHANICAL

Cat. No.	Description	Approx. Weight per 100
41187	For Nos. 00 and 000 wire, $\frac{5}{8}''$ tap	400
41188	For Nos. 00 and 000 wire, $\frac{3}{4}''$ tap	400
30458	For No. 0000 wire, $\frac{5}{8}''$ tap	585
41186	For No. 0000 wire, $\frac{3}{4}''$ tap	585

SCREW CLAMP—FORM A

The form of the grooved trolley wire permits the use of a clamping ear which holds the wire with perfect security, and at the same time offers no obstruction to the passage of the trolley wheel.

Diagram Showing How The Clamping Ear Holds Grooved Trolley Wire

Diameter flange $1\frac{7}{16}$ in.; Thickness $\frac{1}{8}$ in.; Height 2 in.

The lips of the ears are so shaped as to give a four-point bearing in the grooves which prevents any tendency of the wire to roll out of the ear as a result of tortional or transverse stress.

The 5 in. and 7 in. Plain Ears are listed in both malleable iron and composition.

The Feeder and Strain Ears are composition with lips tinned for soldering to the wire.

All Screw Clamp Ears for grooved wires are interchangeable on Nos. 00, 000 and 0000 wire. They have $1\frac{7}{16}$ in. hub flanges and have $\frac{5}{16}$–18 screws.

5 IN. PLAIN

Cat. No.	Description	Approx. Weight per 100
37804	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, mal. iron, sherardized	66
27627	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, comp.	75
59564	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, mal. iron, sherardized	66
30310	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, comp.	75

EARS FOR GROOVED WIRE

SCREW CLAMP EARS—FORM A

7 IN. PLAIN

The 7 in. Plain Ears, being designed especially for use with Nos. 000 and 0000 grooved wires, are extra heavy throughout.

Cat. No.	Description	Approx. Weight per 100
37805	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, mal. iron, sherardized	88
34124	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, comp.	100
37806	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, mal. iron, sherardized	88
27628	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, comp.	100

10 IN. CURVE

The Curve Ears may also be advantageously employed in straight line construction, especially with Nos. 000 and 0000 wires.

37808	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, mal. iron, sherardized	125
37685	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, mal. iron, sherardized	125

14 IN. CURVE

59568	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, mal. iron, sherardized	185
43716	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, mal. iron, sherardized	185

7 IN. FEEDER—WITH SUSPENSION BOSS

59565	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, comp.	115
59566	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, comp.	115

These feeder ears will accommodate feeder wire up to and including 4/0.

EARS FOR GROOVED WIRE

SCREW CLAMP EARS—FORM A

7 IN. FEEDER—WITHOUT SUSPENSION BOSS

Cat. No.	Description	Approx. Weight per 100
48455	For Nos. 00, 000 and 0000 wires, comp.	100

This ear will accommodate feeder wire up to and including 4/0.

12 IN. STRAIN

Cat. No.	Description	Approx. Weight per 100
34127	For Nos. 00, 000 and 0000 wires, $\frac{5}{8}''$ tap, comp.	165
21485	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, comp.	165

12 IN. STRAIN—EXTRA HEAVY

Cat. No.	Description	Approx. Weight per 100
59567	For Nos. 00, 000 and 0000 wires, $\frac{3}{4}''$ tap, comp.	200

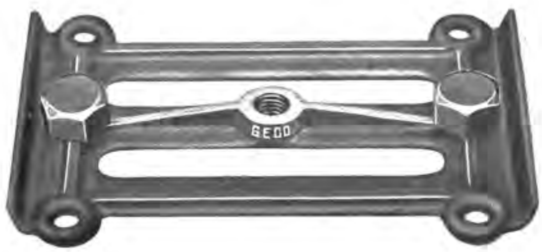
7 IN. HALF STRAIN

Cat. No.	Description	Approx. Weight per 100
61232	For Nos. 00, 000 and 0000 wires, comp.	90

STRAIN PLATES

Strain Plate with Double Boss Ear

The Strain Plate consists of a malleable iron casting designed for support at the center by any standard straight line hanger, the center hole being tapped for either $\frac{5}{8}$ in. or $\frac{3}{4}$ in. stud. $\frac{1}{2}$ in. holes are provided at each corner of the plate for attachment of guy wires. The double boss ears listed on pages 46 and 51 are generally used with the strain plate, though the use of two screw clamp ears either 5 in. or 7 in. long, is sometimes preferred.



Overall length 10 in.; length between centers of pull off eyes $7\frac{3}{4}$ in.; length between centers of stud bolts $7\frac{3}{4}''$; overall width $6\frac{3}{4}$ in.; width between centers of pull off eyes $5\frac{1}{2}$ in. Standard sherardized finish throughout.

Cat. No.	Description	Approx. Weight per 100
62537	Strain Plate only, $\frac{5}{8}''$ tap, $\frac{5}{8}''$ studs	300
62536	Strain Plate only, $\frac{3}{4}''$ tap, $\frac{3}{4}''$ studs	310

SOLDERED SPLICING SLEEVES

In order to secure the greatest possible strength, Soldered Splicing Sleeves are made from hard drawn seamless tubing, so annealed as to relieve all internal strains in the metal and avoid all danger of weather cracks to which hard drawn brass is liable under exposure to the weather and extreme temperature changes. The sleeves are accurately tapered to insure smooth transition of the trolley wheel and resist the wear encountered in severe service. Since the weakest point of any sleeve must be at the slot, especial precautions are taken in forming it, and no more of the metal is cut away than is necessary to permit rapid installation on the trolley wire. The sleeves are tinned for soldering.

BRASS SLEEVES (STANDARD)

Cat. No.	Description	Approx. Weight per 100
64431	For No. 0 round wire, 10″x $\frac{5}{8}$″	50
64432	For No. 0 round wire, 15″ x $\frac{5}{8}$″	75
64433	For No. 00 round or grooved wire, 10″ x $\frac{5}{8}$″	55
64434	For No. 00 round or grooved wire, 16″ x $\frac{5}{8}$″	75
64435	For No. 000 round or grooved wire, 11″ x $\frac{3}{4}$″	90
64436	For No. 000 round or grooved wire, 18″ x $\frac{3}{4}$″	130
64437	For No. 0000 round or grooved wire, 12″ x $\frac{7}{8}$″	150
64438	For No. 0000 round or grooved wire, 20″ x $\frac{7}{8}$″	210

PURE COPPER SLEEVES

88641	For No. 0 round wire, 15″ x $\frac{5}{8}$″	80
88651	For No. 00 round or grooved wire, 16″ x $\frac{5}{8}$″	80
88672	For No. 000 round or grooved wire, 18″ x $\frac{3}{4}$″	130
88785	For No. 0000 round or grooved wire, 20″ x $\frac{7}{8}$″	200

MECHANICAL SPLICING SLEEVES

For use without solder. Made of brass with tempered steel wedges.

Cat. No.	Description	Approx. Weight per 100
64441	For No. 0 round wire, 10″ long	75
64442	For No. 00 round or grooved wire, 11″ long	90
64443	For No. 000 round or grooved wire, 11″ long	115
64444	For No. 0000 round or grooved wire, 12″ long	125

STRAIN INSULATORS

GIANT

Recent radical improvements in design give the Giant Strain Insulator a largely increased mechanical strength and a dielectric strength to care for the potentials encountered in direct suspension work. The insulation under stress is exclusively sheet mica (under compression) and the limit of its mechanical strength is the rupturing limit of the metal parts without regard to temperature or other service conditions. The insulators are made in two sizes, having 2 in. and $2\frac{5}{8}$ in. diameters, and equipped with standard and large eyes and standard and large clevises in any combination. All metal parts are sherardized.

STRENGTH

MECHANICAL			ELECTRICAL		
	2″	$2\frac{5}{8}$″		2″	$2\frac{5}{8}$″
Test load	2500 lbs.	4000 lbs.	Test voltage	5000 v.	5000 v.
Average breaking load	5000 lbs.	8000 lbs.	Average breakdown voltage	12000 v.	15000 v.

DIMENSIONS

DIMENSIONS OF EYES			DIMENSIONS OF CLEVISES		
	Inside Diam.	Outside Diam		Spread	Diam. of Through Bolt
Standard eye for 2″ ins.	$\frac{9}{16}$″	$1\frac{5}{16}$	Standard clevis for 2″ ins.	$\frac{9}{16}$″	$\frac{3}{8}$″
Large eye for 2″ ins.	$\frac{11}{16}$″	$1\frac{9}{16}$″	Standard clevis for $2\frac{5}{8}$″ ins.	$\frac{5}{8}$″	$\frac{1}{2}$″
Standard eye for $2\frac{5}{8}$″ ins.	$\frac{9}{16}$″	$1\frac{7}{16}$″	Large clevis for $2\frac{5}{8}$″ ins.	$\frac{3}{4}$″	$\frac{5}{8}$″
Large eye for $2\frac{5}{8}$″ ins.	$\frac{13}{16}$″	$1\frac{13}{16}$″			

2 IN. GIANT

Cat. No. 64425

Cat. No. 64417

Cat. No.	Description	Distance Between Centers of Eyes or Clevis Bolt Holes	Approx. Weight per 100
64417	With standard eye and clevis	$4\frac{5}{32}$″	105
64418	With 2 standard clevises	$4\frac{19}{32}$″	115
64419	With large eye and standard clevis	$4\frac{9}{32}$″	110
64425	With 2 standard eyes	$3\frac{23}{32}$″	87
64427	With large eye and standard eye	$3\frac{27}{32}$″	92
64428	With 2 large eyes	$3\frac{31}{32}$″	95

STRAIN INSULATORS

2 5/8 IN. GIANT

Cat. No. 64426

Cat. No. 64420

Cat. No.	Description	Distance Between Centers of Eyes or Clevis Bolt Holes	Approx Weight per 100
64420	With standard eye and clevis	$4\frac{7}{16}''$	165
64421	With standard eye and large clevis	$4\frac{7}{16}''$	173
64422	With large eye and large clevis	$4\frac{5}{8}''$	182
64423	With 2 standard clevises	$4\frac{7}{8}''$	180
64424	With 2 large clevises	$4\frac{7}{8}''$	200
64426	With 2 standard eyes	$4''$	155
64429	With large eye and standard eye	$4\frac{3}{16}''$	165
64430	With 2 large eyes	$4\frac{3}{8}''$	200

SPHERICAL

The Spherical Strain Insulators are made in two sizes having diameters $2\frac{1}{4}$ in. and $2\frac{3}{4}$ in. They are designed especially for use in span and guy wires in relatively light construction. The smaller size is suitable for a working load of 1000 lbs.; the average tensile strength is 3000 lbs. The $2\frac{3}{4}$ in. size has an average tensile strength of 5000 lbs., and is suitable for a working load up to 2000 lbs. Both sizes are subjected to a potential test of 5000 volts.

DIMENSIONS OF EYES	Inside Diam.	Outside Diam.	DIMENSIONS OF CLEVISES	Spread	Diam. of Through Bolt
Eye for $2\frac{1}{4}''$ insulator	$\frac{17}{32}''$	$1\frac{1}{4}''$	Clevis for $2\frac{1}{4}''$ insulator	$\frac{17}{32}''$	$\frac{1}{2}''$
Eye for $2\frac{3}{4}''$ insulator	$\frac{17}{32}''$	$1\frac{1}{4}''$	Clevis for $2\frac{3}{4}''$ insulator	$\frac{17}{32}''$	$\frac{1}{2}''$

Cat. No. 27378

Cat. No. 27380

Cat. No.	Description	Distance Between Centers of Eyes or Clevis Bolt Holes	Approx. Weight per 100
27378	$2\frac{1}{4}''$ insulator, with mal. iron eyes, sherardized	$3\frac{9}{16}''$	85
16399	$2\frac{1}{4}''$ insulator, with comp. eyes	$3\frac{9}{16}''$	85
27380	$2\frac{3}{4}''$ insulator, with mal. iron eyes, sherardized	$4''$	125
17221	$2\frac{3}{4}''$ insulator, comp. eyes	$4''$	125

Cat. No. 27379

Cat. No. 27381

27379	$2\frac{1}{4}''$ insulator, with mal. iron eye and clevis, sherardized	$4''$	130
16400	$2\frac{1}{4}''$ insulator, with comp. eye and clevis	$4''$	130
27381	$2\frac{3}{4}''$ insulator, with mal. iron eye and clevis, sherardized	$4\frac{7}{16}''$	155
17222	$2\frac{3}{4}''$ insulator, with comp. eye and clevis	$4\frac{7}{16}''$	155

STRAIN INSULATORS

WOOD

WITH TWO EYES

The Wood Strain Insulators are made from selected hickory, treated by a special oil impregnating process which permanently excludes moisture. All end caps have standard sherardized finish.

Cat. No.	A	B	C	D	Test Load	Average Breaking Load	Approx. Weight per 100
16727	9½″	5″	1″	$\frac{9}{16}$″	3500 lbs.	7000 lbs.	140
37488	9½″	5″	1¼″	$\frac{9}{16}$″	5000 lbs.	10000 lbs.	175
61563	12 ″	5″	1¾″	¾″	7500 lbs.	15000 lbs.	440
37489	20 ″	15″	1″	$\frac{9}{16}$″	3500 lbs.	7000 lbs.	180
36313	20 ″	15″	1¼″	$\frac{9}{16}$″	5000 lbs.	10000 lbs.	235
48433	28½″	24″	1¼″	$\frac{9}{16}$″	5000 lbs.	10000 lbs.	300

WITH EYE AND CLEVIS

Cat. No.	A	B	C	D	E	Test Load	Average Breaking Load	Approx. Weight per 100
43229	9¾″	5″	1″	$\frac{9}{16}$″	$\frac{17}{32}$″	3500 lbs.	7000 lbs.	160
43230	9¾″	5″	1¼″	$\frac{9}{16}$″	$\frac{17}{32}$″	5000 lbs.	10000 lbs.	185
43231	20¼″	15″	1″	$\frac{9}{16}$″	$\frac{17}{32}$″	3500 lbs.	7000 lbs.	225
43232	20¼″	15″	1¼″	$\frac{9}{16}$″	$\frac{17}{32}$″	5000 lbs.	10000 lbs.	295

Clevis has $\frac{17}{32}$ in. bolt hole and ½ in. bolt.

WITH EYE AND TAPPED BOSS

Cat. No.	A	B	C	D	Tap	Test Load	Average Breaking Load	Approx. Weight per 100
17030	9¼″	5″	1″	$\frac{9}{16}$″	⅝″-11	3500 lbs.	7000 lbs.	110
100126	9¼″	5″	1¼″	$\frac{9}{16}$″	⅝″-11	5000 lbs.	10000 lbs.	190

TURNBUCKLES

INSULATED TURNBUCKLE

Insulated turnbuckles are provided with drop forged steel eyebolts. In turnbuckles with malleable iron castings, the eyebolts are sherardized to prevent rusting and in the composition turnbuckles the eyebolt is heavily plated with copper. The casting is made in two halves which fit around the head of the insulated portion and are then riveted together, thus affording a resistance to tensile strain limited only by the ultimate breaking point of the solid metal. The swivel bearing is metal to metal and is designed so that there is no relative motion between the insulated portion and the adjoining head. The maximum draw-up for both sizes is 4 in.

Cat. No.	Description	Test Load	Average Breaking Load	Max. Length Between Eyes	Diameter of Eyes	Approx. Weight per 100
27382	$\frac{5}{8}$" bolt, mal. iron, sherardized	4000 lbs.	8000 lbs.	$11\frac{3}{4}$"	$\frac{3}{4}$"	325
17223	$\frac{5}{8}$" bolt, comp.	2500 lbs.	5000 lbs.	$11\frac{3}{4}$"	$\frac{3}{4}$"	350
40802	$\frac{3}{4}$" bolt, mal. iron, sherardized	7000 lbs.	14000 lbs.	12"	1"	350
40803	$\frac{3}{4}$" bolt, comp.	4500 lbs.	9000 lbs.	12"	1"	375

TURNBUCKLE WITH INSULATED EYE

This consists of a forged steel turnbuckle with one eye insulated with moulded compound, protected on the inside by a special steel ring having its edges beveled to prevent cutting the guy wire. These turnbuckles have standard sherardized finish.

Turnbuckle with Insulated Eye

Cat. No.	Description	Test Load	Average Breaking Load	Max. Take-up	Diam. Bolt	Max. Length Between Centers of Eyes	Approx. Weight per 100
27383	Forged turnbuckle, with ins. eye	3000 lbs.	6000 lbs.	$6\frac{1}{2}$"	$\frac{1}{2}$"	$18\frac{3}{4}$"	275
100293	Forged turnbuckle, with ins. eye	4000 lbs.	8000 lbs.	$6\frac{1}{2}$"	$\frac{5}{8}$"	$18\frac{3}{4}$"	325

TROLLEY FROGS

For different classes of service three sets of frogs, differing in the divergence angle of tongues and length of pan, are furnished.

For ordinary city service, with turnout radii not exceeding about 50 feet, the 20° frogs are suitable, but, with the longer radii introduced by suburban and interurban work, smaller divergence angles are necessary.

The following table gives the range of distance from track switch point to track frog with which each set of trolley frogs may be most satisfactorily used:

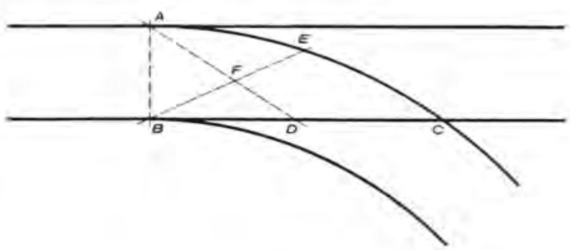
Frog Distance	Divergence Angle of Trolley Frog
Up to 22 feet	20°
From 20 to 30 feet	15°
Above 28 feet	8°

The minimum frog distance given in the table with which the 15° frogs may be used to best advantage corresponds to a turnout radius of 40 feet, but when suburban cars, using high speed trolley wheels, run over city tracks it is advisable to use 15° rather than 20° frogs throughout the city construction even where the minimum frog distance is less than 20 feet.

In order to insure smooth transition of the wheel between tongue and pan, the pans of all Form G frogs have, at each end, an inclined plane rising at a very acute angle from the horizontal, which receives the flange of the wheel at a point depending upon the depth of the wheel groove. The depth of tongues and rise of the inclined plane admit the use of a groove depth of from $\frac{3}{4}$ in. to $1\frac{1}{8}$ in.

All standard frogs are provided with four pull off rings, but similar frogs with two rings can be furnished if specially ordered.

The following diagram shows an excellent method of properly placing the frogs on the line, and while certain variables, such as super-elevation of the outer rail on the curve, length of wheel base, and projection of trolley pole rearward from center of car, will necessitate slight variation of setting, this location will be found so nearly correct that a very small alteration, which must be determined by experiment, will compensate for the variable conditions.



TO LOCATE TROLLEY FROG

From switch point, A, draw a line to center point, D, of frog distance BC, and from switch point B, draw a line to center point E, of arc AEC. The intersection of these two lines at F will be the proper location of the frog.

TROLLEY FROGS, FORM G

20 DEGREE FROGS

FOR ROUND OR GROOVED WIRES

20 Degree V Frog

20 Degree 3-Way Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
29133	Right-hand frog, for No. 0 and 00 wires, comp.	17″	6½″	710
29134	Left-hand frog, for No. 0 and 00 wires, comp.	17″	6½″	710
29132	V frog, for No. 0 and 00 wires, comp.	17″	6½″	725
29135	3-way frog, for No. 0 and 00 wires, comp.	17″	7⅜″	1000
46645	Right-hand frog, for No. 000 and 0000 wires, comp.	17″	6½″	710
46646	Left-hand frog, for No. 000 and 0000 wires, comp.	17″	6½″	710
46644	V frog, for No. 000 and 0000 wires, comp.	17″	6½″	725
46647	3-way frog, for No. 000 and 0000 wires, comp.	17″	7⅜″	1000

All pull off eyes are ½ in. in diameter.

TROLLEY FROGS, FORM G

15 DEGREE FROGS

FOR ROUND OR GROOVED WIRES

15 Degree Left-hand Frog

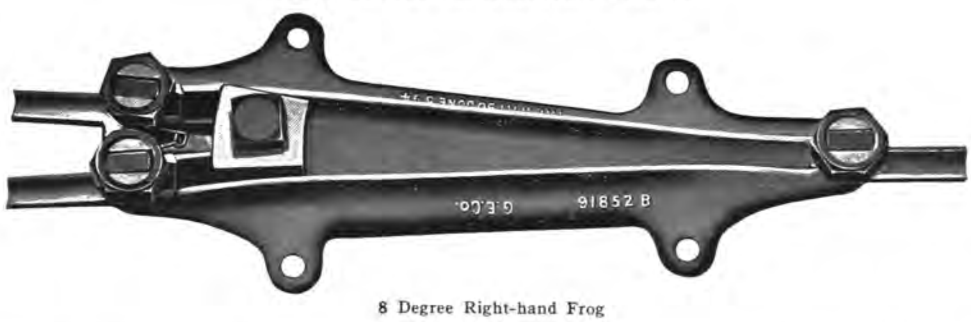
15 Degree 3-Way Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
29130	Right-hand frog, for Nos. 00, 000 and 0000 wires, comp.	18″	$5\frac{9}{16}$″	875
29131	Left-hand frog, for Nos. 00, 000 and 0000 wires, comp.	18″	$5\frac{9}{16}$″	875
29129	V frog, for Nos. 00, 000 and 0000 wires, comp.	18″	$5\frac{9}{16}$″	890
37487	3-way frog, for Nos. 00, 000 and 0000 wires, comp.	18″	$7\frac{3}{8}$″	1150

All pull off eyes are $\frac{1}{2}$ in. in diameter.
Frogs similar to the above but for 1/0 wire will be furnished at the same price.

8 DEGREE FROGS

FOR ROUND OR GROOVED WIRES



8 Degree Right-hand Frog

29127	Right-hand frog, for Nos. 00, 000 and 0000 wires, comp.	$21\frac{7}{8}$″	6″	1300
29128	Left-hand frog, for Nos. 00, 000 and 0000 wires, comp.	$21\frac{7}{8}$″	6″	1300
29126	V frog, for Nos. 00, 000 and 0000 wires, comp.	$21\frac{7}{8}$″	6″	1350

All pull off eyes are $\frac{1}{2}$ in. in diameter.
Frogs similar to the above but for 1/0 wire will be furnished at the same price.

TROLLEY FROGS, FORM G

DRAWBRIDGE FROG

Drawbridge Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
16395	Complete, 5/8" tap, for Nos. 00, 000 and 0000 wires, comp.	15"	7 7/8"	875
15993	Without spring contact, comp.	15"	7 7/8"	690

Frogs similar to the above but for 1/0 wire will be furnished at the same price.

TROLLEY FROGS, FORM G2

Frog with One Tongue in Position, Other Two Disconnected

The Form G2 frogs are like the Form G, excepting in material and the arrangement of the end tongues. The body of the Form G2 is sherardized malleable iron and the renewable end tongues are composition. The tongue proper, which is peaned over the trolley wire, and the shoe, which clamps the wire under pressure from the large clamping nut, are in one piece and may be removed and replaced without in any way disturbing the frog body.

20 DEGREE FROGS
FOR ROUND OR GROOVED WIRES

20 Degree Left-hand Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
110745	Right-hand frog, for Nos. 0 and 00 wires, mall. iron, sherardized	17"	6½"	710
60302	Right-hand frog, for Nos. 000 and 0000 wires, mall. iron, sherardized	17"	6½"	710
110746	Left-hand frog, for Nos. 0 and 00 wires, mall. iron, sherardized	17"	6½"	710
60301	Left-hand frog, for Nos. 000 and 0000 wires, mall. iron, sherardized	17"	6½"	710
110747	V frog, for Nos. 0 and 00 wires, mall. iron, sherardized	17"	6½"	725
60303	V frog, for Nos. 000 and 0000 wires, mall. iron, sherardized	17"	6½"	725
110748	3-way frog, for Nos. 0 and 00 wires, mall. iron, sherardized	17"	7 7/8"	1000
60307	3-way frog, for Nos. 000 and 0000 wires, mall. iron, sherardized	17"	7 7/8"	1000
110756	End tongue for all frogs for Nos. 0 and 00 wires, comp.			50
65856	End tongue for all frogs for Nos. 000 and 0000 wires, comp.			50

All pull off eyes ½ in. in diameter.

TROLLEY FROGS, FORM G2

15 DEGREE FROGS

FOR ROUND OR GROOVED WIRES

15 Degree Left-hand Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
110749	Right-hand frog, for Nos. 0 and 00 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	875
60228	Right-hand frog, for Nos. 000 and 0000 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	875
110750	Left-hand frog, for Nos. 0 and 00 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	875
60226	Left-hand frog, for Nos. 000 and 0000 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	875
110751	V frog, for Nos. 0 and 00 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	890
60229	V frog, for Nos. 000 and 0000 wires, mall. iron sherardized	18″	$5\frac{9}{16}$″	890
110752	3-way frog, for Nos. 0 and 00 wires, mall. iron sherardized	18″	$7\frac{3}{8}$″	1150
60234	3-way frog, for Nos. 000 and 0000 wires, mall. iron sherardized	18″	$7\frac{3}{8}$″	1150
110756	End tongue for all frogs, for Nos. 0 and 00 wires, comp.			50
65856	End tongue for all frogs, for Nos. 000 and 0000 wires, comp.			50

All pull off eyes are $\frac{1}{2}$ in. in diameter.

8 DEGREE FROGS

FOR ROUND OR GROOVED WIRES

8 Degree Left-hand Frog

110753	Right-hand frog, for Nos. 0 and 00 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1300
60131	Right-hand frog, for Nos. 000 and 0000 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1300
110754	Left-hand frog, for Nos. 0 and 00 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1300
60132	Left-hand frog, for Nos. 000 and 0000 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1300
110755	V frog, for Nos. 0 and 00 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1350
60133	V frog, for Nos. 000 and 0000 wires, mall. iron sherardized	$21\frac{7}{8}$″	6″	1350
110756	End tongue for all frogs, for Nos. 0 and 00 wires, comp.			50
65856	End tongue for all frogs, for Nos. 000 and 0000 wires, comp.			50

All pull off eyes are $\frac{1}{2}$ in. in diameter.

TROLLEY FROGS—SPECIAL

8 DEGREE HIGH SPEED FROGS

FOR ROUND OR GROOVED WIRES

8 Degree Right-hand Frog

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
58720	Right-hand frog, complete with guard plate and clamping ears for Nos. 00, 000 and 0000 comp.	$23\frac{7}{8}''$	$6\frac{5}{8}''$	1900
58721	Left-hand frog, complete with guard plate and clamping ears for Nos. 00, 000 and 0000 comp.	$23\frac{7}{8}''$	$6\frac{5}{8}''$	1900
58722	V frog, complete with guard plate and clamping ears for Nos. 00, 000 and 0000 comp.	$23\frac{7}{8}''$	$6\frac{5}{8}''$	1900

All pull off eyes are ½ in. in diameter.

8 DEGREE FROGS

For line work where both wheel and sliding collectors are employed the following are offered.

8 Degree Right-hand Frog

49054	Right-hand frog, for Nos. 00, 000 and 0000 wires, comp.	22″	$6\frac{1}{4}''$	1375
59825	Left-hand frog, for Nos. 00, 000 and 0000 wires, comp.	22″	$6\frac{1}{4}''$	1375
59826	V frog, for Nos. 00, 000 and 0000 wires, comp.	22″	$6\frac{1}{4}''$	1375

All pull off eyes are ½ in. in diameter.

15 DEGREE FROGS

Suitable for yard work where sliding collectors are used.

15 Degree Right-hand Frog

66673	Right-hand frog, for Nos. 00, 000 and 0000 wires, comp.	$17\frac{5}{8}''$	$6\frac{1}{8}''$	950
66674	Left-hand frog, for Nos. 00, 000 and 0000 wires, comp.	$17\frac{5}{8}''$	$6\frac{1}{8}''$	950
66675	V frog, for Nos. 00, 000 and 0000 wires, comp.	$17\frac{5}{8}''$	$6\frac{1}{8}''$	975

All pull off eyes are ½ in. in diameter.

CROSSINGS, FORM G, UNINSULATED

The principle of the inclined plane to insure smooth transition of the trolley wheel between tongue and pan has been embodied in the design of all Form G Crossings, and the maximum speed at which the trolley will operate at crossing points has been greatly increased thereby. They will accommodate round or grooved wires of the sizes indicated in the tables.

RIGHT ANGLE CROSSING

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
11297	For Nos. 00, 000 and 0000 wires, comp.	$15\frac{3}{8}$"	$15\frac{3}{8}$"	910

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

ADJUSTABLE CROSSING

The Form G Adjustable Crossing can be set at any angle between 30 and 90 degrees.

Overall length of each runway $20\frac{3}{8}$ in.

Cat. No.	Description	Approx. Weight per 100
11298	For Nos. 00, 000 and 0000 wires, comp.	1075

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

CROSSINGS, FORM G, UNINSULATED

35 DEGREE CROSSING

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
42413	Crossing for Nos. 00, 000 and 0000 wires, comp.	16″	5½″	865

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

15 DEGREE CROSSING

Cat. No.	Description	Overall Length	Overall Width	Approx. Weight per 100
19490	Crossing for Nos. 00, 000 and 0000 wires, comp.	21¼″	5⅜″	1025

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

For use where both wheel and sliding collectors are employed, the following are offered.

RIGHT ANGLE CROSSING

This crossing is similar to the right angle crossing for wheel collectors, Cat. No. 11297, excepting that in the pan is provided a double groove runway for wheels, and heavy extension flanges offer a smooth underrun for sliding collectors.

Cat. No.	Description	Approx. Weight per 100
64170	For Nos. 00, 000 and 0000 wires, comp.	1000

CROSSINGS, FORM G, UNINSULATED

ADJUSTABLE CROSSING

The Adjustable Crossing is composed of light structural steel sections with sherardized finish, having a dip at the center point to provide clearance for the passage of the sliding collector.

Cat. No.	Description	Approx. Weight per 100
48835	Adjustable crossing for Nos. 00, 000 and 0000 wires	4000

CROSSINGS, FORM L, INSULATED

The Form L Insulated Crossing consists of a beam of selected second growth hickory thoroughly impregnated with preservative oils to exclude moisture, finished with black japan, and castings of standard composition metal with a replaceable white fiber runway. Attachment to the trolley wires is effected by mechanical clamps so that the crossing may be installed quickly without soldering and without cutting either wire.

The fiber runways as listed include fiber plates with screws. The crossings will accommodate round or grooved wires of the sizes indicated in the tables.

SINGLE TROLLEY

RIGHT ANGLE CROSSING

Overall length 35½ in.; overall width 18½ in.

Cat. No.	Description	Approx. Weight per 100
46184 100935	Right angle crossing, for Nos. 00, 000 and 0000 wires . . . . White fiber runway, for Cat. No. 46184	1750

Crossings similar to above, but for 1/0 wire will be furnished at the same price.

CROSSINGS, FORM L, INSULATED

SINGLE TROLLEY

ADJUSTABLE CROSSINGS

The Form L Adjustable Crossings can be set at any angle between 45 and 90 degrees.

Overall length 36 in.; maximum overall width $16\frac{1}{2}$ in.

Cat. No.	Description	Approx. Weight per 100
19406	Adjustable crossing for Nos. 0 and 00 wires	1275
19407	White fiber runway for Cat. No. 19406	18

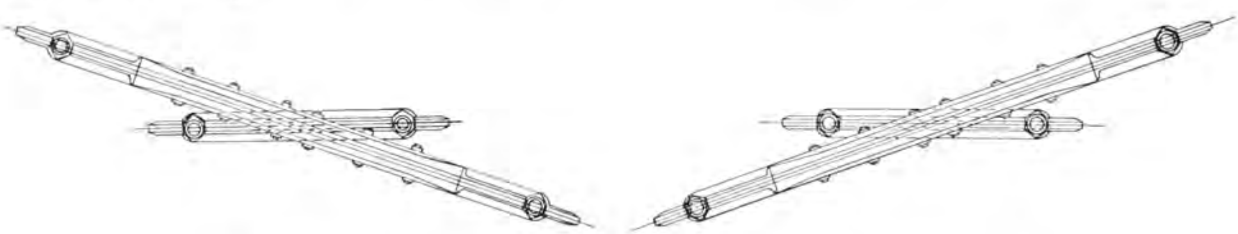
Overall length $35\frac{1}{2}$ in.; maximum overall width $16\frac{1}{2}$ in.

26150	Adjustable crossing, for Nos. 00, 000 and 0000 wires	1400
19407	White fiber runway for Cat. No. 26150	18

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

ACUTE ANGLE

The Acute Angle Crossings can be furnished either right or left hand. The right hand crossing is considered standard and is generally applicable. However, under certain conditions such as the crossing of a 250 and 500 volt line, right and left crossings are not interchangeable. The left hand crossings are, therefore, listed and will be made up on order at the same prices as the corresponding right hand crossings.



Left-hand Crossing

Right-hand Crossing

CROSSINGS, FORM L, INSULATED

SINGLE TROLLEY

ACUTE ANGLE—RIGHT-HAND CROSSINGS

Cat. No.	Description	Overall Dimensions Length	Overall Dimensions Width	Approx. Weight per 100
30615	35° Right-hand crossing, for Nos. 00, 000 and 0000 wires	39″	9½″	1725
30616	White fiber runway, for Cat. No. 30615			25
30613	27° Right-hand crossing, for Nos. 00, 000 and 0000 wires	39″	9⅛″	1700
30614	White fiber runway, for Cat. No. 30613			25
30611	20° Right-hand crossing, for Nos. 00, 000 and 0000 wires	46½″	6¾″	1685
30612	White fiber runway, for Cat. No. 30611			25
30609	15° Right-hand crossing, for Nos. 00, 000 and 0000 wires	46½″	6⅜″	1685
30610	White fiber runway, for Cat. No. 30609			25
46181	8° Right-hand crossing, for Nos. 00, 000 and 0000 wires	56½″	5″	1675
100919	White fiber runway, for Cat. No. 46181			25

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

LEFT-HAND CROSSINGS

Cat. No.	Description	Overall Dimensions Length	Overall Dimensions Width	Approx. Weight per 100
100181	35° Left-hand crossing, for Nos. 00, 000 and 0000 wires	39″	9½″	1725
100924	White fiber runway, for Cat. No. 100181			25
100180	27° Left-hand crossing, for Nos. 00, 000 and 0000 wires	39″	9⅛″	1700
100923	White fiber runway, for Cat. No. 100180			25
64167	20° Left-hand crossing, for Nos. 00, 000 and 0000 wires	46½″	6¾″	1685
100922	White fiber runway, for Cat. No. 64167			25
64166	15° Left-hand crossing, for Nos. 00, 000 and 0000 wires	46½″	6⅜″	1685
100921	White fiber runway, for Cat. No. 64166			25
100179	8° Left-hand crossing, for Nos. 00, 000 and 0000 wires	56½″	5″	1675
100120	White fiber runway, for Cat. No. 100179			25

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

DOUBLE TROLLEY

The Double Trolley Crossings consist primarily of an insulating beam and two cross tongues spaced suitably for use where the double trolley wires are 6½ inches between centers. Crossings with tongue spacing either greater or less than standard will be supplied for special conditions at prices corresponding to the standard.

Crossings consisting of two insulating beams and a single cross tongue or with two beams and two cross tongues (for the crossing of two double trolley lines) are built to order.

CROSSINGS, FORM L, INSULATED

DOUBLE TROLLEY

RIGHT-ANGLE CROSSING

Overall length $43\frac{1}{2}$ in.; overall width $18\frac{1}{2}$ in.

Cat. No.	Description	Approx. Weight per 100
46185	Right-angle crossing, for Nos. 00, 000 and 0000 wires, $6\frac{1}{2}''$ between trolley centers . .	1925
100936	White fiber runway, for Cat. No. 46185	

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

ADJUSTABLE CROSSING

The Adjustable Double Crossing may be set at any angle between 45 and 90 degrees; when set at 45 degrees, the distance between wires is $4\frac{3}{4}$ inches, and at 90 degrees $6\frac{1}{2}$ inches.

Overall length $43\frac{1}{2}$ in.; maximum overall width $16\frac{1}{2}$ in.

64634	Adjustable crossing, for Nos. 00, 000 and 0000 wires, $6\frac{1}{2}''$ between pivot points	2100
100917	White fiber runway, for Cat. No. 64634	

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

CROSSINGS, FORM L, INSULATED

DOUBLE TROLLEY

ACUTE ANGLE

RIGHT-HAND CROSSING

Cat. No.	Description	Overall Dimensions Length	Overall Dimensions Width	Distance Between Trolley Centers	Approx. Weight per 100
64169	35° Right-hand crossing, for Nos. 00, 000 and 0000 wires	49½″	9½″	6½″	2300
100929	White fiber runway, for Cat. No. 64169				
100184	27° Right-hand crossing, for Nos. 00, 000 and 0000 wires	49½″	9½″	6½″	2400
100928	White fiber runway, for Cat. No. 100184				
100183	20° Right-hand crossing, for Nos. 00, 000 and 0000 wires	49½″	9½″	6½″	2500
100927	White fiber runway, for Cat. No. 100183				
62552	15° Right-hand crossing, for Nos. 00, 000 and 0000 wires	71½″	6⅞″	6½″	2600
100926	White fiber runway, for Cat. No. 62552				

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

LEFT-HAND CROSSING

100268	35° Left-hand crossing, for Nos. 00, 000 and 0000 wires	49½″	9½″	6½″	2300
100934	White fiber runway, for Cat. No. 100268				
100187	27° Left-hand crossing, for Nos. 00, 000 and 0000 wires	49½″	9½″	6½″	2400
100933	White fiber runway, for Cat. No 100187				
100830	20° Left-hand crossing, for Nos. 00, 000 and 0000 wires	64″	6¾″	6½″	2500
100932	White fiber runway, for Cat. No. 100830				
100186	15° Left-hand crossing, for Nos. 00 000 and 0000 wires	64″	6¾″	6½″	2600
100931	White fiber runway, for Cat. No. 100186				

Crossings similar to the above, but for 1/0 wire will be furnished at the same price.

SECTION INSULATORS, FORM L

The Form L Section Insulator consists of a beam of selected second growth hickory well seasoned and treated with preservative oils to exclude moisture, finished with black japan, and castings of the standard composition metal, with a replaceable runway of hickory. Attachment to the trolley wires is made by double mechanical clamps at each end. The wood runway in conjunction with the accurately aligned castings offers a straight under-run insuring a smooth passage for the trolley wheel. For 600 volt service the wood runway provides a 7 in. break in the trolley circuit—for 1200 volt service the break is 12 in.

The insulators will accommodate round or grooved wires of the sizes indicated in the tables.

600–1200 VOLTS

Overall length 31½ in.

Cat. No.	Description	Overall Length	Approx. Weight per 100
19410	Section insulator, for Nos. 0 and 00 wires, 600 volts	31½″	1010
19491	Section insulator, for Nos. 00, 000 and 0000 wires, 600 volts	31½″	975
21456	Wooden runway, for Cat. Nos. 19410 and 19491		15
46190	Section insulator, for Nos. 00, 000 and 0000 wires, 1200 volts	36½″	1200
100176	Wooden runway, for Cat. No. 46190		20

600 VOLTS

Overall length 31½ in.

46740	Section insulator, for Nos. 0 and 00 wires, ⅝″ tap, 7″ break	1060
60434	Section insulator, for Nos. 00, 000 and 0000 wires, ⅝″ tap, 7″ break	1025
46741	Section insulator, for Nos. 0 and 00 wires, ¾″ tap, 7″ break	1060
60435	Section insulator, for Nos. 00, 000 and 0000 wires, ¾″ tap, 7″ break	1025
21456	Wooden runway, for Cat. Nos. 46740, 60434, 46741 and 60435	15

AUTOMATIC SECTION INSULATORS—600 VOLTS

This device is a combined Section Insulator and Automatic Section Switch, and, while it is designed especially for use in mine tramway work, may often be used to advantage on spur tracks in surface work where it is desirable to cut out the spur section after the car has run back on to the main line.

The switch blade is operated by the trolley wheel, and is permanently connected to the feeder or to the main line trolley wire.

Overall length 30½ in.; height 5⅛ in.

Cat. No.	Description	Approx. Weight per 100
34870	Automatic section insulator, for Nos. 00, 000 and 0000 wires	1650
34871	Switch clips with screws	12
34872	Locking spring	5

Section insulators similar to the above, but for 1/0 wire will be furnished at the same price.

LINE MATERIAL FOR CATENARY CONSTRUCTION

The radical departure in the design of trolley line construction made necessary by the advent of high tension current distribution for electric railway operation resulted in great improvements in mechanical as well as electrical features of the trolley line. The catenary system of line construction, while providing ample insulation surface for the highest potentials used or contemplated, also incidentally affords marked mechanical improvement which is important with the high speeds of modern suburban and interurban operation, and steam railroad electrification.

Catenary Line Construction on the Washington, Baltimore and Annapolis Railway

In direct suspension construction the limit for pole spacing with reasonable sag in the trolley wire is approximately 100 ft. and the minimum deflection attainable with this spacing necessitates heavy upward tension on the trolley to maintain contact with the wire. In the catenary construction on the other hand the spacing of the poles is only a matter of weight of span which each pole can carry, and of sag permissible in the messenger cable. It has been found that, without unduly increasing the height and the weight of the poles, the spacing may be 150 ft. on tangents.

The catenary system which is equally applicable to bracket or cross span construction consists essentially of an arrangement of a slack messenger cable and suitable hangers so distributed as to maintain the trolley wire practically without sag between suspension points, or to limit the sag as may be necessary for various conditions of operation.

The blow of a collector passing suspension points at high speed is thus greatly reduced. The shorter distance between hangers necessitates less stress in the trolley wire and reduces danger of break in the line.

The catenary system, therefore, offers the mechanical advantages of a longer pole spacing and a flatter trolley wire, and a flexibility in the line which obviates the hammer blow of the collector at suspension points, and reduces danger of mechanical breakage.

LINE MATERIAL FOR CATENARY CONSTRUCTION

In catenary bracket construction, the messenger is carried by porcelain petticoat insulators on the bracket arms, and in cross span construction the messenger is insulated either by strain insulators introduced in the span wire or by an insulated messenger hanger or support. The strain insulators for this purpose and for all pull-offs and anchorages for voltages up to and including 3300 volts are of specially treated wood, while those for higher voltages are of porcelain *under compression. The entire insulating system is designed for three times the normal working voltage under the severest weather conditions.* This factor of safety in dielectric strength is of vital importance, especially in lines operating over steam railroad tracks, because of the deteriorating effect of deposit from smoke on the insulation surface.

The features of catenary construction which vary in adaptation to different operating conditions are the messenger and strain insulators and supports and the spacing of trolley wire hangers.

The three-point suspension in which, with 150 ft. pole spacing, the hangers are 50 ft. apart has been found ample to maintain a sufficiently level trolley wire for operation with wheel collector at

Double Track Tangent Construction

speeds up to sixty-five miles per hour. A new element is, however, introduced by the sliding pantograph or bow trolley which, on account of its great inertia, requires a closer spacing of the trolley supports. It has been found that an eleven-point suspension, which with 150 ft. pole spacing brings the hangers 13.6 ft. apart, renders the trolley wire sufficiently level for this type of collector.

All the catenary hangers catalogued in the following pages are of lengths suitable for a 22-inch deflection (distance between messenger and trolley wire at messenger supports) and this deflection is recommended excepting for special conditions.

In this section are listed the various devices which are distinctly for catenary work. Others such as splicing sleeves, low voltage strain insulators, frogs and crossings, are suitable for both direct suspension and catenary construction and are listed in the direct suspension section of this catalogue.

Lists of materials for various types of construction shown elsewhere in this catalogue are useful for general estimating purposes.

BRACKETS

The angle iron bracket, by reason of its horizontal stiffness greatly facilitates initial adjustment of the messenger during installation and insures maintaining uniform sag in messenger span throughout the length of the tangent. Its horizontal stiffness is also of great value in case of line breakage, the line remaining undisturbed except for two or three spans on either side of the break.

The angle bracket consists of two 2 in. x 1½ in. x ¼ in. angle irons joined at the extreme end by a space block and rivet, and by a second space block approximately 2 ft. nearer the pole. The guy rod which supports the bracket from the pole top is attached to this second space block, and the

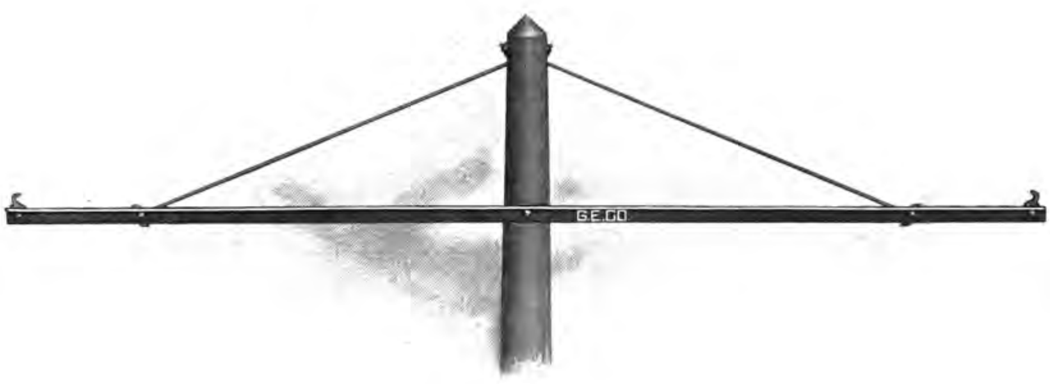
LINE MATERIAL FOR CATENARY CONSTRUCTION

BRACKETS

slot formed between the angles by the space blocks through which the insulator pin bolt passes provides means for transverse adjustment of the messenger with respect to the track. The inner ends of the angles are sprung apart to span the pole to which they are lagged or bolted. This bracket is suitable for 7 ft. 6 in. distance between track center and pole face.

Angle Iron Bracket Arm
Cat. No. 43322

Cat. No.	Description	Approx. Weight per 100
43322	9 ft. Angle Iron Bracket, japanned	6000



Cat. No. 47016

For double track pole construction, a bracket arm having two guy rods and two sets of fittings is used. This double bracket is riveted at one end and bolted at the other to allow for spanning the pole in installation. It is 16 ft. over all and suitable for 14 ft. track center.

Cat. No.	Description	Approx. Weight per 100
47016	16 ft. Double Angle Iron Bracket, japanned	11000

LINE MATERIAL FOR CATENARY CONSTRUCTION

BRACKETS

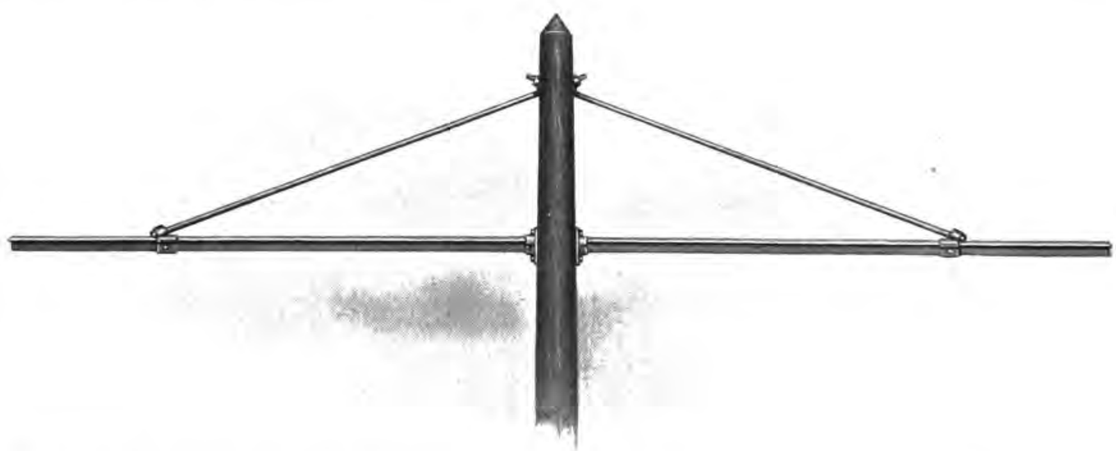
The "T" iron bracket has all of the advantages of the angle iron bracket, excepting its stiffness in the horizontal plane.

The guy rod is attached to the arm approximately 2 ft. from the end and the extension beyond the guy rod attachment provides for transverse adjustment of the messenger.

"T" Iron Bracket—Cat. No. 48414

The "T" iron bracket consists of a "T" iron arm $2\frac{1}{4}$ in. x $2\frac{1}{4}$ in. x $\frac{5}{16}$ in., guy rod, pole fitting and two 5 in. x $\frac{1}{2}$ in. lag screws but does not include insulator pin. The length of the standard "T" iron bracket is 8 ft. 6 in. which is suitable for 7 ft. 6 in. distance between track center and pole face.

Cat. No.	Description	Approx. Weight per 100
48414	8 ft. 6 in. "T" Bracket, japanned	5500

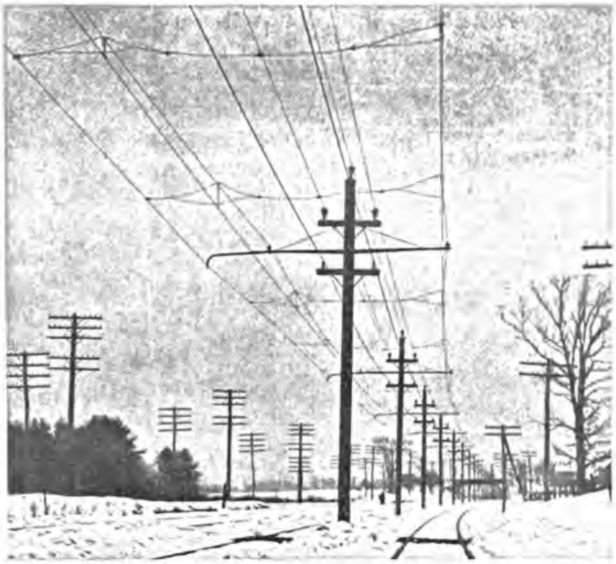


For double track work with 14 ft. track centers the "T" iron bracket consists of two arms, two guy rods and two sets of fittings, each arm being 7 ft. 6 in. long.

48415	Double "T" Iron Bracket with arms, 7 ft. 6 in. long, japanned	10000

LINE MATERIAL FOR CATENARY CONSTRUCTION

BRACKET EXTENSIONS



Double Track Pull-Off with Bracket Extensions

The extension for the angle iron bracket consists of a "T" iron 2 in. x 2 in. x ¼ in., the web of which fits into the slot of the bracket replacing the outer space block. A bolt is provided for securing the extension in place.

The extension for "T" iron brackets consists of "T" iron 2 in. x 2 in. x ¼ in. to which are riveted malleable iron castings for clamping to the bracket arm. Two bolts are furnished for securing it in place.

Cat. No. 67458

Cat. No. 88965

Cat. No.	Description	Approx. Weight per 100
67458	4 ft. Extension for Angle Iron Brackets, japanned	2000
88965	4 ft. Extension for "T" Iron Brackets, japanned	2600

INSULATOR PINS

Cat. No. 46742

The insulator pin for the angle iron bracket is of malleable iron and engages the slot of the bracket, along which it is adjustable. It is clamped in position by a bolt passing upward through the slot. The diameter at the pin top is 1¼ in.

The pin for the "T" iron bracket is malleable iron with a hook bolt which permits adjustment of the pin along the bracket arm. The diameter at the pin top is 1¼ in.

Both insulator pins have the standard sherardized finish.

Cat. No. 48416

46742	Insulator Pin for Angle Iron Bracket	200
48416	Insulator Pin for "T" Iron Bracket	250

LINE MATERIAL FOR CATENARY CONSTRUCTION

MESSENGER INSULATORS

Cat. No. 43324

Insulator Cat. No.	43324	48453
Diameter	4½"	7"
Height	3½"	4"
Top Groove Diameter	⅝"	⅝"
Side Groove Diameter	½"	½"
Test voltage	40,000	65,000
Line voltage	3,300	11,000
Size pin hole	1⅜"	1⅜"
Standard Glaze finish	Brown	Brown

Two Piece Insulator
Cat. No. 48453

The smaller of these two insulators is offered for voltages up to and including 3300 and the larger for voltages up to and including 11,000. Both insulators have been thoroughly tested out in years of service and are adequate for the service for which they are recommended. Both are threaded for cementing on 1⅜ in. pins.

The upper shell of the 11,000 volt insulator is grooved so as to limit fractures from missiles and leave sufficient porcelain for insulation against normal potential even after the edges have been broken off. Malicious breakage of insulators is responsible for more trouble in maintenance of high potential lines than any other cause. This grooving of the petticoat affords considerable insurance against grounding of the line.

To insure customers against defective insulators, it is recommended that insulators be generally purchased assembled on the pins so that purchasers may have the benefit of the high potential shop test after assembling. When assembling the insulators in the fields, the cementing should be done with a good grade of neat Portland cement.

For assembled insulators and pins, including high potential tests, an additional charge will be made.

Cat. No.	Description	Approx. Weight per 100
43324	Messenger Insulator for voltages up to and including 3300	300
48453	Messenger Insulator for voltages up to and including 11000	450

TANGENT HANGERS

Form CF Hanger

The Form CF hanger, for supporting the trolley wire from the messenger cable, consists of a stem of flat steel strip, riveted at one end to a malleable iron screw clamp trolley ear; at the other end the stem is bent to form a loop by which the hanger is suspended. The loop is so formed that the hanger cannot free itself of the messenger; at the same time it permits a 2¾ in. vertical movement of the trolley wire independently of the messenger.

The Form CA hanger differs from the Form CF only in that the messenger loop of the latter is replaced by a malleable iron sisterhook and its stem is turned through 90 degrees.

Form CA Hanger

FORM CF			FORM CA		
Cat. No.*	Length in In.	Approx. Wt. per 100	Cat. No.*	Length in In.	Approx. Wt. per 100
100078	6	73	48442	6	64
100079	6¾	75	48443	6¾	66
100080	8½	80	48444	8½	71
100081	11	86	48445	11	77
100082	12	88	48446	12	79
100083	13½	91	48447	13½	82
100084	14¾	94	48448	14¾	85
100085	16	97	48449	16	88
100086	17½	100	48450	17½	91
100087	19¼	104	48451	19¼	95
100088	20½	106	48452	20½	97

All hangers have standard sherardized finish throughout.

*These hangers are of lengths suitable for 22 in. deflection.

LINE MATERIAL FOR CATENARY CONSTRUCTION

TANGENT HANGERS

FORM CG

As an alternative to Forms CA and CF hangers, the Company offers its Form CG hanger which can be furnished as readily as the other two. It is made of $\frac{1}{8}$ in. x 1 in. flat steel strip with a loop formed at the top to fit over the messenger cable, allowing a play of 2 in. The trolley wire clamp is made of two interchangeable malleable iron castings. Both bolts used are standard machine bolts.

STEADY YOKES

On long tangents it may be desirable to steady the trolley wire against lateral movement and Trolley Wire Steadies are provided for this purpose. They are installed at intervals of about 1000 feet and, for bracket construction and either Forms CA, CF or CG hangers, consist of the steady yoke, steady ear, strain insulators, bracket extension, eye bolt and steel cable for the guys. The arrangement is illustrated on page 100. The steady ear generally used is Cat. No. 37685, 10-inch curve clamping ear. The eye bolt should be threaded for at least four inches of its length to permit adjustment. The size recommended is 16 in. x $\frac{5}{8}$ in.

Cat. No.	Description	Approx. Weight per 100
111099	Steady Yoke, $\frac{3}{4}$" stud, mall. iron sherardized	200

PULL-OFF HANGERS

In order to insure clearances for the passage of sliding collectors, the pull-off hangers are designed for use with bridles which are attached to the ear and the upper part of the pull-off stem, and which lead to the pull-off insulator or to a steel ring into which the wire is made up.

The Form CF pull-off hanger is provided with a messenger clamp having an eye for single guying and also a slot for a guy wire from the second line in double track construction. The messenger clamp is free to move vertically between the top of the hanger stem and the adjustable stem clamp. An adjustment of six in. below the nominal length of the hanger is entirely feasible so that two lengths of hangers will provide for pull-offs at any point in the line. The stem is $\frac{5}{8}$ in. in diameter.

The Form CA pull-off hanger differs from the Form CF primarily in that the messenger clamp casting is threaded to the stem and the distance between messenger and trolley wire is therefore fixed by adjustment when installing. These hangers are adjustable through a length of one and one half in. greater and less than the nominal length. The stem of the Form CA hanger is $\frac{3}{4}$ in. in diameter.

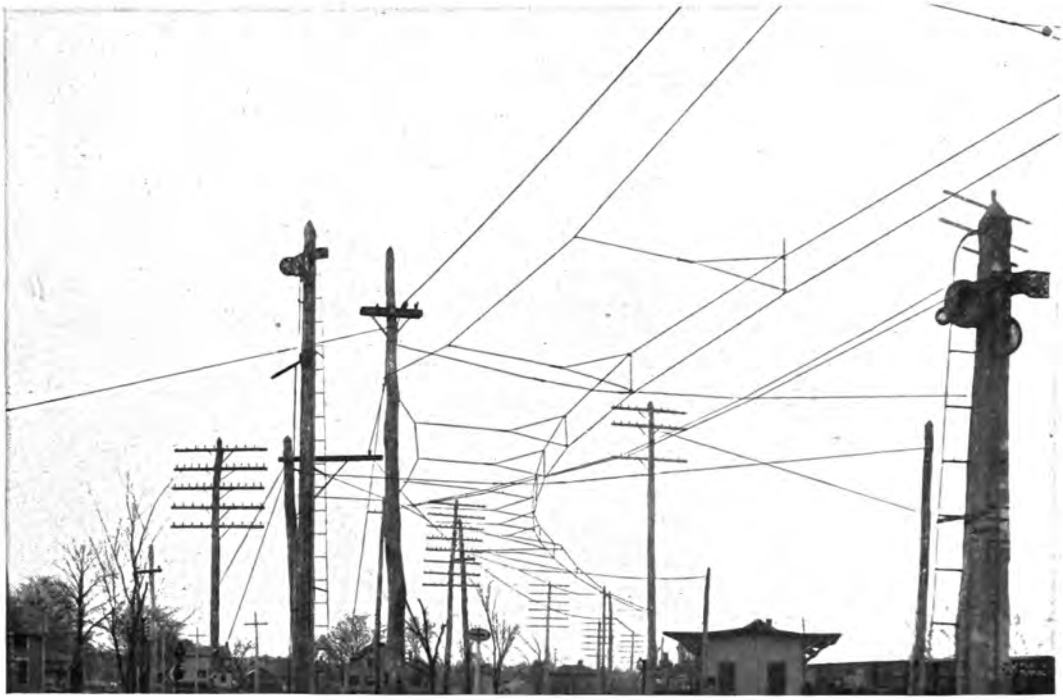
Both CF and CA pull-off hangers have standard sherardized finish throughout.

Form CF Pull-Off Hanger

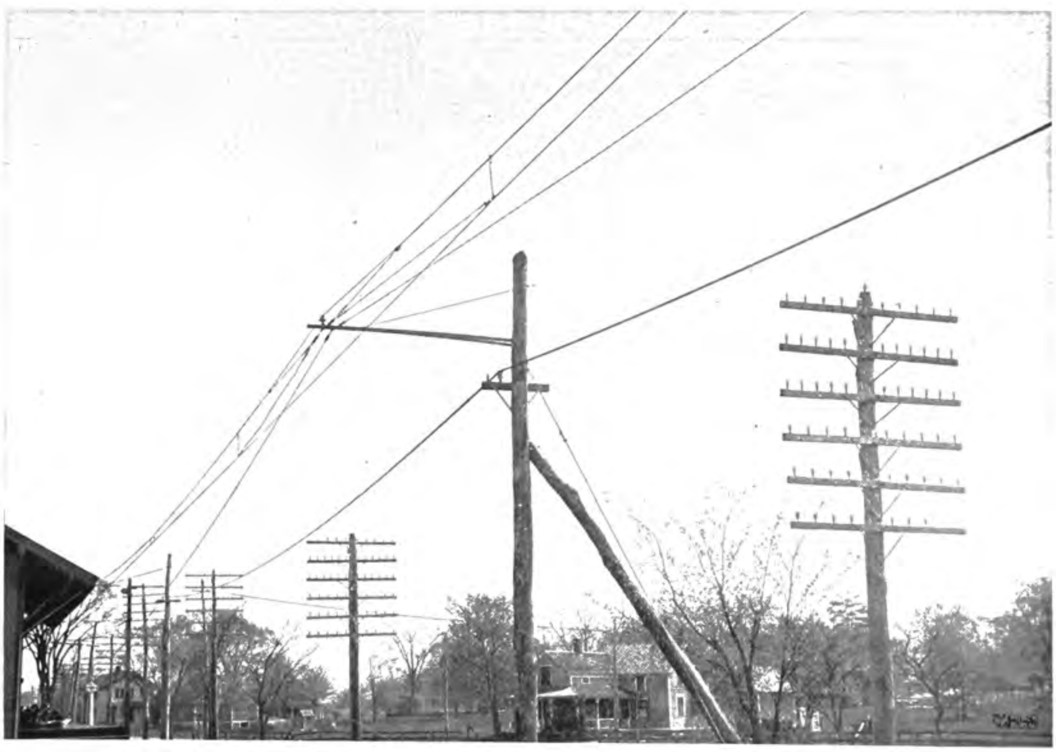
FORM CF			FORM CA		
Cat. No.	Length in In.	Approx. Wt. per 100	Cat. No.	Length in In.	Approx. Wt. per 100
68931	15	400	48439	14	480
68932	18	410	48440	17	500
68933	21	420	48441	20	520

Form CA Pull-Off Hanger

LINE MATERIAL FOR CATENARY CONSTRUCTION



Single Track Curve with Form CF Pull-Offs



Single Track Anchorage—Form CF

LINE MATERIAL FOR CATENARY CONSTRUCTION

ANCHORAGE MATERIAL

To provide vertical flexibility at anchorage points in lines using the Form CF tangent and pull-off hangers, the trolley wire and messenger are clamped independently and the clamps guyed to the anchor eye through a strain insulator and a turnbuckle.

The Form CA anchor hanger for use with Form CA tangent and pull-off hangers is fitted with a ⅝ in. steel stem and is arranged for guying to the anchor eye through a bridle with suitable strain insulator and turnbuckle.

Either method of anchoring provides ample clearance for sliding collectors and prevents forming "pockets" or angles between trolley and guy wires in which a collector may catch.

All anchorage devices excepting ears which are of composition and tinned for soldering are sherardized throughout.

Cat. No. 48522

Cat. No. 61232

Cat. No. 100217

Cat. No. 46572

Cat. No. 48417

Cat. No. 64368

Cat. No. 46703

Cat. No.	Description	Approx. Weight per 100
100217	Messenger Anchor Clamp	300
*61232	Trolley Wire Anchor Ear	90
64368	15¾″ Form CA Anchor Hanger	360
48522	Anchor Turnbuckle, 6″ x ⅝″	200
46572	Anchor Eye for Angle Iron Bracket	300
48417	Anchor Eye for "T" Iron Bracket	250
46703	Span Wire Anchor Clamp	525

* Half strain soldered clinch ears may be used if preferred.

SPAN WIRE MESSENGER HANGERS

Cat. No. 60958

The span wire messenger hangers for the attachment of the messenger to the cross span are used throughout tangents and curves in cross span construction, excepting where replaced at anchorages by the span wire anchor clamp. The hangers are arranged for adjustment to any angle between the messenger and span wires.

Cat. No. 48454

The insulation of Cat. No. 48454 is a porcelain spool. Provision for drainage of moisture from the upper surface is made through the center along the metal stud.

LINE MATERIAL FOR CATENARY CONSTRUCTION

SPAN WIRE MESSENGER HANGERS—(Concluded)

Cat. No.	Description	Approx. Weight per 100
60958	Span Wire Messenger Hanger, sherardized	80
48454	Insulated Span Wire Messenger Hanger, metal parts sherardized	430

STRAIN INSULATORS

The strain insulators used in catenary work are the same as for direct suspension construction shown on page 59, excepting the following porcelain insulators.

The strain insulators for high potentials possess mechanical and electrical features of vital importance. The interlinking of the holes provided for attachment of the guy wires brings the material under mechanical stress entirely in compression and the crushing strength of the material is considerably above the maximum stress to which it can be subjected in service. Because of the form of the insulator it is impossible for rain driving in any direction to maintain a continuous surface between terminals. All surfaces are exposed to the washing action of rain from different directions so that accumulation of dust or harboring of insects is prevented.

Cat. No. 45207

Cat. No.	Description	Approx. Weight per 100
45207	6½″ Strain Insulator, max. safe working voltage 11000 max. safe working load 2500 lbs.	350
61912	7½″ Strain Insulator, max. safe working voltage 15000 max. safe working load 4500 lbs.	1050

SECTION INSULATORS

600 VOLTS

Cat. No. 89586

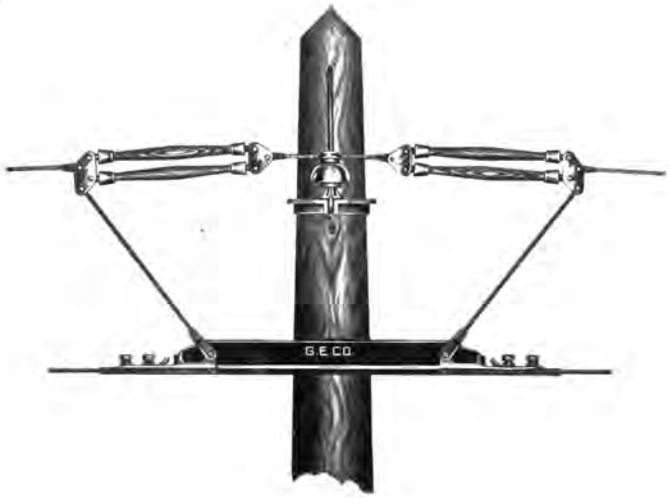
In the section insulators for wheel collectors, the trolley insulation is provided by a device similar to the Form L direct suspension section insulator excepting that the wood beams and runways are longer and adapted to care for higher voltages and speeds. The messenger insulation consists of wood strains.

Cat. No.	Description	Approx Weight per 100
89586	Section Insulator, complete, for Nos. 00, 000 and 0000 wires, 7″ break	2000
100247	Trolley Insulator only, for Cat. No. 89586	1200
100176	Wooden Runway for Cat. No. 100247	20

LINE MATERIAL FOR CATENARY CONSTRUCTION

SECTION INSULATORS

1200-3300 VOLTS



Cat. No. 43705

Cat. No.	Description	Approx. Weight per 100
43705	Section Insulator, complete, for Nos. 00, 000 and 0000 wires, 24″ break, 1200-2400 volts	3300
60436	Trolley Insulator only, for Cat. No. 43705	1700
100177	Wooden Runway for Cat. No. 60436	35
112151	Section Insulator, complete, for Nos. 00, 000 and 0000 wires, 36″ break, 3300 volts	5000
112152	Trolley Insulator only, for Cat. No. 112151	3000
112153	Wooden Runway for Cat. No. 112152	75

3300-11000 VOLTS FOR WHEEL AND SLIDING COLLECTORS

The section insulator for use with both wheel and sliding collectors consists of a wooden beam of large cross section to which terminal castings are attached by through bolts insulated from the beam by porcelain spool insulators. A 60 in. renewable runway on the bottom offers a level passage for any style of collector. The messenger is insulated by wood and porcelain strain insulators in series.

Cat. No. 60433

Cat. No.	Description	Approx. Weight per 100
60433	Section Insulator, complete, for Nos. 00, 000 and 0000 wires, 60″ break	15000
100178	Wooden Runway for Cat. No. 60433	250

LINE MATERIAL FOR CATENARY CONSTRUCTION

STEEL STRAND

Common galvanized strand is not recommended for any purpose in catenary construction and wherever steel strand is used it should be one of the three special grades, properties of which are given in the following table.

PROPERTIES OF SEVEN STRAND WIPED GALVANIZED STEEL CABLE SIEMENS-MARTIN STRAND 90,000 LB. PER SQ. IN.

Dia. in In	Tensile Strength in Lb.	Elastic Limit in Lb.	Elongation	Lay in In.
$\frac{1}{4}$	3060	1830	6–9%	3
$\frac{5}{16}$	4850	2910	6–9%	$3\frac{1}{2}$
$\frac{3}{8}$	6800	4080	5–8%	4
$\frac{7}{16}$	9000	5300	5–8%	$4\frac{1}{2}$
$\frac{1}{2}$	11000	6600	5–8%	$4\frac{1}{2}$
$\frac{5}{8}$	19000	11400	4–6%	5
HIGH STRENGTH OR SECOND GRADE, 150,000 LB. PER SQ. IN.				
$\frac{1}{4}$	5100	3315	3–5%	$3\frac{1}{2}$
$\frac{5}{16}$	8100	5265	3–5%	4
$\frac{3}{8}$	11500	7475	3–5%	$4\frac{1}{2}$
$\frac{7}{16}$	15000	9500	3–5%	5
$\frac{1}{2}$	18000	11700	3–5%	5
$\frac{5}{8}$	25000	16250	2–4%	$5\frac{1}{2}$
EXTRA HIGH STRENGTH OR THIRD GRADE, 225,000 LB. PER SQ. IN.				
$\frac{1}{4}$	7600	5700	$2\frac{1}{2}$–4%	4
$\frac{5}{16}$	12100	9075	$2\frac{1}{2}$–4%	$4\frac{1}{2}$
$\frac{3}{8}$	17250	12930	$2\frac{1}{2}$–4%	5
$\frac{7}{16}$	22500	16800	$2\frac{1}{2}$–4%	$5\frac{1}{2}$
$\frac{1}{2}$	27000	20250	$2\frac{1}{2}$–4%	$5\frac{1}{2}$
$\frac{5}{8}$	42000	31500	$1\frac{1}{2}$–3%	6

WEIGHT

Dia. in In.	Per 1000 Ft. Lb	Per Mile Lb.	Dia. in In.	Per 1000 Ft. Lb.	Per Mile Lb.
$\frac{1}{4}$	115	607	$\frac{7}{16}$	370	1953
$\frac{5}{16}$	210	1108	$\frac{1}{2}$	510	2692
$\frac{3}{8}$	300	1584	$\frac{5}{8}$	700	3696

For ordinary conditions, the messenger cable should be of $\frac{7}{16}$ in. extra galvanized Siemens-Martin steel. For pull-offs $\frac{1}{4}$ in. cable is satisfactory, and for general guying purposes $\frac{3}{8}$ in. extra galvanized Siemens-Martin strand is generally recommended. Special conditions may call for "high strength" cable, but as this cable requires mechanical fastenings on account of its stiffness, it should be used only where absolutely necessary.

DEFLECTORS

Deflectors are for use with sliding collectors and are designed to depress the collector when a car is turning from a siding to the main line, or crossing from one track to another, and are interchangeable on either right or left hand turnouts and on Nos. 00, 000 and 0000 grooved wires. Deflectors must be designed especially for local conditions and prices will be quoted on specification of crossing or divergence angles and conditions of operation. These deflectors will not interfere with the operation of wheel collectors.

LINE MATERIAL FOR CATENARY CONSTRUCTION

CONSTRUCTION NOTES

HANGERS FOR SHORT TANGENT SPANS

To prevent creeping of the messenger and unequal strains at the brackets, the tension of the messenger wire is made the same in short spans as in the 150 ft. spans; and with this constant tension, the sag of the messenger and consequently the length of the trolley hangers vary with the length of span. The number and length of hangers required for different spans is shown in the following table:

ELEVEN-POINT CONSTRUCTION

Length Pole Spacing	Points	Number of Hangers per Span: 6″	6¾″	8½″	11″	12″	13½″	14¾″	16″	17½″	19¼″	20½″
150 ft.	11	1	2	2	2	–	–	2	–	–	2	–
125 ft.	9	–	–	–	1	2	2	–	2	–	2	–
110 ft.	8	–	–	–	–	–	2	2	–	2	–	2
95 ft.	7	–	–	–	–	–	–	–	3	2	–	2
80 ft.	6	–	–	–	–	–	–	–	–	2	2	2
70 ft.	5	–	–	–	–	–	–	–	–	–	3	2
55 ft.	4	–	–	–	–	–	–	–	–	–	–	4

THREE-POINT CONSTRUCTION

Length Pole Spacing	Points	6″	6¾″	8½″	11″	12″	13½″	14¾″	16″	17½″	19¼″	20½″
150 ft.	3	1	–	–	–	–	–	2	–	–	–	–
125 ft.	3	–	–	–	1	–	–	–	–	2	–	–
110 ft.	3	–	–	–	–	–	1	–	–	2	–	–
95 ft.	3	–	–	–	–	–	–	–	1	–	2	–
80 ft.	3	–	–	–	–	–	–	–	–	1	2	–
70 ft.	2	–	–	–	–	–	–	–	–	–	–	2
55 ft.	2	–	–	–	–	–	–	–	–	–	–	2

CURVE CONSTRUCTION

In all curve work the use of pull-off hangers is recommended to secure the proper curvature of messenger and trolley wire. On curves not sharper than 10 degrees or 574 ft. radius, pull-off hangers bridled to a backbone run between the line poles or bracket extensions, depending on whether the poles are set outside or inside the curve, are recommended. On all curves sharper than 10 degrees it is generally cheaper and better practice to set the line poles or extra guy poles outside the curve and to bridle the pull-off hangers to a backbone run between them. On sharp curves the bracket extension method would require a close pole spacing which in the interest of economy should be avoided.

In general the adoption of some standard pole spacing for curves is preferable as it will reduce the number of special length hangers to be carried in stock. As an assistance to this end the following table is given, designating definite pole spacings for the various degrees of curvature and also indicating the number and lengths of tangent and pull-off hangers per span. This pole and pull-off spacing will keep the trolley wire within from four to six inches of the track center.

ELEVEN-POINT CURVE CONSTRUCTION

Angle of Curve	Radius		Pole Spacing	No. Pull-off Point	Number of Hangers per Span — Straight Line Hangers											Pull-Off Hangers		
					6″	6¾″	8½″	11″	12″	13½″	14¾″	16″	17½″	19¼″	20½″	14″	17″	20″
0°– 2°	0	2865	150	1	1	2	2	2	–	–	2	–	–	1	–	–	–	1
2°– 4°	2865	1433	150	2	1	2	2	2	–	–	–	–	–	2	–	2	–	–
4°– 6°	1433	955	125	2	–	–	–	1	2	–	–	2	–	2	–	2	–	–
6°–10°	955	574	95	2	–	–	–	–	–	–	–	3	–	–	2	–	2	–
10°–14°	574	410	95	3	–	–	–	–	–	–	–	2	–	–	2	–	3	–
14°–20°	410	288	70	3	–	–	–	–	–	–	–	–	–	2	2	–	–	3
	288	150	70	4	–	–	–	–	–	–	–	–	–	–	2	–	–	4
	150	75	55	6	–	–	–	–	–	–	–	–	–	–	–	–	–	6
	75	40	50	8	–	–	–	–	–	–	–	–	–	–	–	–	–	8

LINE MATERIAL FOR CATENARY CONSTRUCTION

THREE-POINT CURVE CONSTRUCTION

Angle of Curve	Radius		Pole Spacing	No. Pull-off Points	Number of Hangers per Span: Straight Line Hangers 6″	6¾″	8½″	11″	12″	13½″	14¾″	16″	17½″	19¼″	20½″	Pull-Off Hangers 14″	17″	20″
0°– 2°	0	2865	150	1	1	–	–	–	–	–	2	–	–	–	–	–	–	1
2°– 4°	2865	1433	150	2	1	–	–	–	–	–	–	–	–	–	–	2	–	–
4°– 6°	1433	955	125	2	–	–	–	1	–	–	–	–	–	–	–	–	2	–
6°–10°	955	574	95	2	–	–	–	–	–	–	–	1	–	–	–	–	2	–
10°–14°	574	410	95	3	–	–	–	–	–	–	–	–	–	–	–	–	3	–
14°–20°	410	288	70	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3
	288	150	70	4	–	–	–	–	–	–	–	–	–	–	–	–	–	4
	150	75	55	6	–	–	–	–	–	–	–	–	–	–	–	–	–	6
	75	40	50	8	–	–	–	–	–	–	–	–	–	–	–	–	–	8

STAGGERING TANGENT LINE

Where sliding collectors are used it is recommended that the tangent line be staggered by means of steadies guyed in opposite directions, to avoid wearing grooves in the collector contact surface. (In bracket construction the standard bracket extensions are used in guying the outside steady yoke arm.)

For this purpose the trolley wire should be displaced approximately eight in. on each side of the track center every 1000 ft., *i.e.*, there should be one complete wave from the extreme position on one side across the track and back to the extreme position on the same side in each 2000 ft. of line.

When the roadbed is new it is well to simply make provisions for staggering, but to defer the actual displacement of the trolley wire until the roadbed is settled and put in final shape, as the sway of the car due to irregularities in the track may be enough to throw the sliding contact entirely off the wire.

GENERAL INFORMATION

The problem of installing catenary material is somewhat different from that in connection with the installation of ordinary direct current construction, on account of the requirements imposed by the messenger cable. To obtain a line which will not require frequent re-adjustment the messenger cable must be installed with practically uniform tension throughout its entire length, that is, the shorter spans require less sag. For this reason certain definite pole spacings have been recommended in the foregoing tables with corresponding hanger lengths. When these hangers are used and the messenger adjusted to bring the trolley wire a uniform distance above the track, the messenger cable will have the correct tension.

As there are in this construction two wires to be provided for instead of one, it is necessary to make suitable provisions for two wires in special work, pull-offs and anchors.

METHOD OF INSTALLATION

BRACKET CONSTRUCTION

After the poles are installed, the brackets should be located at a height of eighteen in. more than the required distance between the top of the rail and the trolley wire; this allows for two in. sag of the bracket due to the yielding of the pole when loaded, in single track construction. For double construction this distance should be sixteen in. greater than the desired height of trolley above the top of rail.

Generally no back guys are required for this construction on tangent track but all poles on curves and at anchor points should be properly guyed. This Company recommends the use of strain insulators in all guy cables.

When brackets and insulators are in place the line is ready for the trolley and messenger wires. The foreman doing the construction work can soon determine what method of running out the trolley and messenger wires is best suited to the conditions under which he has to work. The following method of installation is suggested and is known from experience to be efficient and practicable.

The trolley and messenger wire may both be run out at once and hung over the brackets, except at curves where the trolley wire should be supported below the bracket arms. The trolley wire should then be pulled up tight and temporarily anchored while resting on the bracket arm.

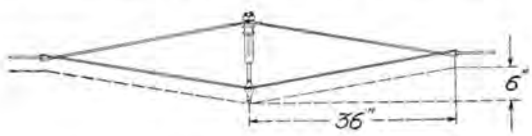
LINE MATERIAL FOR CATENARY CONSTRUCTION

METHOD OF INSTALLATION

BRACKET CONSTRUCTION—(Concluded)

In ordinary construction it is generally inconvenient to measure the tension on the trolley wire. For this reason it is recommended, in order to obtain the desired tension of about one thousand pounds for 0000 trolley wire, that the pull be made with a pair of three sheave blocks, and a "luff" or purchase with a pair of two sheave blocks. Three men can pull a trolley to about the right tension with this combination.

The messenger wire should next be adjusted for tension to give the sag at (A) in the accompanying sketch of about 9 in. at 30 degrees F., 10 in. at 60 degrees F., and 11 in. at 85 degrees F., after which it may be lifted in position on the insulators and tied in. The trolley wire should then be dropped and temporarily supported by hooks from the brackets and from the messenger wire at the center of the span. The line will then be ready for the hangers which should be installed in accordance with the table given on page 88. Both messenger and trolley wires should be anchored every one-half mile on tangent track, and at the ends of tangent track approaching a curve. Sufficient slack should be left in the curves to allow the trolley and messenger wires to



Sketch of Clearance

be pulled over to the center of the track. Where bridles for pull-offs and anchors are used, care should be taken to see that no wires are allowed within a space six inches above the plane of the trolley wire at a distance of three feet from the trolley wire. This clearance is necessary to avoid interference with sliding contacts.

SPAN CONSTRUCTION

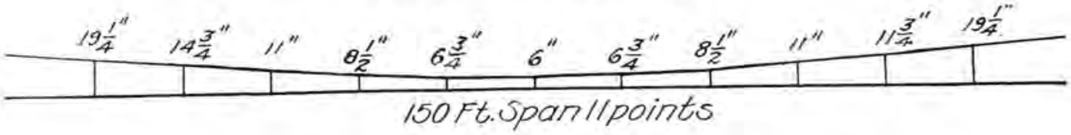
In span construction the span wire should be installed so that when the weight of the messenger and trolley is put on it, there will be a sag of about one foot for each 20 ft. of span, and the back guys should be insulated for full line potential.

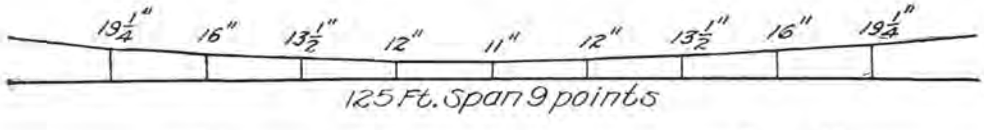
After the poles are guyed and the spans in place, the messenger and trolley wires are run out and hung temporarily from the span wires by hooks. The tension on the trolley and messenger wires and the installation of hangers may then proceed as in bracket construction.

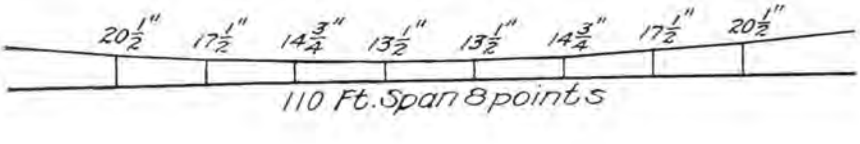
The following sketches and diagrams show convenient methods of satisfying conditions met in every day practice.

HANGERS FOR ELEVEN-POINT TANGENT TRACK CONSTRUCTION AND SHORT SPANS

(FOR 22-INCH DEFLECTION)

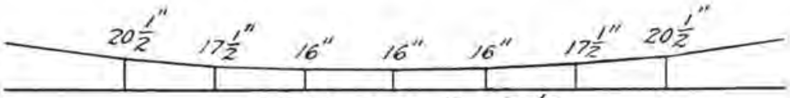




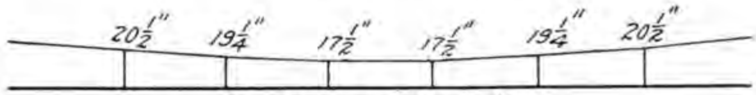


LINE MATERIAL FOR CATENARY CONSTRUCTION

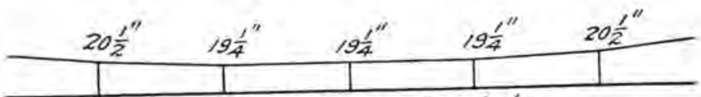
HANGERS FOR ELEVEN-POINT TANGENT TRACK CONSTRUCTION AND SHORT SPANS



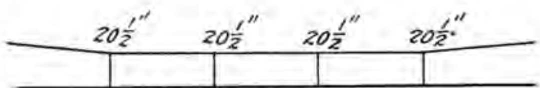
95 Ft. Span 7 points



80 Ft. Span 6 points



70 Ft. Span 5 points

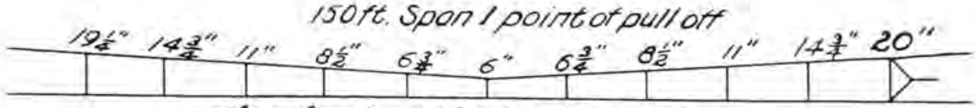


55 Ft. Span 4 points

HANGERS FOR ELEVEN-POINT CURVE CONSTRUCTION AND SHORT SPANS

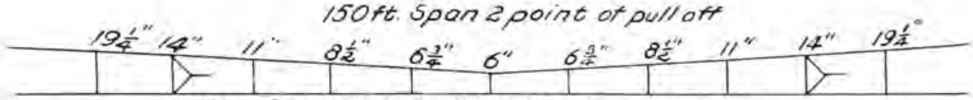
(FOR 22-INCH DEFLECTION)

150 ft. Span 1 point of pull off



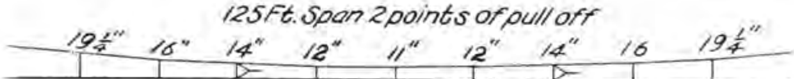
0° to 2° or above 2865 Ft. Radius Curves

150 ft. Span 2 point of pull off



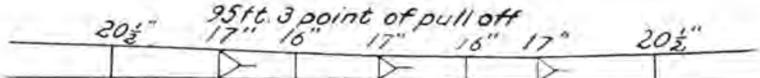
2° to 4° or 2865 to 1433 Ft. Radius Curves

125 Ft. Span 2 points of pull off



4° to 6° or 1433 to 955 Ft. Radius Curves

95 ft. 3 point of pull off

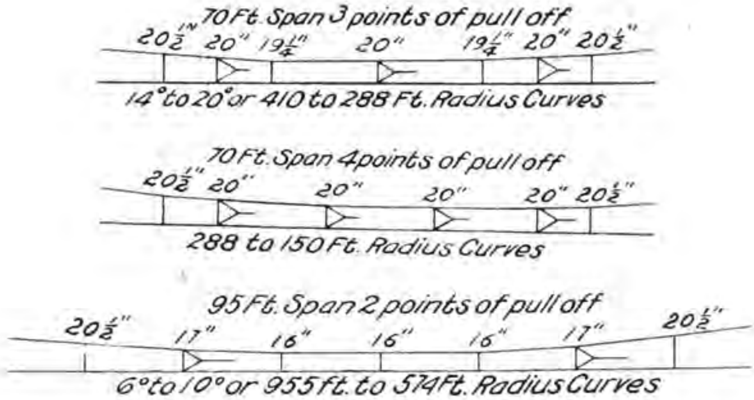


10° to 14° or 574 to 410 Ft. Radius Curves

LINE MATERIAL FOR CATENARY CONSTRUCTION

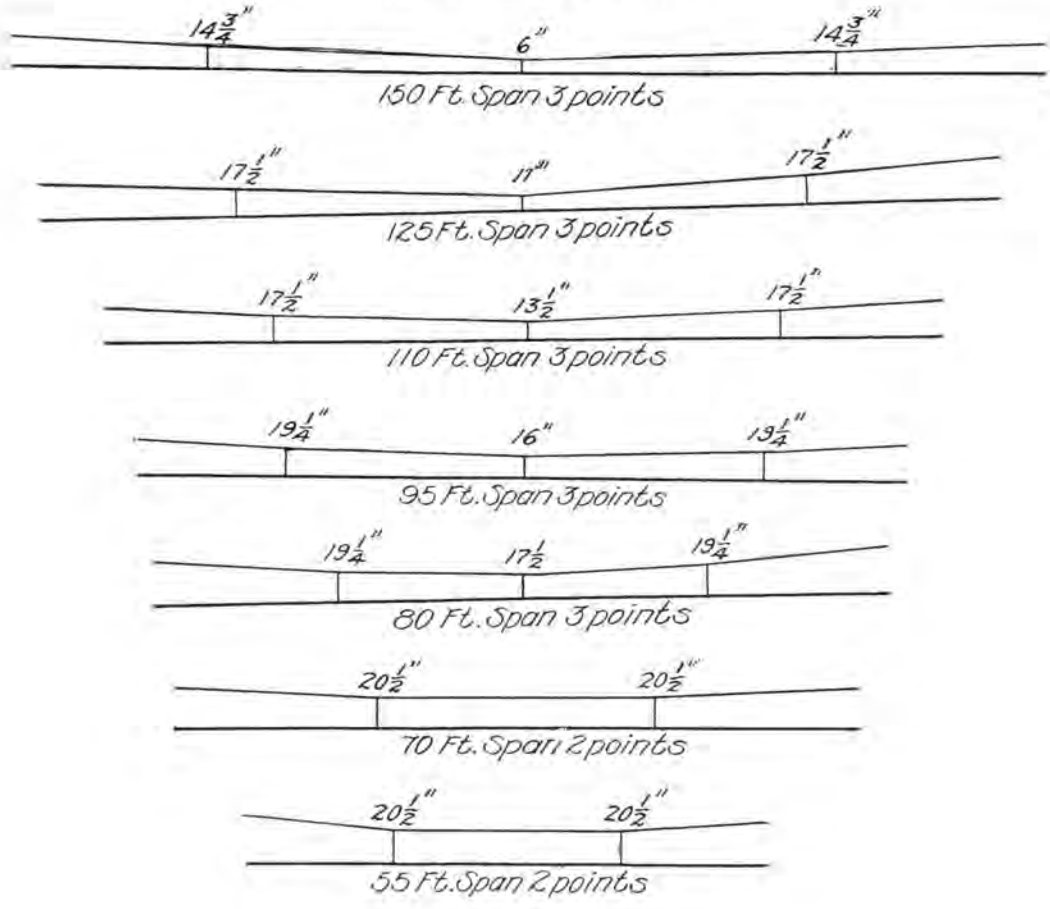
HANGERS FOR ELEVEN-POINT CURVE CONSTRUCTION AND SHORT SPANS

(FOR 22-INCH DEFLECTION)



HANGERS FOR THREE-POINT TANGENT TRACK CONSTRUCTION AND SHORT SPANS

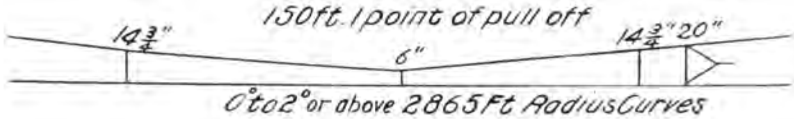
(FOR 22-INCH DEFLECTION)

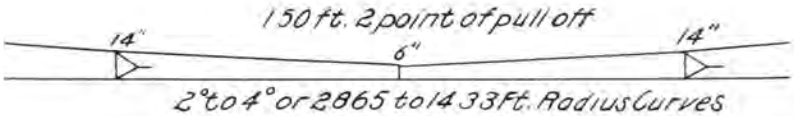


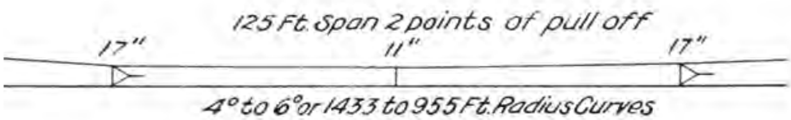
LINE MATERIAL FOR CATENARY CONSTRUCTION

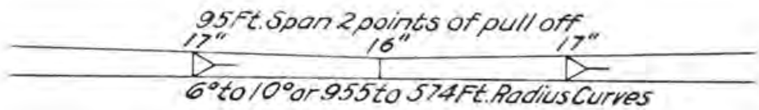
HANGERS FOR THREE-POINT CURVE CONSTRUCTION AND SHORT SPANS

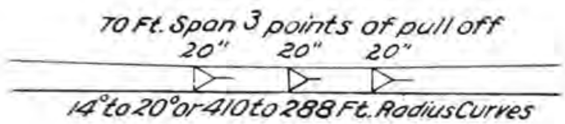
(FOR 22-INCH DEFLECTION)

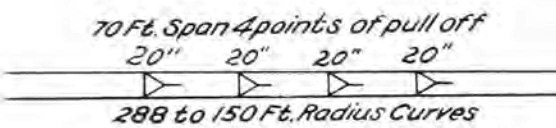


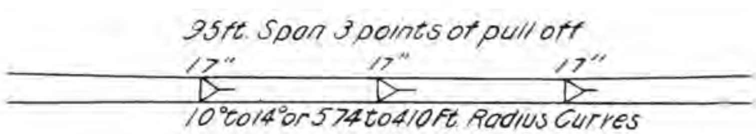




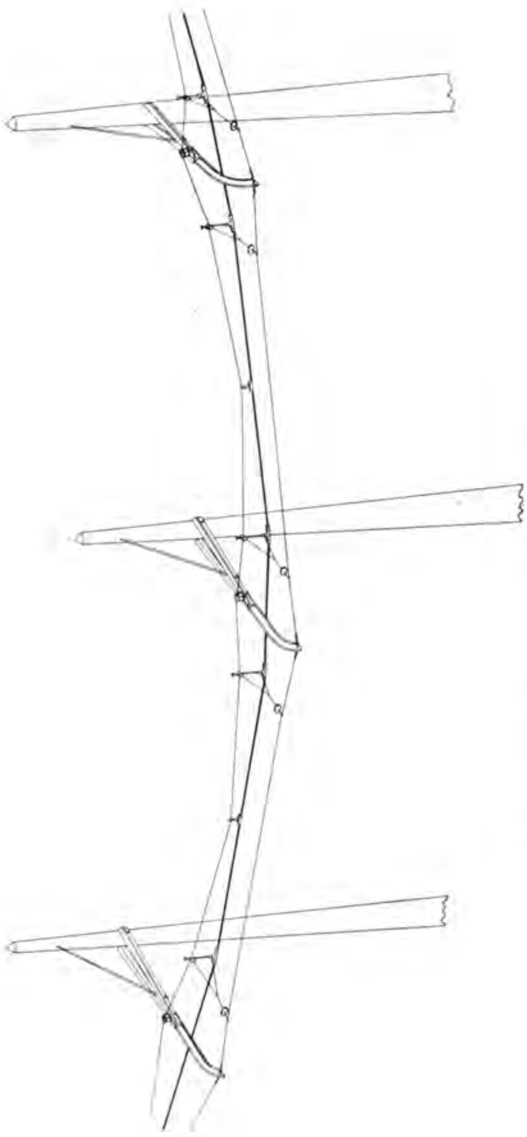




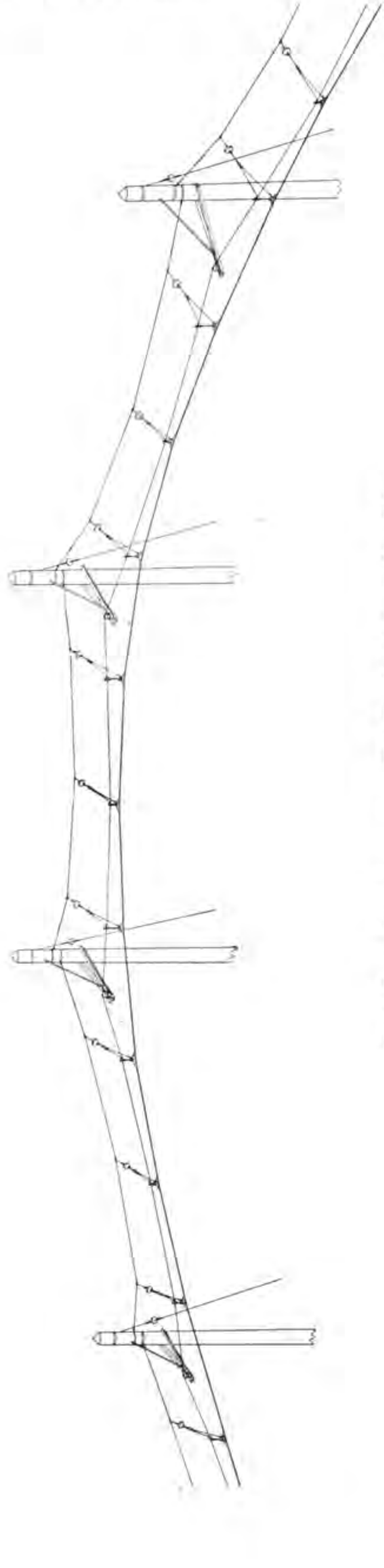




LINE MATERIAL FOR CATENARY CONSTRUCTION

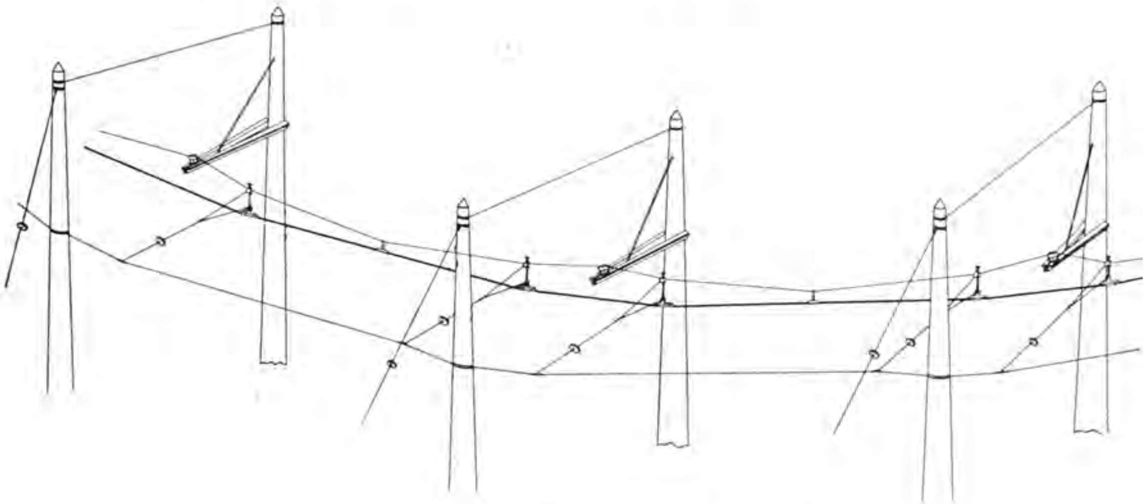


Single Track Curve Construction—With Bracket Extensions

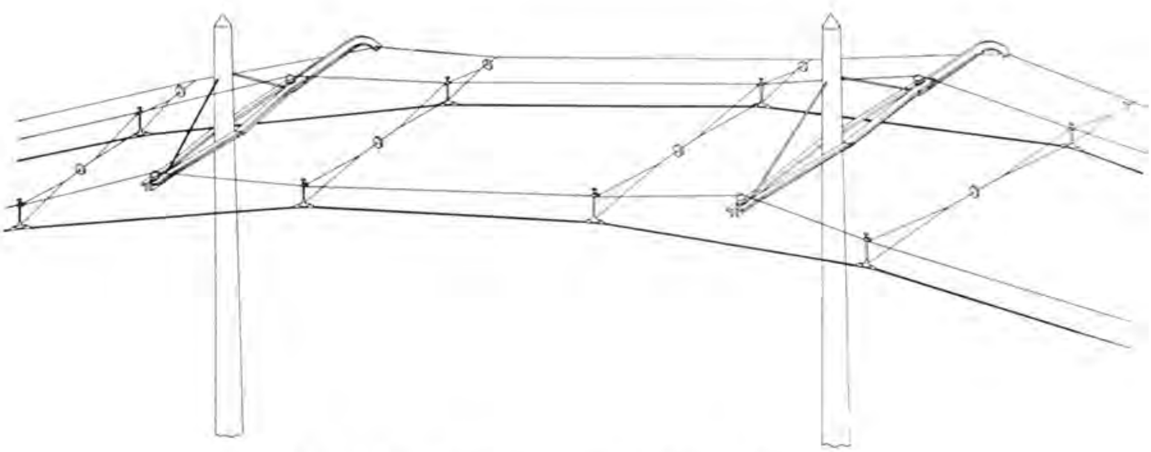


Single Track Curve Construction—With Backbone between Line Poles

LINE MATERIAL FOR CATENARY CONSTRUCTION

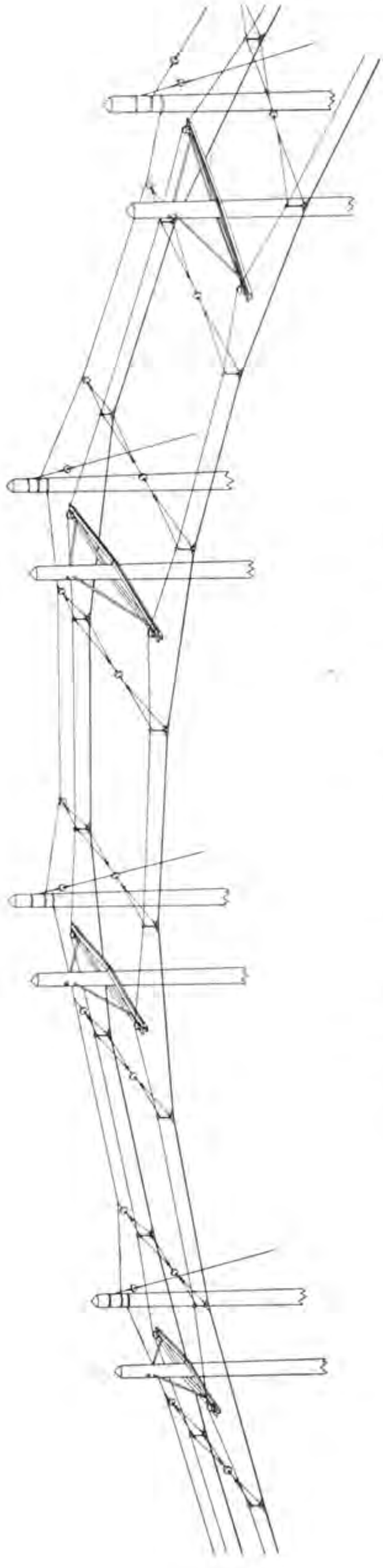


Single Track Curve Construction—With Extra Poles Set for Backbone

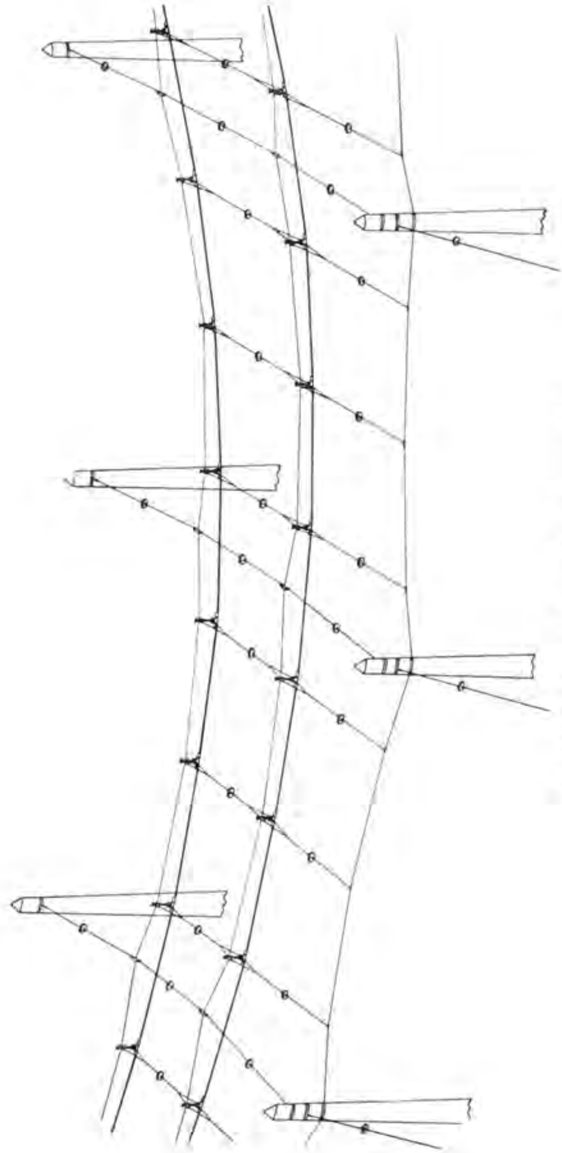


Double Track Curve Construction—With Bracket Extensions

LINE MATERIAL FOR CATENARY CONSTRUCTION

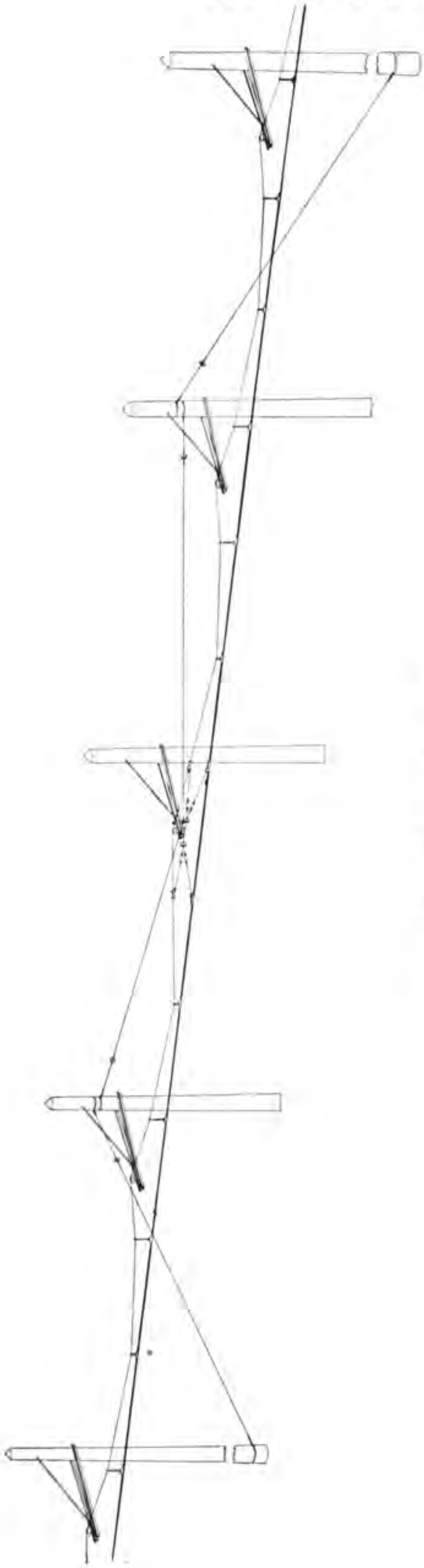


Double Track Curve Construction—With Extra Poles Set for Backbone

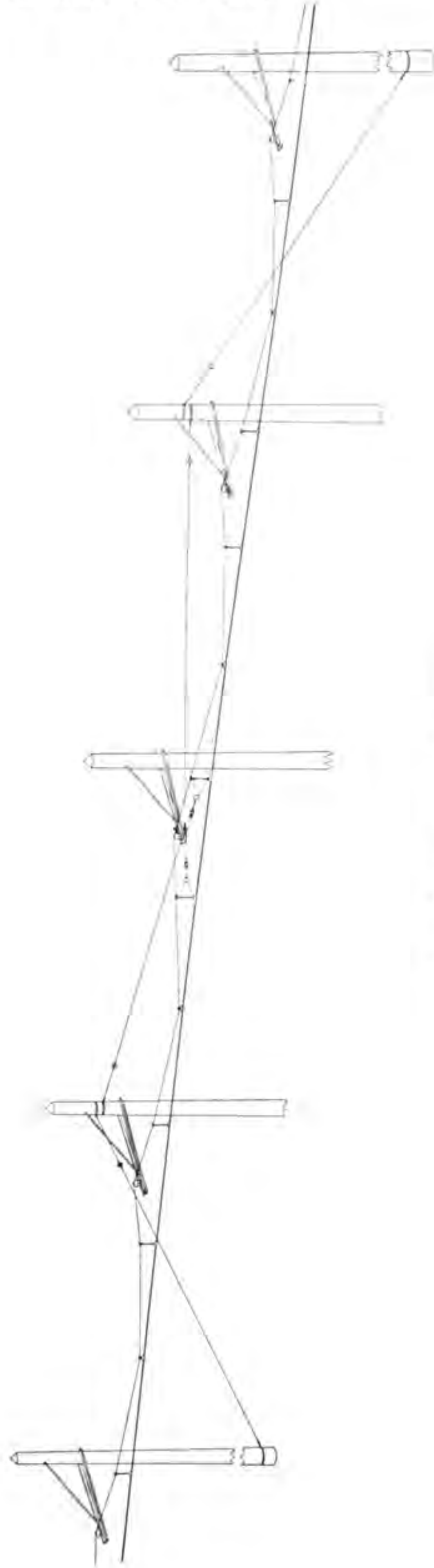


Double Track Cross Span Curve Construction

LINE MATERIAL FOR CATENARY CONSTRUCTION

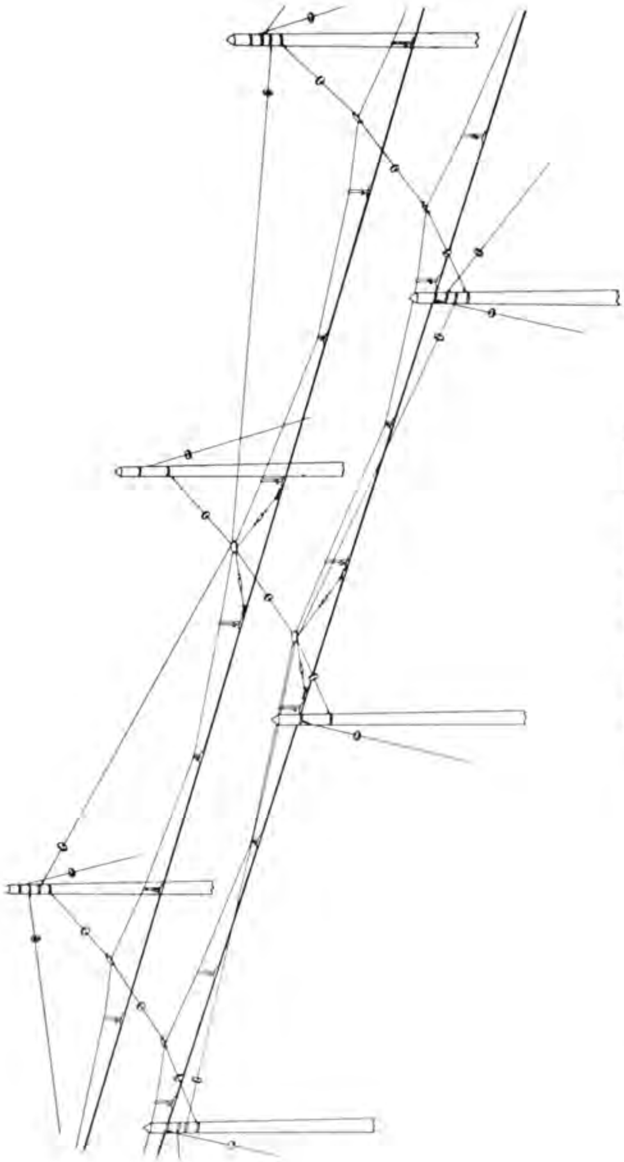


Single Track Anchorage—Form CF

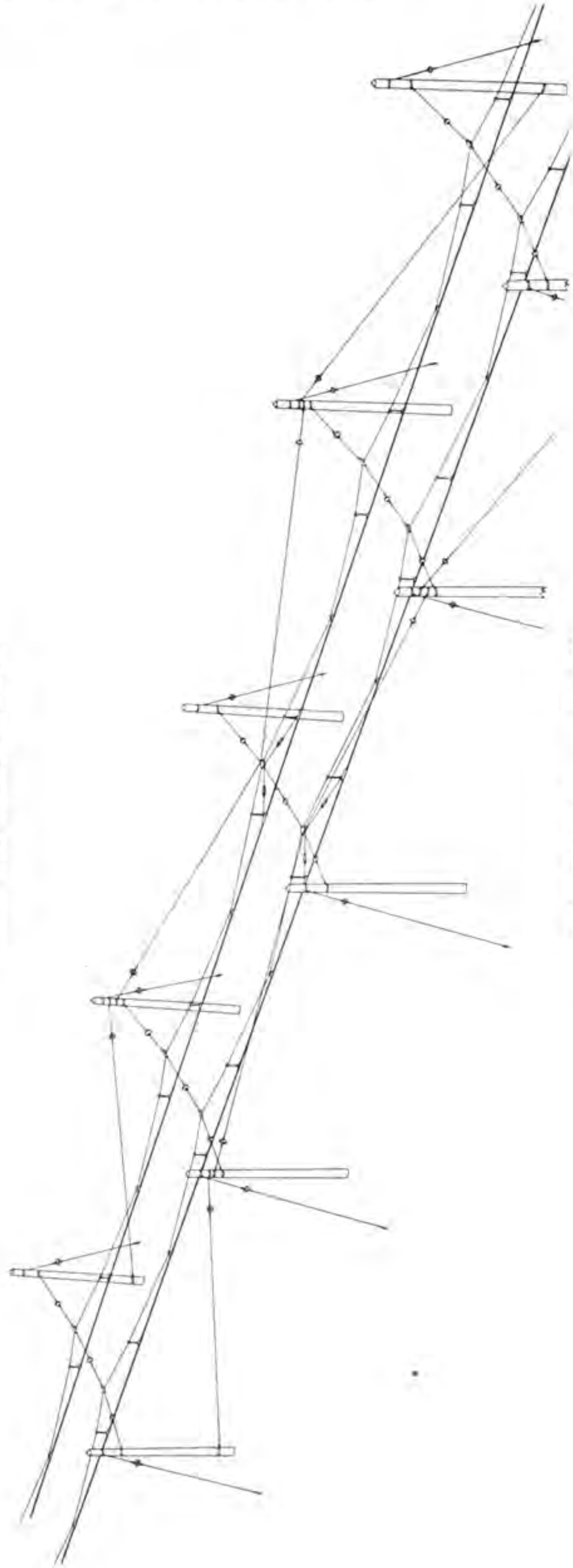


Single Track Anchorage—Form CA

LINE MATERIAL FOR CATENARY CONSTRUCTION

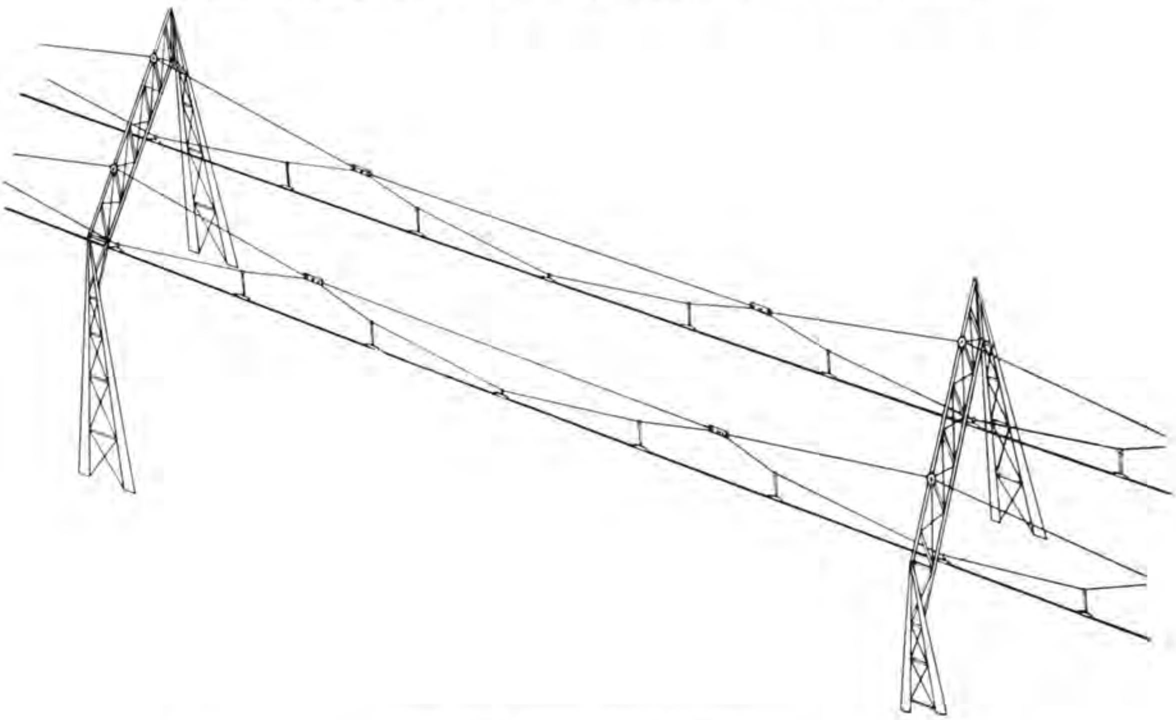


Double Track Anchorage—Form CF

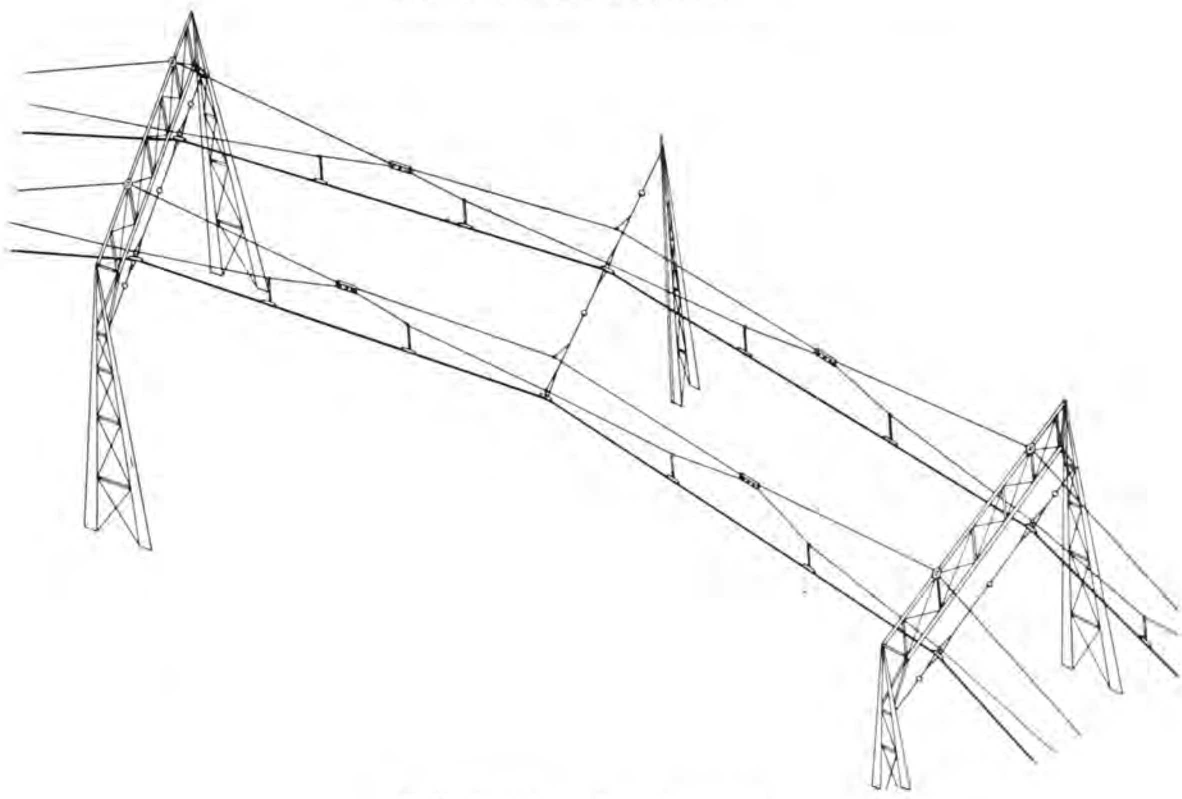


Double Track Anchorage—Form CA

LINE MATERIAL FOR CATENARY CONSTRUCTION

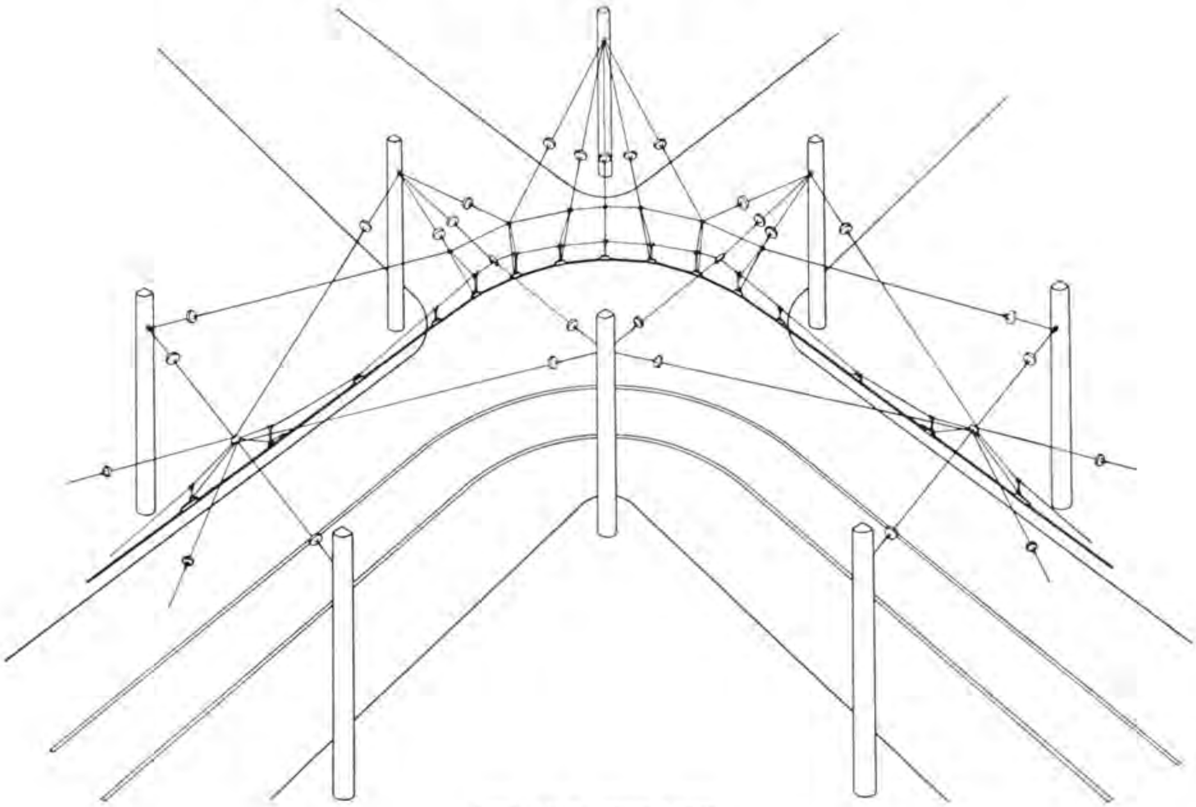


Double Track Tangent—Bridge Construction

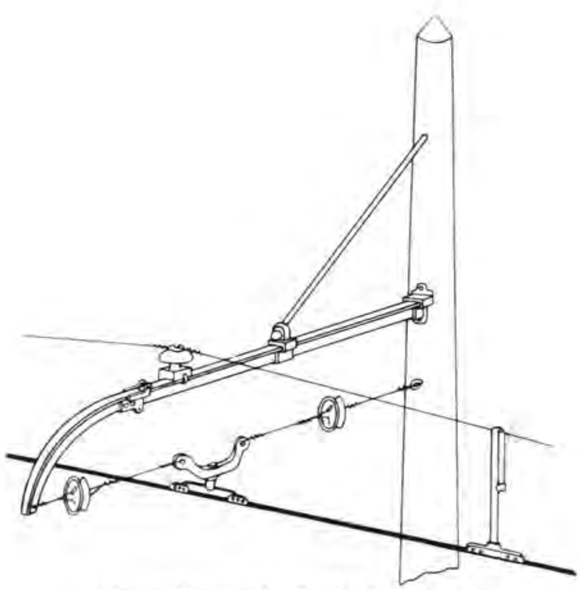


Double Track Curve—Bridge Construction

LINE MATERIAL FOR CATENARY CONSTRUCTION

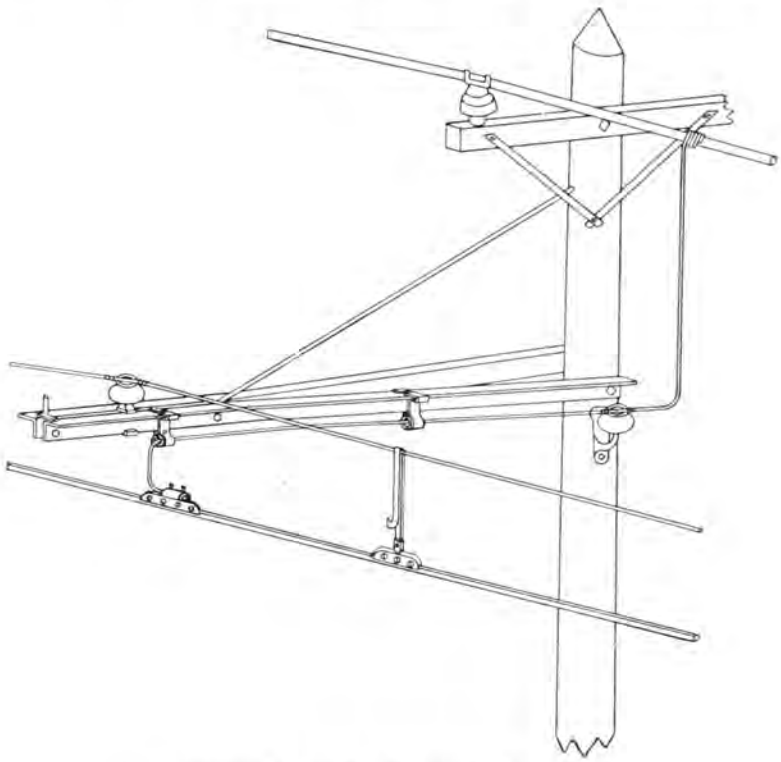


Single Track—Street Corner

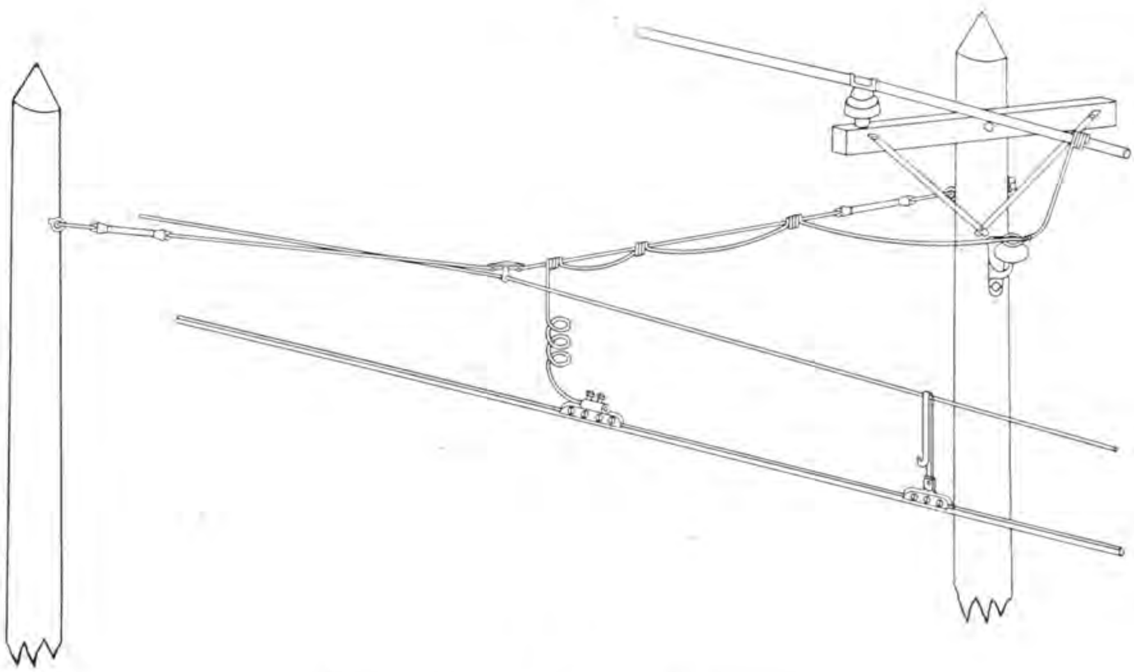


Trolley Wire Steady—Bracket Construction

LINE MATERIAL FOR CATENARY CONSTRUCTION



Arrangement of Feeder Tap—Bracket Construction

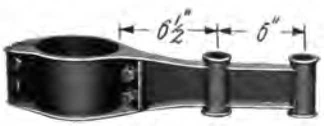


Arrangement of Feeder Tap—Cross Span Construction

CROSS ARMS

MALLEABLE IRON—FEEDER

These arms as listed are suitable for Standard Pipe Poles of various diameters. It should be noted that the diameters given are "pipe measurements." The actual outside diameters, corresponding to the nominal diameters are given in the note below. The diameter of the insulator pin holes is $1\frac{1}{16}$ in.



2-Pin Single Arm

4-Pin Double Feeder Arm

DOUBLE

2-PIN

Cat. No.	Description	Approx. Weight per 100
40113	For 4" standard pipe pole	1300
40114	For 5" standard pipe pole	1450
40115	For 6" standard pipe pole	1600
40116	For 7" standard pipe pole	1700

4-PIN

40117	For 4" standard pipe pole	1700
40118	For 5" standard pipe pole	1900
40119	For 6" standard pipe pole	2000
40120	For 7" standard pipe pole	2200

6-PIN

40121	For 4" standard pipe pole	2200
40122	For 5" standard pipe pole	2400
40123	For 6" standard pipe pole	2500
40124	For 7" standard pipe pole	2700

SINGLE

1-PIN

40137	For 4" standard pipe pole	950
40138	For 5" standard pipe pole	1100
40139	For 6" standard pipe pole	1200
40140	For 7" standard pipe pole	1300

2-PIN

40141	For 4" standard pipe pole	1250
40142	For 5" standard pipe pole	1400
40143	For 6" standard pipe pole	1500
40144	For 7" standard pipe pole	1600

CROSS ARMS

MALLEABLE IRON—FEEDER—SINGLE (Concluded)

3-PIN

Cat. No.	Description	Approx. Weight per 100
40145	For 4" standard pipe pole	1475
40146	For 5" standard pipe pole	1600
40147	For 6" standard pipe pole	1700
40148	For 7" standard pipe pole	1800

NOTE.—Actual outside diam. of 4 in. Standard Pipe Pole, $4\frac{1}{2}$ in.
Actual outside diam. of 5 in. Standard Pipe Pole, $5\frac{9}{16}$ in.
Actual outside diam. of 6 in. Standard Pipe Pole, $6\frac{5}{8}$ in.
Actual outside diam. of 7 in. Standard Pipe Pole, $7\frac{5}{8}$ in.

WOOD CROSS ARMS

The wood cross arms are furnished in yellow pine—painted two coats. The low tension feeder and the high tension arms are bored for $1\frac{1}{2}$ in. pins and two $\frac{1}{2}$ in. lag screws. The telephone arms are bored for $1\frac{1}{4}$ in. pins and two $\frac{1}{2}$ in. lag screws. Arms with other boring will be furnished to order.

LOW TENSION FEEDER—CROSS SECTION 3 1/4 IN. x 4 1/4 IN.

Cat. No.	No. of Pins	Length in In.	Spacing in Inches			Approx. Weight per 100
			Ends	Center	Sides	
40179	2	36	4	28		100
40180	4	48	4	16	12	140
40181	4	60	4	18	17	170
40182	4	72	4	24	20	210
40183	6	72	4	16	12	210

HIGH TENSION—CROSS SECTION 4 IN. x 5 IN.

100000	2	36	4	28		150
100001	2	48	4	40		210
100002	4	60	4	18	17	250
100003	4	72	4	22	21	310
100004	4	96	4	32	28	430
100005	6	96	4	20	17	430
100006	6	120	4	28	21	550

TELEPHONE—CROSS SECTION 2 3/4 IN. x 3 3/4 IN.

100007	2	24	3	18		50
100008	2	30	3	24		70
100009	4	42	3	16	10	95
100010	6	62	3	16	10	140
100011	8	82	3	16	10	180
100012	10	102	3	16	10	235
100013	4	48	3	16	13	110
100014	6	72	3	16	$12\frac{1}{2}$	165
100015	8	96	3	16	$12\frac{1}{3}$	220
100016	12	120	3	14	10	275

CROSS ARM BRACES

Diameter of hole at pole end $\frac{9}{16}$ in; at cross arm end $\frac{7}{16}$ in.

Cat. No.	Description	Approx. Weight per 100
40184	20″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, plain	180
40185	20″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, galvanized	180
40186	24″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, plain	215
40187	24″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, galvanized	215
40188	28″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, plain	250
40189	28″ x $1\frac{1}{4}$″ x $\frac{1}{4}$″, galvanized	250
40190	20″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, plain	160
40191	20″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, galvanized	160
40192	24″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, plain	190
40193	24″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, galvanized	190
40194	28″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, plain	220
40195	28″ x $1\frac{7}{32}$″ x $\frac{7}{32}$″, galvanized	220
100017	20″ x 1″ x $\frac{3}{16}$″, plain	110
100018	20″ x 1″ x $\frac{3}{16}$″, galvanized	110
100019	24″ x 1″ x $\frac{3}{16}$″, plain	125
100020	24″ x 1″ x $\frac{3}{16}$″, galvanized	125
100021	28″ x 1″ x $\frac{3}{16}$″, plain	140
100022	28″ x 1″ x $\frac{3}{16}$″, galvanized	140

CROSS ARM CLAMPS

FOR FASTENING WOOD CROSS ARMS TO IRON POLES

Cat. No. 40162

Cat. No. 40166

CAT. NO.		Dia. of Pole	APPROX. WEIGHT PER 100	
Single Cross Arm	Double Cross Arm		Single	Double
40161	40165	4″	675	850
40162	40166	5″	925	1150
40163	40167	6″	1050	1325
40164	40168	7″	1150	1450

BOLTS, NUTS AND WASHERS

CROSS ARM BOLTS

FOR FASTENING WOOD CROSS ARMS TO WOOD POLES

CAT. NO.		Length	Diameter	Approx. Weight per 100
Plain	Galvanized			
100097	100103	10″	$\frac{1}{2}$″	65
100098	100104	12″	$\frac{1}{2}$″	75
100099	100105	14″	$\frac{1}{2}$″	85
100100	100106	16″	$\frac{1}{2}$″	95
100101	100107	18″	$\frac{1}{2}$″	105
100102	100108	20″	$\frac{1}{2}$″	115
42427	42433	10″	$\frac{5}{8}$″	100
42428	42434	12″	$\frac{5}{8}$″	125
42429	42435	14″	$\frac{5}{8}$″	140
42430	42436	16″	$\frac{5}{8}$″	155
42431	42437	18″	$\frac{5}{8}$″	175
42432	42438	20″	$\frac{5}{8}$″	190

The above Catalogue Numbers cover bolts with nuts but without washers.

WELDED STEEL EYE BOLTS

40210	40220	6″	$\frac{1}{2}$″	60
40211	40221	10″	$\frac{1}{2}$″	80
40212	40222	12″	$\frac{1}{2}$″	95
40213	40223	14″	$\frac{1}{2}$″	105
43684	43686	16″	$\frac{1}{2}$″	120
40214	40224	10″	$\frac{5}{8}$″	130
40215	40225	12″	$\frac{5}{8}$″	150
40216	40226	14″	$\frac{5}{8}$″	170
43685	43687	16″	$\frac{5}{8}$″	190
40217	40227	12″	$\frac{3}{4}$″	235
40218	40228	14″	$\frac{3}{4}$″	260
40219	40229	16″	$\frac{3}{4}$″	285

The above Catalogue Numbers cover bolts with nuts and washers.

DROP FORGED STEEL EYE BOLTS

CAT. NO.		Length	DIAMETER		Approx. Weight per 100
Plain	Galvanized		Stock	Eye	
40798	40780	6″	$\frac{1}{2}$″	$\frac{11}{16}$″	60
40799	40781	8″	$\frac{1}{2}$″	$\frac{11}{16}$″	70
64544	40782	10″	$\frac{1}{2}$″	$\frac{11}{16}$″	80
40230	40232	12″	$\frac{1}{2}$″	$\frac{11}{16}$″	95
64545	40783	14″	$\frac{1}{2}$″	$\frac{11}{16}$″	105
64546	40784	16″	$\frac{1}{2}$″	$\frac{11}{16}$″	120
64548	40786	6″	$\frac{5}{8}$″	$\frac{3}{4}$″	90
64549	40787	8″	$\frac{5}{8}$″	$\frac{3}{4}$″	110
64550	40788	10″	$\frac{5}{8}$″	$\frac{3}{4}$″	130
40231	40233	12″	$\frac{5}{8}$″	$\frac{3}{4}$″	150

The above Catalogue Numbers cover bolts with nuts and washers.
The bolts are threaded four inches.
Variations in length can be furnished at corresponding prices.

BOLTS, NUTS AND WASHERS

DROP FORGED STEEL EYE BOLTS—(Concluded)

Cat. No. Plain	Cat. No. Galvanized	Length	Diameter Stock	Diameter Eye	Approx. Weight per 100
64551	40789	14"	5/8"	3/4"	170
64552	48837	16"	5/8"	3/4"	190
64553	40791	18"	5/8"	3/4"	210
64555	40793	10"	3/4"	1"	210
64556	40794	12"	3/4"	1"	235
64557	40795	16"	3/4"	1"	285
64558	40796	18"	3/4"	1"	310
64559	40797	20"	3/4"	1"	335

The above Catalogue Numbers cover bolt with nuts and washers.
The bolts are threaded four inches.
Variations in length can be furnished at corresponding prices.

FORK BOLTS

Cat. No.	Description	Approx. Weight per 100
19464	Fork bolt with porcelain insulator, 12" x 5/8"	195
43683	Fork bolt with porcelain insulator, 14" x 5/8"	360

The above Catalogue Numbers cover bolts with nut but no washer.

CARRIAGE BOLTS

Length of thread is about three times the diameter.

PRICE PER HUNDRED

Length in Inches	Diameter 1/4"	Diameter 3/8"	Diameter 1/2"	Diameter 9/16"-5/8"
1½	$1.00	$1.90	...	...
1¾	1.04	1.98	...	...
2	1.08	2.06	...	...
2½	1.16	2.22	$3.00	$5.20
3	1.24	2.38	3.22	5.54
3½	1.32	2.54	3.44	5.88
4	1.40	2.70	3.66	6.22
4½	1.48	2.86	3.88	6.56
5	1.56	3.02	4.10	6.90
6	1.72	3.34	4.54	7.58
7	1.88	3.66	4.98	8.26
8	2.04	3.98	5.42	8.94
9	2.20	4.30	5.86	9.62
10	2.36	4.62	6.30	10.30
11	2.52	4.94	6.74	10.98
12	2.68	5.26	7.18	11.66

Prices on galvanized bolts will be quoted on application.

WEIGHT IN LBS. PER HUNDRED

Length In Inches	Diameter 1/4"	Diameter 3/8"	Diameter 1/2"	Diameter 5/8"	Length In Inches	Diameter 1/4"	Diameter 3/8"	Diameter 1/2"	Diameter 5/8"
1½	3.2	8.9	17.4	32.	5	7.6	19.1	35.5	60.4
1¾	3.7	9.	18.6	34.	6	8.9	22.	40.6	68.4
2	3.9	10.3	20	36.4	7	10.2	24.9	45.8	76.4
2½	4.5	11.8	22.6	40.4	8	11.4	27.8	50.9	84.4
3	5.1	13.2	25.1	44.4	9		30.8	56.1	92.4
3½	5.8	14.7	27.7	48.4	10		33.7	61.3	101.
4	6.4	16.2	30.3	52.4	11		34.8	66.4	109.
4½	7.	17.6	32.9	56.4	12		37.5	71.6	117.

BOLTS, NUTS AND WASHERS

STANDARD MACHINE BOLTS

The prices given below apply to bolts with Square Heads and Nuts. For Hexagonal Nuts add 10 per cent. For Hexagonal Heads and Nuts add 20 per cent.

PRICE PER HUNDRED

Length In Inches	DIAMETER						
	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"-5/8"	3/4"
1½	$1.70	$2.00	$2.40	$2.80	$3.60	$5.20	$7.20
2	1.78	2.12	2.56	3.00	3.86	5.58	7.70
2½	1.86	2.24	2.72	3.20	4.12	5.96	8.20
3	1.94	2.36	2.88	3.40	4.38	6.34	8.70
3½	2.02	2.48	3.04	3.60	4.64	6.72	9.20
4	2.10	2.60	3.20	3.80	4.90	7.10	9.70
4½	2.18	2.72	3.36	4.00	5.16	7.48	10.20
5	2.26	2.84	3.52	4.20	5.42	7.86	10.70
5½	2.34	2.96	3.68	4.40	5.68	8.24	11.20
6	2.42	3.08	3.84	4.60	5.94	8.62	11.70
6½	2.50	3.20	4.00	4.80	6.20	9.00	12.20
7	2.58	3.32	4.16	5.00	6.46	9.38	12.70
7½	2.66	3.44	4.32	5.20	6.72	9.76	13.20
8	2.74	3.56	4.48	5.40	6.98	10.14	13.70
9	2.90	3.80	4.80	5.80	7.50	10.90	14.70
10	3.06	4.04	5.12	6.20	8.02	11.66	15.70
11	3.22	4.28	5.44	6.60	8.54	12.42	16.70
12	3.38	4.52	5.76	7.00	9.06	13.18	17.70
13			6.08	7.40	9.58	13.94	18.70
14			6.40	7.80	10.10	14.70	19.70
15			6.72	8.20	10.62	15.46	20.70
16			7.04	8.60	11.14	16.22	21.70
17					11.66	16.98	22.70
18					12.18	17.74	23.70
19					12.70	18.50	24.70
20					13.22	19.26	25.70

Length of thread is about three times the diameter of bolt head. Bolts with longer thread furnished to order. Prices on galvanized bolts will be quoted on application.

AVERAGE WEIGHT PER HUNDRED INCLUDING NUTS

Length In Inches	DIAMETER							
	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
1½	3.9 lbs.	6.2 lbs.	9.7 lbs.	14.7 lbs.	20.4 lbs.	26. lbs.	37. lbs.	58. lbs.
2	4.6	7.2	11.3	16.5	22.4	29.	39.9	63.2
2½	5.4	8.2	12.9	18.5	25.	32.2	44.1	69.
3	6.2	9.3	14.5	20.5	27.8	35.4	48.3	75.2
3½	6.9	10.4	16.1	22.6	30.6	38.7	52.5	81.4
4	7.6	11.5	17.7	24.7	33.4	42.	56.7	87.6
4½	8.3	12.6	19.2	26.8	36.2	45.3	60.9	93.8
5	9.	13.7	20.7	28.9	39.	48.6	65.1	100.
5½	9.7	14.8	22.2	31.	41.8	51.9	69.2	106.
6	10.4	15.9	23.7	33.1	44.6	55.2	73.4	112.
6½	11.1	17.	25.2	35.2	47.4	58.5	77.6	118.5
7	11.8	18.1	26.7	37.3	50.2	61.8	81.8	124.5
7½	12.5	19.2	28.2	39.4	53.1	65.1	86.	130.5
8	13.2	20.3	29.7	41.5	56.	68.5	90.	136.5
9			33.1	45.7	61.5	75.2	98.	149.
10			36.5	49.9	67.	81.9	106.3	161.
11			40.	54.	72.5	88.7	114.6	173.
12			43.5	58.3	78.	95.5	122.9	184.5
13			47.	62.5	83.5	102.3	131.2	196.5
14			50.5	66.7	89.	109.1	139.5	209.
15			54.	70.9	94.5	116.	148.	221.
16			57.5	75.1	100.	123.	156.5	233.
17					105.5	130.	165.	245.
18					111.	137.	173.5	257.5
19					116.5	144.	182.	270.
20					122.	151.	190.5	282.

BOLTS, NUTS AND WASHERS

ROUND PLATE WASHERS

Dimensions in Inches: Outside Diam.	Dimensions in Inches: Diam. of Hole	Thickness Wire Gauge	Size of Bolt in Inches	Average Number in 100 Lbs.	List Price per 100 Lbs.
$\frac{3}{4}$	$\frac{5}{16}$	No. 16	$\frac{1}{4}$	13900	$12.20
$\frac{7}{8}$	$\frac{3}{8}$	No. 16	$\frac{5}{16}$	11250	11.40
1	$\frac{7}{16}$	No. 14	$\frac{3}{8}$	6800	10.50
$1\frac{1}{4}$	$\frac{1}{2}$	No. 14	$\frac{7}{16}$	4300	9.70
$1\frac{3}{8}$	$\frac{9}{16}$	No. 12	$\frac{1}{2}$	2600	9.20
$1\frac{1}{2}$	$\frac{5}{8}$	No. 12	$\frac{9}{16}$	2250	9.10
$1\frac{3}{4}$	$\frac{11}{16}$	No. 10	$\frac{5}{8}$	1300	9.00
2	$\frac{13}{16}$	No. 10	$\frac{3}{4}$	1010	8.80
$2\frac{1}{4}$	$\frac{15}{16}$	No. 9	$\frac{7}{8}$	860	8.80
$2\frac{1}{2}$	$1\frac{1}{16}$	No. 9	1	625	8.80

Prices on galvanized round plate washers quoted on application.

SQUARE PLATE WASHERS

Dimensions in Inches: Width	Dimensions in Inches: Thickness	Dimensions in Inches: Size Bolt	Approx. Weight per 1000	List Price per 100 Lbs.
2	$\frac{1}{8}$	$\frac{1}{2}$	140	$9.20
2	$\frac{3}{16}$	$\frac{1}{2}$ or $\frac{5}{8}$	200	9.00
$2\frac{1}{4}$	$\frac{3}{16}$	$\frac{5}{8}$ or $\frac{3}{4}$	250	8.80
3	$\frac{3}{16}$	$\frac{5}{8}$ or $\frac{3}{4}$	450	8.80
4	$\frac{3}{16}$	$\frac{5}{8}$ or $\frac{3}{4}$	800	8.80
5	$\frac{3}{16}$	$\frac{3}{4}$ or 1	1250	8.80

Prices on galvanized square washers quoted on application.

NATIONAL LOCK WASHERS

Description	List Price per 1000
For $\frac{1}{4}''$ Bolt	$8.25
For $\frac{3}{8}''$ Bolt	9.50
For $\frac{1}{2}''$ Bolt	9.75
For $\frac{9}{16}''$ Bolt	10.75
For $\frac{5}{8}''$ Bolt	12.25
For $\frac{3}{4}''$ Bolt	13.25

GIMLET OR CONE POINT LAG SCREWS

PRICE PER HUNDRED

Length Under Head in Inches	Diameter: $\frac{1}{4}''$ and $\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$	$\frac{1}{2}''$	$\frac{9}{16}''$–$\frac{5}{8}''$	$\frac{3}{4}''$
2	$2.45	$2.96	$3.47	$4.11	$6.00	
$2\frac{1}{2}$	2.65	3.22	3.79	4.47	6.50	$9.20
3	2.85	3.48	4.11	4.83	7.00	9.90
$3\frac{1}{2}$	3.05	3.74	4.43	5.19	7.50	10.60
4	3.25	4.00	4.75	5.55	8.00	11.30
$4\frac{1}{2}$	3.45	4.26	5.07	5.91	8.50	12.00
5	3.65	4.52	5.39	6.27	9.00	12.70
$5\frac{1}{2}$	3.85	4.78	5.71	6.63	9.50	13.40
6	4.05	5.04	6.03	6.99	10.00	14.10
$6\frac{1}{2}$	4.25	5.30	6.35	7.35	10.50	14.80
7	4.45	5.56	6.67	7.71	11.00	15.50
$7\frac{1}{2}$	4.65	5.82	6.99	8.07	11.50	16.20
8	4.85	6.08	7.31	8.43	12.00	16.90
9	5.25	6.60	7.95	9.15	13.00	18.30
10	5.65	7.12	8.59	9.87	14.00	19.70

Prices will be quoted upon application for galvanized lag screws or for larger sizes.

BOLTS, NUTS AND WASHERS—TURNBUCKLES

GIMLET OR CONE POINT LAG SCREWS—(Concluded)

AVERAGE WEIGHT PER HUNDRED

Length Under Head in Inches	DIAMETER						
	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
2	4.8 lbs.	6.7 lbs.	10.3 lbs.	13. lbs.	22.8 lbs.	24. lbs.	
2½	5.6	8.4	11.9	15.6	25.3	27.2	39 lbs.
3	6.5	9.1	13.5	18.2	27.8	30.5	45
3½	7.3	10.6	15.1	20.6	30.4	33.7	51
4	8.2	12.	16.7	22.9	33.	37.	57
4½	9.	13.	18.6	25.2	35.5	40.2	62
5	9.9	14.	20.5	27.5	38.	43.5	67
5½	10.8	15.	22.4	30.3	40.7	47.	72
6	11.7	16.	24.2	32.	43.3	50.6	77
7			28.	36.5	50.	57.8	87
8				41.	56.8	64.7	97
9				45.5	63.5	72.	107
10				50.	70.3	79.2	117

TURNBUCKLES

DROP FORGED STEEL

WITH TWO EYES

Cat. No. 40237

Plain	Galvanized	Description	Approx. Weight per 100
40236	40240	3/8" bolts, 4" opening	75
40237	40241	1/2" bolts, 6" opening	160
40238	40242	1/2" bolts, 9" opening	190
40239	40243	5/8" bolts, 12" opening	395

WITH EYE AND HOOK

Cat. No. 40245

40244	40248	3/8" bolts, 4" opening	75
40245	40249	1/2" bolts, 6" opening	170
40246	40250	1/2" bolts, 9" opening	215
40247	40251	5/8" bolts, 12" opening	400

INSULATOR PINS

ALL WOOD PINS

Cat. No	Description	DIMENSIONS				Approx. Weight per 100
		A	B	C	D	
100023	Oak pin, painted	4	4	1	$1\frac{1}{4}$	45
100024	Oak pin, unpainted	4	4	1	$1\frac{1}{4}$	40
100025	Locust pin, unpainted	4	4	1	$1\frac{1}{4}$	35
8749	Oak pin, painted	$4\frac{1}{4}$	$4\frac{3}{4}$	1	$1\frac{1}{2}$	50
8750	Oak pin, unpainted	$4\frac{1}{4}$	$4\frac{3}{4}$	1	$1\frac{1}{2}$	45
8751	Locust pin, unpainted	$4\frac{1}{4}$	$4\frac{3}{4}$	1	$1\frac{1}{2}$	40
100026	Oak pin, painted	$4\frac{1}{4}$	$4\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	55
100027	Oak pin, unpainted	$4\frac{1}{4}$	$4\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	50
100028	Locust pin, unpainted	$4\frac{1}{4}$	$4\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	45
40252	Locust pin, unpainted (special for Trans. Insulators)	$5\frac{3}{4}$	$4\frac{1}{4}$	1	$1\frac{1}{2}$	50

WOOD SIDE BRACKETS

Cat. No.	Description	Approx. Weight per 100
7798	Oak bracket, painted, 12″ long	80
8747	Oak bracket, unpainted, 12″ long	75
8841	Locust bracket, unpainted, 12″ long	70

IRON PINS

Cat. No.	Description	DIMENSIONS				Approx. Weight per 100
		A	B	C	D	
69066	Malleable iron pin	$5\frac{1}{2}$	4	1	$1\frac{1}{2}$	350
69067	Grey iron pin	$5\frac{1}{2}$	4	1	$1\frac{1}{2}$	325
69068	Malleable iron pin	$5\frac{1}{2}$	4	$1\frac{3}{8}$	$1\frac{1}{2}$	400
69069	Grey iron pin	$5\frac{1}{2}$	4	$1\frac{3}{8}$	$1\frac{1}{2}$	375

IRON BRACKETS

Cat. No. 8744

Cat. No. 40201

Cat. No. 17194

Of these brackets, Cat. No. 8744 is intended for light feeder wires. Cat. No. 40201 is a heavier bracket with curved back for pole use, and will carry the largest size feeder. Cat. Nos. 17194 and 60669 are extra heavy and made of gray iron.

INSULATOR PINS

IRON BRACKETS—(Concluded)

Cat. No.	Description	Approx. Weight per 100
8744	Side bracket, 1″ thread	85
40201	Side bracket, curved back, heavy 1″ thread	290
17194	Side bracket, extra heavy, 1″ thread	710
60669	Side bracket, extra heavy $1\frac{3}{8}$″ thread	800

STEEL PINS WITH WOOD TOPS

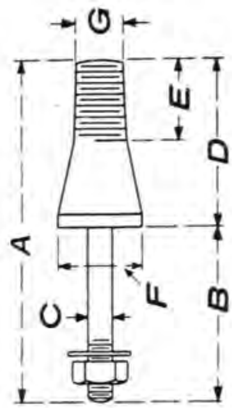
Cat. No. 40260

These pins consist of high carbon steel bolts with paraffined wood tops having 1 in. or $1\frac{3}{8}$ in. thread.

Prices include nut and washer.

Cat. No.	Dimensions in Inches A	B	C	D	E	F	G	Approx Weight per 100
40258	9	5	$\frac{5}{8}$	4	$1\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{3}{8}$	110
40259	$10\frac{1}{2}$	6	$\frac{5}{8}$	$4\frac{1}{2}$	2	$2\frac{1}{4}$	$1\frac{3}{8}$	125
40260	$9\frac{1}{2}$	5	$\frac{1}{2}$	$4\frac{1}{2}$	2	$1\frac{7}{8}$	1	60
40261	$8\frac{1}{2}$	5	$\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{7}{8}$	1	60
40262	$10\frac{1}{2}$	$5\frac{1}{4}$	$\frac{1}{2}$	$5\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	1	80

For pins having other dimensions than given above, or for pins with galvanized bolts, prices will be quoted on application.



STEEL PINS WITH PORCELAIN AND WOOD TOPS

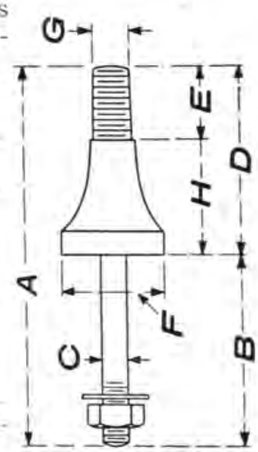
These pins are built with a steel bolt the total length of the pin. The threaded portion is paraffined wood, and is supported on a porcelain base; the porcelain serves to prevent burning of the pin, due to arcing around the skirt of the insulator.

Prices include nut and washer.

Cat. No. 40269

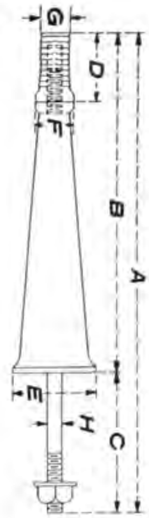
Cat. No.	Dimensions in Inches A	B	C	D	E	F	G	H	Approx Weight per 100
40263	$9\frac{1}{2}$	$4\frac{3}{4}$	$\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{5}{8}$	1	3	110
40264	$10\frac{1}{4}$	$4\frac{7}{8}$	$\frac{1}{2}$	$5\frac{3}{8}$	$2\frac{3}{8}$	$2\frac{5}{8}$	1	3	125
40265	$8\frac{1}{2}$	$4\frac{1}{2}$	$\frac{1}{2}$	4	$1\frac{3}{4}$	$2\frac{1}{4}$	1	$2\frac{1}{4}$	90
40266	$10\frac{1}{2}$	6	$\frac{5}{8}$	$4\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{8}$	$2\frac{1}{4}$	155
40267	11	$5\frac{1}{4}$	$\frac{1}{2}$	$5\frac{3}{4}$	$2\frac{1}{4}$	3	$1\frac{3}{8}$	$3\frac{1}{2}$	155
40268	11	$5\frac{1}{4}$	$\frac{5}{8}$	$5\frac{3}{4}$	$2\frac{1}{4}$	3	$1\frac{3}{8}$	$3\frac{1}{2}$	200
40269	11	$5\frac{1}{4}$	$\frac{1}{2}$	$5\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{5}{8}$	$1\frac{3}{8}$	3	125
40270	$12\frac{1}{2}$	$5\frac{1}{2}$	$\frac{5}{8}$	7	$3\frac{1}{2}$	3	$1\frac{3}{8}$	$3\frac{1}{2}$	225

For pins having other dimensions than given above, or for pins with galvanized bolts, prices will be quoted on application.



INSULATOR PINS

STANDARD "LEE" PINS—ALL METAL



The "Lee" pin consists of a hollow iron base, a separable iron thimble and a steel stud bolt with nut and washer. The thimble is designed for cementing into the insulator and because of the separable feature the cementing may be done at whatever place is most convenient without causing difficulty in shipping. This renders unnecessary the expensive practice of cementing in the field.

Cat. No.	DIMENSIONS IN INCHES								Approx. Weight per 100
	A	B	C	D	E	F	G	H	
100165	13 1/8	6 1/4	6 7/8	3	3	1 3/4	1 1/8	3/4	450
100166	14 3/8	7 1/2	6 7/8	3	3	1 3/4	1 1/8	3/4	490
100167	15 7/8	9	6 7/8	3	3 3/4	1 3/4	1 1/8	3/4	550
100168	17 7/8	11	6 7/8	3	3 3/4	1 3/4	1 1/8	3/4	655
100169	19 3/8	12 1/2	6 7/8	3	3 3/4	1 3/4	1 1/8	3/4	725
100170	20 7/8	14	6 7/8	3	4 3/4	1 3/4	1 1/8	3/4	820

Pins with other lengths of stud bolts or with extended pin base can be furnished if specifically ordered.

RIDGE IRONS

These irons are arranged for attachment to the top of wood poles with 3/8 in. lag screws. The irons are galvanized.

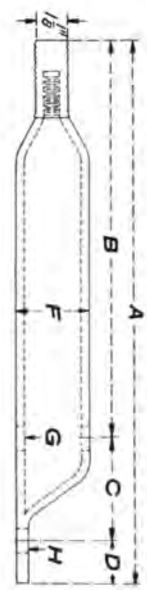
Cat. No. **40203**

Cat. No. **40204**

Cat. No.	Description	DIMENSIONS IN INCHES				Approx. Weight per 100
		Height Overall	Height of Iron	Between Legs	Size Iron	
40203	Ridge Iron, with wood pin and porcelain pin base . . .	11 3/4	7	6	1/8 x 2 1/4	275
40204	Ridge Iron, with all wood pin .	11 1/2	7	6	1/8 x 2 1/4	250

PIPE POLE-TOP PINS

WITH SEPARABLE THIMBLES



Cat. No.	DIMENSIONS IN INCHES							Approx. Weight per 100
	A	B	C	D	F*	G	H	
100171	13	8 1/2	3 1/2	1	2	17/32	17/32	445
100172	15	10	4	1	2	21/32	17/32	505
100173	17 1/2	11 3/4	4 1/2	1 1/4	2	21/32	17/32	580
100174	20 1/2	14	5 1/4	1 1/4	2	21/32	17/32	670
100175	23 1/2	16	6	1 1/2	2	21/32	17/32	760

*Nominal pipe measurement. The actual diameter is 2.375 in.

INSULATORS

FEEDER TAP

FOR ATTACHING FEEDER TAP TO BRACKET ARM

For use in pole bracket construction for insulating taps run from the feeder to the trolley wire. Opening in insulating bushings is 1 in.

Feeder Tap Insulator

Cat. No.	Description	Approx. Weight per 100
40207	For 1¼″ pipe (1.66″ outside diam.) mall. iron, galv.	160
40208	For 1½″ pipe (1.9″ outside diam.) mall. iron, galv.	180
40209	For 2″ pipe (2.38″ outside diam.) mall. iron, galv.	200

Cat. No. 64259

FEEDER WIRE, 600 VOLTS

WITH TOP AND SIDE BEARING

Cat. No. 64259 is an all compound insulator suitable for feeders up to and including 500,000 c.m. The special compound used will not soften at a temperature less than 650 degrees fahrenheit.

Cat. No	Description	Approx. Weight per 100
64259	Insulator with top and side grooves for 4/0 to 500,000 c.m. feeders 1″ pin hole	225

TIE TOP

WITH TOP AND SIDE BEARING

The tie top insulator consists of a sherardized malleable iron shell into which the standard insulating compound is moulded. It is furnished with both 1 in. and 1⅜ in. pin holes and is suitable for the heaviest loads in all locations excepting corners, for which standard corner insulators are used.

Cat. No. 46012

Cat. No.	Description	Diam. Pin Hole	Approx. Weight per 100
46013	Insulator with top and side grooves for No. 0000 and smaller cond.	1″	415
46012	Insulator with top and side grooves for 500,000 c.m. and smaller cond.	1″	445
46007	Insulator with top and side grooves for No. 0000 and smaller cond.	1⅜″	410
46006	Insulator with top and side grooves for 500,000 c.m. and smaller cond.	1⅜″	440
46005	Insulator with top and side grooves for 800,000 c.m. and smaller cond.	1⅜″	520
46004	Insulator with top and side grooves for 1,500,000 c.m. and smaller cond.	1⅜″	540

INSULATORS

FEEDER WIRE, 600 VOLTS—CLIP TOP

WITH TOP AND SIDE BEARING

The clip top insulators have sherardized malleable iron shells with the standard moulded compound insulation. They are listed for two sizes of pins and to accommodate cables up to 1,500,000 c.m. cross section. The top clips being well malleablized are readily peaned over the feeder to hold it in place. It should be noted particularly that in all the General Electric Company's iron clad insulators, the iron shells extend well below the lowest bearing point of the insulator pins thereby greatly strengthening them against side strains. The clip top insulators are offered for any service excepting at corners, for which standard corner insulators are used.

Cat. No. 46010

Cat. No.	Description	Diam. Pin Hole	Approx. Weight per 100
46011	Insulator with top clips and side groove for No. 0000 and smaller cond.	1"	390
46010	Insulator with top clips and side groove for 500,000 c.m. and smaller cond.	1"	415
46003	Insulator with top clips and side groove for No. 0000 and smaller cond.	1⅜"	385
46002	Insulator with top clips and side groove for 500,000 c.m. and smaller cond.	1⅜"	410
46000	Insulator with top clips and side groove for 800,000 c.m. and smaller cond.	1⅜"	495
46001	Insulator with top clips and side groove for 1,500,000 c.m. and smaller cond.	1⅜"	520

WEDGE TOP

WITH TOP AND SIDE BEARING

Cat. No. 61110

This insulator is like the clip top insulator in general design but the clip tops are replaced by malleable iron clamping wedges, which are free to move up and down the inclined slots but effectually prevented from horizontal movement. This design makes it practically impossible for the feeder to be pulled from the insulator top by side strains. It is furnished with either 1 in. or 1⅜ in. pin holes and for cables up to and including 1,500,000 c.m. cross section. All metal parts are sherardized.

Cat. No.	Description	Diam. Pin Hole	Approx. Weight per 100
61110	Insulator with top wedges and side groove for 0000 to 500,000 c.m. cond.	1"	520
61109	Insulator with top wedges and side groove for 0000 to 500,000 c.m. cond.	1⅜"	515
61108	Insulator with top wedges and side groove for 600,000 to 1,500,000 c.m. cond.	1⅜"	625

CORNER INSULATOR

WITH SIDE BEARING ONLY

Cat. No. 46008

The corner insulator is arranged with side bearing only and designed for use at street corners where the sharpest turns and greatest side strains are met. Like our other metal clad insulators, it is furnished with a sherardized malleable iron shell which extends well below the lowest bearing point of the pin.

Cat. No	Description	Diam. Pin Hole	Approx. Weight per 100
46014	For 0000 to 500,000 c.m. conductor	1"	390
46008	For 0000 to 500,000 c.m. conductor	1⅜"	385
46009	For 600,000 to 1,500,000 c.m. conductor	1⅜"	440

INSULATORS

FEEDER WIRE, 600 VOLTS

GLASS

Cat. No. 40275

Cat. No. 40276

Cat. No. 40278

Cat. No.	DIMENSIONS IN INCHES					No. per Bbl.	Approx. Weight Each
	Diam.	Height	Top Groove	Side Groove	Pin Hole		
40275	$3\frac{1}{2}$	$4\frac{1}{2}$	1	$\frac{7}{8}$	1	110	$2\frac{1}{8}$
40276	$3\frac{3}{4}$	4	$1\frac{1}{8}$	1	1	125	2
*40277	$4\frac{1}{4}$	$5\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{4}$	1	50	4
40278	4	$4\frac{1}{4}$	$1\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	75	$2\frac{5}{8}$

* Similar in appearance to Cat. No. 40276.

PORCELAIN

Cat. No. 40282

Cat. No. 40279

Cat. No. 40280

40279	$3\frac{3}{4}$	3	$1\frac{1}{4}$	$\frac{5}{8}$	1	200	$1\frac{1}{2}$
40280	$3\frac{1}{2}$	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{7}{8}$	1	200	$1\frac{1}{2}$
40282	$4\frac{1}{4}$	$4\frac{1}{4}$	$1\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{3}{8}$	100	$2\frac{3}{4}$

INSULATORS

FOR TELEPHONE, TELEGRAPH, SIGNAL WORK, ETC.

GLASS

Cat. No. **9322**

Cat. No. **40271**

Cat. No. **9312**

Cat. No.	Description	Dimensions in Inches					Working Voltage	No. per Bbl.	Approx. Weight Each
		Diam.	Height	Top Groove	Side Groove	Pin Hole			
9322	Standard pony glass	$2\frac{1}{4}$	$3\frac{1}{2}$		$\frac{3}{8}$	1		400	$\frac{9}{16}$
9312	Standard pony glass, double petticoat	$2\frac{3}{4}$	$3\frac{1}{2}$		$\frac{3}{8}$	1		300	$\frac{3}{4}$
40271	Glass transposition	$3\frac{7}{8}$	$4\frac{1}{2}$		$\frac{3}{8}$	1		100	$2\frac{1}{4}$

PORCELAIN

Cat. No. **40272**

Cat. No. **40273**

Cat. No. **40274**

Cat. No.	Description	Diam.	Height	Top Groove	Side Groove	Pin Hole	Working Voltage	No. per Bbl.	Approx. Weight Each
40272	Porcelain transposition	$3\frac{1}{2}$	$4\frac{1}{2}$		$\frac{3}{8}$	1		150	$1\frac{1}{2}$
40273	Pony porcelain, deep groove double petticoat	$3\frac{1}{4}$	$3\frac{1}{2}$		$\frac{5}{8}$	1		200	$1\frac{1}{4}$
*40274	Porcelain	$3\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{3}{8}$	1	6600	200	$1\frac{1}{4}$

* For use on telephone circuits where the wires are carried on the same poles with high tension power lines. In such cases the induced potential between the telephone wires and ground often reaches several thousand volts, so that it is necessary in every instance, to suspend both sides of the telephone circuit on high tension insulators.

INSULATORS

FOR ALTERNATING CURRENT WORK

FOR WORKING VOLTAGES UP TO 3500

Cat. No. **40283** Glass

Cat. No. **40274** Porcelain

Cat. No. **40284** Glass

Cat. No.	DIMENSIONS IN INCHES					No. per Bbl.	Approx. Wt. Each
	Diam.	Height	Top Groove	Side Groove	Pin Hole		
40283	$4\frac{3}{8}$	$4\frac{1}{8}$	None	$\frac{3}{8}$	1	125	$2\frac{1}{4}$
40284	$4\frac{3}{8}$	$3\frac{7}{8}$	1	$\frac{7}{8}$	1	125	$2\frac{1}{2}$
40274	$3\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{3}{8}$	1	150	$1\frac{1}{4}$

FOR WORKING VOLTAGES UP TO 7500

Cat. No. **40285**

Cat. No. **40287**

Cat. No.	DIMENSIONS IN INCHES					Test Voltage	No. per Bbl.	Approx. Weight in Lbs.
	Diam.	Height	Top Groove	Side Groove	Pin Hole			
40285	$4\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{1}{8}$	1	1	40000	100	$2\frac{1}{8}$
*40286	5	$4\frac{1}{8}$	$\frac{5}{8}$	$\frac{3}{4}$	1	40000	80	$2\frac{1}{2}$
40287	$5\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	1	40000	100	$2\frac{1}{8}$
†40288	$6\frac{3}{8}$	$4\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	50000	50	3

*Similar in appearance to Cat. No. 40285.
†Similar in appearance to Cat. No. 40287.

INSULATORS

FOR ALTERNATING CURRENT WORK

FOR WORKING VOLTAGES UP TO 11000

PORCELAIN

Cat. No. **100156**

Cat. No. **100158**

Cat. No. **100157**

Cat. No.	Dimensions in Inches: Diam.	Height	Top Groove	Side Groove	Pin Hole	Test Voltage	No. in Bbl.	Approx. Weight Each
100156	5 3/4	4 1/2	5/8	1/2	1 3/8	50000	65	3
100158	6 3/4	5 3/8	1	7/16	1 3/8	50000	40	4 1/4
100157	5 3/4	5 1/4	5/8	3/4	1 3/8	50000	50	4 1/2

FOR WORKING VOLTAGES UP TO 22000

Cat. No. **100161**

Cat. No. **100159**

Cat. No. **100160**

100161	7 1/4	7	1	5/8	1 3/8	70000	20	8
100159	6 3/4	5 3/4	5/8	1/2	1 3/8	70000	35	6
100160	7 1/8	7	3/4	1/2	1 3/8	70000	26	6

INSULATORS

FOR ALTERNATING CURRENT WORK

FOR WORKING VOLTAGES UP TO 33000

PORCELAIN

Cat. No. 100162

Cat. No. 100163

Cat. No. 100164

Cat No.	DIMENSIONS IN INCHES					Test Voltage	No. in Bbl. or Crate	Approx. Ship. Weight Each
	Diam.	Height	Top Groove	Side Groove	Pin Hole			
100162	8	9	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	86000	15	$9\frac{3}{4}$
100164	$8\frac{5}{8}$	$7\frac{3}{8}$	$\frac{3}{4}$	$\frac{5}{8}$	$1\frac{3}{8}$	85000	16	$10\frac{1}{3}$
100163	$8\frac{1}{2}$	$8\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	85000	15	11

PORCELAIN STRAIN INSULATOR

STANDARD PORCELAIN INSULATOR FOR SPAN AND ANCHOR WIRES

Cat. No.	Length	Width	Groove
110900	$2\frac{1}{2}''$	$2\frac{5}{16}''$	$\frac{1}{2}''$
110901	$3\frac{1}{4}''$	$2\frac{3}{4}''$	$\frac{5}{8}''$

INSULATED POLE TOPS—CLAMPS—CLIPS

FOR IRON POLES

COMPLETE WITH WOOD PLUG, EYEBOLT AND NUT

Cat. No. **66448**

Cat. No.	Dia. of Top of Pole	Weight per 100
66448	3″	1500
66450	4″	1600
66452	4½″	1700
66454	5″	2000
66456	6″	3600
66458	7″	3800

POLE TOPS WITH FEEDER ARMS, COMPLETE WITH WOOD PLUG, EYEBOLT AND NUT

Cat. No. **66460**

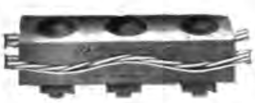
Cat. No.	Dia. of Top of Pole	Weight per 100
66460	3″	4700
66462	4″	4800
66464	4½″	4900
66466	5″	5000
66468	6″	5900
66470	7″	7000

TROLLEY TERMINAL CLAMP


Cat. No. **27437**

Cat. No.	Description	Weight per 100
27437	Terminal clamp for dead ending trolley wires, malleable iron, sherardized	355

SCHAPER GUY WIRE CLAMP



108530	Three bolt clamp for $\frac{3}{8}$″, $\frac{7}{16}$″ and $\frac{1}{2}$″ strand—forged steel galvanized	225

CROSBY CLIPS


Cat. No. **49211**

Cat. No.	Description	Weight per 100
49211	Clip for $\frac{1}{4}$″ strand	30
49212	Clip for $\frac{3}{8}$″ strand	37
49213	Clip for $\frac{7}{16}$″ strand	80

FEEDER CABLE SPLICERS AND CONNECTORS—SECTION SWITCHES

CABLE SPLICER

Cat. No.	Size of Cable	Cat. No.	Size of Cable
43508 43509 43510	250,000 c.m. 300,000 c.m. 400,000 c.m.	43511 43512 43513	500,000 c.m. 750,000 c.m. 1,000,000 c.m.

CABLE CONNECTOR

43538 43539 43540	250,000 c.m. 300,000 c.m. 400,000 c.m.	43541 43542 43543	500,000 c.m. 750,000 c.m. 1,000,000 c.m.

SECTION SWITCHES

In these switch boxes, the hinge clip of the switch is connected to the trolley line, and the box is so constructed that the cover can be closed and locked whether the switch is open or closed, thus preventing any interference with the line by unauthorized persons.

CAT. NO.		Amp. Cap.	WEIGHT EACH	
With Box	Without Box		With Box	Without Box
40305	40313	200	12	5
40307	40315	400	$17\frac{1}{2}$	8
*40321		400	32	
40309	40317	600	23	11
40311	40319	1200	46	28

*Has fuse block.

Cat. No. **40307**
Section Switch

Cat. No. **40321**
Section Switch and Fuse

SECTION SWITCHES

AUTOMATIC SECTIONALIZING SWITCH

FOR RAILWAY FEEDER SYSTEMS

The automatic sectionalizing switch herein illustrated and described is designed to improve the efficiency of direct current feeder systems by permitting all section feeders to be placed in multiple. This is accomplished by connecting the switch directly across the section insulators, which, while giving all the advantages of the non-sectionalizing system, does not, in consequence of the automatic operation of the switch, do away with the beneficial results gained from a sectionalized system.

Automatic Sectionalizing Switch

Suppose the trolley or third rail system to be divided into three sections, A, B and C (see connection diagram Fig. 1), and cars become banked during rush hours, etc. in section B, it will be seen that under the general conditions of section feeding the feeders to sections A and C will be idle while the feeder to section B will be insufficient, with a resultant drop in potential and consequent bad operating conditions.

The system, however, can be made continuous and all feeders placed in multiple by the use of the automatic sectionalizing switch, the operation of which is as follows:

* The switch is connected across the section insulator by the taps G and H. Circuit breaker B on being closed energizes section B and current passes through tap G, switch blade Y, contactor operating coil X to contact stud on relay which is open circuited. On closing circuit breaker C, section C is energized, current passes through tap H, switch blade Z, and relay operating coil W to ground, closing the relay disk V. This in turn completes the circuit through the contactor operating coil X, causing the contactor to close and completing the circuit across the insulator, thus placing all feeders in multiple. It will be noted that under these conditions should cars become banked in any one section, current from the other sections will be fed across the section insulators, thus increasing materially the efficiency of the entire copper distribution. The switch will not operate until both breakers, feeding the sections it is connected to, are closed.

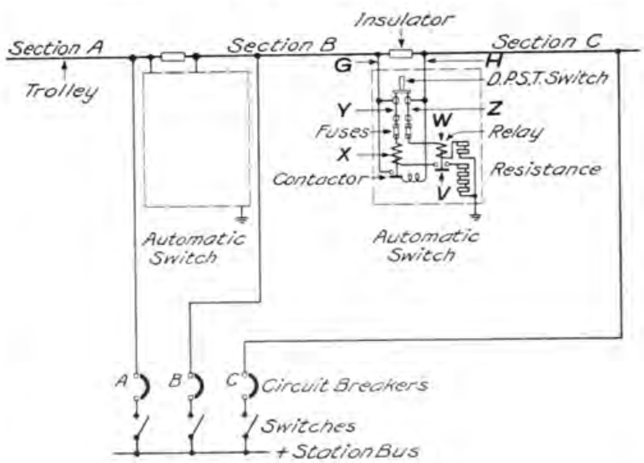


Fig. 1

Connections of Automatic Sectionalizing Switch on Direct Current Trolley Systems

In systems where these switches have been installed, exchange current readings taken during rush hours, as high as 600 and 700 amperes have been recorded, with a resultant increase in potential of from 100 to 150 volts.

In cases of short circuits the isolation of the section affected is very simple. A short circuit occurring on section A will, as the system is continuous, cause †Breakers A, B and C to drop out and all automatic switches to open circuit. When the station operator closes Breaker A, it will at once open, showing the locality of the trouble. He will next close Breakers B and C, which will energize these sections, causing the automatic switch to close and tying the two sections together.

When the short circuit in section A has been remedied, Breaker A can be closed, automatically tying in section A with the rest of the system.

* The above description holds good for the operation of the switches properly connected between any number of sections, and for making rails continuous between substations. (See Fig. 2.)

SECTION SWITCHES—OVERHEAD LINE TOOLS

AUTOMATIC SECTIONALIZING SWITCH—(Concluded)

FOR RAILWAY FEEDER SYSTEMS

Attention is especially called to the fact that a section cannot be isolated, *i.e.*, both sectionalizing switches will not drop out until the circuit breakers feeding the two adjacent sections and the breaker feeding the section to be isolated have been tripped. After the sectionalizing switches have thus been open-circuited, the breakers feeding the two adjacent sections can be closed.

The sectionalizing switch and box enclosing it are constructed and finished to withstand severest weather conditions. As the location and suspension of the switch depend on local conditions, no brackets are furnished.

This switch is highly recommended to customers wishing to improve their operating conditions without the large outlay for feeder copper generally necessary. Its use is also highly recommended in the original layout of feeder systems since by its adoption a smaller cross-section of feeder copper can be utilized.

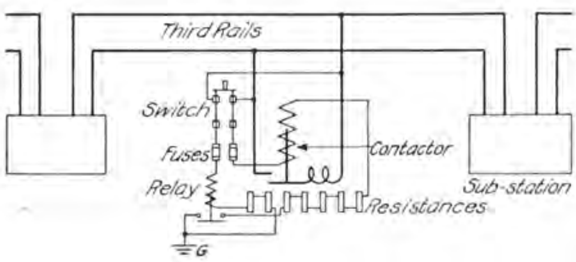
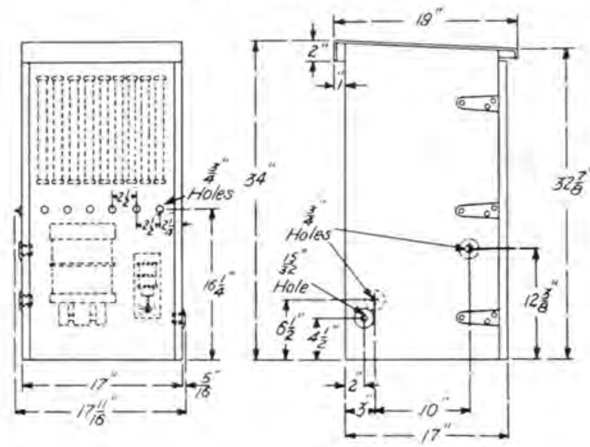


Fig. 2

Connections of Automatic Sectionalizing Switch on Direct Current Third Rail Systems—Rails Continuous Between Sub-Stations

DIMENSIONS



Cat. No.	Description	Capacity in Amp.	Total Weight in Lb.
61872	Automatic sectionalizing switch	1000	195

†(Railway Rating)—1000 amperes can be carried 60 per cent. of the time. Continuous capacity is 600 amperes.

OVERHEAD LINE TOOLS

Cat. No. 16914

Cat. No.	Description
16914	Trolley wire tightener, max. length 3′ 8½″, take up 1′
100031	Trolley wire tightener, max. length 5′ 8½″, take up 1′ 6″

OVERHEAD LINE TOOLS

Cat. No. 100029

Cat. No.	Description
100029 100030	Trolley wire tightener, max. length 7′ 2″, take up 2′ 2″ Trolley wire tightener, max. length 10′ 2″, take up 2′ 2″

Cat. No. 16762

16762	Soldering copper for line work, weight 6 lbs.

Cat. No. 19457

19457	Tongs for tightening cap and cone suspensions

Cat. No. 35799

35799	Wrench for Form H mining suspensions

Cat. No. 46765

46765	Wrench for Forms H, D and G, straight line suspensions

TROLLEY WIRE HAULING CLAMP

Cat. No. 16915

Cat. No.	Description
16915	Trolley wire hauling clamp

OVERHEAD LINE TOOLS—ANCHOR RODS AND ANCHORS

WIRE CABLE THIMBLES

Cat. No.	Dia. of Cable	Approx. Wgt. per 100
88390	$\frac{1}{4}$"	6
88389	$\frac{5}{16}$"	7
88388	$\frac{3}{8}$"	10
88387	$\frac{7}{16}$"	14
88386	$\frac{1}{2}$"	18
88385	$\frac{5}{8}$"	25

FEEDER STRAIN CLAMPS

Cat. No.	Description
100077	For No. 0000 cable—M. I. sherardized
100076	For No. 250,000-300,000 c.m. cable—M. I. sherardized
100075	For No. 400,000-650,000 c.m. cable M. I. sherardized
100074	For No. 700,000-1,000,000 c.m. cable—M. I. sherardized

DISTRIBUTING RINGS

100032	$2\frac{1}{2}$" x $\frac{1}{4}$" wrought iron ring
100033	3 " x $\frac{3}{8}$" wrought iron ring
100034	4 " x $\frac{1}{2}$" wrought iron ring

ANCHOR RODS AND ANCHORS

ANCHOR RODS—GALVANIZED

Cat. No. **48838**

Cat. No.	Diameter	Length	Approx. Wgt. per 100
100035	$\frac{1}{2}$"	5′	425
100036	$\frac{1}{2}$"	6′	500
100037	$\frac{1}{2}$"	7′	575
100038	$\frac{1}{2}$"	8′	650
100039	$\frac{5}{8}$"	5′	650
48838	$\frac{5}{8}$"	6′	750
100040	$\frac{5}{8}$"	7′	850
100041	$\frac{5}{8}$"	8′	950
100042	$\frac{3}{4}$"	6′	1100
100043	$\frac{3}{4}$"	7′	1250
100044	$\frac{3}{4}$"	8′	1400
100045	$\frac{3}{4}$"	10′	1700
100046	1"	8′	2500
100047	1"	10′	2800
100048	1"	12′	3100

Above Cat. Nos. cover anchor rods with nuts but without washers.

ANCHOR RODS AND ANCHORS

HARPOON ANCHOR

Cat. No.	Diameter	Length	Approx. Wgt. per 100
100049	1"	5 ft.	2200

MATHEWS' GUY ANCHORS

Fig. 1

Fig 2

Fig. 3

Fig. 5

Fig. 4

Cat. No.	Description	Approx. Holding Power in Lbs.	Fig. No.	Approx. Weight per 100
88391	5" Anchor—no rod	12500	2	250
88392	6" Anchor—no rod	15000	2	450
88393	5" Anchor with round rod, ½" x 6'	12500	3	650
88394	6" Anchor with round rod, ⅝" x 6'	15000	3	1000
88395	7" Anchor with round rod, ¾" x 6'	17500	3	1500
88399	Wrench for Cat. Nos. 88391, 88392, 88393 and 88394		1	1800
88418	Wrench for Cat. No. 88395		1	2400
*110706	Ratchet wrench for use with Cat. Nos. 88399 and 88418		5	
88396	8" Anchor with square rod, 1⅛" x 6'	20000	4	3800
88397	10" Anchor with square rod, 1¼" x 6'	25000	4	5000
88398	12" Anchor with square rod, 1½" x 6'	30000	4	8000

*The ratchet wrench used in conjunction with the regular wrench makes it possible to set anchors at acute angles or close to walls, etc.

The anchors listed above are finished plain—prices for similar anchors galvanized furnished on application.

INDEX OF SUBJECTS

INDEX TO CATALOGUE NUMBERS

INDEX TO CATALOGUE NUMBERS

INDEX TO CATALOGUE NUMBERS

Bul no. 4748
July 1910

RAIL BONDS

GENERAL
ELECTRIC
COMPANY

ERRATA

To accompany Bulletin No. 4748

RAIL BONDS

Page 12—Reference to page 155 under "Bonds with Offset Tucking" should be changed to 35.

Page 34—Reference to pages 152 and 153 should be changed to 32 and 33 respectively.

Page 35—Reference to pages 149, 152 and 153 should be changed to 29, 32 and 33 respectively.

Page 38—Reference to page 163 should be changed to 43.

Page 43—Reference to page 158 should be changed to 38.

RAIL BONDS

GENERAL ELECTRIC COMPANY
Supply Department
SCHENECTADY, N. Y.

July, 1910

Bulletin No. 4748

ADVICE REGARDING THE PLACING OF ORDERS

1. Orders, and correspondence regarding orders, must always be sent to the nearest Sales Office. (See list of Sales Offices at end of this catalogue.)

2. Catalogue numbers should be used wherever possible.

3. Avoid ordering goods "same as last." If it is advisable to refer to a previous order the date and number of the order and the number of our invoice covering previous shipment should be specified to avoid delay and error in locating it.

4. In ordering, catalogue numbers should be accompanied by the name of the article. This insures complete identification, and lessens the danger of typographical errors in transmitting orders. Where it is impossible to give the catalogue number, a full description of the article required should be furnished.

5. State distinctly how goods are to be shipped—whether by freight, express or mail. If any special route is preferred, it should be mentioned on the order.

6. Careful attention is given to the proper packing of goods, especially glassware, and receipts are obtained from carriers for delivery in good condition. This Company cannot, therefore, be held responsible for goods damaged or lost in transportation. All possible precaution, however, will be used to prevent injury or delay, and, if required, shipments will be traced. All claims for breakage should be presented to transportation companies handling the freight. We will gladly co-operate with our customers in having such claims adjusted by the carriers.

7. All claims must be made within three days of the receipt of the goods and should be accompanied by the package slip which is forwarded with each shipment.

8. When referring to orders, always give the number or date of your order as well as the name of the consignee of the goods.

9. Do not return material of any kind without first communicating with the nearest Sales Office and obtaining—

First: Approval for returning goods.

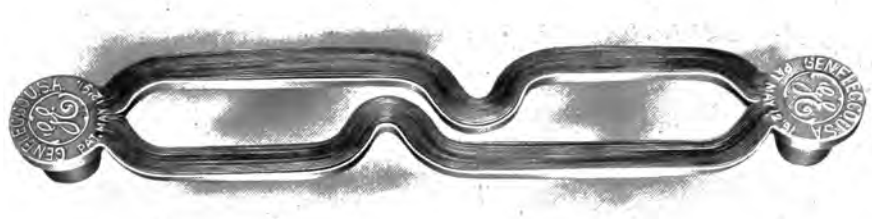
Second: Returned Apparatus tag, giving proper shipping directions.

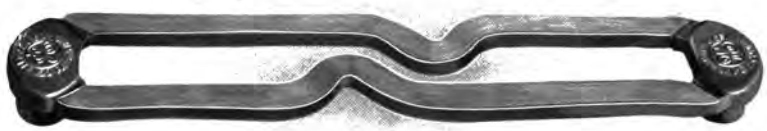
10. All returned goods must be plainly marked with the name and address of the sender, and proper notice of shipment and shipping receipt should be sent to the Sales Office.

11. Prices are subject to change without notice and it is understood that this Company will in no way be held responsible for such changes.

12. All prices are listed at point of manufacture. Charges for boxing and packing will be made in accordance with our regular custom

RAIL BONDS





Form A stud terminal rail bond with branched flat wire or ribbon conductors, for use on web of rail under splice bar.

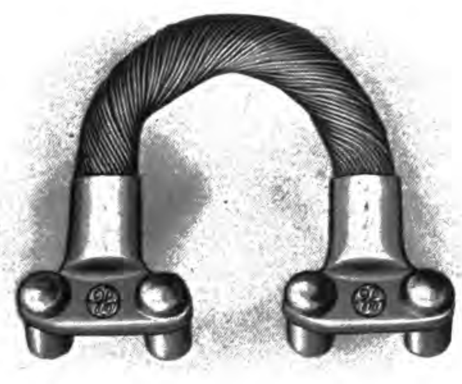
Form B stud terminal rail bond with flat wire or ribbon conductor (unbranched), for use on web of rail under splice bar.

Form C stud terminal rail bond with flat wire conductor, for use on flange or foot of rail.

Form D stud terminal rail bond with single cable conductor, for spanning splice bars or cross-bonding. The conductor may pass under splice bar when space permits.

Form E similar to Form D except conductor is of solid wire.

Form F stud terminal bond with branched cable conductor, for use on web of rail under splice bar.

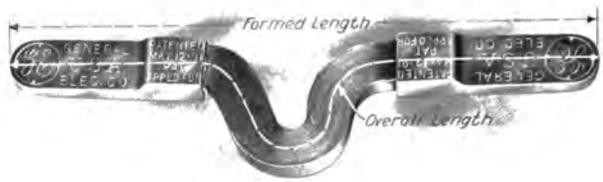


Form M1 twin stud terminal bond with cable conductor, for use on head of rail.

SOLDERED TYPE

Form AS soldered terminal rail bond with branched flat wire or ribbon conductors, for use on web of rail under splice bar.

SOLDERED TYPE—(Continued)



Form BS soldered terminal rail bond with flat wire or ribbon conductors, for use on head of rail.

Form GS soldered T shaped terminal bond with cable wire conductor, for use on head of rail.

Form CS soldered terminal rail bond with flat wire or ribbon conductor, for use on flange or foot of rail.

SOLDERED TYPE—(Concluded)

Form DS soldered terminal rail bond with single cable conductor, for spanning splice bar or cross-bonding. The conductor may pass under splice bar when space permits.

SELECTION OF BONDS

The General Electric Company will be glad to submit recommendations and drawings to meet any condition which may be referred to it. Where conditions permit, the compressed terminal bond concealed under the joint plate is to be preferred. Its location on the rail protects it from injury from outside sources and prevents its being stolen. Its construction is such as to make it perfectly adapted to withstand both the vertical and the horizontal movements of the joint. The method of applying compressed terminal bonds calls for the exercise of only ordinary care in drilling the holes and mounting the compressor. The uniformly good results obtained with this bond depend less upon the exercise of personal judgment by the bonding gang than is the case with any other type of bond. Notwithstanding this fact, however, there is a legitimate field for each of the types of bond included in this catalogue.

An attempt to crowd more copper than is recommended under a splice bar will result undoubtedly in the breaking of the conductors. This company recommends, therefore, that customers follow its suggestions and thereby avoid those difficulties which would be encountered by overlooking certain points in selecting and installing rail bonds.

Requests for information in this connection should be accompanied by the following:

(a) Name of maker and section numbers of rail and joint plate, or a sketch showing section through rail and joint plate.

(b) If patented joint, name of joint.

(c) Distance from end of rail to center of first bolt hole, and distance between centers of first and second bolt holes.

(d) Diameter of joint plate bolts.

The following table gives in circular mils the sectional area of copper equivalent to steel rails of various weights and having various resistance coefficients.

Weight of Rail Lbs. per Yard	RATIO OF RESISTANCE OF STEEL TO RESISTANCE OF COPPER									
	6	7	8	9	10	11	12	13	14	15
	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.	c.m.
50	1061030	909455	795773	707354	636618	578743	530515	489705	454725	424410
60	1273236	1091346	954928	848825	763942	694491	636618	587646	545670	509292
70	1485442	1273237	1114083	990296	891266	810239	742721	685587	636615	594174
75	1591545	1364183	1193660	1061031	954927	868115	795773	734558	682087	636615
80	1697648	1455127	1273238	1131766	1018589	925989	848825	783528	727560	679056
90	1909854	1637018	1432393	1273237	1145913	1041735	954928	881469	818505	763938
100	2122060	1818910	1591546	1414708	1273236	1157486	1061030	979410	909450	848820

The ratio of resistance of steel ordinarily used for track rails (with the present tendency to use steel high in carbon), to the resistance of copper, averages closely 13 to 1. The area of the cross section of a rail is one tenth of its weight in pounds per yard. A 70 pound rail will, therefore, have a sectional area of seven square inches, the equivalent of 685,587 circular mils of copper at the 13 to 1 ratio.

COMPRESSED STUD TERMINAL BONDS

We illustrate in the following pages all of the standard forms of compressed stud terminal bonds. They should be installed with our special, double-screw, or hydraulic compressors.

The accompanying illustration shows in cross section a $\frac{7}{8}$ in. diameter terminal compressed into a $\frac{7}{8}$ in. diameter hole in a piece of steel $\frac{5}{8}$ in. thick, representing the web of a rail. It was compressed with a double-screw compressor, exerting a pressure of 20 tons, operated by one man with the standard 40 in. wrench. Two annular grooves $\frac{1}{16}$ in. wide and $\frac{1}{16}$ in. deep were cut in the walls of the hole, and it will be observed that these grooves became completely filled with copper. This indicates that the studs are soft and malleable, flowing easily and evenly under the pressure of the screw, and that the compressor screw forces the copper back into the hole, entirely filling it before it forms the rivet head over the hole.

APPLICATION OF BONDS

Holes should be drilled with well sharpened tools so that the walls and edges of the hole will be smooth and free from burrs and other irregularities. Bond holes should be of the exact diameter of the bond stud to be inserted.

Oil should not be used in the drilling of holes, as all traces of it cannot readily be removed from the hole, and oil will prevent proper contact between the copper and the steel. A solution of soda and water or plain water may be used, but care should be exercised to see that the hole is wiped perfectly dry before the terminal is inserted. Bonds should not be installed in damp weather. If these simple precautions be disregarded, the electrical efficiency of the bonding will be greatly affected.

If bond holes have been drilled some time prior to the applying of the bonds, the holes should be reamed, as a clean, bright contact is essential.

Rail bond terminals should be rubbed clean and bright with a piece of fine emery cloth before they are inserted in the rail.

Rail bond studs should never be upset with a hammer. Hammering a terminal merely puts a rivet head over the hole, and does not force the copper back into contact with the steel surrounding the hole.

The compression method of installing bonds is admitted generally to be the correct one. After the head of the bond has been drawn up tightly against the web of the rail by the outer screw of our special compressor, the inner screw forces the copper back into the hole. The compressing portion of this inner screw is so designed that a rivet head cannot be formed on the terminal until the hole has been completely filled, even to the pores of the steel. The rivet or button head seals the union, and insures practically a moisture-proof joint. A solution of red lead and linseed oil may be applied to the terminal and adjacent steel, after compression. This will effectually seal the joint against the admission of moisture.

APPLICATION OF BONDS—(Concluded)

To effect radial expansion of the copper in the hole equally in all directions, the inner screw of the bond compressor should be centered in the depression in the end of the terminal.

Bond holes should be located so as to allow for the spacing determined upon between the abutting rail lengths. For instance in single bonding, the holes for a 10 in. bond to be applied to rail lengths spaced $\frac{1}{8}$ in. apart, should be drilled $4\frac{15}{16}$ in. from the end of the rail.

The General Electric Company strongly advises against the locating of bond holes close to the end of the rail. In most cases this sort of drilling provides for a bond too short to embody the necessary flexibility. Moreover it has been found that where the shock caused by the wheels pounding on the joint is dissipated through the copper at the point where it is fixed rigidly to the rail, it has a tendency to shorten the life of the copper.

BONDS WITH OFFSET TUCKING

In most methods of double bonding under the joint plate, the terminals of each bond are applied at unequal distances from the ends of the rails, making it necessary to offset the tucking from the middle of the bond, so as to avoid interfering with the insertion of the joint bolts or the terminals of the other bond. The General Electric Company aims to have the tucking coincide with the spacing between rail ends, and, to accomplish this, must know the exact location of bond holes relatively to the ends of the rails. This information may be conveyed conveniently by a rough pencil sketch showing the side elevation of the rails with the bond drillings indicated.

In order to obtain the double advantage of the mechanical security of the compressed terminal and the efficient electrical contact of a soldered joint, there is an occasional demand for bonds with tinned terminals. Any compressed terminal bond may be furnished with tinned terminals.*

Before installing this style of bond, the rail surrounding the hole should be faced with the special facing tool shown on page 155. The bond hole and spot face should be tinned.

After compression,. the terminal of the bond and the surrounding steel are heated, soldering the bond to the rail. The joint should be allowed to cool slowly.

TERMINAL LENGTH

All orders for stud terminal bonds to be applied to the web of the rail, should state either the section number of the rail or the thickness of the web in inches. This information will enable us to ship bonds with terminals of the correct length. Manifestly a terminal stud sufficiently long to insure good results upon compression in a web $\frac{5}{8}$ in. thick, is too long for a web $\frac{3}{8}$ in. thick, as too much copper in a terminal will cause it to form into a rivet head over the hole before the hole is completely filled.

Lacking knowledge of the web thickness, this company will ship bonds with the following terminal lengths for the terminal diameters given. These lengths have been found best suited to average conditions.

Diameter of Terminal	Length of Terminal
$\frac{1}{2}''$	$\frac{11}{16}''$
$\frac{5}{8}''$	$\frac{11}{16}''$
$\frac{3}{4}''$	$\frac{3}{4}''$
$\frac{7}{8}''$	$\frac{3}{4}''$
$1''$	$\frac{13}{16}''$

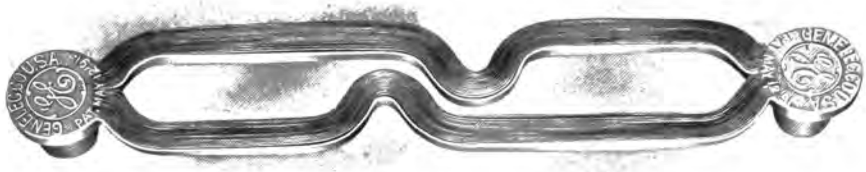
FORM A RIBBON BONDS

The Form A ribbon bond is furnished for use under the joint plate where, usually, the space is restricted, and extreme compactness of design is necessary. The conductor of this bond is composed of thin copper ribbons pressed into the desired shape. The relative movement of the rails is almost wholly in the vertical plane, therefore the laminations are horizontal so as to afford maximum flexibility in the vertical plane.

The bonding space provided in most rail sections with standard angle bars is so distributed as to require the unbalanced form of bond, having more than half of the total conductor section in the lower branch. The balanced form of bond is suitable for use in the great majority of cases only under special angle bars and the patented joints. To enable us to determine the correct distribution of the conductor laminations all orders for bonds should state the maker's name and section number of the rail on which the bonds are to be used.

* Standard Ribbon Bonds of 4/0 section with $\frac{7}{8}$ in. dia. terminals may be furnished with extra large head on terminal to provide large area of contact.

FORM A-1 RIBBON BOND

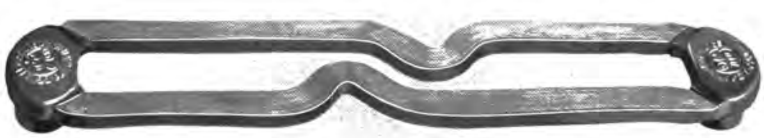


Form A-1 Ribbon Bond Equally Divided Middle Tucking

The above style of bond is used for single bonding rail joints where the available space both above and below the bolts is sufficient to accommodate one-half the total cross sectional area of the bond.

Girder Rail Bonded with one Form A-1 Ribbon Bond Spanning Both Inner Bolts

FORM A-5 RIBBON BOND



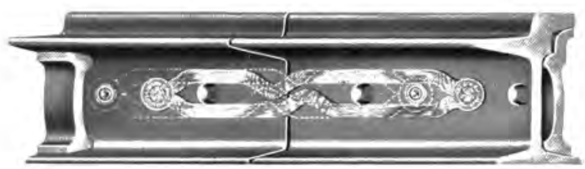
This bond is used under the same conditions as the Form A-1, from which it differs only in the method of bringing the conductors out of the terminal at two points instead of one.

Girder Rail Bonded with two Form A-5 Ribbon Bonds Spanning Both Inner Bolts

FORM A-2 RIBBON BOND

This bond is similar to the Form A-1 excepting that the tucking in the equally divided conductor is offset from the middle of the bond. It is used for double bonding.

All orders for Form A-2 bonds should state the exact location of the bond holes relative to the ends of the rails. This information will determine the location of the tucking.

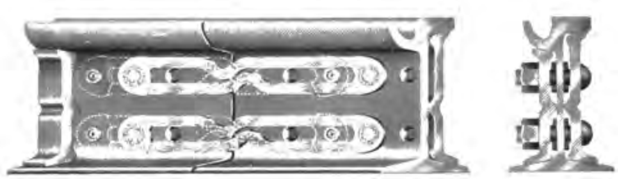


Girder Rail Double Bonded with two Form A-2 Ribbon Bonds

FORM A-6 RIBBON BOND

This bond is similar to the Form A-2 excepting that the conductors issue from the terminal at two points instead of one. The tucking is offset from the middle for double bonding.

When ordering Form A-6 bonds, give the exact location of the bond holes to insure the proper locating of the tuck.



Girder Rail Bonded with four Form A-6 Ribbon Bonds
Two on Each Side of Rail

FORM A-3 RIBBON BOND

Form A-3 Unbalanced Ribbon Bond Middle Tucking

This bond is similar to the Form A-1 excepting that it has more ribbons in one branch than in the other. It is adapted for use where the available space on one side of the bolts is insufficient to accommodate one-half of the total conductor section.

T Rail Bonded with one Form A-3 Unbalanced Ribbon Bond

FORM A-7 RIBBON BOND

This bond is the same as the Form A-3 excepting that the conductor is brought out of the terminal at two points instead of one.

T Rail Bonded with Form A-7 Ribbon Bond
Spanning Both Inner Bolts

FORM A-4 RIBBON BOND

Form A-4 is similar to the Form A-3 excepting that the tuck is offset from the middle. It is used in double bonding.

When ordering A-4 bonds, give the exact location of the bond holes relative to the ends of the rails, so that we may know where to locate the tucking.

T Rail Double Bonded with two Form A-4 Unbalanced Ribbon Bonds

FORM A-8 RIBBON BOND

Form A-8 bond is similar to Form A-4 except in the scheme of having the conductor issue at two points in the terminal instead of one.

This bond is used for double bonding and all orders for it should give the exact location of the bond holes relative to the ends of the rails to insure the proper locating of the tuck.

T Rail Double Bonded with Form A-8 Ribbon Bonds
Spanning Both Inner Bolts

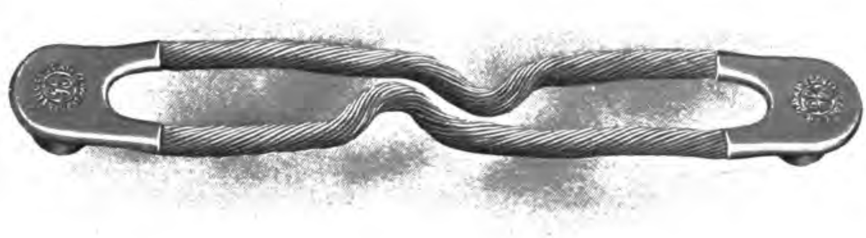
FORM F CABLE BOND

The Form F bond is intended for use under the joint plate. It has cable wire instead of flat wire conductors.

Cable conductors are equally flexible in all planes, and are well adapted for use where the bonding space is not restricted.

The general recommendations that are given for selecting and installing flat wire bonds apply also to cable bonds.

FORM F-5 CABLE BOND



This bond is similar to the Form A-5 excepting the conductor is of extra flexible cable instead of ribbon. It is intended for use under the joint plate when the bonding space permits.

T Rail Bonded with one Form F-5 Bond, Spanning Both Inner Bolts

FORM F-6 CABLE BOND

This bond is similar to Form F-5 except the tucking is offset from the middle. It is adapted to double bonding of joints.

In ordering please give the exact location of the bond holes relative to the ends of the rails, to enable us to locate the tucking.

T Rail Double Bonded with two Form F-6 Bonds

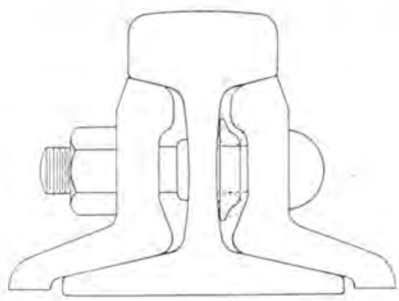
FORM F-9 BOND

In many sections of rail the bonding space is so distributed that it will not accommodate the standard forms of bonds with equal branches, there being more room below than above the joint plate bolts. When ribbon bonds are employed this condition is met by a bond having more ribbons in the lower branch than in the upper. This method of unbalancing the branches cannot be followed satisfactorily in the cable form of bond because the cable is not so compact as the flat wire conductor, and when a sufficient number of wires are transferred from the upper to the lower conductor to obtain the requisite clearance for the upper branch, the lower branch is too large to fit into the space below the bolts without being badly pinched between the rail and the plate. This pinching will very materially shorten the life of the bond, as the conductor is not free to move.

When the cable form of bond is desired for use where the rail conditions are such as described, this Company recommends that the standard balanced bond be used with the conductors pressed at the factory to a shape that will insure ample clearance between the bond and the angle bar.

The accompanying illustration shows the General Electric Company's Form F-9 cable bond with the conductor pressed to approximately a triangular section excepting in the tuck, where the original round shape of the cable is preserved. The tuck coming between the bolts where there is ample room does not require a change in shape.

Flexibility tests prove that the pressing of the conductor does not affect the life of the bond.



Sectional View of 70 Lb. A.S.C.E. Rail with Standard Angle Bars, Showing 4/0 Bond with Round Cable Conductors in Dotted Lines and Pressed Cable Conductors in Solid Lines

FORM F-10 CABLE BOND

This bond is similar to Form F-9 having pressed cable conductors but is tucked off center to adapt it to double-bonding.

FORM F-10 CABLE BOND —(Concluded)

When ordering F-10 bonds give the exact location of the bond holes relative to the ends of the rails, so that the bonds may be tucked in the right place.

T Rail Double Bonded with two Form F-10 Bonds

FORM B RIBBON BOND

Form B Ribbon Bond

Where the inner bolt holes are located so as to permit the drilling of a bond hole between the end of the rail and the bolt hole, a short bond with undivided conductor in the form of a letter "S" may be installed. This bond must be made too short to embody the requisite flexibility and is recommended only for temporary work, such as is done in mines, where the rails are frequently shifted and the bond destroyed. It is an efficient bond at low cost for this class of work.

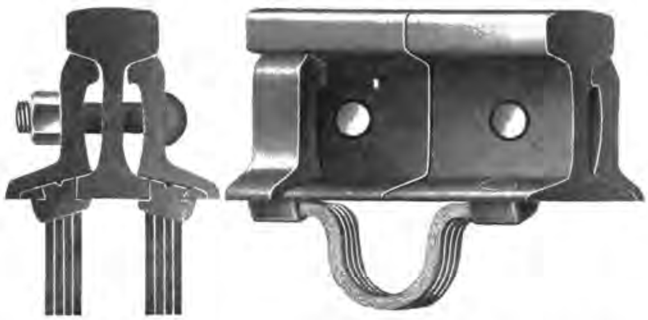
T Rail Bonded with One Form B Bond

FORM C RIBBON FOOT BOND
FOR FOOT OF RAIL

Form C beveled head foot bond is adapted for use on the foot of T rails having suspended joints. Its most general adaptation has been for bonding third rails. The terminal heads are beveled to correspond with the bevel of the rail foot. As in the Forms A and B bonds, the conductor laminations are so disposed as to give maximum flexibility in the vertical plane.

FORM C RIBBON FOOT BOND—(Concluded)

FOR FOOT OF RAIL



Two Form C Beveled Head Bonds Applied to the Base of a T Rail Largely Used for Bonding Third Rails

To apply this bond the special hydraulic punch shown on page 38, and the hydraulic compressor on page 43 are recommended.

The hydraulic punch of 100 tons capacity punches a tapered hole in the foot of the rail. The smaller aperture of the hole, which is at the bottom, is of the same diameter as the bond terminal. The 35-ton compressor forces the copper back into the hole against the taper until the top of the terminal is flush with the top surface of the rail foot. The holes in the rail may be drilled at right angles with the top surface of the rail foot and the bond applied with screw compressor No. 40294, on page 42.

To furnish Form C bonds with terminals of the correct length to insure flush compression, it is necessary that the section number of the rail and the maker's name be given or a sketch of the rail in cross section, showing the distance between the edge of the foot and the center of the hole, be given.

When greater clearance is desired between bond conductor and track ballast than is obtainable with one long sweeping tuck as illustrated above, double tucking as shown in the accompanying illustration may be employed.

Form C foot bonds should have a developed length of at least 7 in. in the smaller conductor sections, and 9 in. in sections above 350,000 cm. They may be formed to give any required distance between terminal centers.

Made in any length, and section up to 500,000 cm.

FORM M-1 TWIN STUD TERMINAL BOND

This bond is a new development in rail bonding, and is for application to the outer side of the head of T rails. This form of bond is applied without disturbing the joint plate. It is short—has the requisite flexibility, and is efficient and durable. The bond is installed with simple tools, and its first cost and the cost of installation are low. Its position on the rail makes it easy to inspect. Each terminal with its two studs is forged from soft, pure copper. The studs are $\frac{1}{2}$ in. in diameter, and spaced $1\frac{1}{4}$ in. between centers. The conductor portion of the bond is flexible cable, which is welded to the terminals at low temperature, and all air is excluded. This process insures a perfect union between the terminals and the conductor, and preserves the purity and malleability of the copper. The conductor issues from the lower side of each terminal, and in the direction of the vertical movement of the joint. This construction removes all stress from the terminals and confines it to the flexible portion of the bond.

It is recommended that the four holes for Form M-1 bond be drilled simultaneously with the General Electric Company's double-twin spindle drilling machine, which will insure their being spaced exactly on the required centers and drilled on the same horizontal plane.

APPLICATION

The four holes in the head of the rail are drilled simultaneously by the four-spindle drilling machine shown on page 38, and the bonds applied with a riveting hammer. The sharp edges of the holes should be dulled with a blunt punch, to avoid cutting the terminal studs as they enter the holes. After drilling, a hand milling cutter, shown on page 40, should be inserted in each hole and a small annular groove cut in its walls near the orifice. The copper will flow into this groove, firmly anchoring the stud and sealing the hole against the admission of moisture. The length of the terminal stud should exceed the depth of the hole by $\frac{1}{16}$ in. As the stud in our standard 4/0 bond is $\frac{9}{16}$ in. long, exclusive of the conical end, the straight wall of the hole should be $\frac{1}{2}$ in. deep. On the outer side of the bond terminal, opposite each stud, is a small copper boss. To install the bond, the hammer should be applied to this boss, lightly at first, and gradually with more force, until the boss has disappeared. This operation will completely fill the hole with dense copper, perfect contact being obtained at the ends of the studs, as well as at the sides.

The same general precautions relating to the application of compressed terminal bonds should be observed in connection with twin stud bonds.

The holes should not be drilled with oil. The contact surfaces of the steel and copper should be dry, clean and bright.

FORMS D AND E RAIL BONDS

Form D

Form E

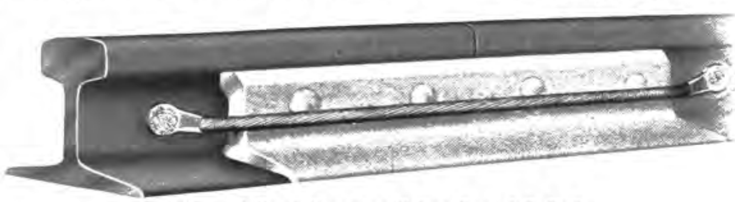
In the Form D rail bond the conductor consists of a single stranded cable. The Form E bond is similar but the conductor is solid wire. Both of these forms of rail bond are adapted to bonding around the splice bar of T or girder rails, cross bonding between rails and tracks, and around special work. The conductors emerge from the terminal head at an angle approximating 15 degrees with the plane of the terminal head. The Form D is recommended for short spans such as around a splice bar. The Form E is recommended where long distances are to be spanned.

FORMS D AND E STUB END BONDS

Form D Stub End Bond

Form E Stub End Bond

A stub end bond is a conductor with a terminal on one end only. It is frequently employed in special work, where the cable end is to be spliced to a long bond spanning crossings and special work. The standard length is 12 in. but they can be furnished in any length desired.



Form D Bond Spanning Splice Bar of T Rail

The developed length of the Form D bond for spanning splice bars should be at least 4 in. longer than the splice bar.

Bonds furnished in any length or section.

SEPARATE BOND TERMINALS

Separate bond terminals are furnished, drilled and tinned for soldering to a conductor which may be scrap trolley wire or feeder cable. They are useful in bonding special work, where many different distances are to be spanned and where it is difficult to predetermine the exact length.

DRILLING OF TERMINAL SHANKS

Orders should specify size of wire or cable conductor to be used and diameter of stud required. When size of conductor is given, in the absence of specifications to the contrary, drilling will be made as follows:

Conductor Cross Section	Diameter of Hole in Shank
0	$\frac{13}{32}''$
00	$\frac{15}{32}''$
000	$\frac{17}{32}''$
0000	$\frac{9}{16}''$
250,000 c.m.	$\frac{5}{8}''$
300,000 c.m.	$\frac{11}{16}''$
350,000 c.m.	$\frac{23}{32}''$
400,000 c.m.	$\frac{49}{64}''$
450,000 c.m.	$\frac{27}{32}''$
500,000 c.m.	$\frac{7}{8}''$

FEEDER CLAMPS FOR CONDUCTOR RAIL

These clamps are for attaching to feeder cables in third rail systems. Stub end bond terminals, shown on page 22, are soldered into the sleeves, and the studs compressed in the conductor rail.

In ordering state size of cable and size of bond conductor to be used.

SOLDERED RAIL BONDS

Appreciating that, in a limited way, there is a legitimate field for soldered rail bonds (as in temporary work, or in bonding old rails where it would prove too expensive to remove the joint plate with the consequent renewal of all bolts), the General Electric Company has developed a full line of bonds of this type.

Great care should be exercised in the soldering, as it often occurs that while the union is strong enough to hold the bond on the rail, the actual area of contact is insufficient to give good electrical results.

SOLDERED RAIL BONDS—(Continued)

As in stud terminal bonds, ribbon conductors are employed when short distances are to be spanned or where space is restricted, as under fish plates, and the laminations are invariably disposed in the horizontal plane in order to afford maximum flexibility to meet the vertical movement of the rail joint.

For bonding to the head of the rail we make a cable wire as well as a ribbon wire bond.

For bonding around fish plates and special work and for cross bonding, etc., cable conductor is employed.

In all of these forms the conductor is *welded* into *forged* copper terminals.

The contact surfaces of all soldered bond terminals are furnished with minute spot bosses which provide space between terminal and rail for an elastic film of solder, to compensate for the different contraction coefficients of the copper and steel.

APPLICATION

The application of soldered rail bonds requires the utmost care to insure adequate electrical and mechanical union between the copper and the steel. This is especially so where the bonds are to be applied to a vertical surface such as the ball or the web of the rail.

The cleaning and tinning of the rail surfaces for the reception of soldered bonds cannot be done too carefully, especially in the case of bonds installed on a vertical surface. All rust and scale must be removed from the surface and the rail heated until the cleaned surface shows a violet or light blue color (280 degrees to 290 degrees C.). Soldering flux (preferably zinc chloride) should then be applied with brush or swab and heavy bar solder rubbed on the cleaned surface until it is thoroughly tinned. The bond should then be clamped lightly to the rail and the joint heated sufficiently to quickly melt wire solder applied to it. The clamp should then be tightened and the wire solder applied as the joint cools down. The practice of cooling the joints with water after soldering has usually been followed in order to expedite the work, but there is good reason to believe that the sudden contraction of the copper terminal, which will respond more quickly than the rail to the cooling effect of the water, tends to shear off the film of solder between terminal and rail. The joints should, therefore, be allowed to cool down naturally if traffic conditions under which the work is done will permit it.

The completed joint should be painted with a good black weatherproof paint.

An efficient working gang for installing soldered bonds consists of a skilled and trustworthy man to direct the work and do the soldering, one helper to handle the torches and two men to operate the grinder.

FORM AS SOLDERED BOND

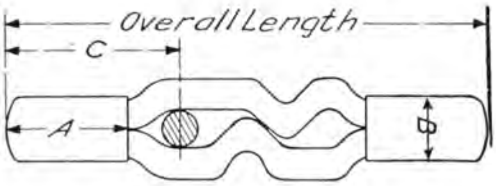
FOR ATTACHMENT TO WEB OF RAIL UNDER FISH PLATE

The Form AS bond corresponds to the Form A stud terminal bond, and is used under like conditions, the terminals being soldered to the web of the rail, and the laminations being divided and "tucked" to span the fish plate bolts.

T Rail Bonded with one Form AS-3 Bond

FORM AS SOLDERED BOND—(Concluded)

FOR ATTACHMENT TO WEB OF RAIL UNDER FISH PLATE



Conductor	DIMENSIONS			Thickness Terminal
	A	B	C	
0000	1.75"	1.00"	2.69"	$\frac{1}{4}$"
300000	1.85"	1.09"	2.875"	$\frac{5}{16}$"

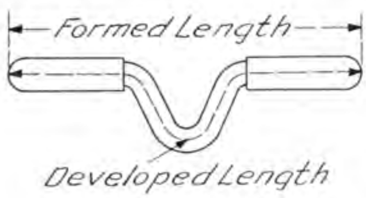
In the dimension table the minimum distance (dimension C) between the center of the fish plate bolt spanned by the conductor, and the outer end of the terminal, is given to assist in determining the overall length necessary for any given joint. As in the classification of the stud terminal bonds, a numeral after the form letters of the Form AS bonds indicates the division and tucking of the ribbons, thus:

Form AS 1 has equally divided ribbons and center tucking.
Form AS 2 has equally divided ribbons and offset tucking.
Form AS 3 has unbalanced ribbons and center tucking.
Form AS 4 has unbalanced ribbons and offset tucking.

On account of the inaccessibility of the Form AS bonds under the fish plates it is essential that they be installed with the greatest care to insure permanency of contact with the rail.

FORM BS SOLDERED BONDS

The Form BS bonds are applied to the outer side of the rail head and do not require removal of the fish plate for their installation. On account of the small amount of material which they contain and the difficulty of removing them by ordinary means, they are practically safe from loss by theft.



Conductor Section	Overall Developed Length	Formed Length
00	7.73"	6"
0000	8.83"	$7\frac{1}{2}$"
400000	11.03"	$8\frac{1}{2}$"

Form BS Bond Applied to Ball of Rail

FORM GS SOLDERED BOND

In the Form GS soldered bond the cable conductor is brought out straight from a point midway between the ends of each terminal. The terminal has a sleeve through which the conductor emerges, which prevents the small wires from being reduced in cross section in the welding operation. This bond is for application to the ball of the rail, and is formed to clear the splice bar. The terminals are tapered and the thinner edge is at the top, making the bond less likely to be knocked off.

T Rail Bonded with one Form GS Bond

Conductor Section	Overall Developed Length	Formed Length
0000	7″	6″

FORM CS SOLDERED BONDS

Form CS Bond

The Form CS bond is designed for attachment to the top or the bottom of the rail base.

FORM CS SOLDERED BONDS—(Concluded)

Conductor Section	Overall Developed Length	Formed Length
00	7.73″	6″
0000	8.83″	7½″

Form CS Bond Applied to Base of Rail

FORM DS SOLDERED BOND

The Form DS soldered bond corresponds to the Form D terminal stud bond, and is for bonding around joint plates, crossbonding, and bonding around special track work.

Conductor Section	DIMENSIONS OF TERMINALS IN INCHES		
	Length	Width	Thickness
00	1.75	.625	.25
0000	2.25	.75	.28

CHANNEL PINS

Channel pins are not recommended for permanent bonding but are occasionally useful for temporary work. They are made with a straight groove deep enough to avoid cutting the wire in driving. The pins are taper pointed and slightly larger than the hole, so that when driven they envelop the wire and make a solid joint.

Cat. No. **17315**

Cat. No.	Diameter	Size of Wire	Weight per 1000
17225	3/8"	4	20
17224	19/32"	0	40
17315	3/4"	00	90
17553	3/4"	0000	70

TRACK DRILLING AND PUNCHING DEVICES AND ACCESSORIES—DRILLS

Many methods are employed for drilling bond holes in rails. Without definite knowledge of the amount of work and the conditions under which it is to be performed, it is difficult to recommend the style of machine to employ. The intention in compiling this information has been to give data on a complete line of devices generally used for drilling and punching rails, from the simplest hand ratchet to the more elaborate power drills and hydraulic punches.

In many cases railways are having bond holes punched or drilled in rails at the mills. It is important that such holes be reamed bright before the bond is applied.

TRACK DRILLING AND PUNCHING DEVICES AND ACCESSORIES—DRILLS—(Concluded)

HAND RATCHET DRILLS WITH SQUARE TAPER SOCKET

CAT. NO. Round Feed Sleeve	CAT. NO. Hex. Feed Sleeve	DIMENSIONS Length of Handle	DIMENSIONS Length of Sleeve	Feed	Weight in Lb.	Socket Accommodates
103273		10″	7¾″	2″	5	No. 1 sq. taper shank drill ⅛″ to 1½″ dia.
103274		12″	8½″	2⅛″	7	No. 1 sq. taper shank drill ⅛″ to 1½″ dia.
103275	103278	15″	9½″	3″	9¾	No. 1 sq. taper shank drill ⅛″ to 1½″ dia.
103276	103279	17″	10¼″	3⅜″	12	No. 2 sq. taper shank drill ⅛″ to 2″ dia.
103277	103280	20″	11¼″	3¾″	15¾	No. 2 sq. taper shank drill ⅛″ to 2″ dia.

HAND RATCHET DRILLS WITH ROUND TAPER SOCKET

CAT. NO. Round Feed Sleeve	Length of Handle	Length of Sleeve	Feed	Weight in Lb.	TAKES MORSE ROUND TAPER SHANK DRILL Min.	TAKES MORSE ROUND TAPER SHANK DRILL Max.	Socket Accommodates
103281	10″	7¾″	1⅜″	5	1/16″	19/32″	
103282	12″	8½″	1½″	6½	39/64″	29/32″	Cat. No. 103285 taper drill sleeve; Cat. No. 103289 flat drill socket
103283	15″	9½″	2¾″	9	59/64″	1¼″	Cat. Nos. 103285 and 103286 taper drill sleeve; Cat. No. 103290 flat drill socket
103284	17″	10¼″	2 5/16″	11	1 17/64″	2″	Cat. No. 103287 taper drill sleeve; Cat. No. 103291 flat drill socket

TAPER SLEEVES FOR HAND RATCHET DRILLS

Taper Sleeve

Cat. No.	Used with Hand Ratchet No.	Takes Standard or Morse Tapered Shank Drills
103285	103282 and 103283	1/16″ to 19/32″ dia.
103286	103283	39/64″ to 29/32″ dia.
103287	103284	59/64″ to 1¼″ dia.

FLAT DRILL SOCKETS FOR HAND RATCHET DRILLS

Flat drill sockets accommodate drills (flat or round) with standard or Morse square taper shank No. 1 or No. 2.

Cat. No. 103289 fits in hand ratchet Cat. No. 103282.

Cat. No. 103290 fits in hand ratchet Cat. No. 103283.

Cat. No. 103291 fits in hand ratchet Cat. No. 103284.

SQUARE TAPER SHANK DRILLS (No. 1 SHANK)

FOR USE WITH HAND RATCHET DRILLS

Shank $1\frac{1}{2}$ in. long, tapered $\frac{5}{8}$ in. to $\frac{3}{8}$ in.

Cat. No.	Diameter	Length Overall	Length Twist
103310	$\frac{1}{2}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103311	$\frac{17}{32}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103312	$\frac{9}{16}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103313	$\frac{19}{32}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103314	$\frac{5}{8}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103315	$\frac{21}{32}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103316	$\frac{11}{16}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103317	$\frac{23}{32}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103318	$\frac{3}{4}''$	$6\frac{1}{2}''$	$4\frac{3}{8}''$
103319	$\frac{25}{32}''$	$6\frac{3}{4}''$	$4\frac{1}{2}''$
103320	$\frac{13}{16}''$	7 "	$4\frac{3}{4}''$
103321	$\frac{27}{32}''$	7 "	$4\frac{3}{4}''$
103322	$\frac{7}{8}''$	$7\frac{1}{2}''$	$5\frac{1}{4}''$
103323	$\frac{29}{32}''$	$7\frac{1}{2}''$	$5\frac{1}{4}''$
103324	$\frac{15}{16}''$	8 "	$5\frac{1}{2}''$
103325	$\frac{31}{32}''$	8 "	$5\frac{1}{2}''$
103326	1 "	$8\frac{1}{2}''$	$6\frac{1}{4}''$
103327	$1\frac{1}{32}''$	$8\frac{1}{2}''$	$6\frac{1}{4}''$
103328	$1\frac{1}{16}''$	9 "	$6\frac{1}{2}''$

SQUARE TAPER SHANK DRILLS (No. 2 SHANK)

FOR USE WITH HAND RATCHET DRILLS

Shank $1\frac{3}{4}$ in. long, tapered $\frac{3}{4}$ in. to $\frac{1}{2}$ in.

Cat. No.	Diameter	Length Overall	Length Twist
103329	$\frac{1}{2}''$	$6\frac{1}{2}''$	4 "
103330	$\frac{17}{32}''$	$6\frac{1}{2}''$	4 "
103331	$\frac{9}{16}''$	$6\frac{1}{2}''$	4 "
103332	$\frac{19}{32}''$	$6\frac{1}{2}''$	4 "
103333	$\frac{5}{8}''$	$6\frac{1}{2}''$	4 "
103334	$\frac{21}{32}''$	$6\frac{1}{2}''$	4 "
103335	$\frac{11}{16}''$	$6\frac{1}{2}''$	4 "
103336	$\frac{23}{32}''$	$6\frac{1}{2}''$	4 "
103337	$\frac{3}{4}''$	$6\frac{1}{2}''$	4 "
103338	$\frac{25}{32}''$	$6\frac{3}{4}''$	$4\frac{3}{8}''$
103339	$\frac{13}{16}''$	7 "	$4\frac{1}{2}''$
103340	$\frac{27}{32}''$	7 "	$4\frac{1}{2}''$
103341	$\frac{7}{8}''$	$7\frac{1}{2}''$	5 "
103342	$\frac{29}{32}''$	$7\frac{1}{2}''$	5 "
103343	$\frac{15}{16}''$	8 "	$5\frac{1}{2}''$
103344	$\frac{31}{32}''$	8 "	$5\frac{1}{2}''$
103345	1 "	$8\frac{1}{2}''$	$5\frac{7}{8}''$
103346	$1\frac{1}{32}''$	$8\frac{1}{2}''$	$5\frac{7}{8}''$
103347	$1\frac{1}{16}''$	9 "	$6\frac{1}{4}''$

TAPER SHANK TWIST DRILLS

STANDARD OR MORSE TAPER FOR USE WITH HAND RATCHETS

Cat. No.	Diameter	Length Overall	Length Twist
103348	$\frac{1}{2}''$	$7\frac{3}{4}''$	$4\frac{1}{2}''$
103349	$\frac{17}{32}''$	$8''$	$4\frac{3}{4}''$
103350	$\frac{9}{16}''$	$8\frac{1}{4}''$	$5''$
103351	$\frac{19}{32}''$	$8\frac{1}{2}''$	$5''$
103352	$\frac{5}{8}''$	$8\frac{3}{4}''$	$5\frac{1}{8}''$
103353	$\frac{21}{32}''$	$9''$	$5\frac{1}{4}''$
103354	$\frac{11}{16}''$	$9\frac{1}{4}''$	$5\frac{1}{2}''$
103355	$\frac{23}{32}''$	$9\frac{1}{2}''$	$5\frac{7}{8}''$
103356	$\frac{3}{4}''$	$9\frac{3}{4}''$	$6\frac{1}{8}''$
103357	$\frac{25}{32}''$	$9\frac{7}{8}''$	$6\frac{1}{4}''$
103358	$\frac{13}{16}''$	$10''$	$6\frac{3}{8}''$
103359	$\frac{27}{32}''$	$10\frac{1}{4}''$	$6\frac{1}{2}''$
103360	$\frac{7}{8}''$	$10\frac{1}{2}''$	$6\frac{7}{8}''$
103361	$\frac{29}{32}''$	$10\frac{5}{8}''$	$7''$
103362	$\frac{15}{16}''$	$10\frac{3}{4}''$	$6\frac{5}{8}''$
103363	$\frac{31}{32}''$	$10\frac{7}{8}''$	$6\frac{3}{4}''$
103364	$1''$	$11''$	$6\frac{7}{8}''$
103365	$1\frac{1}{32}''$	$11\frac{1}{8}''$	$7''$
103366	$1\frac{1}{16}''$	$11\frac{1}{4}''$	$7\frac{1}{8}''$

FLAT DRILLS WITH STANDARD OR MORSE SQUARE TAPER SHANK

NOS. 1 OR 2

Flat Drill

CAT. NO.		
No. 1 Shank	No. 2 Shank	Diameter
103292	103301	$\frac{1}{2}''$
103293	103302	$\frac{5}{8}''$
103294	103303	$\frac{3}{4}''$
103295	103304	$\frac{7}{8}''$
103296	103305	$1''$
103297	103306	$1\frac{1}{8}''$
103298	103307	$1\frac{1}{4}''$
103299	103308	$1\frac{3}{8}''$
103300	103309	$1\frac{1}{2}''$

All drills 6 in. long. Drills easily sharpened and capable of fast work. Adapted to hand ratchets with square taper sockets.

Drift

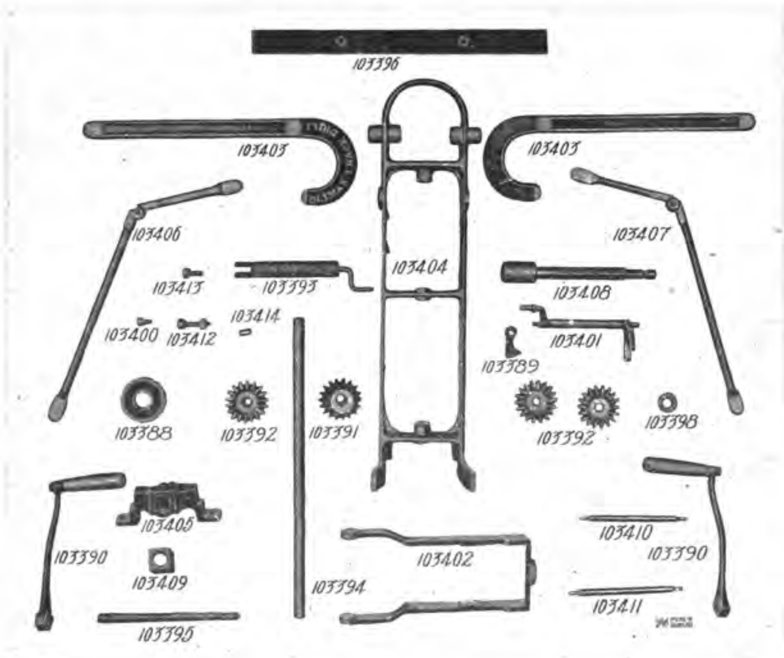
Cat. No. 103386 drift is used to remove taper drills and sockets from ratchet drill shanks. It is 7 in. long, finished complete and case hardened.

CLIMAX TRACK DRILL

This track drill is substantially built and well adapted to hard usage. It has crucible steel gears and forged steel hooks. The hooks are shaped to permit drilling of holes as close as $\frac{1}{2}$ in. to the end of the rail, and are adjustable lengthwise to extend over a Weber joint or a guard rail. The hooks may be adjusted to the height of the rail by a set screw. To clear the track it is necessary only to break the back brace and throw the hooks backward.

Cat. Co.	Description	Weight in Lb.
103387	Climax Track Drill for T Rail	60

REPAIR PARTS FOR CLIMAX DRILL



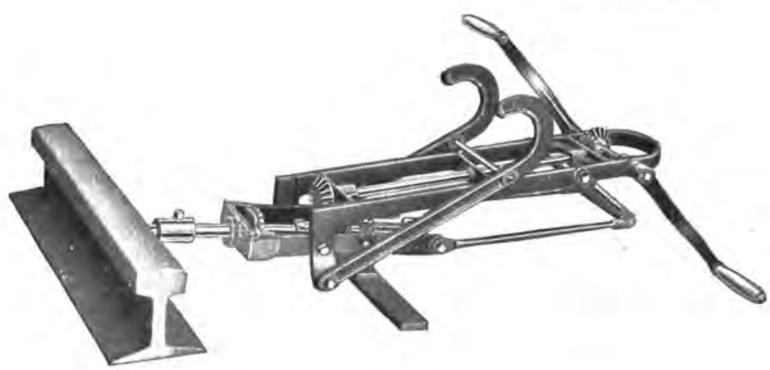
Cat. No.	Description	Cat. No.	Description
103388	Ratchet Wheel	103402	Bottom Frame
103389	Ratchet Feed Dog	103403	Hook (2)
103390	Crank (2)	103404	Upright Frame
103391	Eccentric Gear	103405	Nut Box
103392	Bevel Gear (3)	103406	Right Toggle Joint
103393	Feed Screw	103407	Left Toggle Joint
103394	Vertical Shaft	103408	Spindle
103395	Crank Shaft	103409	Steel Nut
103396	Foot Plate	103410	Joint Handle
103397	Foot Plate Bolt (2)	103411	Hook Coupling
103398	Ball Bearing	103412	$1\frac{1}{4}''$ Bolt (6)
103399	Brass Bushing	103413	$1''$ Bolt (3)
103400	Spindle Cap Set Screw	103414	Key for Ratchet Wheel
103401	Rocker Shaft		

PAULUS TRACK DRILL

The Paulus Track Drill has proved to be a most satisfactory hand operated upright machine for drilling rails. It is provided with an automatic feeding device that requires no attention. A dog connecting ratchet on the feed screw is operated by an eccentric which is put in motion by the revolving spindle and results in as coarse a feed as is consistent with the best results from a point of view of time and of safety to the bit.

Cat. No.	Description	Weight in Lb.
103415	Paulus Track Drill for T Rail	60
103416	Paulus Track Drill for Girder Rail	100

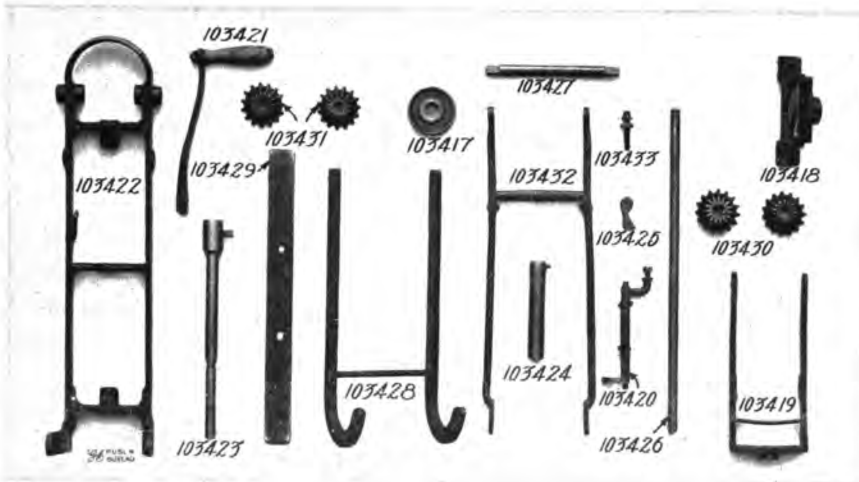
REPAIR PARTS OF PAULUS TRACK DRILL



Following is a list of renewal parts for Paulus Track Drills:

When ordering repair parts for Paulus Drills please state whether they are required for the "T" rail or girder rail pattern.

REPAIR PARTS OF PAULUS TRACK DRILL—(Concluded)



Cat. No.	Description	Cat. No.	Description
103417	Ratchet Wheel	103426	Vertical Shaft
103418	Housing for Ratchet Wheel	103427	Crank Shaft
103419	Lower Frame	*103428	Rail Hooks
103420	Rocker Shaft	103429	Foot Plate
103421	Two Cranks	103430	Two Upper Gears
103422	Upper Frame	103431	Two Lower Gears
103423	Spindle	103432	Back Brace
103424	Feed Screw	103433	Set Screw
103425	Ratchet Feed Dog		

*Style of rail, T or Girder, must be specified.

ROUND STRAIGHT SHANK DRILLS

These drills listed below are adapted to drilling machines shown on pages 152 and 153. Diameter of shank is $\frac{41}{64}$ in; length of shank $2\frac{1}{4}$ in.; length overall 6 in.; length of twist 3 in.

Cat. No.	Diameter	Cat. No.	Diameter	Cat. No.	Diameter	Cat. No.	Diameter
103434	$\frac{1}{2}''$	103439	$\frac{21}{32}''$	103444	$\frac{13}{16}''$	103449	$\frac{31}{32}''$
103435	$\frac{17}{32}''$	103440	$\frac{11}{16}''$	103445	$\frac{27}{32}''$	103450	$1''$
103436	$\frac{9}{16}''$	103441	$\frac{23}{32}''$	103446	$\frac{7}{8}''$	103451	$1\frac{1}{32}''$
103437	$\frac{19}{32}''$	103442	$\frac{3}{4}''$	103447	$\frac{29}{32}''$	103452	$1\frac{1}{16}''$
103438	$\frac{5}{8}''$	103443	$\frac{25}{32}''$	103448	$\frac{15}{16}''$		

THE MAGIC HIGH SPEED BIT

The Magic High Speed Bit

This bit is made of Sheffield air hardened steel and will retain its temper even at a very high temperature.

THE MAGIC HIGH SPEED BIT—(Concluded)

Fits the chuck of any standard collapsible track drill. Diameter of rod shank $\frac{41}{64}$ in. May be used with drilling machines shown on pages 152 and 153.

Cat. No.	Dia. of Bit
103453	$\frac{1}{2}$"
103454	$\frac{5}{8}$"
103455	$\frac{3}{4}$"
103456	$\frac{7}{8}$"
103457	1 "

FLAT HIGH-SPEED STEEL BITS

These bits do not require any special or expensive chuck, as they have same size shank as the standard track drill bit. They bore easily and quickly, and retain their cutting edge much longer, and can readily be reground.

Cat. No.	Size, Inches	Cat. No.	Size, Inches
103458	$\frac{5}{8}$	103462	$\frac{7}{8}$
103459	$\frac{11}{16}$	103463	$\frac{15}{16}$
103460	$\frac{3}{4}$	103464	1
103416	$\frac{13}{16}$	103465	$1\frac{1}{16}$

Bits have $\frac{41}{64}$ in. straight shank, and may be used with drilling machine shown on pages 152 and 153.

RAIL FACING TOOLS

Diameter of shank $\frac{41}{64}$ in.

For use with upright drills on pages 152 and 153.

This tool is used to clean the surface of the rail surrounding the bond hole. When the head of a compressed terminal bond is to be soldered to the rail it is essential that the rail be brightened to insure good contact.

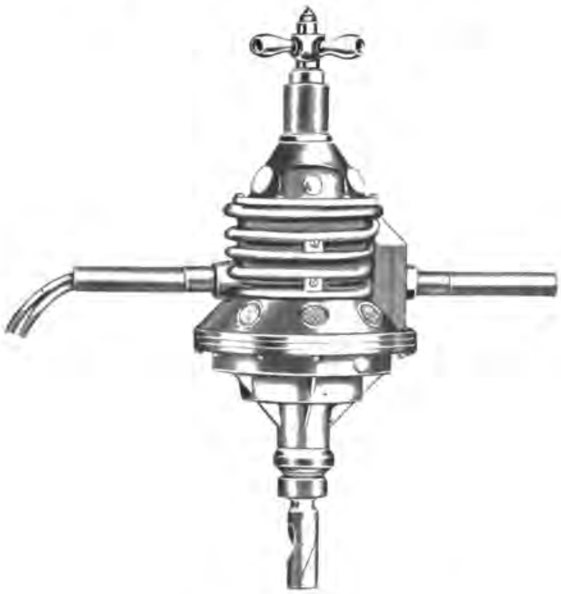
In ordering, specify diameter of bond hole.

Cat. No.	Description
103466	Facing Tool for Upright Drills . . . .

This tool is for the same purpose as the one above, but is adapted for use with hand ratchet drills on page 149. Specify size of taper shank desired.

103467	Facing Tool for Ratchet Drills . . . .

DUNTLEY ELECTRIC DRILL



This drill has been specially designed to operate on circuits of from 450 to 600 volts direct current, and will handle drilling in iron or steel up to 1 in. in diameter. For wood boring it will handle work up to $2\frac{1}{2}$ in. in a very satisfactory manner. This drill is regularly equipped with socket to take standard round, taper shank drills. It is furnished with feed screw, starting switch, 20 ft. of cable, and a fuse block and 3 fuses.

Special precautions have been taken to prevent danger of shocks to workmen, and if directions are followed there is no danger from this source, even though the windings of the tool may become grounded.

The design and construction of these tools has been carefully worked out in accordance with the most approved principles. The armature is built up on a steel shaft, hardened and ground, and with the driving pinion an integral part. The armature core is made of the highest grade of electrical sheet, and is wound with specially insulated magnet wire, held in the slots by means of wedges, no binding wire being used. The commutator is large in diameter, containing a great many bars of hard drawn copper, insulated throughout with the best amber mica. The brushes are of carbon. A fan is provided on the armature shaft and revolves at the speed of the armature, setting up a circulation of air through the openings provided for that purpose.

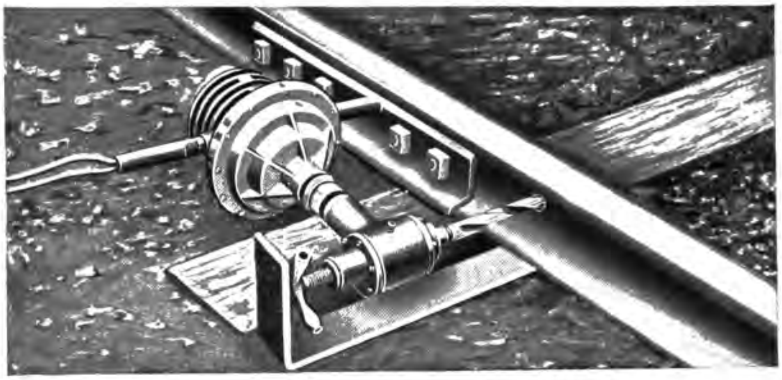
Cat. No.	Description	Weight in Lb.
103468	Duntley Electric Drill	35

No. 3 BOYER ANGLE GEAR

Where it is necessary to work in very close quarters or drill near to the ties, we recommend the use of our No. 3 Boyer Angle Gear in connection with our electric drill. This gear is no larger than an ordinary hand ratchet. Distance from center of spindle to the outside of housing, $1\frac{3}{4}$ in. Distance from point of feed screw to the end of socket, $8\frac{1}{4}$ in.

No. 3 BOYER ANGLE GEAR—(Concluded)

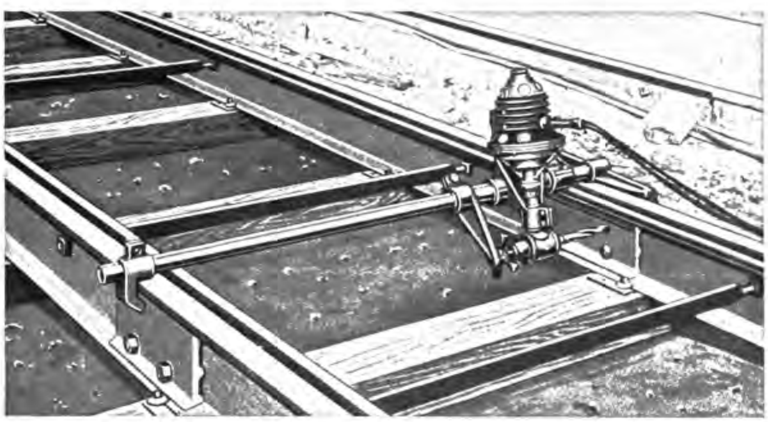
Cat. No.	Description	Weight in Lb.
103469	No. 3 Boyer Angle Gear	13



Application of the Angle Gear

The application of the angle gear in connection with the Duntley drill and ordinary "old man" is shown in the accompanying illustration. The angle gear is used here on account of the shallowness of the track, which will not permit the use of the drill directly.

DUNTLEY TRACK DRILL



The accompanying illustration shows the combination of the Duntley 550-volt drill and the Boyer angle gear in a track drill, being built with a view of accomplishing quick and accurate work in the drilling of track for bond holes, joint plate or tie rods. The relative positions of the drill and angle gear are maintained by means of a connecting casting which slides on a split sleeve or quill on the main bar. This sleeve can be clamped to the bar in any desired position, and when so clamped limits the drill to a longitudinal movement, due to a feather in the quill.

In drilling, the feed screw is forced against the backing up arm, which can be readily loosened and backed up after a hole has been drilled, allowing the drill and angle gear to be pulled back out of the way. Weight 120 pounds. Capacity 1 in. steel.

HYDRAULIC FOOT BOND PUNCH

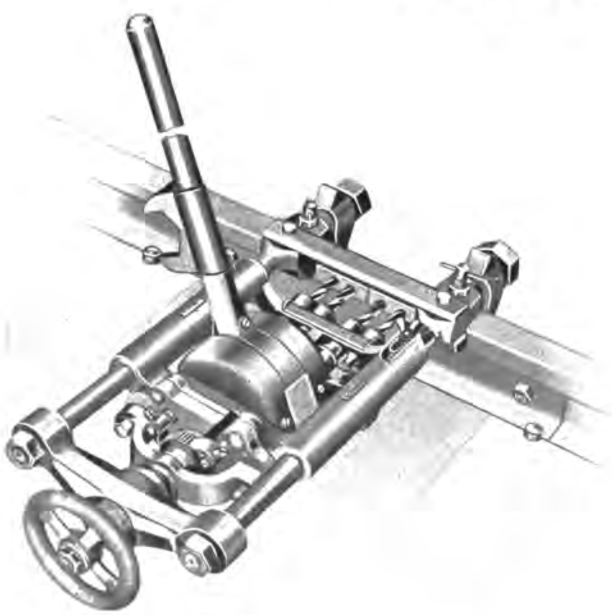
This tool is designed to punch bond holes in the foot of T rails. The ram and punch are at the bottom or underneath the rail and operate upwards, punching a tapered hole with the large aperture at the top. The tool punches the hole at right angles with the top surface of the rail base. Dogs provided with adjusting screws drop over the ball of the rail, preserving the alignment and holding the tool firmly during operation. Guide pieces are provided to show proper location of bond holes. A rod placed at the end of the punch after the slug is removed forces the ram back into the cylinder by a crank placed between the two vertical handles.

This is the companion tool to the Hydraulic Foot Bond Compressor shown on page 163.

Cat. No. **40295**

Cat. No.	Description	Weight in Lb.
40295	Hydraulic Foot Bond Punch, 100 tons	180

DOUBLE-TWIN SPINDLE DRILL



This machine is designed to drill all four holes at one time in the head of T rails for the Twin Stud Terminal Bond. The machine is easy to handle and operate, and it works rapidly and accurately. It has a positive automatic feeding device, which can be adjusted within wide limits. The drills are operated by a lever, each stroke of which rotates the drills through a positive mechanism which provides equal rotation for all drill points.

Each spindle is provided with an adjusting sleeve so that each drill may be set independently of the others. This provision offsets uneven wearing or setting of rails and disalignment of rails on curves. Each machine is equipped with a gauge for determining the depth of the holes. Frames can be raised or lowered quickly to bring the holes into their correct positions. The machines are attached to the rails and operated without disturbing rail joints.

DOUBLE-TWIN SPINDLE DRILL—(Concluded)

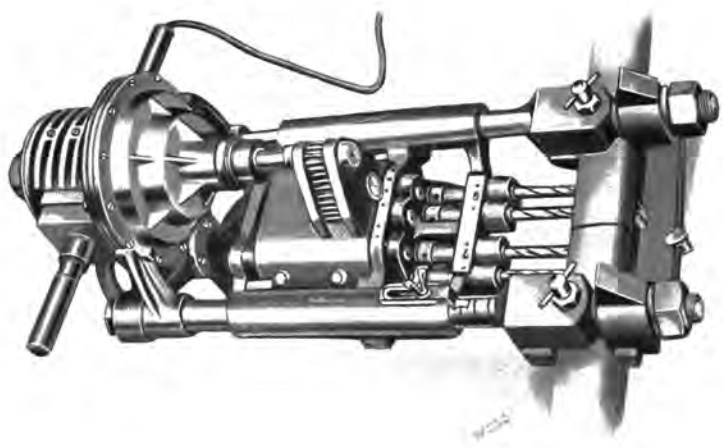
The drill points are held rigidly in the machine and seldom break or chip. For the same reason the desired holes may be started without first prick punching the rail.

The levers by which the machines are operated are detachable so that the tools may be moved easily from place to place. When car or train service over the tracks to be bonded must not be disturbed, these drilling machines can be attached rigidly to the splice bars instead of to the head of the rail.

Each drilling machine is equipped with all fittings and one complete set of new drills. Many parts of these machines are interchangeable and small parts may be ordered by mail.

Cat. No.	Description	Weight in Lb.
103470	Hand Operated Double-Twin Spindle Drill	125

MOTOR DRILL



Double-Twin Drill Operated by Electric Motor

The Multiple-Spindle Drill is so designed that it can be operated by a small electric motor instead of a lever. The machine as shown makes a very compact and efficient portable drill. It is a highly developed, high speed tool, that will endure the very severe conditions of track work. Easily handled and operated by two men. With this machine, Twin Terminal bonds can be installed at a very low cost.

The motor is extremely light and compact, and it will operate directly on a 500-volt trolley circuit. The internal windings are thoroughly well protected and insulated, and the armature shaft is geared direct to the drill spindles. A device, not shown, for correctly and easily sharpening the drills can be attached to the motor.

Cat. No.	Description	Weight in Lb.
103471	Motor Operated Double-Twin Spindle Drill	280

TWIST DRILLS

These drills are made especially for the Double-Twin Spindle Drill and are uniform in size, being ½ in. in diameter by 6 in. long. The drills give very good results without lubrication if they are properly sharpened.

Cat. No.	Description
103472	Special ½" Twist Drill

HAND TOOLS FOR TWIN STUD TERMINAL BONDS

HAND MILLING CUTTER

The Hand Milling Cutter cuts the small groove in the hole. With a swinging motion that will keep the milling teeth pressed against the sides of the hole, the cutter is rotated several times within the hole.

Cat. No.	Description	Weight in Lb.
103473	Milling Cutter with handle	½
103474	Extra Cutter only	¼

The punch is made of tool steel, tempered. It is to round off and blunt the sharp edge of the hole.

The double faced riveting hammer is especially adapted for applying twin stud terminal bonds.

Cat. No.	Description	Weight
103475	Dulling Punch	3 oz.
103476	Riveting Hammer	2½ lb.

RAIL BOND COMPRESSORS

DOUBLE SCREW COMPRESSORS

All of our Double Screw Compressors are of the same design, and differ only in size and the amount of pressure they exert. The distribution of the metal in the frame is such as to make the machines strong and substantial, and as light as is practicable.

After the terminal has been inserted in the hole and the compressor mounted on the rail, the inner screw is centered in the depression in the bond terminal. The outer screw is then drawn up with the handwheel until it rests against the rail web, thus holding the machine rigid and drawing the bond head up tight against the opposite side of the web. Compression is then effected with the wrench on the inner screw.

The end of the compressing screw is so designed that the hole in the rail must be completely filled with copper before the terminal can be riveted or button-headed over the hole.

The handwheel may be detached easily and discarded when work is to be done in limited space, as over ties, as the outer screw is provided with a hexagonal end to take a wrench.

The compressing power of these machines is from 20 to 30 tons.

Cat. No. 68935 is designed to take the lighter rails from 30 to 40 lb. It has a vertical adjusting screw to center the compressing screw in the depression in the bond terminal. Power exerted 15 tons.

All compressors are furnished with operating wrench. Extra wrenches may be ordered by catalogue number.

Cat. No.	Used With	Diameter of Terminal up to	Top of Jaw to Center of Screw	Weight in Lb.
61040	T Rails, 5″ and under	$\frac{7}{8}$″	$3\frac{3}{8}$″	51
103485	T Rails, 5″ and under	$1\frac{1}{8}$″	$3\frac{3}{8}$″	68
61041	T and Girder Rails, 7″ and under	$\frac{7}{8}$″	$4\frac{3}{4}$″	82
61042	T and Girder Rails, 9″ and under	$\frac{7}{8}$″	7″	110
103486	T and Girder Rails, 9″ and under	$1\frac{1}{8}$″	7″	122
68935	T Rails 30 to 40 lbs.	$\frac{3}{4}$″	$2\frac{1}{8}$″	30

WRENCHES FOR COMPRESSORS

Cat. No.	Description	Weight in Lb.
68936	24″ Wrench for Compressor No. 68935	6
61180	40″ Wrench for Compressors Nos. 61040, 61041 and 61042	13
103487	42″ Wrench for Compressors Nos. 103485 and 103486	15

PARTS OF SCREW COMPRESSORS

Cat. No.	Description	Weight in Lb.
103488	Inner Screw only for Compressors Nos. 61040, 61041 and 61042	5
103491	Outer Screw only for Compressors Nos. 61040, 61041 and 61042	3
103489	Inner Screw only for Compressors Nos. 103485 and 103486	8
103492	Outer Screw only for Compressors Nos. 103485 and 103486	5
103490	Inner Screw only for Compressor No. 68935	5
103493	Outer Screw only for Compressor No. 68935	3
103494	Frame only for Compressor No. 61040	40
103495	Frame only for Compressor No. 103485	52
103496	Frame only for Compressor No. 61041	71
103497	Frame only for Compressor No. 61042	99
103498	Frame only for Compressor No. 103486	106
103499	Frame only for Compressor No. 68935	22
103500	Handwheel only for all compressors except No. 68935*	3

*Compressor No. 68935 has no provision for handwheel.

SCREW COMPRESSOR FOR FOOT BONDS

Cat. No. **40294**

This compressor is used for installing the Form C Beveled Head Foot Bond. The bond holes are drilled or punched at right angles to the upper surface of the foot of the rail.

The body or frame is made of forged steel. The compressing screw is of tool steel with square cut threads, and is carefully tempered. Two handles are provided for conveniently carrying the tool about. The tightening wedge is attached to the frame by a chain to prevent loss. When ordering this machine please give section number of rail used.

The compressor weighs 80 lbs.

Cat. No.	Description
40294	Foot Bond Screw Compressor

PARTS OF FOOT BOND COMPRESSOR

Cat. No.	Description	Weight in Lb.
103501	Frame only	66
103502	Compressing Screw only	9
103503	Tightening Wedge only *	5

*When ordering Tightening Wedge please give section number of rail used.

HYDRAULIC FOOT BOND COMPRESSOR

Cat. No. **40296**

This is the companion tool to the Foot Bond Punch illustrated on page 158. It is intended for the installation of Form C Beveled Head Foot Bonds. The holes in the rail are tapered with the large aperture at the top; the bond terminals are inserted from beneath the rail, and compressed backward against the taper, forming an absolutely water-tight and flush joint, and a perfect contact. The bonds are drawn into place before being compressed, by means of the crank and side bars. A guide plate is attached to the lower end of these side bars to indicate the proper location of the tool and insure the ram being directly over the bond. Weight complete, 135 pounds.

Cat. No.	Description
40296	Hydraulic Conductor Bond Compressor, 35 tons

SCREW HYDRAULIC WEB BOND COMPRESSOR

This tool is designed for compressing the terminals of bonds in the web of T or girder rails.

Cat. No.	Description	Weight in Lb.
108051	Hydraulic Web Bond Compressor for T Rails up to 100 lbs. per yd.	115
108482	Hydraulic Web Bond Compressor for Girder Rails up to 7" high	160
108483	Hydraulic Web Bond Compressor for Girder Rails up to 9" high	190

HYDRAULIC CONDUCTOR BOND COMPRESSORS

For Use in Underground Conduit Work

This tool is designed for compressing bond terminals in conductor rails for underground contact systems. In such work one end of the bond is compressed in the rail while it is lying loose in the street; this tool is intended for that part of the work. After the rail is in place and fixed on its insulators, the remaining bond terminal is compressed with the special tool shown below.

Cat. No.	Description
40298	Hydraulic Conductor Bond Compressor, weight 110 pounds, capacity 15 tons

Cat. No. 40298

Cat. No. 40299

For Use in Manhole

This compressor is designed for compressing the bond terminals in underground conductor rails after they are set in position in conduit. The tool is dropped into position through the manhole, and is supported by means of the cross bar which extends across the hole. It is drawn up tight against the rail with the crank and screw, and the hook catching in the slot holds the tool firmly during operation. Weight, 110 lbs.; capacity, 15 tons.

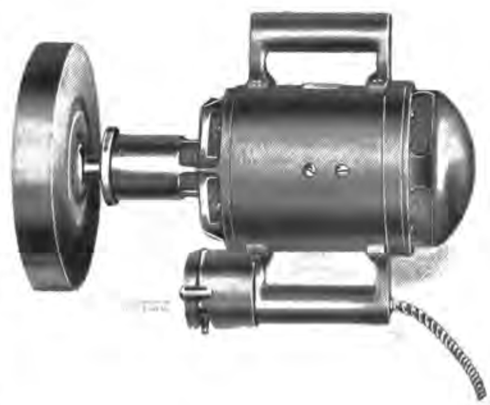
Cat. No.	Description
40299	Hydraulic Conductor Bond Compressor

DUNTLEY PORTABLE ELECTRIC GRINDER

FOR 460 TO 600 VOLT CIRCUITS

For grinding rails for bonds, either soldered or otherwise fastened, we are offering a portable electric grinder that will accomplish a very large amount of work at a rapid rate. This tool is light, absolutely portable, and can be handled by a comparatively inexperienced operator.

The grinder carries an emery wheel 8 in. in diameter, and $\frac{5}{8}$ in. face. The speed of the tool is 3,000 r.p.m. and the weight complete is 28 lbs. It is regularly equipped with an 8 in. in diameter by $\frac{5}{8}$ in. face emery wheel, and two 20-ft. lengths of cable attached to the grinder. The switch is mounted on the machine within easy reach of the hand.



DUNTLEY PORTABLE ELECTRIC GRINDER—(Concluded)

FOR 460 TO 600 VOLT CIRCUIT

Cat. No.	Description	Weight in Lb.
103477	Portable Electric Grinder	28

HAND POWER GRINDING MACHINE

Rail Grinding Machine

This machine is simple in construction, compact and light. It may be carried readily by two men. The legs and handles are iron pipe. It is equipped with a flexible shaft and an emery wheel 8 in. in diameter with ⅝ in. face.

Cat. No.	Description
103478	Grinding Machine with 5 ft. flexible shaft
103479	Flexible Shaft only, 5 ft. long
103480	Emery Wheel only, ⅝″ x 8″
103481	Carborundum Wheel only, ⅝″ x 8″

Cat. No. 103482

TORCH

For kerosene burning this machine is equipped with two powerful burners, mounted on a 10 gallon brazed tank, tested at 200 lbs. pressure per square inch. The burners are mounted on swivel joints, and are easily adjustable to any position.

For gasolene burning the machine is equipped with a large single burner of great power.

Cat. No.	Description	Weight in Lb.
43688	Gasolene Torch 10 gallons	60
103482	Kerosene Torch 10 gallons	75

BLOW TORCHES

Cat. No. **43689**

Cat. No. **43690**

Cat. No. 43689 is a Kerosene Torch, capacity 15 gals. It will heat a rail to soldering temperature in one-fourth the time required with Gasoline Torch. It may be refilled without exhausting the pressure in the tank. Cat. No. 43690 is the same as Cat. No. 43689 except that it has flexible hose instead of pipe connections, adapting it for use on elevated structures, etc.

Cat. No.	Description	Weight in Lb.
43689	Kerosene Torch with pipe connected burners	105
43690	Kerosene Torch with flexible hose	115

SOLDERED BOND CLAMPS

Cat. No.	Description
103483	Clamp for Forms AS, BBS and DS Soldered Bonds

103484	Clamp for Form BS Soldered Bonds

INDEX TO SUBJECTS

INDEX TO CATALOGUE NUMBERS

ALTERNATING CURRENT SWITCHBOARD PANELS

THREE-PHASE THREE-WIRE AND SINGLE-PHASE

1150 AND 2300 VOLTS, 25/125 CYCLES

90 INCHES HIGH

WITH SECONDARY APPARATUS

General Electric Company

July, 1910 *Schenectady, N. Y.* **Bulletin No. 4749**

NOTICE

This bulletin contains a number of references to other publications. Information regarding the matters thus referred to may be had from any local office of the Company.

The panels listed are all of the sectionalized type and each section has a separate catalogue number. Since each section includes essential apparatus, **three sections** (one top, one middle and one bottom) **are required to form a complete panel.**

The pages are sectionalized so that the user may have before him a picture of the complete panel desired together with a full description of the equipment. All sections included between full sized pages are interchangeable for **equal capacities** excepting as noted on the top sections.

The following procedure will simplify the selection of a panel,

1 The index on page 1 will tell where the panel may be found.

2 Choose the top section first and the note above the table of catalogue numbers will indicate at once just what middle and bottom sections may be used.

3 Check the "Equipment" given for the panel chosen and thus insure that it meets all requirements. The diagrams of connections which are included with each class of panels clearly illustrate the function of each piece of apparatus comprising the equipment.

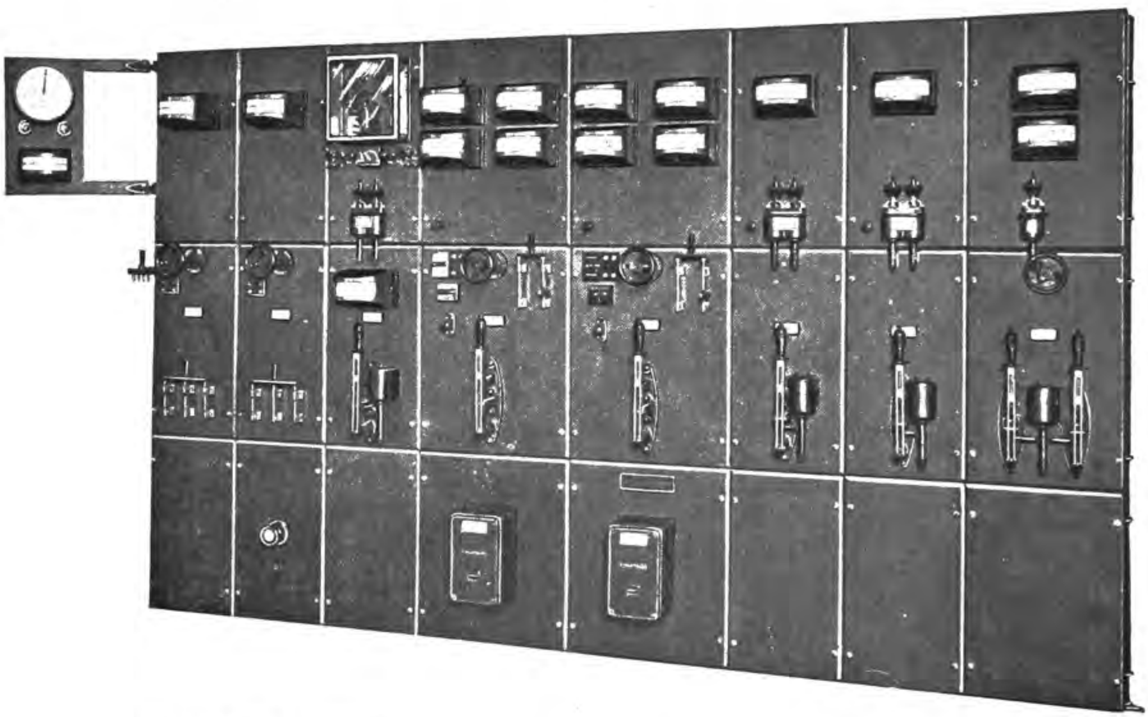
ALTERNATING CURRENT SWITCHBOARD PANELS

THREE-PHASE THREE-WIRE AND SINGLE-PHASE
*1150 AND 2300 VOLTS—*25/125 CYCLES

90 INCHES HIGH—WITH SECONDARY APPARATUS

*All panels are listed for *2300 volts, 60 cycles,* but with slight modifications may be used for 1150 volts or any frequency from 25 to 125 cycles. See *Voltage* and *Frequency* under General Information.

The following illustration shows a switchboard comprised entirely of standard panels.



THREE-PHASE PANELS

Blank Panels are listed in S 611.
Exciter Panels are listed in S 413.
Switchboard Arrangements will be found on pages in rear of section.

SINGLE-PHASE FEEDER PANELS

ACCESSORIES

GENERAL INFORMATION

These panels are designed for general use in central stations and isolated plants, suitable provision being made for operating generators in parallel.

All A.C. instruments and meters are operated from the secondaries of standard current and potential transformers and the automatic oil switches are of the transformer trip form. The use of secondary apparatus produces *maximum safety to both the operator and the system* and is recommended for all 2300 volt systems.

The instruments, meters, oil switches, etc., furnished with these panels are of the General Electric Company's highest grade for 2300 volt switchboards, and sufficient information regarding them is given under the "Equipment" of the panels to enable the reader to refer to the various bulletins which contain detailed descriptions.

VOLTAGE

Unless otherwise ordered, apparatus will be calibrated for 2300 volts. Panels may be used to control 1150 volt generators and feeders, but when generator panels are used for 1150 volt machines the kilowatt rating of the panel is decreased one-half.

FREQUENCY

Unless otherwise ordered, apparatus will be calibrated for 60 cycles. All panels may be used on any frequency from 25 to 125 cycles without additional charge excepting those equipped with 50 watt potential transformers for which an additional charge will be made when used for frequencies less than 60 cycles.

MATERIAL OF PANELS

All sections are oiled Natural Black Slate 1 1/2 in. thick, with 3/8 in. bevel. Blue Vermont Marble, Black Enameled Slate or panels 2 in. thick may be substituted at increased prices which may be obtained from any office of the General Electric Company.

FRAMEWORK

A complete supporting framework of 1 1/4 in. pipe with necessary fittings is included with each panel, excepting the pipe for tie rods. For panels equipped with remote control oil switches a suitable pipe framework for supporting oil switch and buses is also included. See Switchboard Arrangements.

SILL

A wooden sill for supporting the switchboard 1 in. from the floor is recommended for all installations. See Switchboard Arrangements. This sill is not furnished by the General Electric Company.

BUSES

Suitable insulating supports for A.C. and exciter buses are furnished with these panels, supports for one set of A.C. buses being furnished on panels having S.T. oil switches and for two sets of A.C. buses on panels having D.T. oil switches. Buses will be located as shown on the Switchboard Arrangements.

Owing to the varying amounts of bus bar copper which may be required for a given panel, it is impossible to include with these panels a *fixed* amount which would not be too great for some cases and too small for others. *All panels are, therefore, listed without copper for buses* and the latter must be ordered by Cat. No. from the bus bar tables on another page.

CONNECTIONS

Each panel is furnished complete with insulated connections from oil switches to buses, necessary small wiring on back of panel, primary leads (not exceeding 15 ft. in length) for potential transformers, and multi-conductor cable (not exceeding 25 ft. in length) for secondary connections from both the current and potential transformers to the terminal blocks on the panel.

It will be noted from the diagrams of connections for the various panels that each panel is so wired on the back that secondary leads from current and potential transformers may be brought to the panel either from above or from below, and that suitable terminal blocks are provided for attaching these leads to the panel. The terminal blocks have suitable terminals and links for the insertion of calibrating instruments while the panel is in service.

The Switchboard Arrangements on the pages in rear of this section show the main connections and supports for same which are to be furnished by the purchaser. When generator panels with governor control switches or feeder panels with regulator control switches are ordered, the purchaser must furnish the necessary control leads from the panel to the governor or regulator.

INSTRUMENT EQUIPMENTS

Alternative instrument equipments are provided for both generator and feeder panels in order that suitable combinations may be available for any of the usual load conditions.

For **Generator Panels** the following are recommended:

(a) For ordinary balanced power loads	*One* A.C. Ammeter, *One* A.C. Voltmeter, *One* D.C. Field Ammeter, *One* A.C. Indicating Wattmeter for units 500 Kw. and above.
(b) For unbalanced lighting loads	**Three* A.C. Ammeters, *One* A.C. Voltmeter, *One* D.C. Field Ammeter, *One* A.C. Indicating Wattmeter.

*The price of combination (b) can be reduced by using one A.C. ammeter and a three-way ammeter switch instead of three ammeters.

INSTRUMENT EQUIPMENTS (Cont'd)

With combination (b) an 8 point receptacle is furnished on the middle section to allow voltage readings on all three phases.

For **Feeder Panels** it is customary to use,

One ammeter for single-phase lighting,

One ammeter and one voltmeter compensated for ohmic drop, for single-phase lighting when regulators are used.

* *Three* ammeters for three-phase lighting,

One ammeter for three-phase power.

When **Ground Detectors** are to be used it is recommended that they be mounted on rigid brackets on top of the switchboard or in some convenient location away from the board.

METER EQUIPMENTS

Watthour meters are listed for both generator and feeder panels. Except where it is necessary to meter certain feeders, *generator watthour meters are recommended* in preference to feeder watthour meters as the former operate at better load factors and are not subject to changes in capacity. When watthour meters are desired for several feeder panels which are not equipped with regulators and which are connected to one set of buses, economy may be practiced by omitting the potential transformers from each panel and using a common set of transformers connected to the bus. Such cases should be referred to the General Office for recommendations.

Meters heretofore known as "Recording Wattmeters" will in the future be known as "Watthour Meters." Throughout this bulletin, the terms "Polyphase Watthour Meter" and "Single-phase Watthour Meter" are used in place of "Polyphase Recording Wattmeter" and "Single-phase Recording Wattmeter" respectively.

† OIL SWITCH EQUIPMENTS

The K-5 oil switches which are listed for all panels are of two classes, all 200 ampere switches being rated 4500 volts while the 300 and 500 ampere switches are rated 7500 volts. Panels are listed with oil switches both on the back of panel and remote control on pipe framework. The latter location is recommended in all cases where double throw switches are required as the connecting cables render the back of the panel almost inaccessible when the former location is used. This is especially true when generator or feeder cables are brought to the switch from the top of the panel. Panels with 200 ampere double-throw oil switches on the back are listed, however, for use in small installations where the more expensive arrangement is not justified.

RELAYS

Relays are not required on any of these panels excepting when an indicating wattmeter or a watthour meter and an automatic oil switch are operated from the same current transformers. However, *time limit relays* are listed for all panels having automatic switches, both for the purpose of securing *greater oil switch rupturing capacity* when required, and for use on circuits subject to heavy *momentary overloads.*

RATINGS OF GENERATOR PANELS

The ampere ratings given for generator panels are the maximum currents which they are designed to carry for one or two hours, the corresponding kilowatt ratings being the normal capacity of the largest machines with which the panels may be used. The kilowatt ratings given are based on unity power factor and overloads of 25 per cent. for one or two hours and 65 per cent. momentarily. For overloads of 50 per cent. for one or two hours and 100 per cent. momentarily multiply the normal kw. rating of the generator by 1.2 and select a panel having a kw. rating at least equal to product thus obtained.

RATINGS OF INDUCTION MOTOR PANELS

The apparent efficiency of an induction motor of given horse-power and voltage varies somewhat with the speed for which the motor is designed, so that panels having a given ampere rating cannot be given a corresponding horse-power rating which will be correct for all speeds. Panels listed herein which are intended for controlling induction motors are, therefore, rated in amperes only, the ratings given being the maximum current (other than momentary) which they are designed to carry. The ampere capacity of the panel required for a given motor may be determined by the following formulas:

For motors with 25 per cent. overload guarantee:

$$\text{Ampere Capacity of Panel} = \frac{\text{H.P.} \times .746 \times 1000 \times 1.25}{1.73 \times \text{volts} \times \text{efficiency} \times \text{power factor}} = \frac{\text{H.P.} \times 539}{\text{volts} \times \text{efficiency} \times \text{power factor}}$$

For motors with 50 per cent. overload guarantee:

$$\text{Ampere Capacity of Panel} = \frac{\text{H.P.} \times .746 \times 1000 \times 1.5}{1.73 \times \text{volts} \times \text{efficiency} \times \text{power factor}} = \frac{\text{H.P.} \times 646.5}{\text{volts} \times \text{efficiency} \times \text{power factor}}$$

RATINGS OF FEEDER PANELS

The ampere ratings given for feeder panels are the maximum current (normal or overload other than momentary) which they are designed to carry. *Panels of larger capacity than necessary* should not as a rule be chosen in order to provide for a possible future increase of load, since the consequent low load factor of the current transformers has an injurious effect on the accuracy of the instruments and meters; furthermore the overload feature on the oil switches is rendered inoperative except on short circuits and extremely heavy overloads due to the very high ratio of the current transformers as compared with the normal load of the circuit to be controlled.

*The price of three-phase lighting equipments can be reduced by using one ammeter and a three-way ammeter switch instead of three ammeters.

†The K-5 oil switch which has been specified under the Equipment of all panels listed herein is a new switch recently developed and will shortly supersede the K-3. However, the full line of K-5 switches is not in production at the present time and the General Electric Company reserves the privilege of substituting, without notice, K-3 switches on orders which are received for any of these panels before the K-5 switch specified is in production.

RUPTURING CAPACITY OF OIL SWITCHES

The switches used on these panels are capable of opening heavy overloads or short circuits on any system where the aggregate full load circuits of all the generators connected to the bus does not exceed the kilowatt ratings given below.

If power is received from an outside source having a capacity in excess of the following limits, the incoming lines must be equipped with automatic switches capable of rupturing the power behind them and the automatic devices must be so set as to limit the bus capacity to the rupturing capacity of the switches connected to the bus.

It will be noted that the rupturing capacity of automatic switches is materially increased by the use of time limit relays.

Switch Ampere Rating	Voltage of Circuit	RUPTURING CAPACITY IN KILOWATTS		
		Non-Automatic	Automatic Instantaneous	Automatic with Time Limit Relay Set for a Minimum of 1 1/2 Seconds Delay
200	1150	5900	2400	5900
200	2300	5300	2100	5300
300–500	1150	6300	2500	6300
300–500	2300	5900	2400	5900

INFORMATION WHICH SHOULD ACCOMPANY ORDERS

Delay in shipment and dissatisfaction on the part of the Purchaser will often be avoided if the order is accompanied by as much of the following information as pertains to the panel or panels ordered.

GENERAL

1. **Order of Panels**—Preferably in the form of a rough sketch including *existing, blank* and *new panels* and also showing any open spaces. See Fig. 1 Page 65 for recommended arrangement.
2. **If Existing Panels are to be matched** give serial numbers of same if of General Electric manufacture, otherwise give brief description preferably in form of sketch showing location of apparatus and bolts on front of panels, location and size of bus bars, location of oil switches, etc.
3. **Location of Oil Switches** when remote control—which of the locations shown in "Switchboard Arrangements" is desired?
4. **Ultimate Total Capacity of Station**—If power is received from an outside source, do conditions exist such as outlined under "Rupturing Capacity of Oil Switches?"
5. **Available Space** behind and above switchboard, also height of basement, if any.

GENERATOR PANELS

1. **Rating of Generators** including voltage, normal load, one or two hour overload, frequency, power factor and maximum excitation.
2. **Location of Rheostats**—All of these panels are designed for chain operated generator field rheostats. Which of the rheostat locations shown on pages in rear of this section is desired?
3. **Main Cables**—Are they to be brought to oil switches from above or from below?

FEEDER PANELS

1. **Main Cables**—Are they to be brought to oil switches from above or from below?
2. **Location of Regulators**—If Feeder Regulators are chain operated, which of the locations shown on pages in rear of this section is desired?
3. **Normal Ampere Load of Circuits** to be controlled —See "Rating of Feeder Panels" on a preceding page.

INDUCTION MOTOR PANELS

1. **Main Cables**—Are they to be brought to oil switches from above or from below?
2. **Rating of Motor** including voltage, normal and overload h.p. rating, power factor and efficiency.
3. **Method of Starting Motor.**

TA REGULATOR PANELS

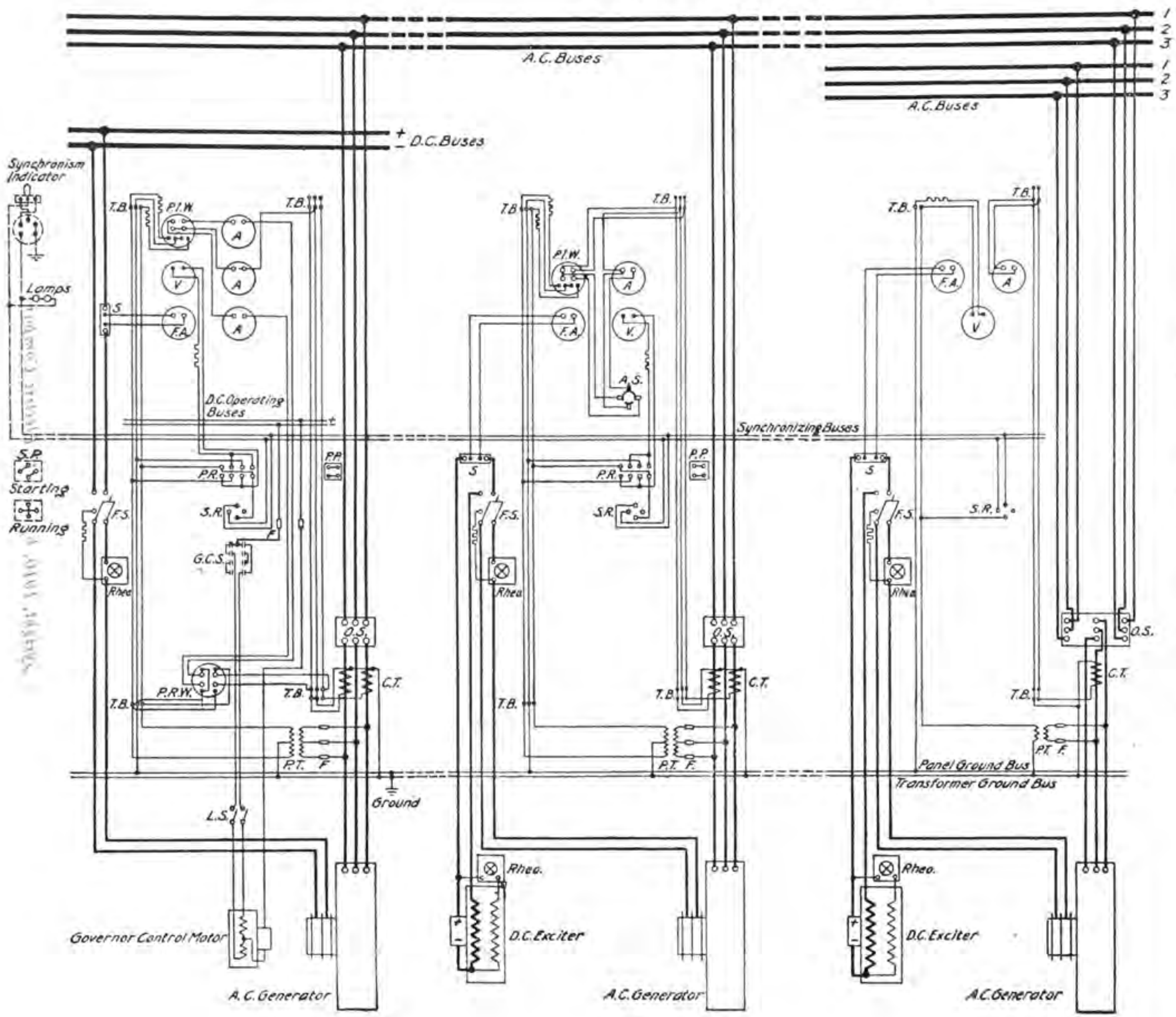
1. Fill out and attach special Regulator Information Blank.
2. If a current transformer is used for compensating for line drop specify where same is to be connected.

THREE-PHASE GENERATOR PANELS
2300 VOLTS—60 CYCLES

26 1/2 TO 1600 KILOWATTS

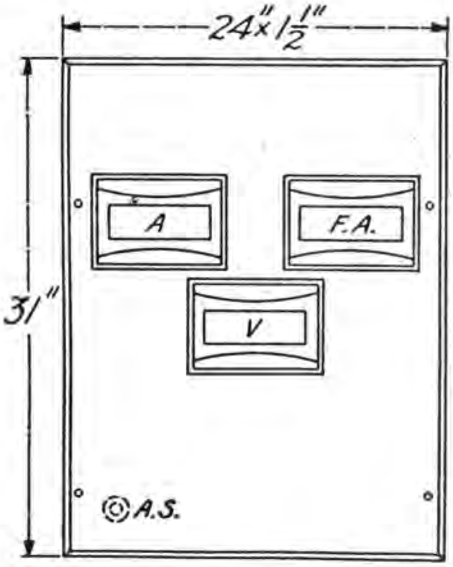
WITH OIL SWITCHES T.P.S.T. AND T.P.D.T. — Mounted on back of panel; Remote control, mounted on pipe framework

DIAGRAMS OF CONNECTIONS



KEY TO SYMBOLS

A =Ammeter (A.C.).
A.S. =Three-way ammeter switch.
C.T. =Current transformer.
F =Fuse.
F.A. =Field ammeter (D.C.).
F.S. =Field switch.
G.C.S. =Governor control switch.
L.S. =Limit switch (included with governor motor).
O.S. =Oil switch.
P.I.W. =Polyphase indicating wattmeter.
P.R.W. =Polyphase watthour meter.
P.R. =Potential receptacle.
P.P. =Potential plug.
P.T. =Potential transformer.
Rheo. =Rheostat.
S =Shunt (only for 80 amp. and over).
S.R. =Synchronizing receptacle.
S.P. =Synchronizing plugs.
T.B. =Terminal board for secondary leads from current and potential transformers.
V =Voltmeter (A.C.).



EQUIPMENT

A = H.E. A.C. ammeter with......amp. scale.

F.A. = D.H. D.C. field ammeter with...... amp. scale (scale to be given with order).

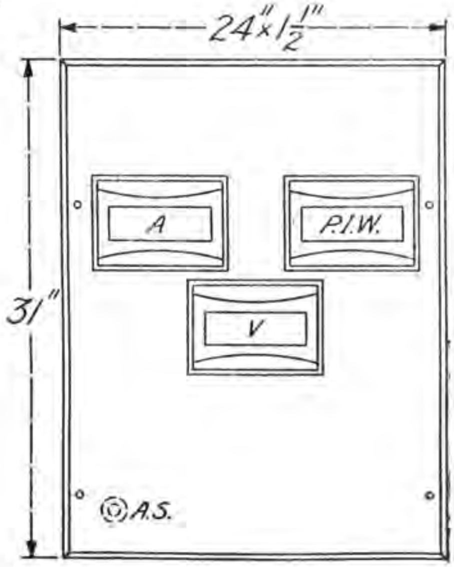
V = H.E. A.C. voltmeter with 175 volt scale.

A.S. (optional) = Three-way ammeter switch for connecting **A** in each phase.

Sections without A.S. cannot be used with Middle Sections, pages 10A and 12A Bottom Sections, page 10B

Sections with A.S. cannot be used with Middle Sections, pages 9A and 11A Bottom Sections, page 9B

Kw. of Gen.	AMP. CAPACITY		CAT. NO.	
	Panel	A	Without A.S.	With A.S.
26.5	8	10	108600	108619
32	10	12	108601	108620
40	12	15	108602	108621
50	16	20	108603	108622
65	20	25	108604	108623
80	25	30	108605	108624
100	30	40	108606	108625
130	40	50	108607	108626
160	50	60	108608	108627
200	65	80	108609	108628
260	80	100	108610	108629
320	100	120	108611	108630
400	125	150	108612	108631
520	160	200	108613	108632
640	200	250	108614	108633
800	250	300	108615	108634
960	300	400	108616	108635
1280	400	500	108617	108636
1600	500	600	108618	108637



EQUIPMENT

A = H.E. A.C ammeter with ...... amp. scale.

P.I.W. = H.E. polyphase indicating watt-meter with ...... kw. scale.

V = H.E. A.C. voltmeter with 175 volt scale.

A.S. (optional) = Three-way ammeter switch for connecting **A** in each phase.

These Sections cannot be used with Bottom Sections, page 9B

Kw. of Gen.	AMP. CAPACITY		P.I.W. Scale in Kw.	CAT. NO.	
	Panel	A		Without A.S.	With A.S.
26.5	8	10	40	108638	108657
32	10	12	50	108639	108658
40	12	15	60	108640	108659
50	16	20	80	108641	108660
65	20	25	100	108642	108661
80	25	30	120	108643	108662
100	30	40	150	108644	108663
130	40	50	200	108645	108664
160	50	60	250	108646	108665
200	65	80	300	108647	108666
260	80	100	400	108648	108667
320	100	120	500	108649	108668
400	125	150	600	108650	108669
520	160	200	800	108651	108670
640	200	250	1000	108652	108671
800	250	300	1200	108653	108672
960	300	400	1500	108654	108673
1280	400	500	2000	108655	108674
1600	500	600	2500	108656	108675

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
3. If **Voltage** or **Frequency** is other than listed, see General Information.
4. **Exciter Panels** are listed in S 413 and should be used whenever the exciters are to be connected to a bus for use with one or more generators.
   When T.A. regulators are used all exciters must be paralleled and exciter panels are therefore necessary.
5. **Rheostat Mechanism**—Use *Concentric Rheostat Mechanism* (for operating both the generator and exciter field rheostats) when generators have individual exciters and exciter panels are not required.
   Use *Chain Rheostat Mechanism* (for operating generator field rheostat only) when generators are excited from an exciter bus or other common source.
6. **One D.P.D.T. Governor Control Switch** Cat. No. 108907 should be ordered in addition to the generator panel whenever the generator is equipped with a motor operated governor.
7. **Synchronizing Equipment**—*One* of the following equipments should be ordered for the entire switchboard, if two or more generators are to be operated in parallel. Equipment B is necessary only when exciter panels are used and the same are not equipped with voltmeters.

Equipment A

One—Swinging bracket containing:
- *One*—110 volt.....cycle synchronism indicator.
- *Two*—Synchronizing lamp receptacles.

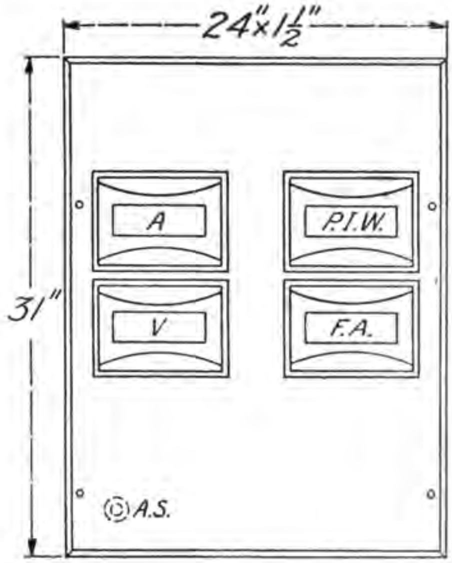
Two—4 point synchronizing plugs.

Equipment B

One—Swinging bracket containing:
- *One*—110 volt.....cycle synchronism indicator.
- *Two*—Synchronizing lamp receptacles.
- *One*—150 volt exciter voltmeter type DH.

Two—4 point synchronizing plugs.
One—4 point potential plug.

	25 Cycles	40 Cycles	60 Cycles
Equipment A—	Cat. No. 59706	Cat. No. 59707	Cat. No. 59708
Equipment B—	Cat. No. 108210	Cat. No. 108211	Cat. No. 108212



EQUIPMENT

A = H.E. A.C. ammeter with...... amp. scale.

P.I.W. = H.E. polyphase indicating wattmeter with...... kw. scale.

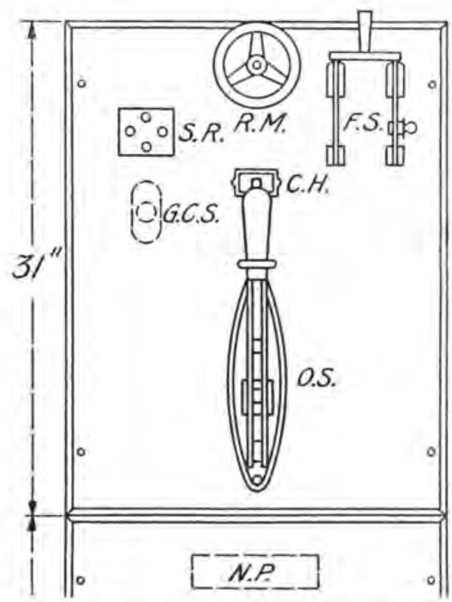
V = H.E. A.C. voltmeter with 175 volt scale.

F.A. = D.H. D.C. field ammeter with...... amp. scale (scale to be given with order).

A.S. (optional) = Three-way ammeter switch for connecting **A** in each phase.

These Sections cannot be used with Bottom Sections, page 9B

Kw. of Gen.	AMP. CAPACITY		P.I.W. Scale in Kw.	CAT. NO.	
	Panel	A		Without A.S.	With A.S.
26.5	8	10	40	108676	108695
32	10	12	50	108677	108696
40	12	15	60	108678	108697
50	16	20	80	108679	108698
65	20	25	100	108680	108699
80	25	30	120	108681	108700
100	30	40	150	108682	108701
130	40	50	200	108683	108702
160	50	60	250	108684	108703
200	65	80	300	108685	108704
260	80	100	400	108686	108705
320	100	120	500	108687	108706
400	125	150	600	108688	108707
520	160	200	800	108689	108708
640	200	250	1000	108690	108709
800	250	300	1200	108691	108710
960	300	400	1500	108692	108711
1280	400	500	2000	108693	108712
1600	500	600	2500	108694	108713



R.M. = ... Rheostat mechanism (chain or concentric). (See page 8A.)

F.S. = D.P.S.T. 250 volt...... amp. field switch with discharge clips. (Discharge resistance is not included.)

S.R. = 4 point synchronizing receptacle.

G.C.S. = Governor control switch—NOT INCLUDED (when desired see page 8A).

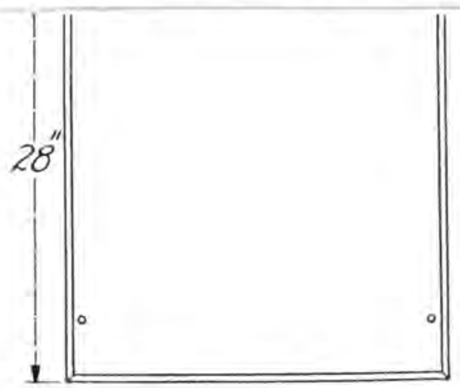
C.H. = Card holder.

O.S. = T.P.S.T...... amp. non-automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism.

N.P. = Name plate (on only one panel in a complete switchboard).

Page 9A

Kw. of Gen.	AMP. CAPACITY			CAT. NO.	
	Panel	O.S.	F.S.	O.S. on Back of Panel	O.S. Remote Control
WITH CHAIN RHEOSTAT MECHANISM					
640	8–200	200	200	108771	108789
960	250–300	300	200	108772	108790
1600	400–500	500	200	108773	108791
640	8–200	200	300	108774	108792
960	250–300	300	300	108775	108793
1600	400–500	500	300	108776	108794
WITH CONCENTRIC RHEOSTAT MECHANISM					
640	8–200	200	200	108777	108795
960	250–300	300	200	108778	108796
1600	400–500	500	200	108779	108797



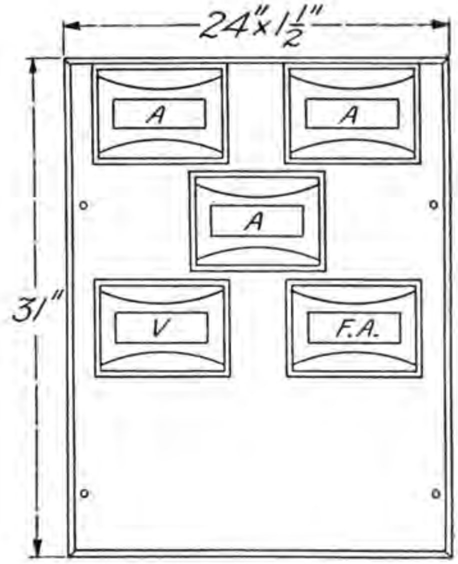
One—Current transformer ...... amp.

One—50 watt 2200–1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

Page 9B

Kw. of Gen.	AMP. CAPACITY		Cat. No.
	Panel	Current Transf'r	
26.5	8	10	108831
32	10	15	108832
40	12	15	108833
50	16	20	108834
65	20	30	108835
80	25	30	108836
100	30	40	108837
130	40	60	108838
160	50	60	108839
200	65	80	108840
260	80	100	108841
320	100	150	108842
400	125	150	108843
520	160	200	108844
640	200	300	108845
800	250	300	108846
960	300	400	108847
1280	400	600	108848
1600	500	600	108849



EQUIPMENT

These Sections cannot be used with Middle Sections, pages 9A and 11A Bottom Sections, page 9B

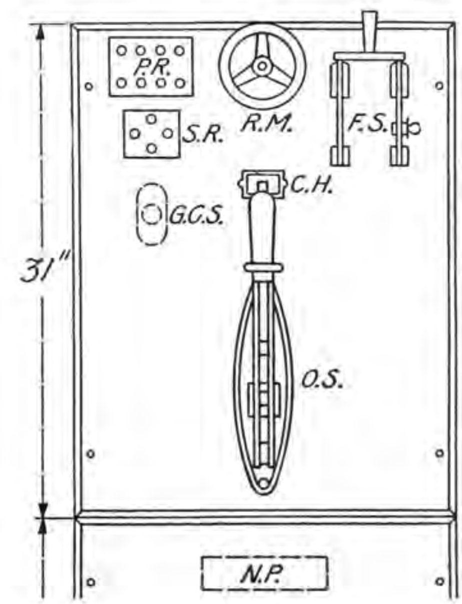
A = *Three* H.E. A.C. ammeters with...... amp. scale.

V = H.E. A.C. voltmeter with 175 volt scale.

F.A. = D.H. D.C. field ammeter with...... amp. scale (scale to be given with order).

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity A	Cat. No.
26.5	8	10	108714
32	10	12	108715
40	12	15	108716
50	16	20	108717
65	20	25	108718
80	25	30	108719
100	30	40	108720
130	40	50	108721
160	50	60	108722
200	65	80	108723
260	80	100	108724
320	100	120	108725
400	125	150	108726
520	160	200	108727
640	200	250	108728
800	250	300	108729
960	300	400	108730
1280	400	500	108731
1600	500	600	108732

Page 10A



P.R. = 8 point potential receptacle with *one* 4 point plug.

R.M. = ... Rheostat mechanism (chain or concentric). (See page 8A.)

F.S. = D.P.S.T. 250 volt......amp. field switch with discharge clips. (Discharge resistance is not included.)

S.R. = 4 point synchronizing receptacle.

G.C.S. = Governor control switch—NOT INCLUDED (when desired see page 8A).

C.H. = Card holder.

O.S. = T.P.S.T......amp. non-automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism.

N.P. = Name plate (on only one panel in a complete switchboard).

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity O.S.	Amp. Capacity F.S.	Cat. No. O.S. on Back of Panel	Cat. No. O.S. Remote Control
WITH CHAIN RHEOSTAT MECHANISM					
640	8–200	200	200	108780	108798
960	250–300	300	200	108781	108799
1600	400–500	500	200	108782	108800
640	8–200	200	300	108783	108801
960	250–300	300	300	108784	108802
1600	400–500	500	300	108785	108803
WITH CONCENTRIC RHEOSTAT MECHANISM					
640	8–200	200	200	108786	108804
960	250–300	300	200	108787	108805
1600	400–500	500	200	108788	108806

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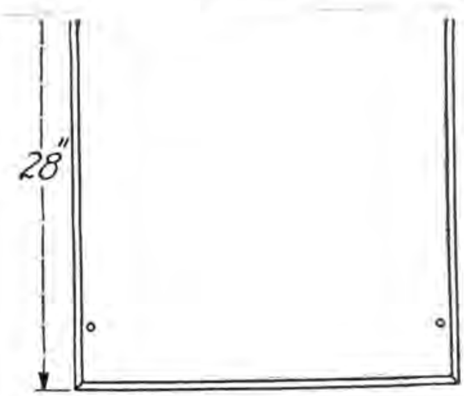
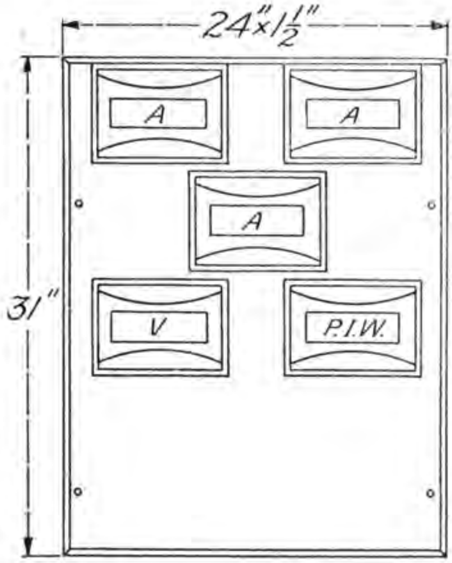


Two—Current transformers......amp.

Two—50 watt 2200–1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity Current Transf'rs	Cat. No.
26.5	8	10	108850
32	10	15	108851
40	12	15	108852
50	16	20	108853
65	20	30	108854
80	25	30	108855
100	30	40	108856
130	40	60	108857
160	50	60	108858
200	65	80	108859
260	80	100	108860
320	100	150	108861
400	125	150	108862
520	160	200	108863
640	200	300	108864
800	250	300	108865
960	300	400	108866
1280	400	600	108867
1600	500	600	108868



These Sections cannot be used with Bottom Sections, page 9B

EQUIPMENT

A = *Three* H.E. A.C. ammeters with ...... amp. scale.

V = H E A.C. voltmeter with 175 volt scale.

P.I.W. = H.E. polyphase indicating wattmeter with ...... kw. scale.

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity A	P.I.W. Scale in Kw.	Cat. No.
26.5	8	10	40	108733
32	10	12	50	108734
40	12	15	60	108735
50	16	20	80	108736
65	20	25	100	108737
80	25	30	120	108738
100	30	40	150	108739
130	40	50	200	108740
160	50	60	250	108741
200	65	80	300	108742
260	80	100	400	108743
320	100	120	500	108744
400	125	150	600	108745
520	160	200	800	108746
640	200	250	1000	108747
800	250	300	1200	108748
960	300	400	1500	108749
1280	400	500	2000	108750
1600	500	600	2500	108751

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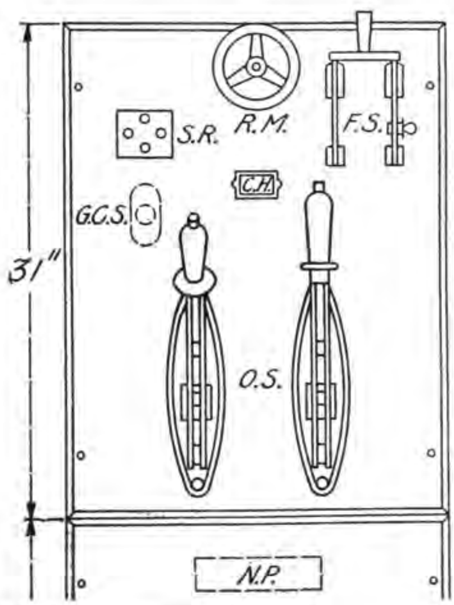


R.M. = ... Rheostat mechanism (chain or concentric). (See page 8A.)

F.S. = D.P.S.T. 250 volt...... amp. field switch with discharge clips. (Discharge resistance is not included.)

S.R. = 4 point synchronizing receptacle.

G.C.S. = Governor control switch—NOT INCLUDED (when desired see page 8A).

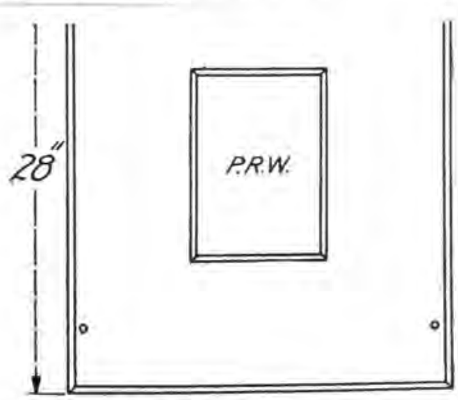
C.H. = Card holder.

O.S. = T.P.D.T......amp. non-automatic **K-5** oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism.

N.P. = Name plate (on only one panel in a complete switchboard).

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity O.S.	Amp. Capacity F.S.	Cat. No. O.S. On Back of Panel	Cat. No. O.S. Remote Control
WITH CHAIN RHEOSTAT MECHANISM					
640	8-200	200	200	108807	108813
960	250-300	300	200	......	108814
1600	400-500	500	200	......	108815
640	8-200	200	300	108808	108816
960	250-300	300	300	......	108817
1600	400-500	500	300	......	108818
WITH CONCENTRIC RHEOSTAT MECHANISM					
640	8-200	200	200	108809	108819
960	250-300	300	200	......	108820
1600	400-500	500	200	......	108821

Page 11B



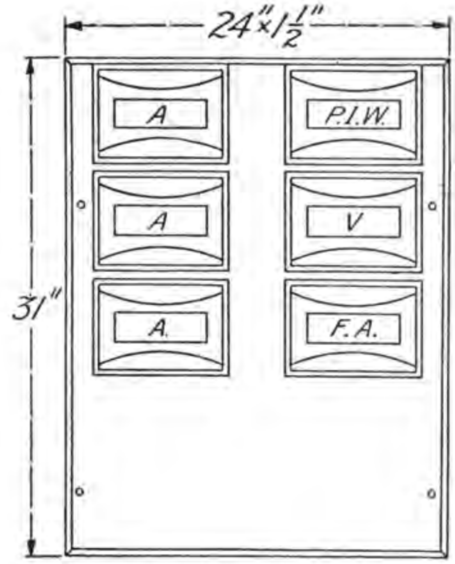
P.R.W. = Polyphase watt-hour meter with metal cover DS-4.

Two—Current transformers......amp.

Two—50 watt 2200-1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

Kw. of Gen.	Amp. Capacity Panel	Amp. Capacity Current Transf'rs	Cat. No.
26.5	8	10	108869
32	10	15	108870
40	12	15	108871
50	16	20	108872
65	20	30	108873
80	25	30	108874
100	30	40	108875
130	40	60	108876
160	50	60	108877
200	65	80	108878
260	80	100	108879
320	100	150	108880
400	125	150	108881
520	160	200	108882
640	200	300	108883
800	250	300	108884
960	300	400	108885
1280	400	600	108886
1600	500	600	108887



EQUIPMENT

A = *Three* H.E. A.C. ammeters with...... amp. scale.

P.I.W. = H.E. polyphase indicating wattmeter with...... kw. scale.

V = H.E. A.C. voltmeter with 175 volt scale.

F.A. = D.H. D.C. field ammeter with...... amp. scale (scale to be given with order).

These Sections cannot be used with Bottom Sections, page 9B

Kw. of Gen.	AMP. CAPACITY Panel	AMP. CAPACITY A	P.I.W. Scale in Kw.	Cat. No.
26.5	8	10	40	108752
32	10	12	50	108753
40	12	15	60	108754
50	16	20	80	108755
65	20	25	100	108756
80	25	30	120	108757
100	30	40	150	108758
130	40	50	200	108759
160	50	60	250	108760
200	65	80	300	108761
260	80	100	400	108762
320	100	120	500	108763
400	125	150	600	108764
520	160	200	800	108765
640	200	250	1000	108766
800	250	300	1200	108767
960	300	400	1500	108768
1280	400	500	2000	108769
1600	500	600	2500	108770

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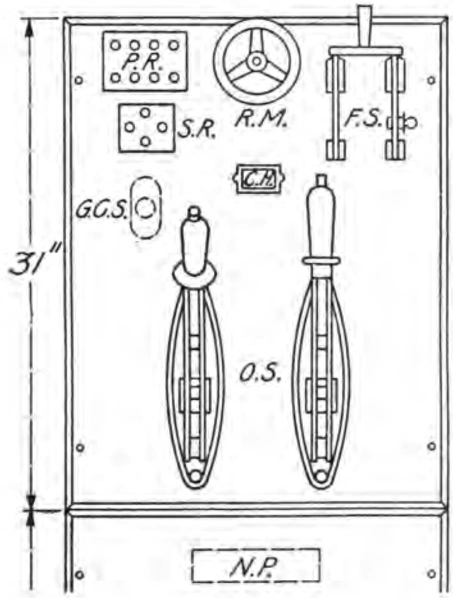

P.R. = 8 point potential receptacle with *one* 4 point plug.

R.M. = ... Rheostat mechanism (chain or concentric). (See page 8A).

F.S. = D.P.S.T. 250 volt...... amp. field switch with discharge clips. (Discharge resistance is not included.)

S.R. = 4 point synchronizing receptacle

G.C.S. = Governor control switch—NOT INCLUDED (when desired see page 8A).

C.H. = Card holder

O.S. = T.P.D.T...... amp. non-automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism.

N.P. = Name plate (on only one panel in a complete switchboard).

Kw. of Gen.	AMP. CAPACITY Panel	AMP. CAPACITY O.S.	AMP. CAPACITY F.S.	CAT. NO. O.S. on Back of Panel	CAT. NO. O.S. Remote Control
WITH CHAIN RHEOSTAT MECHANISM					
640	8–200	200	200	108810	108822
960	250–300	300	200	......	108823
1600	400–500	500	200	......	108824
640	8–200	200	300	108811	108825
960	250–300	300	300	......	108826
1600	400–500	500	300	......	108827
WITH CONCENTRIC RHEOSTAT MECHANISM					
640	8–200	200	200	108812	108828
960	250–300	300	200	......	108829
1600	400–500	500	200	......	108830

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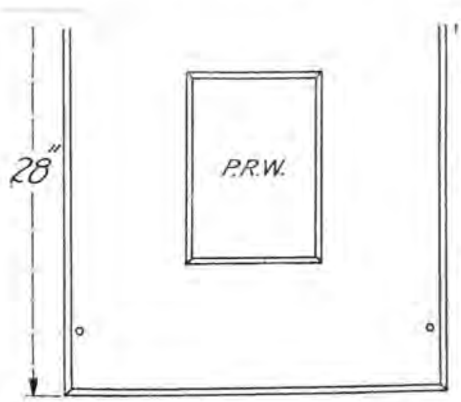


P.R.W. = Polyphase watt-hour meter with glass cover DS-5.

Two—Current transformers...... amp.

Two—50 watt 2200-1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

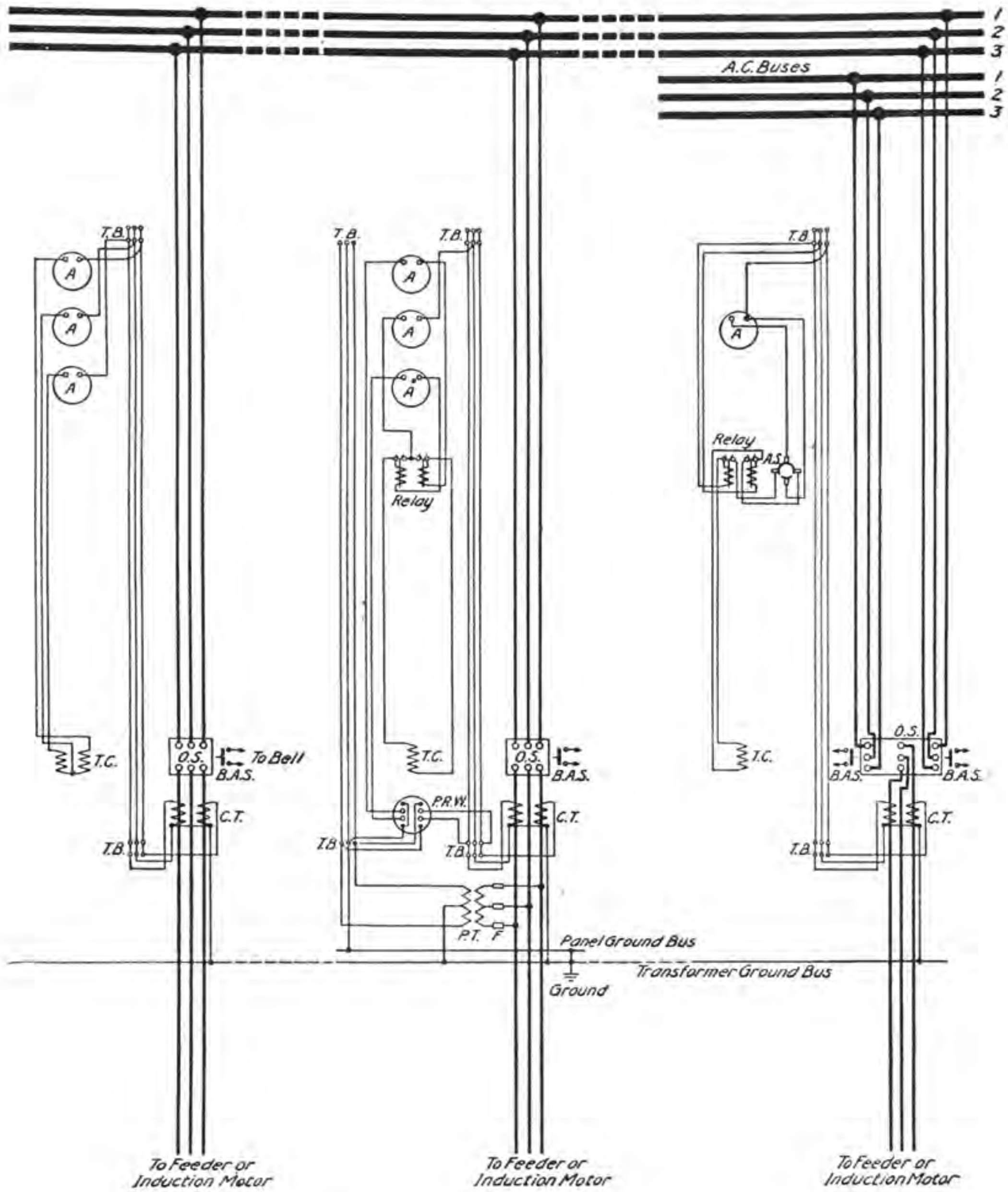
Kw. of Gen.	AMP. CAPACITY Panel	AMP. CAPACITY Current Transf'rs	Cat. No.
26.5	8	10	108888
32	10	15	108889
40	12	15	108890
50	16	20	108891
65	20	30	108892
80	25	30	108893
100	30	40	108894
130	40	60	108895
160	50	60	108896
200	65	80	108897
260	80	100	108898
320	100	150	108899
400	125	150	108900
520	160	200	108901
640	200	300	108902
800	250	300	108903
960	300	400	108904
1280	400	600	108905
1600	500	600	108906

SINGLE-CIRCUIT THREE-PHASE FEEDER OR INDUCTION MOTOR PANELS

2300 VOLTS—60 CYCLES
8 TO 500 AMPERES

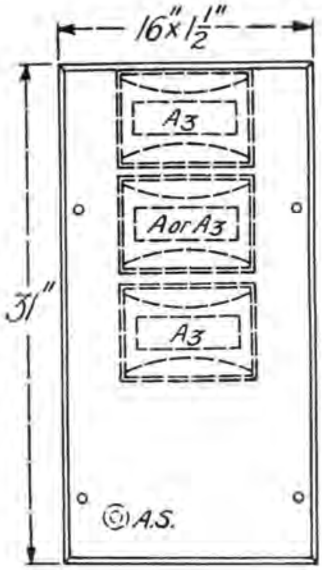
WITH OIL SWITCHES T.P.S.T. AND T.P.D.T. { Mounted on back of panel
Remote control, mounted on pipe framework

DIAGRAMS OF CONNECTIONS



KEY TO SYMBOLS

A	=Ammeter.
A.S.	=Three-way ammeter switch.
B.A.S.	=Bell alarm switch.
C.T.	=Current transformer.
F	=Fuse.
O.S.	=Oil switch.
P.T.	=Potential transformer.
P.R.W.	=Polyphase watthour meter.
T.B.	=Terminal board for secondary leads from current and potential transformers.
T.C.	=Trip coil on oil switch.



EQUIPMENT

A3(optional) = *Three* H.E. A.C. ammeters with......amp. scales.

A(optional) = *One* H.E. A.C. ammeter with ......amp. scale.

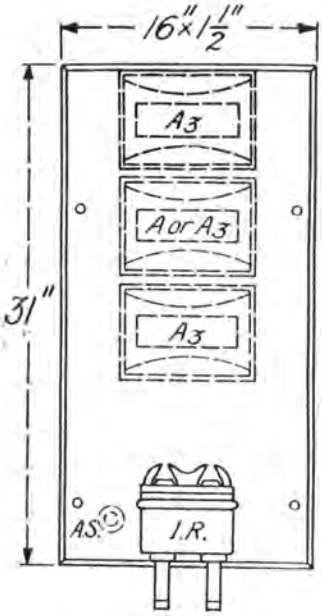
A.S.(optional) = Three-way ammeter switch for connecting A in each phase.

These Sections cannot be used with
Middle Sections, page 17A
Bottom Sections, page 17B

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Blank	With A	With A and A.S.	With A3
8	10	108908	108911	108968	109025
10	12		108912	108969	109026
12	15		108913	108970	109027
16	20		108914	108971	109028
20	25		108915	108972	109029
25	30		108916	108973	109030
30	40		108917	108974	109031
40	50		108918	108975	109032
50	60		108919	108976	109033
65	80		108920	108977	109034
80	100		108921	108978	109035
100	120		108922	108979	109036
125	150		108923	108980	109037
160	200		108924	108981	109038
200	250		108925	108982	109039
250	300		108926	108983	109040
300	400		108927	108984	109041
400	500		108928	108985	109042
500	600		108929	108986	109043

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. Avoid ordering *panels larger than necessary* for present requirements—See "Rating of Feeder Panels."
3. Always consider the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
4. If *Voltage* or *Frequency* is other than listed see General Information.
5. *Lightning Arresters* are not included with these panels.
6. See General Information for method of determining *ampere capacity of panel required for a given Induction Motor.*
7. These panels cannot be used with any motors which require a controller or starting equipment mounted on the panel; for instance, those Form K motors which do not have self-contained starting compensators.



EQUIPMENT

A3(optional) = *Three* H.E. A.C. ammeters with ...... amp. scale.

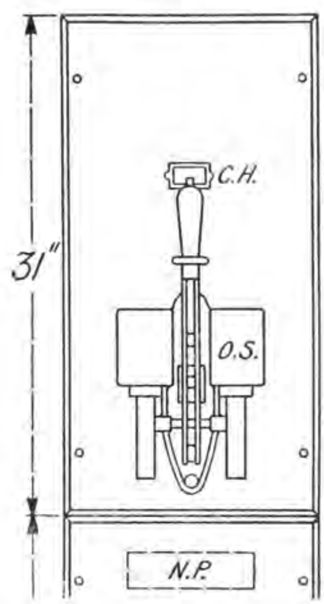
A(optional) = *One* H.E. A.C. ammeter with ...... amp. scale.

I.R. = D.P. instantaneous overload relay.

A.S.(optional) = Three-way ammeter switch for connecting A in each phase.

These Sections cannot be used with Middle Sections, page 16A Bottom Sections, page 16B

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Without A, AS or A3	With A	With A and A.S.	With A3
8	10		108949	109006	109063
10	12		108950	109007	109064
12	15		108951	109008	109065
16	20		108952	109009	109066
20	25		108953	109010	109067
25	30		108954	109011	109068
30	40		108955	109012	109069
40	50		108956	109013	109070
50	60		108957	109014	109071
65	80		108958	109015	109072
80	100	108910	108959	109016	109073
100	120		108960	109017	109074
125	150		108961	109018	109075
160	200		108962	109019	109076
200	250		108963	109020	109077
250	300		108964	109021	109078
300	400		108965	109022	109079
400	500		108966	109023	109080
500	600		108967	109024	109081

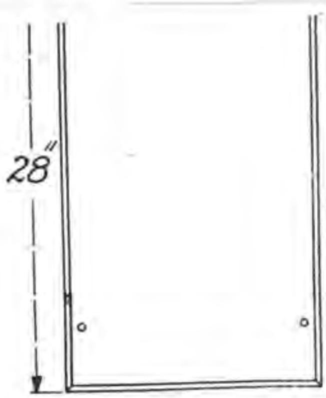


C.H. = Card holder.

O.S. = T.P.S.T. ...... amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

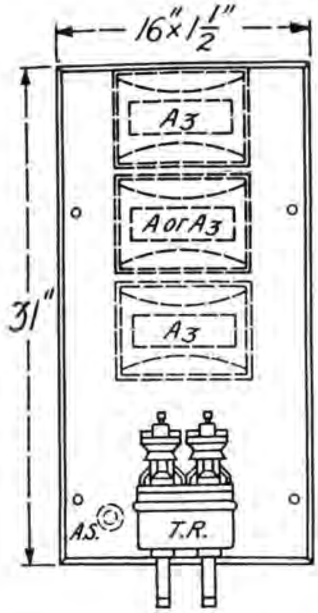
AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8–200	200	109082	109088
250–300	300	109083	109089
400–500	500	109084	109090



Two—Current transformers ...... amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
8	10	109094
10	15	109095
12	15	109096
16	20	109097
20	30	109098
25	30	109099
30	40	109100
40	60	109101
50	60	109102
65	80	109103
80	100	109104
100	150	109105
125	150	109106
160	200	109107
200	300	109108
250	300	109109
300	400	109110
400	600	109111
500	600	109112



EQUIPMENT

A3(optional) = *Three* H.E. A.C. ammeters with......amp. scales.

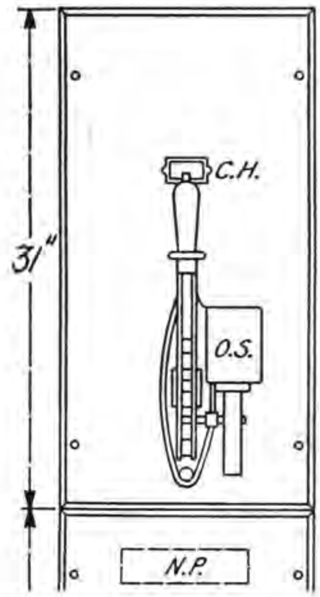
A(optional) = *One* H.E. A.C. ammeter with ......amp. scale.

T.R. = D.P. time limit overload relay.

A.S.(optional) = Three-way ammeter switch for connecting A in each phase.

These Sections cannot be used with Middle Sections, page 16A

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Without A. AS or A3	With A	With A and A.S.	With A3
8	10		108930	108987	109044
10	12		108931	108988	109045
12	15		108932	108989	109046
16	20		108933	108990	109047
20	25		108934	108991	109048
25	30		108935	108992	109049
30	40		108936	108993	109050
40	50	108909	108937	108994	109051
50	60		108938	108995	109052
65	80		108939	108996	109053
80	100		108940	108997	109054
100	120		108941	108998	109055
125	150		108942	108999	109056
160	200		108943	109000	109057
200	250		108944	109001	109058
250	300		108945	109002	109059
300	400		108946	109003	109060
400	500		108947	109004	109061
500	600		108948	109005	109062

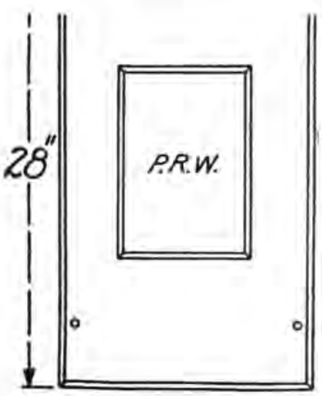


C.H. = Card holder.

O.S. = T.P.S.T......amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8–200	200	109085	109091
250–300	300	109086	109092
400–500	500	109087	109093



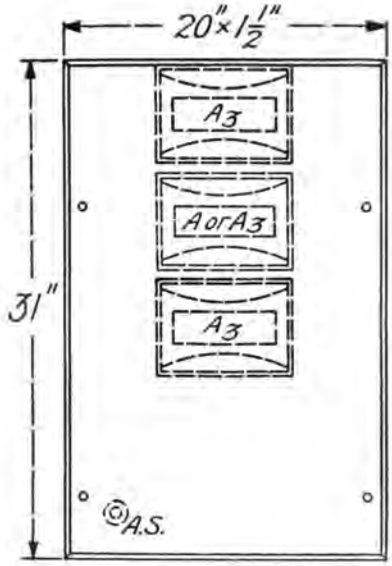
P.R.W. = Polyphase watt-hour meter DS-4 with metal cover (or DS-5 with glass cover).

Two—Current transformers......amp.

Two—50 watt 2200–1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Transformers	With DS-4 P.R.W.	With DS-5 P.R.W.
8	10	109113	109132
10	15	109114	109133
12	15	109115	109134
16	20	109116	109135
20	30	109117	109136
25	30	109118	109137
30	40	109119	109138
40	60	109120	109139
50	60	109121	109140
65	80	109122	109141
80	100	109123	109142
100	150	109124	109143
125	150	109125	109144
160	200	109126	109145
200	300	109127	109146
250	300	109128	109147
300	400	109129	109148
400	600	109130	109149
500	600	109131	109150



EQUIPMENT

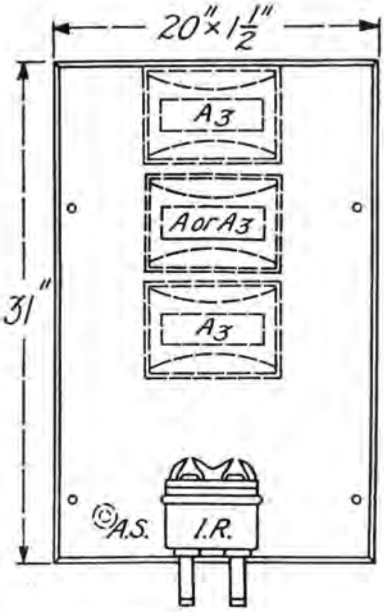
A3(optional) = *Three* H.E. A.C. ammeters with......amp. scales.

A(optional) = *One* H.E. A.C. ammeter with ......amp. scale.

A.S.(optional) = Three-way ammeter switch for connecting A in each phase.

These Sections cannot be used with
Middle Sections, page 20A
Bottom Sections, page 20B

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Blank	With A	With A and A.S.	With A3
8	10	109151	109154	109211	109268
10	12		109155	109212	109269
12	15		109156	109213	109270
16	20		109157	109214	109271
20	25		109158	109215	109272
25	30		109159	109216	109273
30	40		109160	109217	109274
40	50		109161	109218	109275
50	60		109162	109219	109276
65	80		109163	109220	109277
80	100		109164	109221	109278
100	120		109165	109222	109279
125	150		109166	109223	109280
160	200		109167	109224	109281
200	250		109168	109225	109282
250	300		109169	109226	109283
300	400		109170	109227	109284
400	500		109171	109228	109285
500	600		109172	109229	109286



EQUIPMENT

A3(optional) = *Three* H.E. A.C. ammeters with......amp. scales.

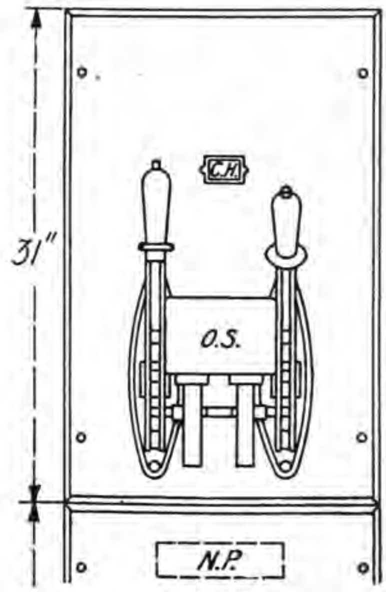
A(optional) = *One* H.E. A.C. ammeter with ......amp. scale.

I.R. = D.P. instantaneous overload relay.

A.S.(optional) = Three-way ammeter switch for connecting **A** in each phase.

These Sections cannot be used with Middle Sections, page 19A Bottom Sections, page 19B

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Without A, AS or A3	With A	With A and A.S.	With A3
8	10	109153	109192	109249	109306
10	12		109193	109250	109307
12	15		109194	109251	109308
16	20		109195	109252	109309
20	25		109196	109253	109310
25	30		109197	109254	109311
30	40		109198	109255	109312
40	50		109199	109256	109313
50	60		109200	109257	109314
65	80		109201	109258	109315
80	100		109202	109259	109316
100	120		109203	109260	109317
125	150		109204	109261	109318
160	200		109205	109262	109319
200	250		109206	109263	109320
250	300		109207	109264	109321
300	400		109208	109265	109322
400	500		109209	109266	109323
500	600		109210	109267	109324

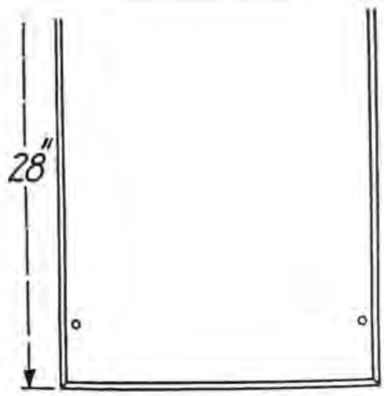


C.H. = Card holder.

O.S. = T.P.D.T.......amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

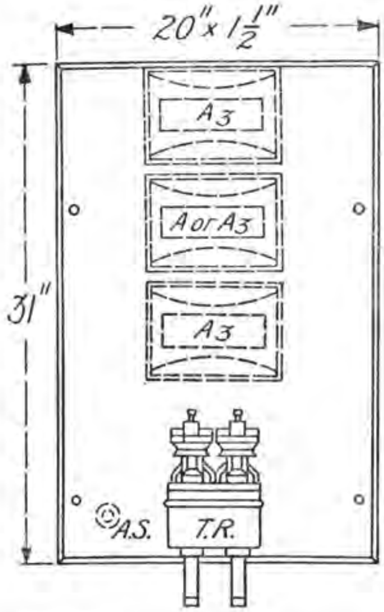
AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8-200	200	109325	109327
250-300	300	—	109328
400-500	500	—	109329



Two—Current transformers......amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
8	10	109333
10	15	109334
12	15	109335
16	20	109336
20	30	109337
25	30	109338
30	40	109339
40	60	109340
50	60	109341
65	80	109342
80	100	109343
100	150	109344
125	150	109345
160	200	109346
200	300	109347
250	300	109348
300	400	109349
400	600	109350
500	600	109351



EQUIPMENT

A3(optional) = *Three* H.E. A.C. ammeters with......amp. scales.

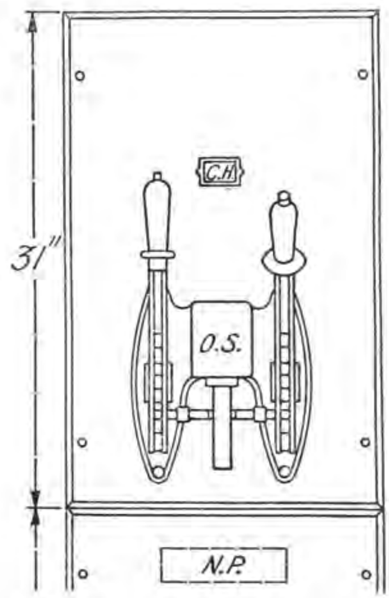
A(optional) = *One* H.E. A.C. ammeter with ......amp. scale.

T.R. = D.P. time limit overload relay.

A.S.(optional) = Three-way ammeter switch for connecting A in each phase.

These Sections cannot be used with Middle Sections, page 19A

AMP. CAPACITY		CAT. NO.			
Panel	A or A3	Without A, A.S. or A3	With A	With A and A.S.	With A3
8	10	109152	109173	109230	109287
10	12		109174	109231	109288
12	15		109175	109232	109289
16	20		109176	109233	109290
20	25		109177	109234	109291
25	30		109178	109235	109292
30	40		109179	109236	109293
40	50		109180	109237	109294
50	60		109181	109238	109295
65	80		109182	109239	109296
80	100		109183	109240	109297
100	120		109184	109241	109298
125	150		109185	109242	109299
160	200		109186	109243	109300
200	250		109187	109244	109301
250	300		109188	109245	109302
300	400		109189	109246	109303
400	500		109190	109247	109304
500	600		109191	109248	109305

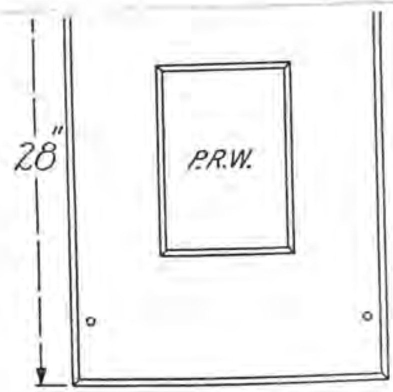


C.H. = Card holder.

O.S. = T.P.D.T.......amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8-200	200	109326	109330
250-300	300	—	109331
400-500	500	—	109332



P.R.W. = Polyphase watt-hour meter DS-4 with metal cover (or DS-5 with glass cover).

Two—Current transformers......amp.

Two—50 watt 2200-1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Transformers	With DS-4 P.R.W.	With DS-5 P.R.W.
8	10	109352	109371
10	15	109353	109372
12	15	109354	109373
16	20	109355	109374
20	30	109356	109375
25	30	109357	109376
30	40	109358	109377
40	60	109359	109378
50	60	109360	109379
65	80	109361	109380
80	100	109362	109381
100	150	109363	109382
125	150	109364	109383
160	200	109365	109384
200	300	109366	109385
250	300	109367	109386
300	400	109368	109387
400	600	109369	109388
500	600	109370	109389

DOUBLE-CIRCUIT
THREE-PHASE FEEDER PANELS

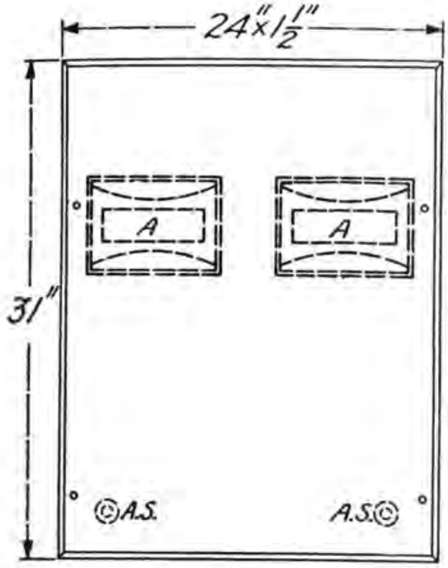
2300 VOLTS—60 CYCLES
8 TO 200 AMPERES PER CIRCUIT

WITH T.P.S.T. OIL SWITCHES { Mounted on back of panel
Remote control, mounted on pipe framework

NOTE

The panels listed are for controlling two circuits of equal capacity, the panel rating being the total ampere capacity of the two circuits. If so ordered, any panel will be furnished with an equipment suitable for two circuits of different capacities providing the ampere capacity of either circuit does not exceed 200 amperes.

For Diagrams of Connections
see
Single-Circuit Panels, Page 14



EQUIPMENT

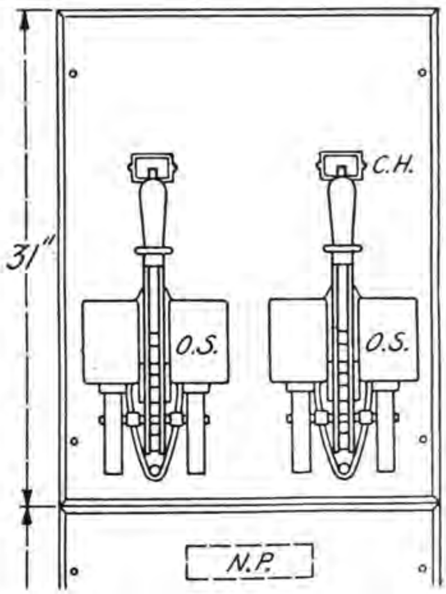
A(optional) = *Two* H.E. A.C. ammeters with ...... amp. scales.

A.S.(optional) = *Two* three-way ammeter switches for connecting A in each phase.

These Sections cannot be used with Middle Sections, page 24A

AMP. CAPACITY		CAT. NO.		
Panel	A	Blank	With A	With A and A.S.
16	10	109390	109392	109422
20	12		109393	109423
24	15		109394	109424
32	20		109395	109425
40	25		109396	109426
50	30		109397	109427
60	40		109398	109428
80	50		109399	109429
100	60		109400	109430
130	80		109401	109431
160	100		109402	109432
200	120		109403	109433
250	150		109404	109434
320	200		109405	109435
400	250		109406	109436

Page 23A



C.H. = *Two* card holders.

O.S. = *Two* T.P.S.T. 200 amp. automatic K-5 oil switches mounted on back of panel (or on pipe framework remote from panel) with operating mechanisms and bell alarm switches.

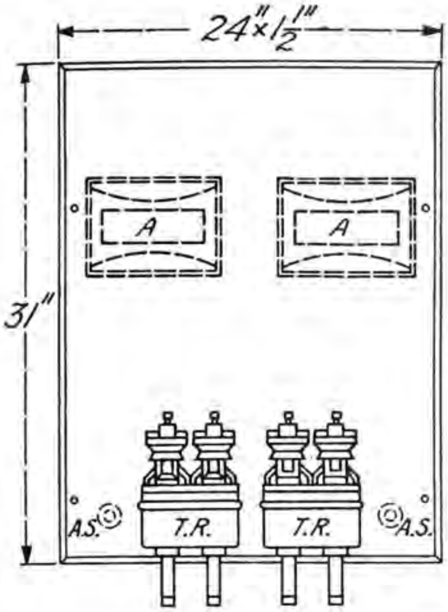
N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
16–400	200	109452	109454

Page 23B

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. Avoid ordering *panels of larger capacity than necessary* for present requirements, for reasons given under "Rating of Feeder Panels."
3. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
4. If *Voltage* or *Frequency* is other than listed, see General Information.
5. Lightning Arresters are not included with these panels.



EQUIPMENT

A(optional) = *Two* H.E. A.C. ammeters with ......amp. scale.

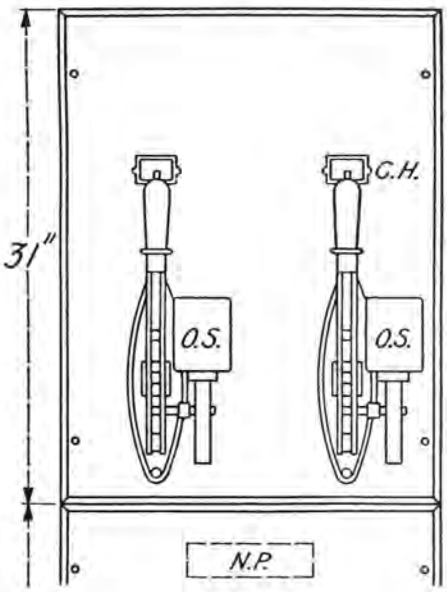
T.R. = *Two* D.P. time limit overload relays.

A.S.(optional) = *Two* three-way ammeter switches for connecting A in each phase.

These Sections cannot be used with Middle Sections, page 23A

AMP. CAPACITY		CAT. NO.		
Panel	A	Without A or A.S.	With A	With A and A.S.
16	10		109407	109437
20	12		109408	109438
24	15		109409	109439
32	20		109410	109440
40	25		109411	109441
50	30		109412	109442
60	40	109391	109413	109443
80	50		109414	109444
100	60		109415	109445
130	80		109416	109446
160	100		109417	109447
200	120		109418	109448
250	150		109419	109449
320	200		109420	109450
400	250		109421	109451

Page 24A



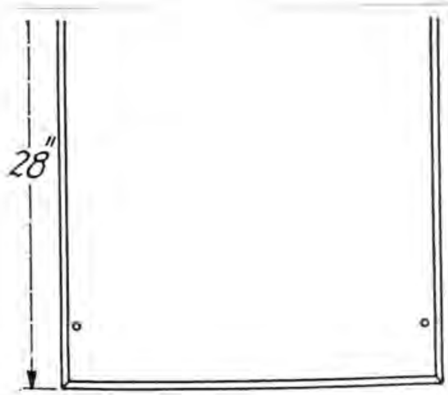
C.H. = *Two* card holders.

O.S. = *Two* T.P.S.T. 200 amp. automatic K-5 oil switches mounted on back of panel (or on pipe framework remote from panel) with operating mechanisms and bell alarm switches.

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
16–400	200	109453	109455

N.P. = Name plate (on only one panel in a complete switchboard).

Page 24B



Four—Current transformers......amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Trans-formers	
16	10	109456
20	15	109457
24	15	109458
32	20	109459
40	30	109460
50	30	109461
60	40	109462
80	60	109463
100	60	109464
130	80	109465
160	100	109466
200	150	109467
250	150	109468
320	200	109469
400	300	109470

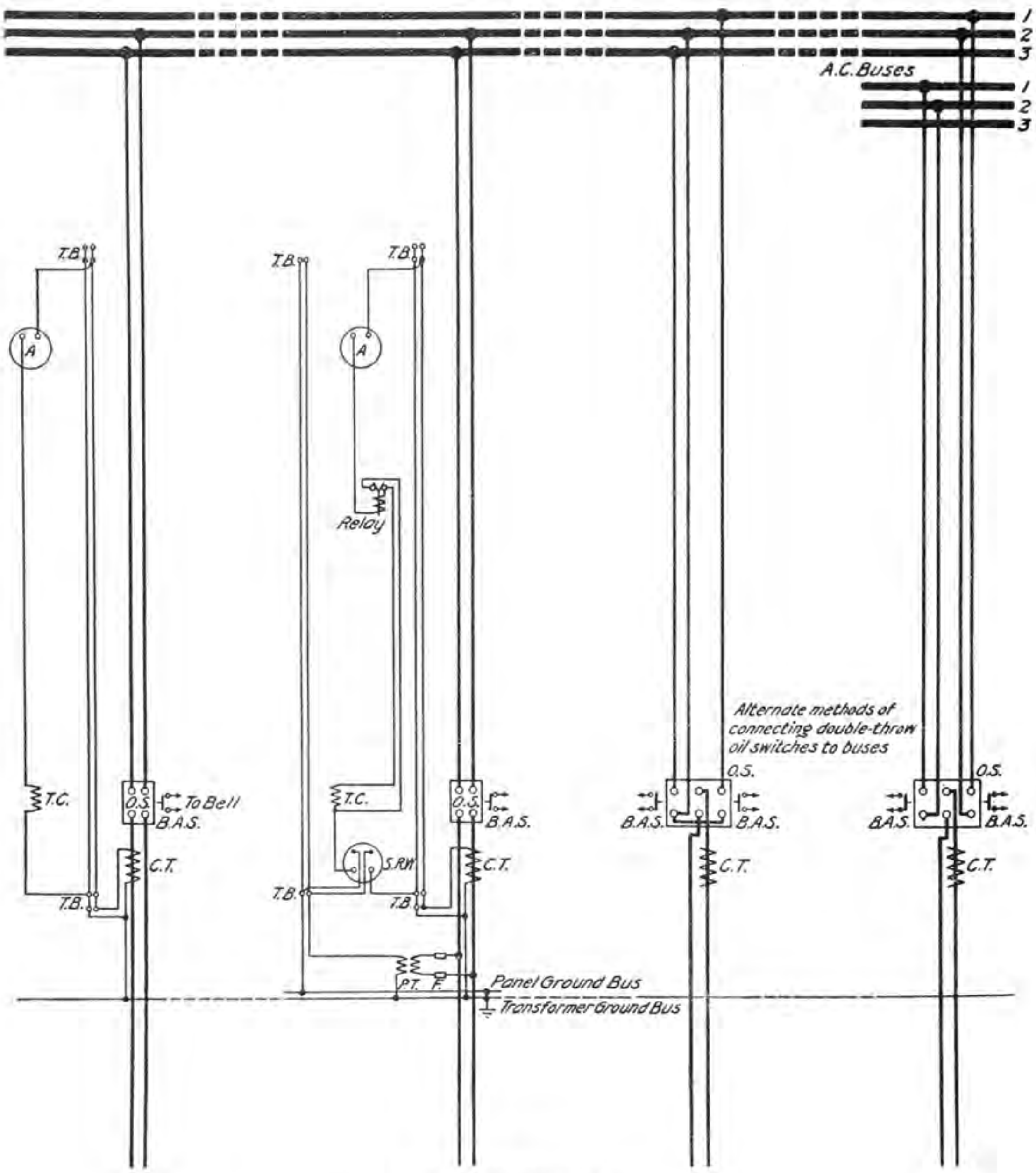
SINGLE-CIRCUIT
SINGLE-PHASE FEEDER PANELS
Without Feeder Regulators

2300 VOLTS—60 CYCLES

8 TO 200 AMPERES

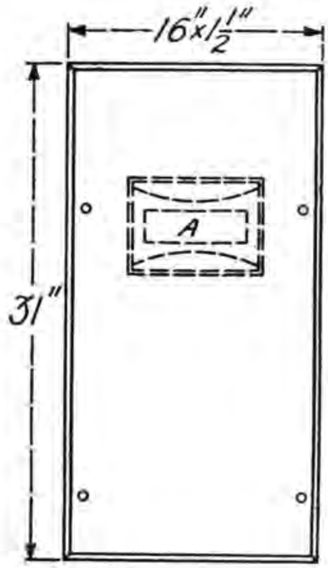
WITH OIL SWITCHES D.P.S.T. AND D.P.D.T. { Mounted on back of panel; Remote control, mounted on pipe framework }

DIAGRAMS OF CONNECTIONS



KEY TO SYMBOLS

A	=Ammeter.
B.A.S.	=Bell alarm switch.
C.T.	=Current transformer.
F	=Fuse.
O.S.	=Oil switch.
P.T.	=Potential transformer.
S.R.W.	=Single-phase watthour meter.
T.B	=Terminal board for secondary leads from current and potential transformers.
T.C	=Trip coil on oil switch.



EQUIPMENT

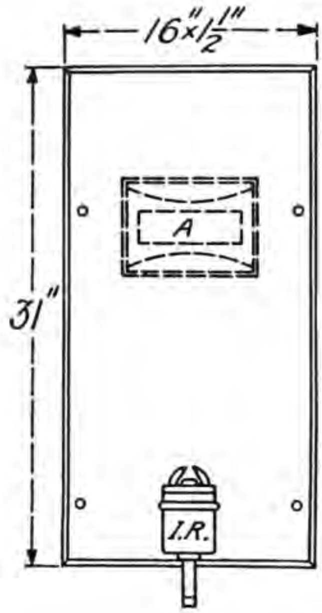
A (optional) = H.E. A.C. ammeter with...... amp. scale.

These Sections cannot be used with Bottom Sections, page 29B

AMP. CAPACITY		CAT. NO.	
Panel	A	Blank	With A
8	10	109471	109474
10	12		109475
12	15		109476
16	20		109477
20	25		109478
25	30		109479
30	40		109480
40	50		109481
50	60		109482
65	80		109483
80	100		109484
100	120		109485
125	150		109486
160	200		109487
200	250		109488

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If panels with D.T. oil switches are ordered, state whether the switch is to be connected for transferring feeder to either of two phases of a single set of buses or to either of two sets of buses. See wirings on preceding page.
3. Avoid ordering *panels of larger capacity than necessary* for present requirements, for reasons given under "Rating of Feeder Panels."
4. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
5. If *Voltage* or *Frequency* is other than listed, see General Information.
6. Lightning Arresters are not included with these panels.



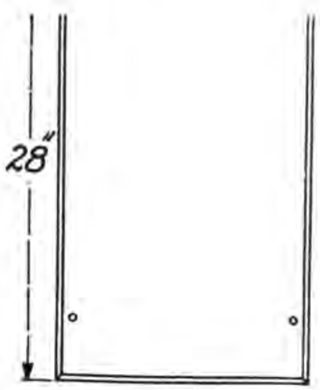
EQUIPMENT

A(optional) = H.E. A.C. ammeter with...... amp. scale.

I.R. = S.P. instantaneous overload relay.

These Sections cannot be used with Bottom Sections, page 28B

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10	109473	109504
10	12		109505
12	15		109506
16	20		109507
20	25		109508
25	30		109509
30	40		109510
40	50		109511
50	60		109512
65	80		109513
80	100		109514
100	120		109515
125	150		109516
160	200		109517
200	250		109518

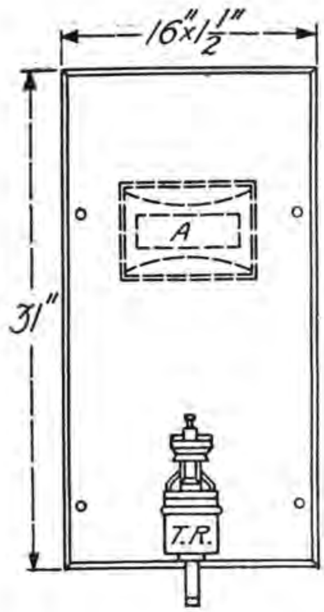


One—Current transformer......amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		
Panel	Current Trans-former	Cat. No.
8	10	109521
10	15	109522
12	15	109523
16	20	109524
20	30	109525
25	30	109526
30	40	109527
40	60	109528
50	60	109529
65	80	109530
80	100	109531
100	150	109532
125	150	109533
160	200	109534
200	300	109535

EQUIPMENT



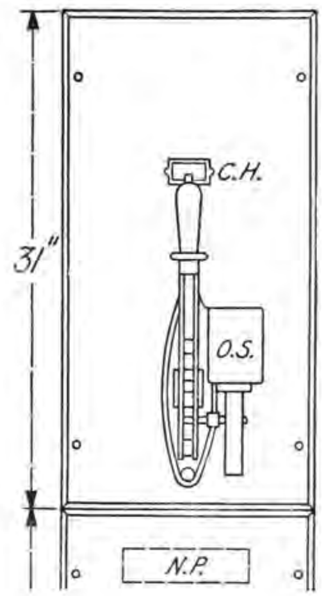
A(optional) = H.E. A.C. ammeter with...... amp. scale.

T.R. = S.P. time limit overload relay.

These Sections may be used with any Middle or Bottom Section

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10	109472	109489
10	12		109490
12	15		109491
16	20		109492
20	25		109493
25	30		109494
30	40		109495
40	50		109496
50	60		109497
65	80		109498
80	100		109499
100	120		109500
125	150		109501
160	200		109502
200	250		109503

Page 29A



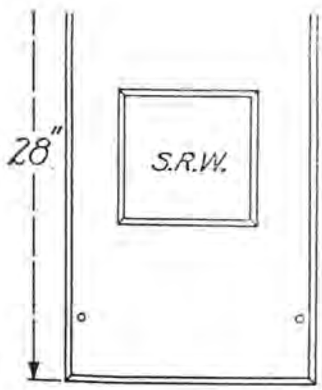
C.H. = Card holder.

O.S. = D P.S.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8–200	200	109519	109520

Page 29B



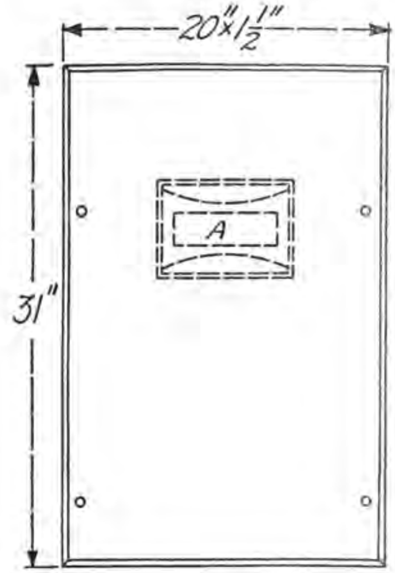
S.R.W. = Single-phase watt-hour meter IS-2 with metal cover (or IS-3 with glass cover).

One—Current transformer...... amp.

One—50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-former	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	109536	109551
10	15	109537	109552
12	15	109538	109553
16	20	109539	109554
20	30	109540	109555
25	30	109541	109556
30	40	109542	109557
40	60	109543	109558
50	60	109544	109559
65	80	109545	109560
80	100	109546	109561
100	150	109547	109562
125	150	109548	109563
160	200	109549	109564
200	300	109550	109565

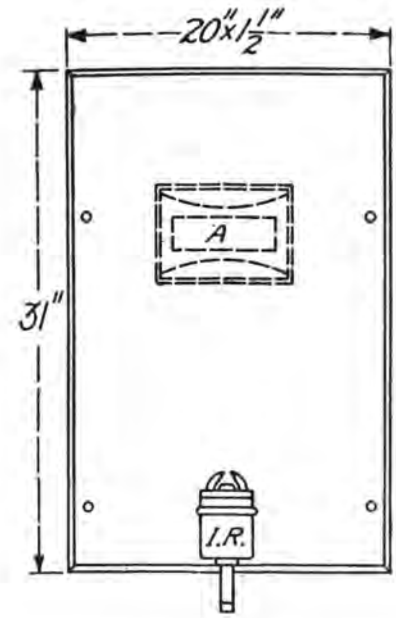


EQUIPMENT

A(optional) = H.E. A.C. ammeter with...... amp. scale

These Sections cannot be used with Bottom Sections, page 32B

AMP. CAPACITY		CAT. NO.	
Panel	A	Blank	With A
8	10	109566	109569
10	12		109570
12	15		109571
16	20		109572
20	25		109573
25	30		109574
30	40		109575
40	50		109576
50	60		109577
65	80		109578
80	100		109579
100	120		109580
125	150		109581
160	200		109582
200	250		109583



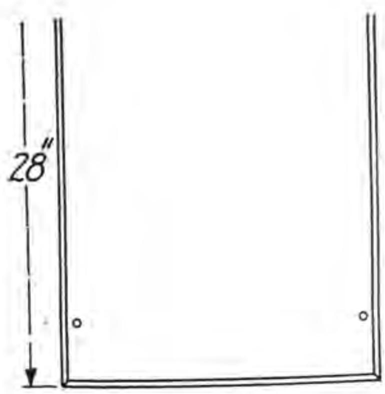
EQUIPMENT

A(optional) = H.E. A.C. ammeter with...... amp. scale.

I.R. = S.P. instantaneous overload relay.

These Sections cannot be used with Bottom Sections, page 31B

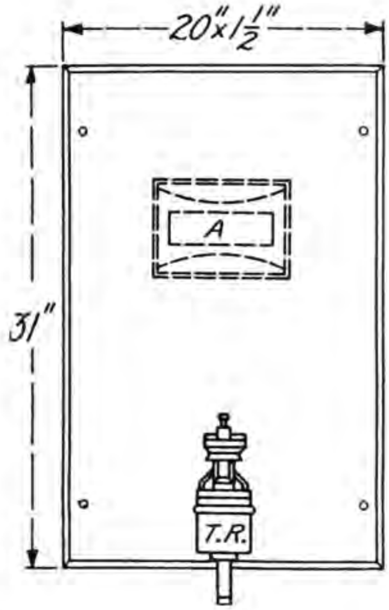
AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10		109599
10	12		109600
12	15		109601
16	20		109602
20	25		109603
25	30		109604
30	40	109568	109605
40	50		109606
50	60		109607
65	80		109608
80	100		109609
100	120		109610
125	150		109611
160	200		109612
200	250		109613



One—Current transformer...... amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformer	
8	10	109616
10	15	109617
12	15	109618
16	20	109619
20	30	109620
25	30	109621
30	40	109622
40	60	109623
50	60	109624
65	80	109625
80	100	109626
100	150	109627
125	150	109628
160	200	109629
200	300	109630



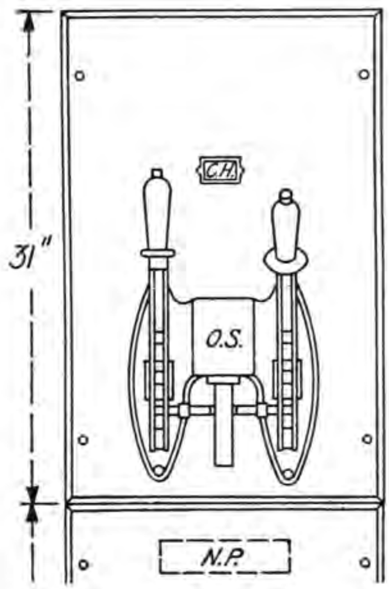
EQUIPMENT

A (optional) = H.E. A.C. ammeter with...... amp. scale.

T.R. = S.P. time limit overload relay.

These Sections may be used with any Middle or Bottom Section

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10	109567	109584
10	12		109585
12	15		109586
16	20		109587
20	25		109588
25	30		109589
30	40		109590
40	50		109591
50	60		109592
65	80		109593
80	100		109594
100	120		109595
125	150		109596
160	200		109597
200	250		109598

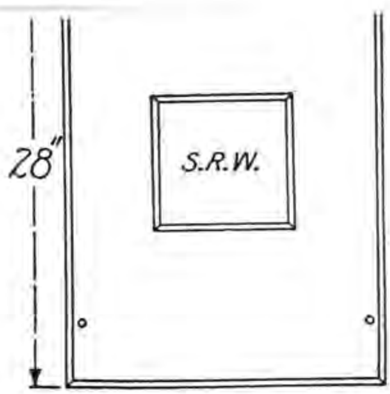


C.H. = Card holder.

O.S. = D.P.D.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
8-200	200	109614	109615



S.R.W. = Single-phase watt-hour meter, IS-2 with metal cover (or IS-3 with glass cover).

One—Current transformer......amp.

One—50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

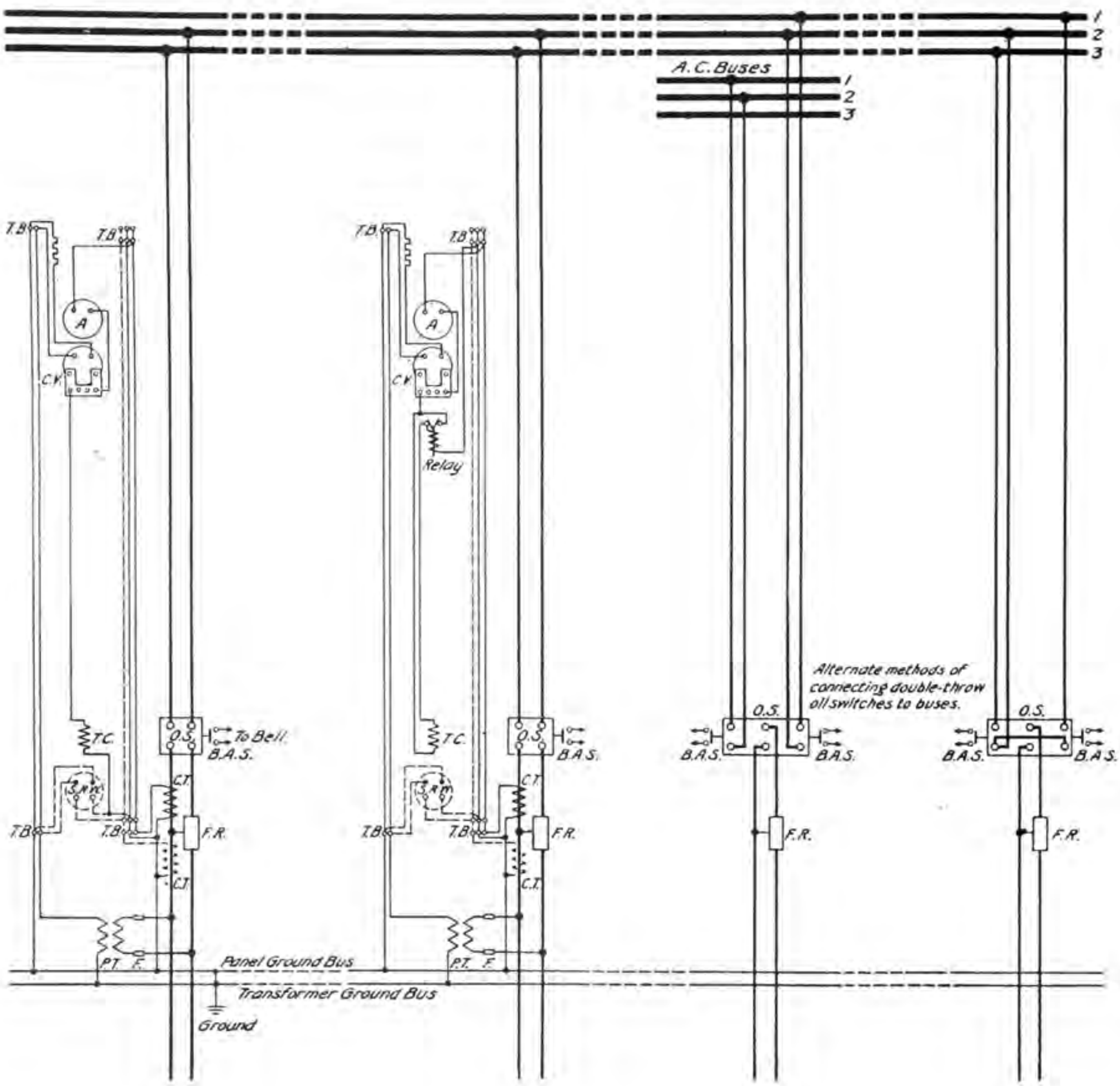
AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-former	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	109631	109646
10	15	109632	109647
12	15	109633	109648
16	20	109634	109649
20	30	109635	109650
25	30	109636	109651
30	40	109637	109652
40	60	109638	109653
50	60	109639	109654
65	80	109640	109655
80	100	109641	109656
100	150	109642	109657
125	150	109643	109658
160	200	109644	109659
200	300	109645	109660

SINGLE-CIRCUIT
SINGLE-PHASE FEEDER PANELS
With Hand Operated Feeder Regulators

2300 VOLTS—60 CYCLES
8 TO 200 AMPERES

WITH OIL SWITCHES D.P.S.T. AND D.P.D.T.
- Mounted on Back of Panel
- Remote Control, Mounted on Pipe Framework

DIAGRAMS OF CONNECTIONS

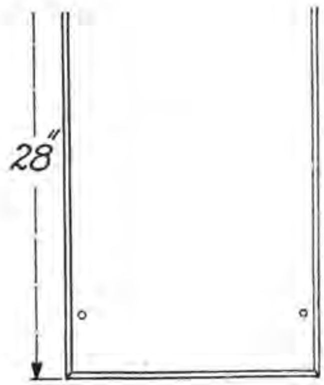


KEY TO SYMBOLS

A =Ammeter.
B.A.S. =Bell alarm switch.
C.T. =Current transformer.
C.V. =Compensated voltmeter.
F =Fuse.
F.R. =Feeder regulator hand controlled (see Bulletin on feeder regulators for connections of motor-operated regulator and control switch).
O.S. =Oil switch.
P.T. =Potential transformer.
S.R.W. =Single-phase watthour meter (dotted lines indicate extra wiring and transformer required when S.R.W. is used).
T.B. =Terminal board for secondary leads from current and potential transformers.
T.C. =Trip coil on oil switch.

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If panels with D.T. oil switches are ordered, state whether the switch is to be connected for transferring the feeder to either of two phases of a single set of buses or to either of two sets of buses. See wirings on preceding page.
3. Avoid ordering *panels of larger capacity than necessary* for present requirements, for reasons given under "Rating of Feeder Panels."
4. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
5. If *Voltage* or *Frequency* is other than listed, see General Information.
6. Lightning Arresters are not included with these panels.



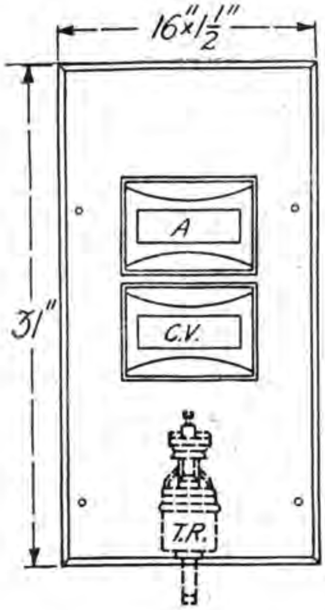
One current transformer......amp.

One 50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformer	
8	10	109695
10	15	109696
12	15	109697
16	20	109698
20	30	109699
25	30	109700
30	40	109701
40	60	109702
50	60	109703
65	80	109704
80	100	109705
100	150	109706
125	150	109707
160	200	109708
200	300	109709

EQUIPMENT

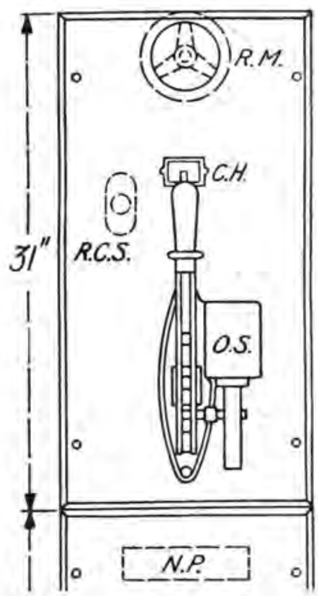


A = H.E. A.C. ammeter with........amp. scale.

C.V. = H.E. compensated voltmeter with 175 volt scale (compensated for ohmic drop only).

T.R. (optional) = S.P. time limit overload relay. (T.R. is moved 1¾ in. to the left when R.M. is used on the middle section.)

AMP. CAPACITY		CAT. NO.	
Panel	A	Without T.R.	With T.R.
8	10	109661	109676
10	12	109662	109677
12	15	109663	109678
16	20	109664	109679
20	25	109665	109680
25	30	109666	109681
30	40	109667	109682
40	50	109668	109683
50	60	109669	109684
65	80	109670	109685
80	100	109671	109686
100	120	109672	109687
125	150	109673	109688
160	200	109674	109689
200	250	109675	109690



R.M. (optional) = Chain operating mechanism for feeder regulator.

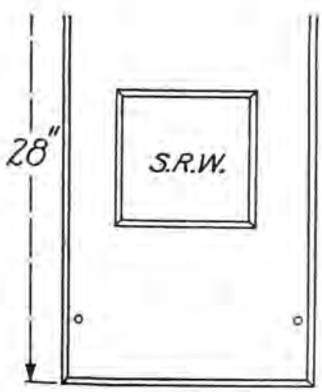
R.C.S. (optional) = D.P.D.T. control switch for electrically operated feeder regulator.

C.H. = Card holder.

O.S. = D.P.S.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. On Back of Panel	O.S. Remote Control
WITH R.M. FOR REGULATOR			
8–200	200	109691	109693
WITH R.C.S. FOR REGULATOR			
8–200	200	109692	109694



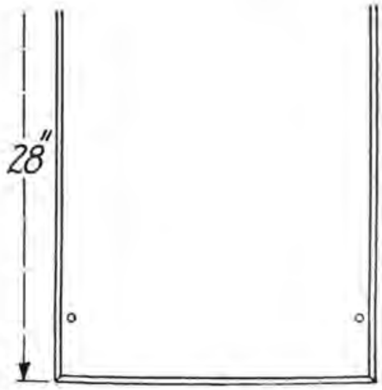
S.R.W. = Single-phase watt-hour meter, IS-2 with metal cover (or IS-3 with glass cover).

Two current transformers......amp.

One 50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-formers	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	109710	109725
10	15	109711	109726
12	15	109712	109727
16	20	109713	109728
20	30	109714	109729
25	30	109715	109730
30	40	109716	109731
40	60	109717	109732
50	60	109718	109733
65	80	109719	109734
80	100	109720	109735
100	150	109721	109736
125	150	109722	109737
160	200	109723	109738
200	300	109724	109739



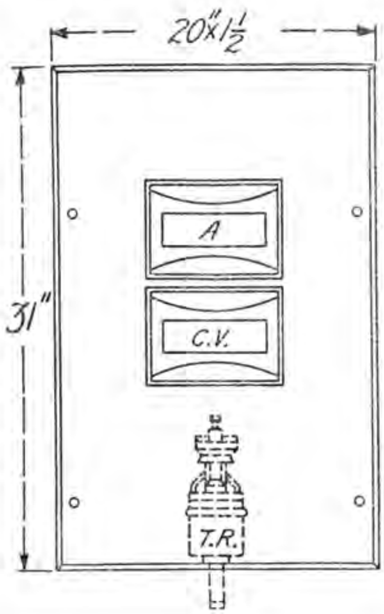
One current transformer......amp.

One 50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformer	
8	10	109774
10	15	109775
12	15	109776
16	20	109777
20	30	109778
25	30	109779
30	40	109780
40	60	109781
50	60	109782
65	80	109783
80	100	109784
100	150	109785
125	150	109786
160	200	109787
200	300	109788

EQUIPMENT



A = H.E. A.C. ammeter with ....amp. scale.

C.V. = H.E. compensated voltmeter with 175 volt scale (compensated for ohmic drop only).

T.R. (optional) = S.P. time limit overload relay. (**T.R.** is moved $1\frac{3}{8}$ in. to the left when **R.M.** is used on the middle section.)

AMP. CAPACITY		CAT. NO.	
Panel	A	Without T.R.	With T.R.
8	10	109740	109755
10	12	109741	109756
12	15	109742	109757
16	20	109743	109758
20	25	109744	109759
25	30	109745	109760
30	40	109746	109761
40	50	109747	109762
50	60	109748	109763
65	80	109749	109764
80	100	109750	109765
100	120	109751	109766
125	150	109752	109767
160	200	109753	109768
200	250	109754	109769

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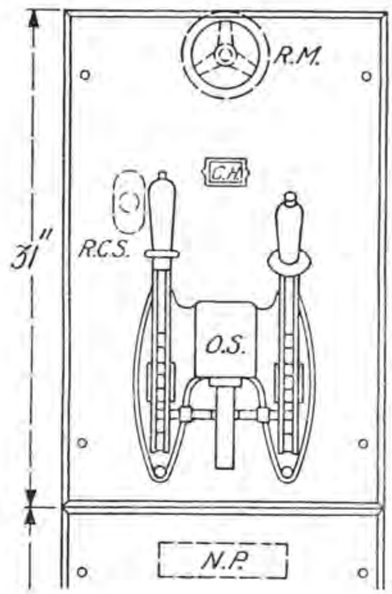


R.M. (optional) = Chain operating mechanism for feeder regulator.

R.C.S. (optional) = D.P.D.T. control switch for electrically operated feeder regulator.

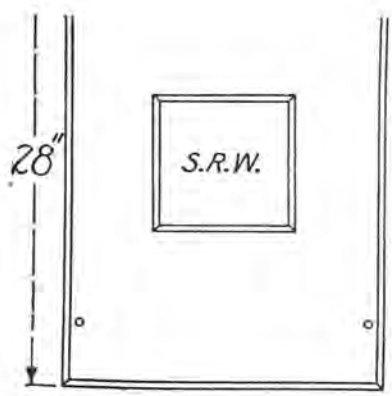
C.H. = Card holder.

O.S. = D.P.D.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
WITH R.M. FOR REGULATOR			
8-200	200	109770	109772
WITH R.C.S. FOR REGULATOR			
8-200	200	109771	109773

Page 38B



S.R.W. = Single-phase watt-hour meter, IS-2 with metal cover (or IS-3 with glass cover).

Two current transformers......amp.

One 50 watt 2200-1100/110 volt 60/125 cycle potential transformer and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

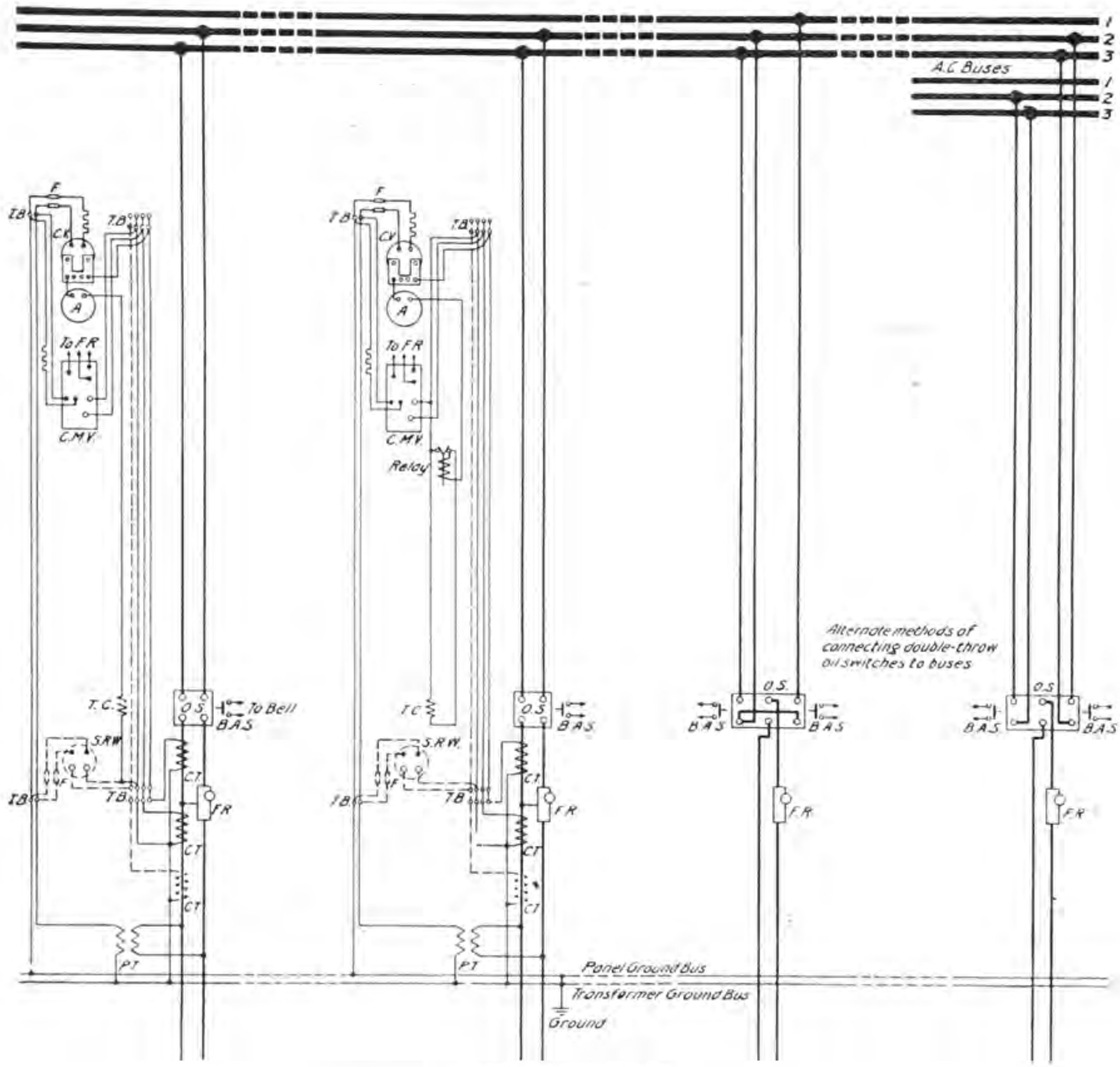
AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-formers	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	109789	109804
10	15	109790	109805
12	15	109791	109806
16	20	109792	109807
20	30	109793	109808
25	30	109794	109809
30	40	109795	109810
40	60	109796	109811
50	60	109797	109812
65	80	109798	109813
80	100	109799	109814
100	150	109800	109815
125	150	109801	109816
160	200	109802	109817
200	300	109803	109818

SINGLE-CIRCUIT
SINGLE-PHASE FEEDER PANELS
With Automatic Feeder Regulators

2300 VOLTS—60 CYCLES
8 TO 200 AMPERES

WITH OIL SWITCHES D.P.S.T. AND D.P.D.T.	Mounted on back of panel Remote control, mounted on pipe framework

DIAGRAMS OF CONNECTIONS

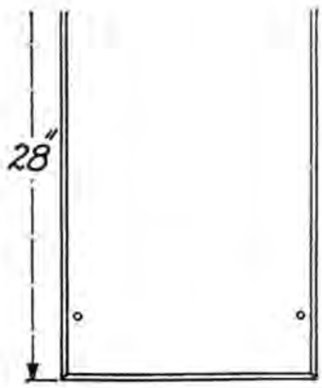


KEY TO SYMBOLS

A	=Ammeter.
B.A.S.	=Bell alarm switch
C.T.	=Current transformer.
C.V.	=Compensated voltmeter.
C.M.V.	=Contact making voltmeter.
F	=Fuse.
F.R.	=Automatic feeder regulator (see bulletin on feeder regulators for connections between **C.M.V.** and **F.R.**).
O.S.	=Oil switch.
P.T.	=Potential transformer.
S.R.W.	=Single-phase watthour meter (dotted lines indicate extra wiring and transformer required when **S.R.W.** is used).
T.B.	=Terminal board for secondary leads from current and potential transformers.
T.C.	=Trip coil on oil switch.

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If panels with D.T. oil switches are ordered, state whether the switch is to be connected for transferring the feeder to either of two phases of a single set of buses or to either of two sets of buses. See wirings on preceding page.
3. Avoid ordering *panels of larger capacity than necessary* for present requirements, for reasons given under "Rating of Feeder Panels."
4. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
5. If *Voltage* or *Frequency* is other than listed, see General Information.
6. Lightning Arresters are not included with these panels.

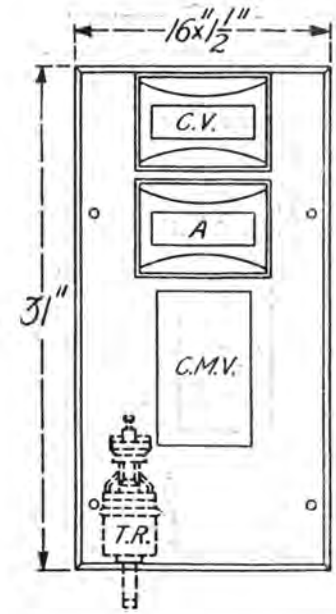


One current transformer......amp.

Mounting only for *one* current transformer and *one* 200 watt potential transformer which are supplied with the contact making voltmeter.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformer	
8	10	109849
10	15	109850
12	15	109851
16	20	109852
20	30	109853
25	30	109854
30	40	109855
40	60	109856
50	60	109857
65	80	109858
80	100	109859
100	150	109860
125	150	109861
160	200	109862
200	300	109863



EQUIPMENT

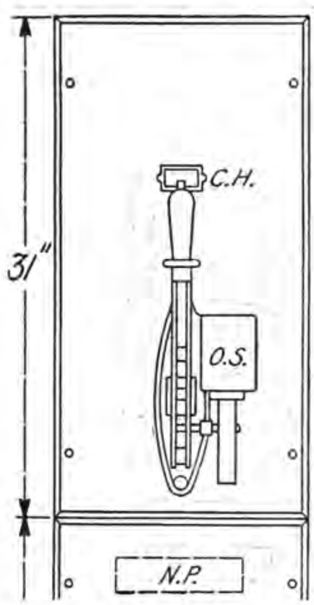
C.V. = H.E. compensated voltmeter with 175 volt scale (compensated for ohmic drop only).

A. = H.E. A.C. ammeter with......amp. scale.

C.M.V. = *Drilling* and *mounting only* for contact making voltmeter (C.M.V. together with *one* current transformer and *one* 200 watt potential transformer are furnished with the automatic regulator).

T.R. (optional) = S.P. time limit overload relay.

AMP. CAPACITY		CAT. NO.	
Panel	A	Without T.R.	With T.R.
8	10	109819	109834
10	12	109820	109835
12	15	109821	109836
16	20	109822	109837
20	25	109823	109838
25	30	109824	109839
30	40	109825	109840
40	50	109826	109841
50	60	109827	109842
65	80	109828	109843
80	100	109829	109844
100	120	109830	109845
125	150	109831	109846
160	200	109832	109847
200	250	109833	109848



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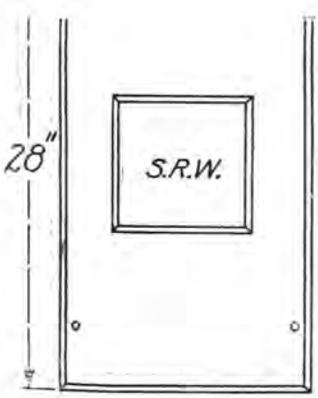
C.H. = Card holder.

O.S. = D.P.S.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. On Back of Panel	O.S. Remote Control
8–200	200	109894	109895



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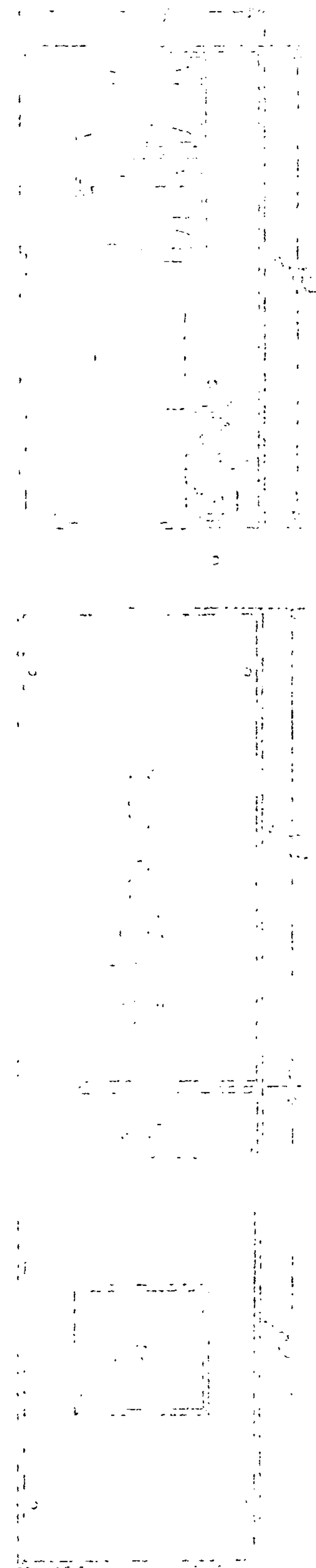
S.R.W. = Single-phase watt-hour meter, IS-2 with metal cover (or IS-3 with glass cover).

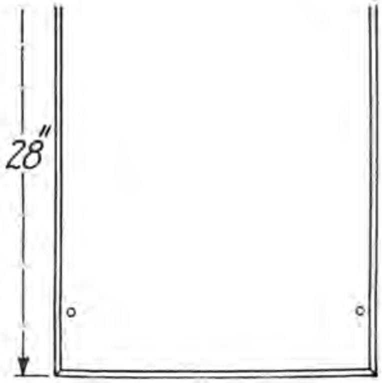
Two current transformers .....amp.

Mounting only for *one* current tramsformer and *one* 200 watt potential transformer which are supplied with the contact making voltmeter.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-formers	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	109864	109879
10	15	109865	109880
12	15	109866	109881
16	20	109867	109882
20	30	109868	109883
25	30	109869	109884
30	40	109870	109885
40	60	109871	109886
50	60	109872	109887
65	80	109873	109888
80	100	109874	109889
100	150	109875	109890
125	150	109876	109891
160	200	109877	109892
200	300	109878	109893



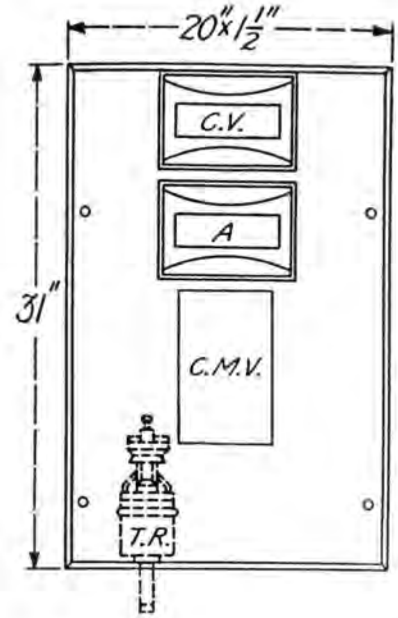


One current transformer......amp.

Mounting only for *one* current transformer and *one* 200 watt potential transformer which are supplied with the contact making voltmeter.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformer	
8	10	110132
10	15	110133
12	15	110134
16	20	110135
20	30	110136
25	30	110137
30	40	110138
40	60	110139
50	60	110140
65	80	110141
80	100	110142
100	150	110143
125	150	110144
160	200	110145
200	300	110146



EQUIPMENT

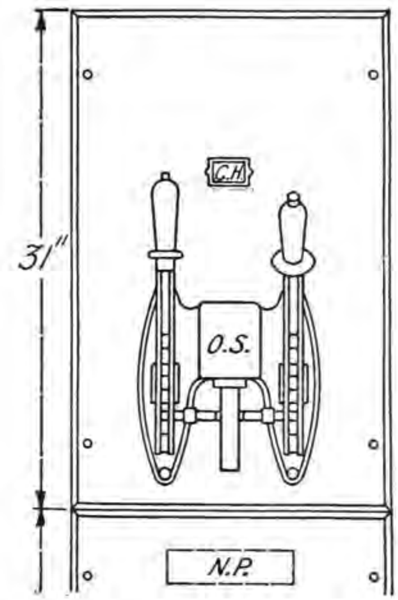
C.V. = H.E. Compensated voltmeter with 175 volt scale (compensated for ohmic drop only).

A = H.E. A.C. ammeter with........amp. scale.

C.M.V. = *Drilling* and *mounting only* for contact making voltmeter (C.M.V. together with *one* current transformer and *one* 200 watt potential transformer are furnished with the automatic regulator).

T.R. (optional) = S.P. time limit overload relay.

AMP. CAPACITY		CAT. NO.	
Panel	A	Without T.R.	With T.R.
8	10	110100	110115
10	12	110101	110116
12	15	110102	110117
16	20	110103	110118
20	25	110104	110119
25	30	110105	110120
30	40	110106	110121
40	50	110107	110122
50	60	110108	110123
65	80	110109	110124
80	100	110110	110125
100	120	110111	110126
125	150	110112	110127
160	200	110113	110128
200	250	110114	110129

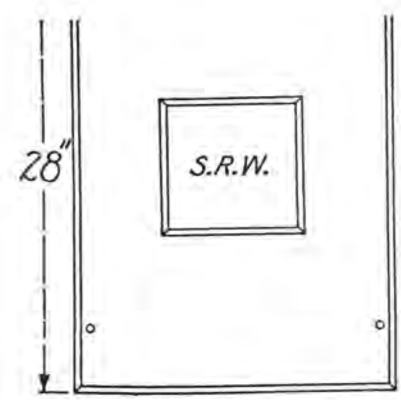


C.H = Card holder.

O.S. = D.P.D.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. On Back of Panel	O.S. Remote Control
8-200	200	110130	110131



S.R.W. = Single-phase watt-hour meter, IS-2 with metal cover (or IS-3 with glass cover).

Two current transformers......amp.

Mounting only for *one* current transformer and *one* 200 watt potential transformer which are supplied with the contact making voltmeter.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		CAT. NO.	
Panel	Current Trans-formers	With IS-2 S.R.W.	With IS-3 S.R.W.
8	10	110147	110162
10	15	110148	110163
12	15	110149	110164
16	20	110150	110165
20	30	110151	110166
25	30	110152	110167
30	40	110153	110168
40	60	110154	110169
50	60	110155	110170
65	80	110156	110171
80	100	110157	110172
100	150	110158	110173
125	150	110159	110174
160	200	110160	110175
200	300	110161	110176

DOUBLE-CIRCUIT
SINGLE-PHASE FEEDER PANELS
Without Feeder Regulators and
With Hand Operated Feeder Regulators

2300 VOLTS—60 CYCLES
8 TO 200 AMPERES PER CIRCUIT

WITH T.P.S.T. OIL SWITCHES { Mounted on back of panel
Remote control, mounted on pipe framework

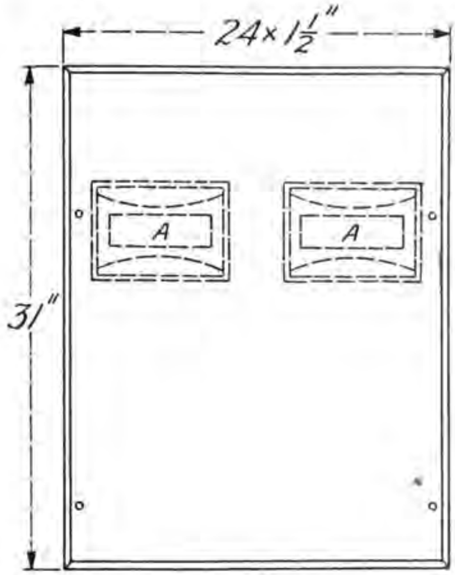
NOTE

The panels listed are for controlling two circuits of equal capacity, the panel rating being the total ampere capacity of the two circuits. If so ordered, any panel will be furnished with an equipment suitable for two circuits of different capacities providing the ampere capacity of either circuit does not exceed 200 amperes.

For diagrams of connections see those for single-circuit panels.

Without Regulators ....Page 26

With Hand Operated Regulators......Page 34

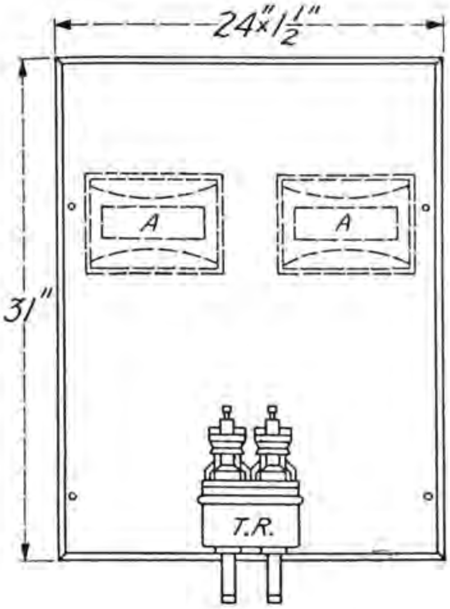


EQUIPMENT

A (optional) = *Two* H.E. A.C. ammeters with ...... amp. scales.

These Sections cannot be used with
Middle Sections, page 50A
Bottom Sections, page 50B

AMP. CAPACITY		CAT. NO.	
Panel	A	Blank	With A
16	10	110177	110179
20	12		110180
24	15		110181
32	20		110182
40	25		110183
50	30		110184
60	40		110185
80	50		110186
100	60		110187
130	80		110188
160	100		110189
200	120		110190
250	150		110191
320	200		110192
400	250		110193



EQUIPMENT

A (optional) = *Two* H.E. A.C. ammeters with ...... amp. scales.

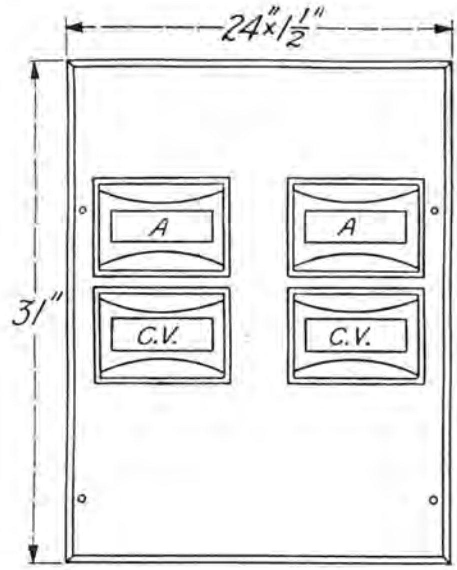
T.R. = D.P. time limit overload relay (used as equivalent of two S.P. relays).

These Sections cannot be used with
Middle Sections, page 50A
Bottom Sections, page 50B

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
16	10	110178	110194
20	12		110195
24	15		110196
32	20		110197
40	25		110198
50	30		110199
60	40		110200
80	50		110201
100	60		110202
130	80		110203
160	100		110204
200	120		110205
250	150		110206
320	200		110207
400	250		110208

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If panels with D.T. oil switches are ordered, state whether the switch is to be connected for transferring the feeder to either of two phases of a single set of buses or to either of two sets of buses. See wirings for single circuit panels.
3. Avoid ordering *panels of larger capacity than necessary* for present requirements, for reasons given under "Rating of Feeder Panels."
4. Always consider carefully the question of "Oil Switch Rupturing Capacity" in order to determine if panels are suitable for future as well as present requirements.
5. If *Voltage* or *Frequency* is other than listed, see General Information.
6. Lightning Arresters are not included with these panels.



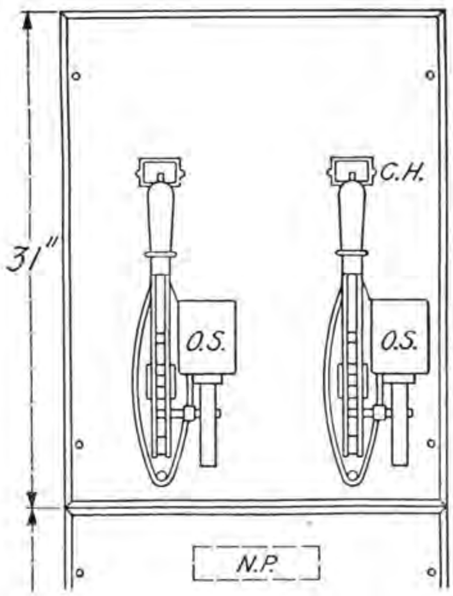
EQUIPMENT

These Sections cannot be used with Middle Sections, page 49A Bottom Sections, page 49B

A = *Two* H.E. A.C. ammeters with .... amp. scales.

C.V. = *Two* H.E. compensated voltmeters with 175 volt scales (compensated for ohmic drop only).

AMP. CAPACITY		Cat. No.
Panel	A	
16	10	110209
20	12	110210
24	15	110211
32	20	110212
40	25	110213
50	30	110214
60	40	110215
80	50	110216
100	60	110217
130	80	110218
160	100	110219
200	120	110220
250	150	110221
320	200	110222
400	250	110223

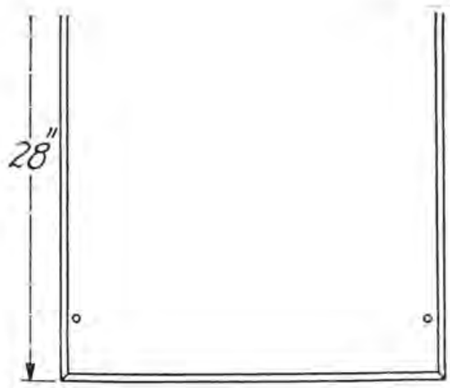


C.H. = *Two* card holders.

O.S. = *Two* D.P.S.T. 200 amp. automatic K-5 oil switches mounted on back of panel (or on pipe framework remote from panel) with operating mechanisms and bell alarm switches.

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
16–400	200	110239	110240

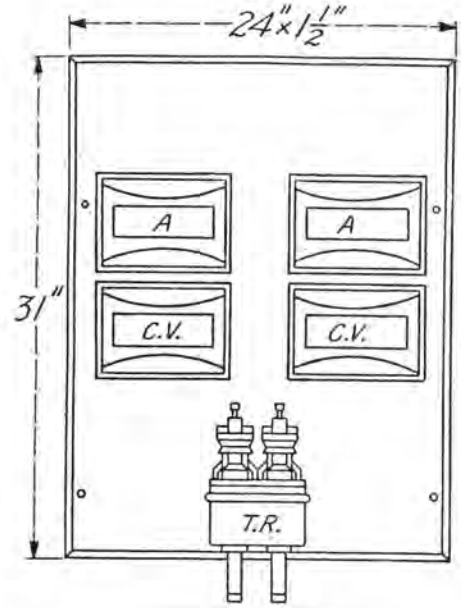
N.P. = Name plate (on only one panel in a complete switchboard).



Two current transformers ...... amp.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
16	10	110245
20	15	110246
24	15	110247
32	20	110248
40	30	110249
50	30	110250
60	40	110251
80	60	110252
100	60	110253
130	80	110254
160	100	110255
200	150	110256
250	150	110257
320	200	110258
400	300	110259



EQUIPMENT

These Sections cannot be used with
Middle Sections, page 49A
Bottom Sections, page 49B

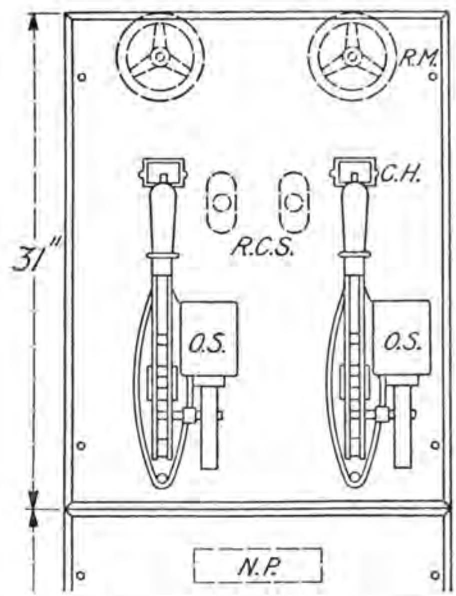
A = *Two* H.E. A.C. ammeters with .... amp. scales.

C.V. = *Two* H.E. compensated voltmeters with 175 volt scales (compensated for ohmic drop only).

T.R. = D.P. time limit overload relay (used as equivalent of two S.P. relays).

AMP. CAPACITY		Cat. No
Panel	A	
16	10	110224
20	12	110225
24	15	110226
32	20	110227
40	25	110228
50	30	110229
60	40	110230
80	50	110231
100	60	110232
130	80	110233
160	100	110234
200	120	110235
250	150	110236
320	200	110237
400	250	110238

Page 50A



R.M. (optional) = *Two* chain operating mechanisms for feeder regulators.

R.C.S. (optional) = *Two* D.P.D.T. control switches for electrically operated feeder regulators.

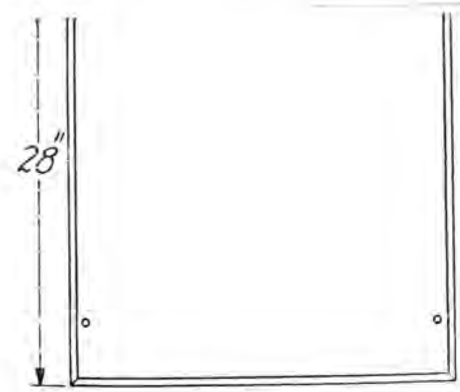
C.H. = *Two* card holders.

O.S. = *Two* D.P.S.T. 200 amp. automatic K-5 oil switches mounted on back of panel (or on pipe framework remote from panel) with operating mechanisms and bell alarm switches.

N.P. = Name plate (on only one panel in a complete switchboard.

AMP. CAPACITY		CAT. NO.	
Panel	O.S.	O.S. on Back of Panel	O.S. Remote Control
WITH R.M. FOR REGULATOR			
16–400	200	110241	110243
WITH R.C.S. FOR REGULATOR			
16–400	200	110242	110244

Page 50B



Two current transformers......amp.

Two 50 watt 2200–1100/110 volt 60/125 cycle potential transformers and fuses.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
16	10	110260
20	15	110261
24	15	110262
32	20	110263
40	30	110264
50	30	110265
60	40	110266
80	60	110267
100	60	110268
130	80	110269
160	100	110270
200	150	110271
250	150	110272
320	200	110273
400	300	110274

TA REGULATOR PANELS
For Forms L & K Regulators

2300 VOLTS—60 CYCLES

DIAGRAMS OF CONNECTIONS

These connections are representative and apply only for the conditions shown. **The connections differ so** what depending upon the number of exciters with which a regulator is used.

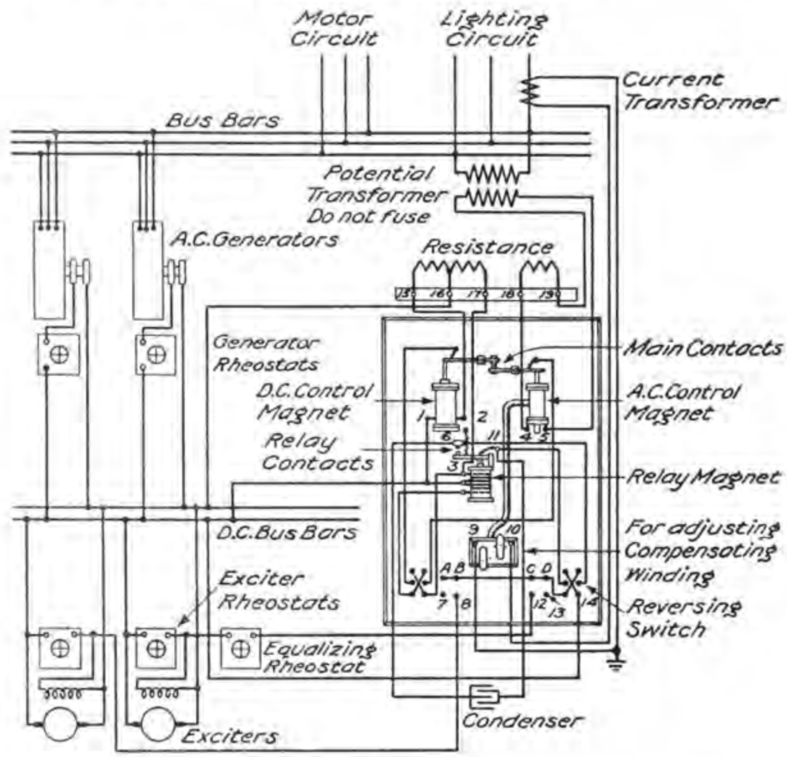


Fig. 1
Type TA Form L Regulator with two exciters and several generators

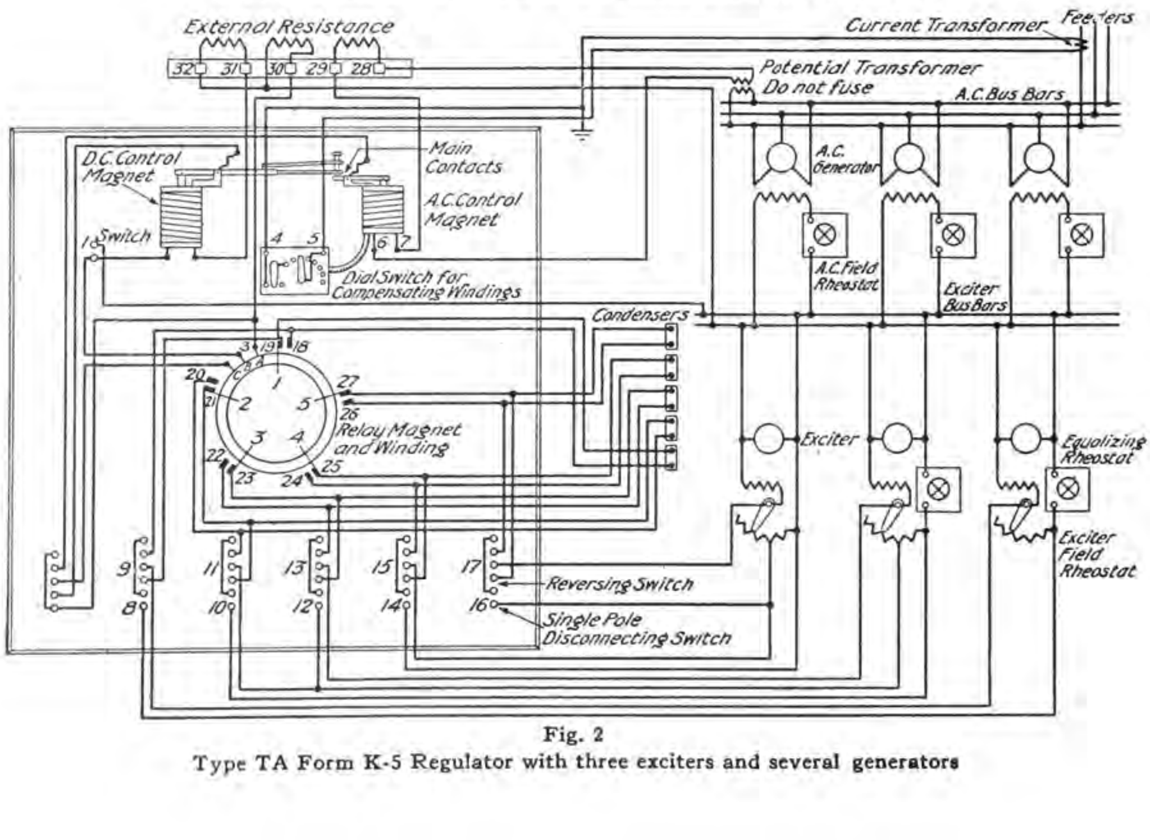
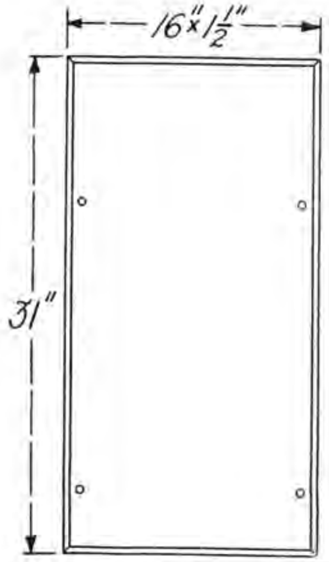


Fig. 2
Type TA Form K-5 Regulator with three exciters and several generators

EQUIPMENT



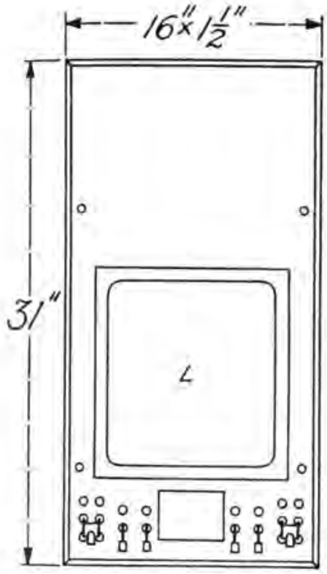
Blank Top Section

Cat. No. 110275

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If *Voltage* or *Frequency* is other than listed, see General Information.
3. Regulator equipments as listed are intended for maintaining *constant bus voltage.* A current transformer is required if the regulator is to be *compounded* and suitable transformers are listed on page 64. When ordering always state where current transformer is to be connected.
4. When TA Regulators are used, provision should be made for *paralleling exciters.* Separate panels for exciter control are therefore necessary.

EQUIPMENT

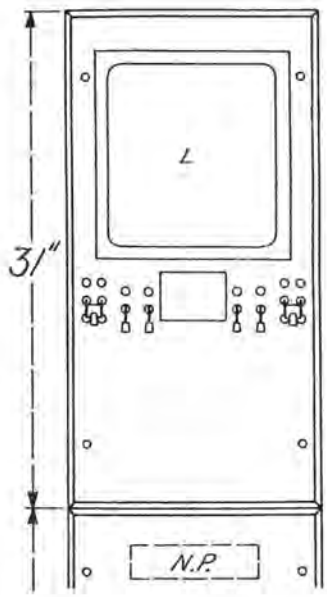


L = Drilling and mounting only for *one* TA regulator Form L.

One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer. **Cat. No. 110276**

Regulator, equalizer rheostats, condensers, or compensator, are not included.

Page 54A



L = Drilling and mounting only for *one* TA regulator Form L.

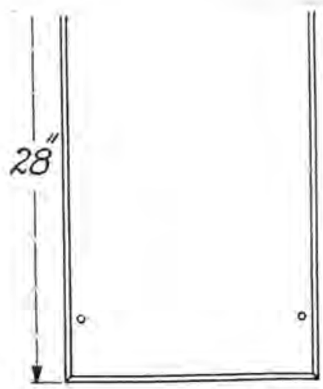
One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Cat. No. 110278

Regulator, equalizer rheostats, condensers, or compensator **are not included.**

N.P. = Name plate (on only one panel in a complete switchboard).

Page 54B

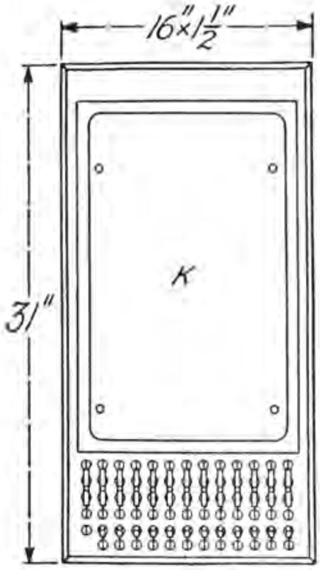


Blank Bottom Section

When A.C. or exciter bus bars extend across panel they must be ordered separately; see "Bus Bar Copper." **Cat. No. 110280**

Current transformer for regulator must be ordered separately; see page 53A, paragraph 3.

EQUIPMENT



This Section cannot be used for regulators larger than K-12.

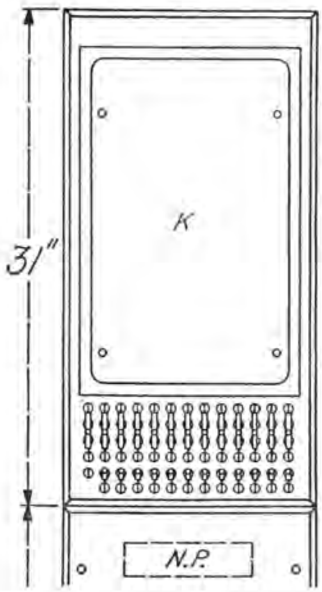
K = Drilling and mounting only for *one* TA regulator Form K.

One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Cat. No. 110277

Regulator, equalizer rheostats, condensers, or compensator **are not included.**

Page 55A



K = Drilling and mounting only for *one* TA regulator Form K.

This Section cannot be used for regulators larger than K-12.

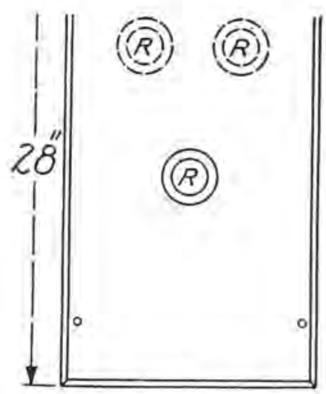
One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Cat. No. 110279

Regulator, equalizer rheostats, condensers, or compensator **are not included.**

N.P. = Name plate (on only one panel in a complete switchboard).

Page 55B



R = Handwheels and mounting for *one, two* or *three* equalizer rheostats.

For *one* equalizer rheostat.
Cat. No. 110281

When A.C. or exciter bus bars extend across panel they must be ordered separately; see "Bus Bar Copper."

For *two* equalizer rheostats.
Cat. No. 110282

Current transformer for regulator must be ordered separately; see page 53A, paragraph 3.

For *three* equalizer rheostats.
Cat. No. 110283

COMBINATION TA REGULATOR AND THREE-PHASE EXCITER MOTOR PANELS

For Forms L & K Regulators

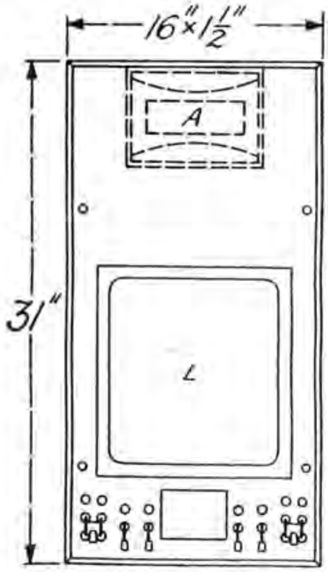
2300 VOLTS—60 CYCLES
8 TO 200 AMPERES

WITH OIL SWITCHES T.P.S.T. AND T.P.D.T. { Mounted on back of panel
Remote control, mounted on pipe framework

DIAGRAMS OF CONNECTIONS

For T.A. Regulators see......page 52

For Induction Motor see......page 14



EQUIPMENT

A(optional) = H.E. A.C. ammeter with ......amp. scale.

L = Drilling and mounting only for *one* TA regulator Form L.

One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Regulator, equalizer rheostat, condensers or compensator are not included

Equalizer rheostats, when required, must be mounted on exciter panels.

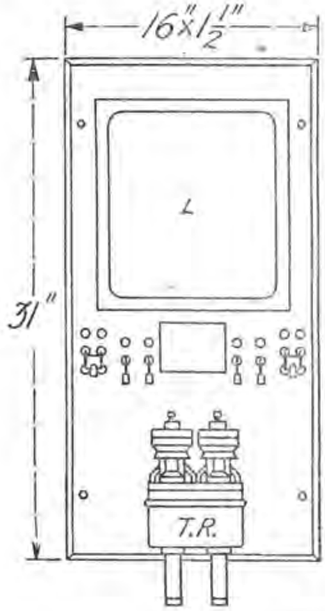
These Sections cannot be used with Middle Sections, page 60A

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10	110284	110285
10	12		110286
12	15		110287
16	20		110288
20	25		110289
25	30		110290
30	40		110291
40	50		110292
50	60		110293
65	80		110294
80	100		110295
100	120		110296
125	150		110297
160	200		110298
200	250		110299

IMPORTANT—NOTE BEFORE ORDERING

1. Do not forget "Information which should accompany orders"—see page 4.
2. If *Voltage* or *Frequency* is other than listed, see General Information.
3. Regulator equipments as listed are intended for maintaining *constant bus voltage*. A current transformer is required if the regulator is to be *compounded* and suitable transformers are listed on page 64. When ordering always state where current transformer is to be connected.
4. When TA Regulators are used, provision should be made for *paralleling exciters*. Separate panels for exciter control are therefore necessary.
5. See General Information for method of determining ampere capacity of panel required for a given motor.

These panels cannot be used with any motors which require a controller or starting equipment mounted on the panel; for instance, those Form K motors which do not have self-contained starting compensators.



EQUIPMENT

L = Drilling and mounting only for *one* TA regulator Form L.

One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

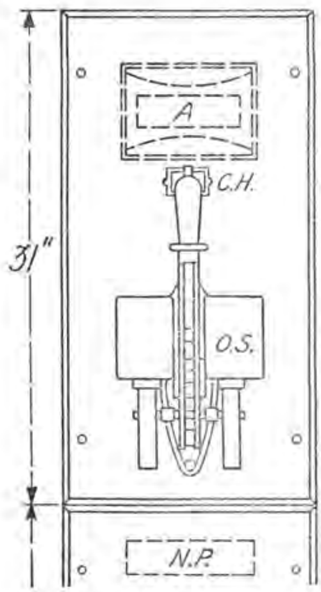
Regulator, equalizer rheostat, condensers, or compensator **are not included.**

Equalizer rheostats, when required, must be mounted on exciter panels.

T.R. = D.P. time limit overload relay.

This Section cannot be used with Middle Sections, page 59A

Cat. No. 110300



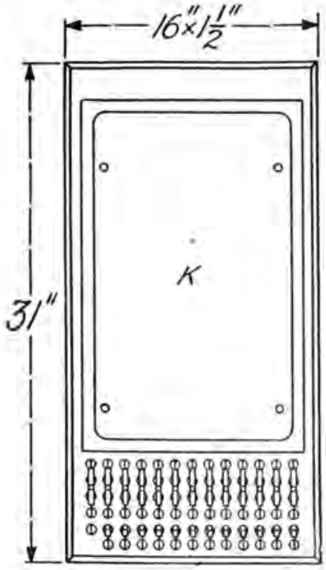
A (optional) = H.E. A.C. ammeter with...... amp. scale.

C.H. = Card holder.

O.S. = T.P.S.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAP.		CAT. NO.			
		Without A		With A	
Panel	A	O.S. on Back of Panel	O.S. Remote Control	O.S. on Back of Panel	O.S. Remote Control
8	10	110334	110350	110335	110351
10	12			110336	110352
12	15			110337	110353
16	20			110338	110354
20	25			110339	110355
25	30			110340	110356
30	40			110341	110357
40	50			110342	110358
50	60			110343	110359
65	80			110344	110360
80	100			110345	110361
100	120			110346	110362
125	150			110347	110363
160	200			110348	110364
200	250			110349	110365



EQUIPMENT

This Section cannot be used with regulators larger than K-12 Middle Sections, page 60A

K = Drilling and mounting only for *one* TA regulator Form K.

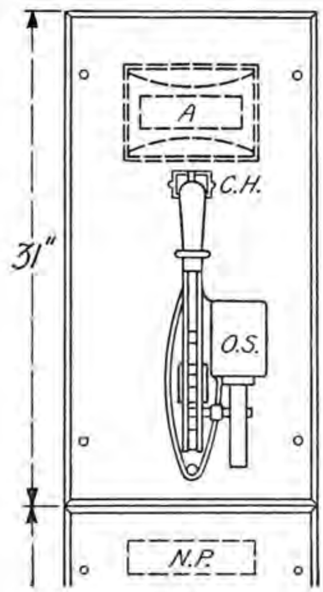
One 200 watt 2200–1100/110 volt 60/125 cycle potential transformer.

Cat. No. 110301

Regulator, equalizer rheostat, condensers, or compensator are not included.

Equalizer rheostats, when required, must be mounted on exciter panels.

Page 60A



A (optional) = H.E. A.C. ammeter with ......amp. scale.

C.H. = Card holder.

O.S. = T.P.S.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAP.		CAT. NO.			
		Without A		With A	
Panel	A	O.S. on Back of Panel	O.S. Remote Control	O.S. on Back of Panel	O.S. Remote Control
8	10	110302	110318	110303	110319
10	12			110304	110320
12	15			110305	110321
16	20			110306	110322
20	25			110307	110323
25	30			110308	110324
30	40			110309	110325
40	50			110310	110326
50	60			110311	110327
65	80			110312	110328
80	100			110313	110329
100	120			110314	110330
125	150			110315	110331
160	200			110316	110332
200	250			110317	110333

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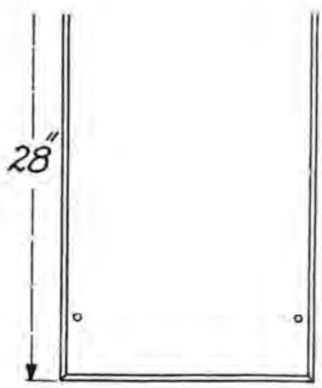
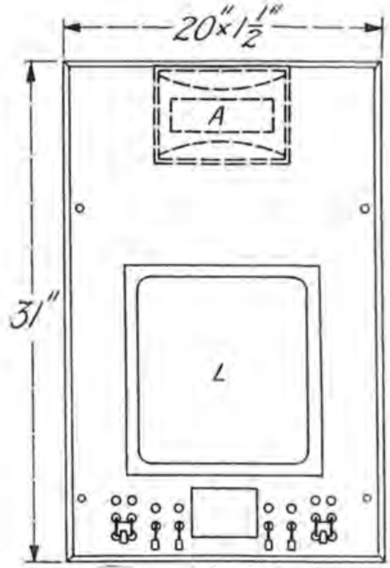


Two current transformers......amp. (for ammeter and oil switch only).

Current transformer for regulator must be ordered separately—see page 58A, paragraph 3.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
8	10	110366
10	15	110367
12	15	110368
16	20	110369
20	30	110370
25	30	110371
30	40	110372
40	60	110373
50	60	110374
65	80	110375
80	100	110376
100	150	110377
125	150	110378
160	200	110379
200	300	110380



EQUIPMENT

A (optional) – H.E. A.C. ammeter with ...... amp. scale.

L – Drilling and mounting only for *one* TA regulator Form L.

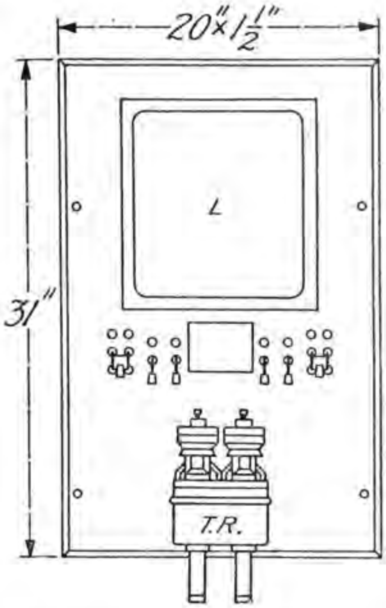
One 200 watt 2200–1100/110 volt 60/125 cycle potential transformer.

Regulator, equalizer rheostat, condensers, or compensator are not included.

Equalizer rheostats, when required, must be mounted on exciter panels.

This Section cannot be used with Middle Sections, page 63A

AMP. CAPACITY		CAT. NO.	
Panel	A	Without A	With A
8	10	110381	110382
10	12		110383
12	15		110384
16	20		110385
20	25		110386
25	30		110387
30	40		110388
40	50		110389
50	60		110390
65	80		110391
80	100		110392
100	120		110393
125	150		110394
160	200		110395
200	250		110396



EQUIPMENT

This Section cannot be used with Middle Sections, page 62A

L = Drilling and mounting only for *one* TA regulator Form L.

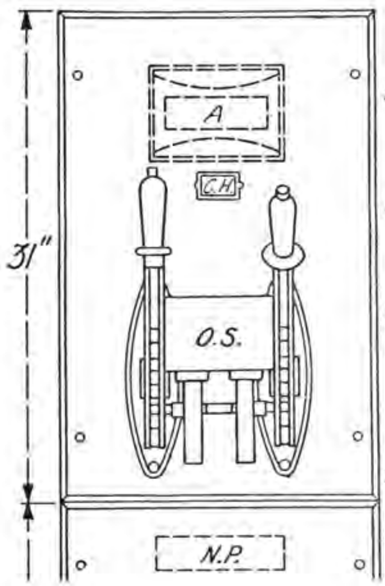
One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Regulator, equalizer rheostat, condensers, or compensator are not included.

Equalizer rheostats, when required, must be mounted on exciter panels.

T.R. = D.P. time limit overload relay.

Cat. No. 110397



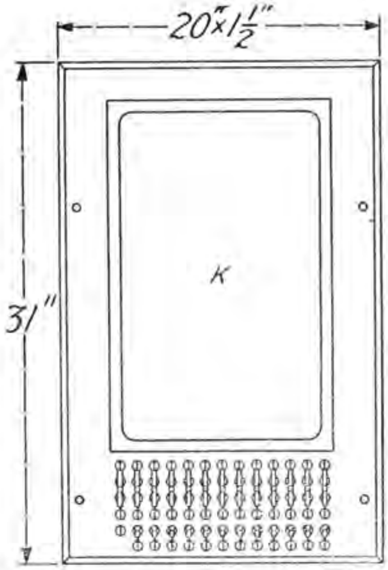
A (optional) = H.E. A.C. ammeter with ...... amp. scale.

C.H. = Card holder.

O.S. = T.P.D.T. 200 amp. automatic K-5 oil switch mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAP.		CAT. NO.			
		Without A		With A	
Panel	A	O.S. on Back of Panel	O.S. Remote Control	O.S. on Back of Panel	O.S. Remote Control
8	10	110399	110415	110400	110416
10	12			110401	110417
12	15			110402	110418
16	20			110403	110419
20	25			110404	110420
25	30			110405	110421
30	40			110406	110422
40	50			110407	110423
50	60			110408	110424
65	80			110409	110425
80	100			110410	110426
100	120			110411	110427
125	150			110412	110428
160	200			110413	110429
200	250			110414	110430



EQUIPMENT

This Section cannot be used with regulators larger than K-12 Middle Sections, page 63A

K = Drilling and mounting only for *one* TA regulator Form K.

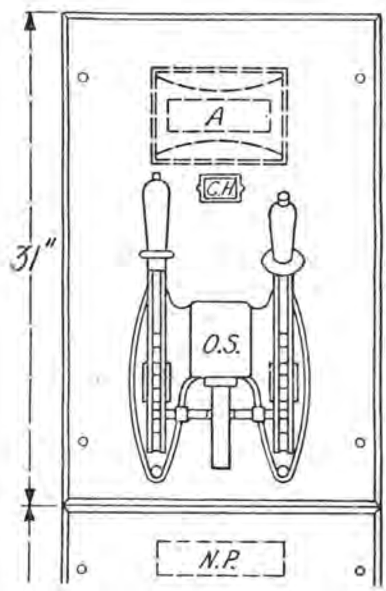
One 200 watt 2200-1100/110 volt 60/125 cycle potential transformer.

Cat. No. 110398

Regulator, equalizer rheostat, condensers, or compensator are not included.

Equalizer rheostats, when required, must be mounted on exciter panels.

Page 63A



A (optional) = H.E. A.C. ammeter with ......amp. scale.

C.H. = Card holder.

O.S. = T.P.D.T. 200 amp. automatic K-5 oil switch, mounted on back of panel (or on pipe framework remote from panel) with operating mechanism and bell alarm switch.

N.P. = Name plate (on only one panel in a complete switchboard).

AMP. CAP.		CAT. NO.			
		Without A		With A	
Panel	A	O.S. on Back of Panel	O.S. Remote Control	O.S. on Back of Panel	O.S. Remote Control
8	10			110432	110448
10	12			110433	110449
12	15			110434	110450
16	20			110435	110451
20	25			110436	110452
25	30			110437	110453
30	40			110438	110454
40	50	110431	110447	110439	110455
50	60			110440	110456
65	80			110441	110457
80	100			110442	110458
100	120			110443	110459
125	150			110444	110460
160	200			110445	110461
200	250			110446	110462

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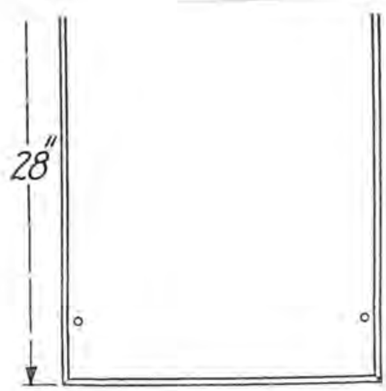

Two current transformers......amp. (for ammeter and oil switch only).

Current transformer for regulator must be ordered separately—see page 58A, paragraph 3.

Bus Bars must be ordered separately; see "Bus Bar Copper."

AMP. CAPACITY		Cat. No.
Panel	Current Transformers	
8	10	110463
10	15	110464
12	15	110465
16	20	110466
20	30	110467
25	30	110468
30	40	110469
40	60	110470
50	60	110471
65	80	110472
80	100	110473
100	150	110474
125	150	110475
160	200	110476
200	300	110477

CURRENT TRANSFORMERS FOR TA REGULATORS

Cat. No.	Ampere Capacity	Ratio	Cat. No.	Ampere Capacity	Ratio
41251	5	1 : 1	41260	150	30 : 1
41252	10	2 : 1	41261	200	40 : 1
41253	15	3 : 1	41262	300	60 : 1
41254	20	4 : 1	41263	400	80 : 1
41255	30	6 : 1	41264	600	120 : 1
41256	40	8 : 1	108053	800	160 : 1
41257	60	12 : 1	41300	1000	200 : 1
41258	80	16 : 1	41301	1500	300 : 1
41259	100	20 · 1	41302	2000	400 : 1

When ordering state whether the current transformer is to be connected in the bus bars to regulate for total generator output or in a particular feeder. circuit.

BUS BAR COPPER

Bus bars must be ordered separately for each panel as per the following sample order:
Item No. 1—*One* three-phase generator panel,
Top Section Cat. No............ A.C. Buses Cat. No............
Middle Section Cat. No............ Exciter Buses Cat. No............
Bottom Section Cat. No............

If the *total current* supplied to a bus by all panels in the board *does not exceed 625 amperes*, bus bars may at once be chosen from the following tables since the ampere capacity of bus required for any panel will be within the minimum limit catalogued. For all other cases the method described on the following page is recommended as a simple means of determining the ampere capacity of bus required.

A.C. BUSES

For One Set of Three-Phase Buses				For Two Sets of Three-Phase Buses			
Ampere Capacity of Bus Required	CAT. NOS.			Ampere Capacity of Bus Required	CAT. NOS.		
	For Panel 16 In. Wide	For Panel 20 In. Wide	For Panel 24 In. Wide		For Panel 16 In. Wide	For Panel 20 In. Wide	For Panel 24 In. Wide
1 to 625	110478	110481	110484	1 to 625	110487	110490	110493
626 to 1250	110479	110482	110485	626 to 1250	110488	110491	110494
1251 to 1875	110480	110483	110486	1251 to 1875	110489	110492	110495

EXCITER BUSES

Ampere Capacity of Bus Required	CAT. NOS.		
	For Panel 16 In. Wide	For Panel 20 In. Wide	For Panel 24 In. Wide
1 to 625	110496	110499	110502
626 to 1250	110497	110500	110503
1251 to 1875	110498	110501	110504

The Cat. Nos. of A.C. Buses cover bare copper bars. If so specified with the order, 0000 B.&S. insulated wire may be substituted when the bus capacity for any panel in the entire switchboard does not exceed 260 amperes. Such substitution should never be made if future extensions are contemplated which will make the ultimate bus capacity for any panel greater than 260 amperes.

The Cat. Nos. of Exciter Buses cover one positive and one negative bus and should not be used with exciter panels for which an equalizer bus is required. Exciter panels and buses for same are listed in S 413.

A SIMPLE METHOD OF DETERMINING BUS CAPACITY

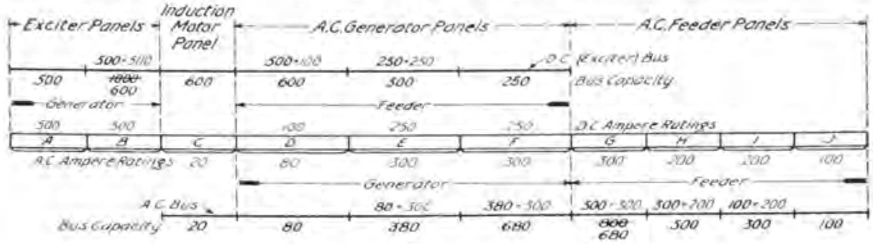

Fig. 1

Fig. 1 illustrates a simple diagrammatical method of determining the ampere capacity of bus required for any panel. The method is as follows:

1—Make a rough plan of the *entire board*, regardless of the number of panels to be ordered.

The Order of Panels shown is recommended, it being most economical of copper and best adapted to future extensions.

2—To avoid confusion keep on one side of board everything pertaining to exciter buses, and on other side everything pertaining to A.C. buses.

3—With single lines represent the exciter and A.C. buses across such panels as they actually extend and by means of arrows indicate that portion of each bus which is connected to feeders and that portion which is connected to generators. **Remember that "Generator" and "Feeder" arrows must always point toward each other,** otherwise the rules given below do not hold. Note also that the field circuits of A.C. generator panels are treated as D.C. feeders for the exciter bus.

4—On each panel mark its ampere rating, *i.e.*, the maximum current it supplies to or takes from the bus. For A.C. generator panels the D.C. rating is the excitation of the machines.

5—Apply the following rules *consecutively*, and note their application in Fig. 1. (For the sake of clearness ampere ratings are shown in light face type and bus capacities in bold face type.)

(a) **Always begin with the tail of the arrow and treat "Generator" and "Feeder" sections of the bus separately.**

(b) **Bus capacity for first panel = Ampere rating of panel.**

(c) **Bus capacity for each succeeding panel = Ampere rating of panel** *plus* **bus capacity for preceding panel.** (See sums marked above the buses in Fig. 1.)

(d) **For a panel not connected to a bus extending across it, use the smaller value of the bus capacities already obtained for the two adjoining panels.** (See exciter bus for panel C.)

(e) **The bus capacity for any feeder panel need not exceed the maximum for the generator panels** (see A.C. bus for panel G) **and vice versa** (see exciter bus for panel B). Hence the corrections made in values obtained by applying rules (b) and (c).

The arrangement of panels shown in Fig. 1 is the one which is mostly used. The above method may, however, be applied to other arrangements, one of which is shown in Fig. 2. Here the generators must feed both ways to the feeders at either end of the board so that in determining A.C. bus capacities it is necessary to first consider the generators with the feeders at one end, and then with the feeders at the other end as shown by the dotted A.C. buses. The required bus capacities are then obtained by taking the maximum values for the two cases.

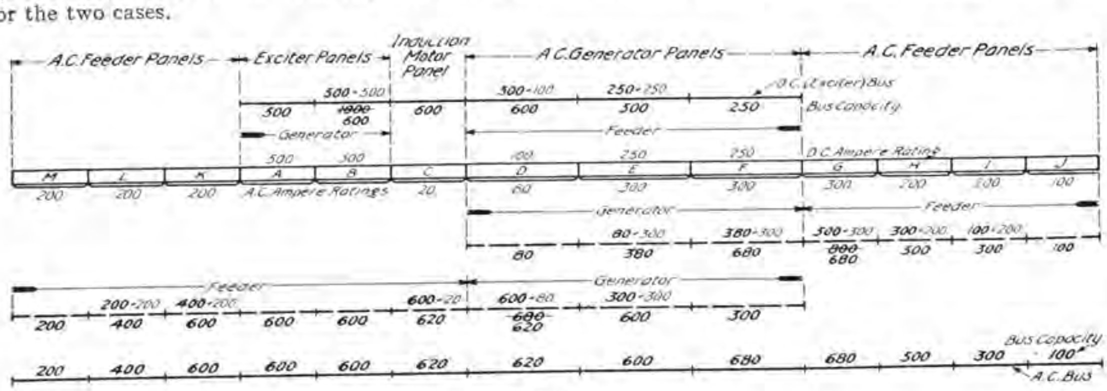

Fig. 2

2300 VOLT A.C. SWITCHBOARD ARRANGEMENTS

Heavy broken lines in the following diagrams (Figs. 3, 4, 5 and 6) show alternate locations for apparatus furnished by the General Electric Company. Light broken lines show material to be furnished by the purchaser.

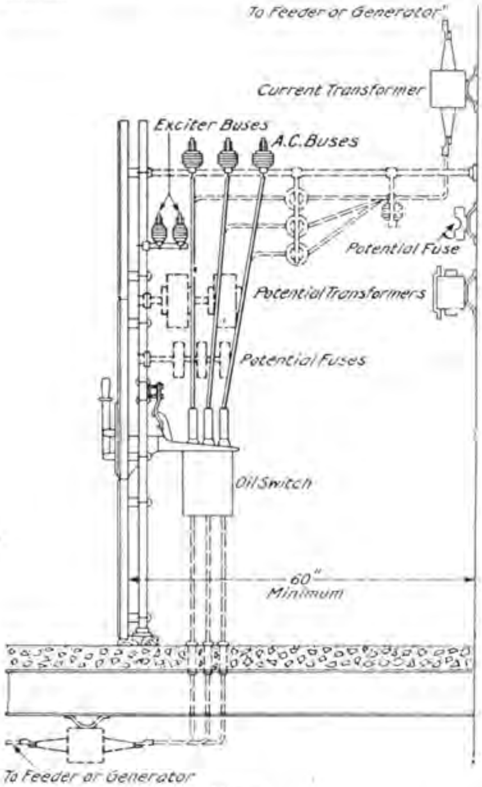

Fig. 3
Single throw oil switch mounted on back of panel

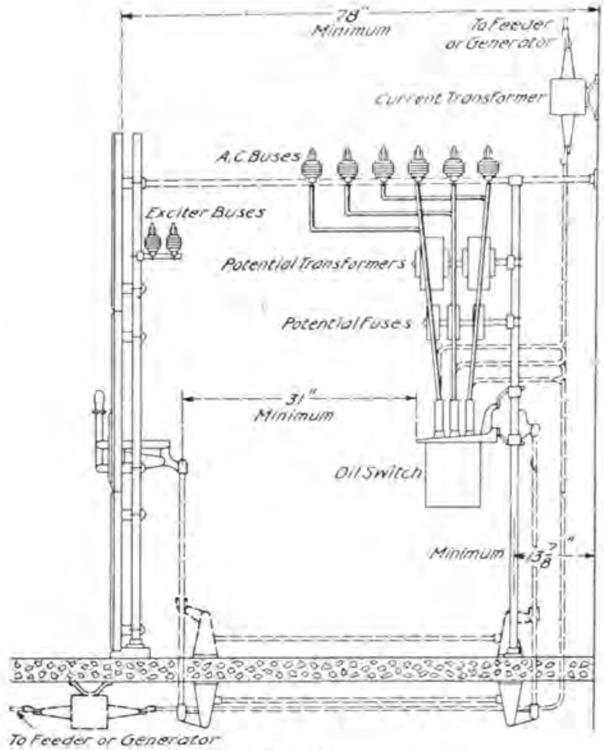

Fig. 4
Single throw remote control oil switch mounted on pipe framework behind switchboard

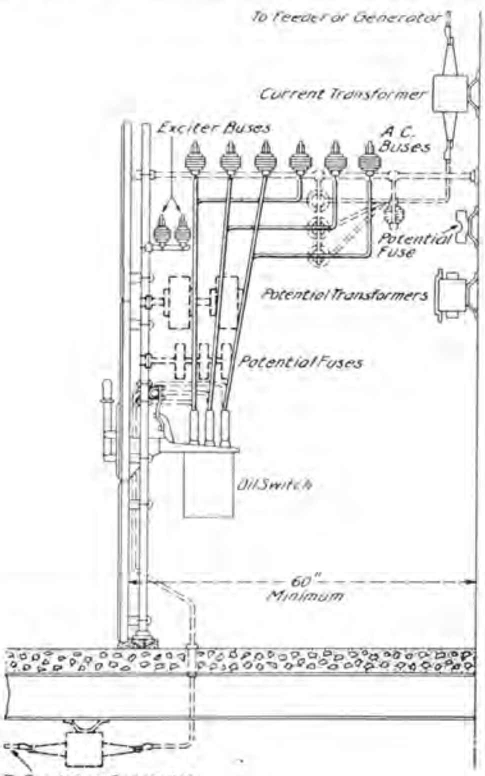

Fig. 5
Double throw oil switch mounted on back of panel

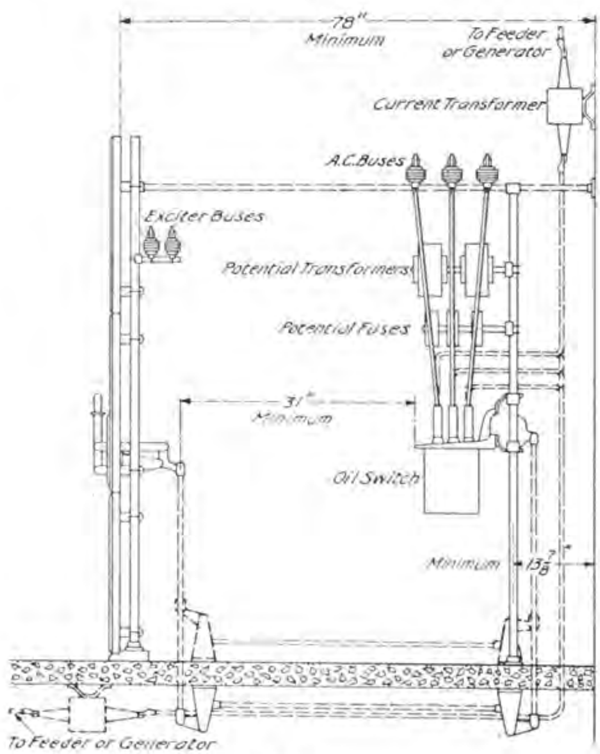

Fig. 6
Double throw remote control oil switch mounted on pipe framework behind switchboard

2300 VOLT A.C. SWITCHBOARD ARRANGEMENTS

Heavy broken lines in the following diagram (Fig. 7) show alternate locations of apparatus furnished by the General Electric Company. Light broken lines show material to be furnished by purchaser.

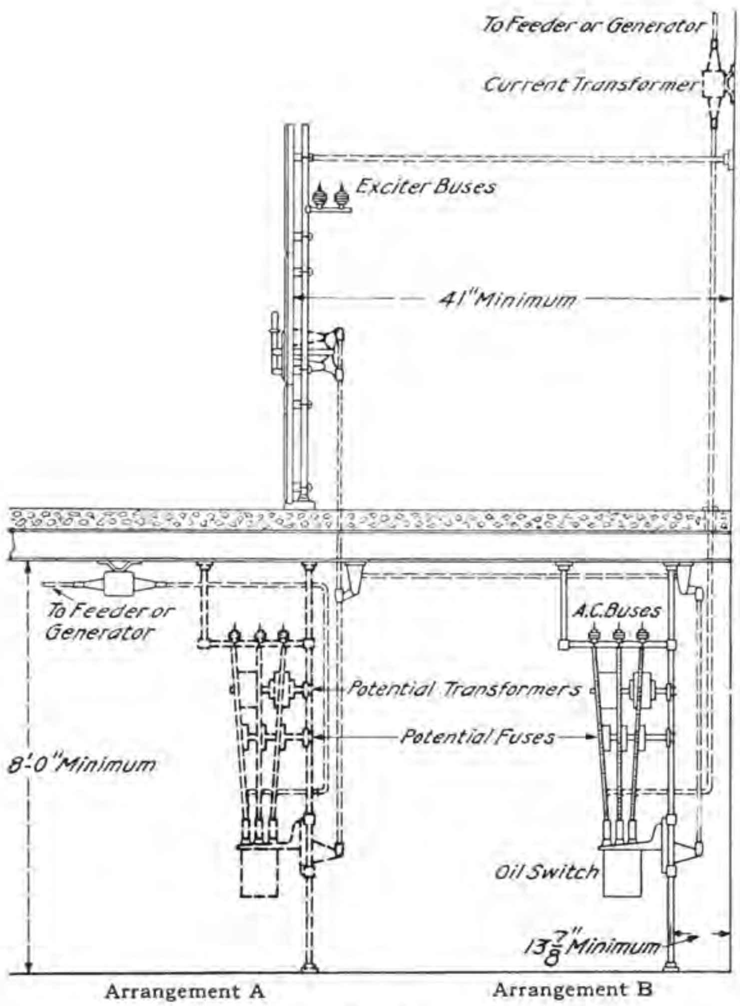

Fig. 7

Single throw remote control oil switch mounted on pipe framework below switchboard

2300 VOLT A.C. SWITCHBOARD ARRANGEMENTS

ALTERNATE LOCATIONS OF GENERATOR FIELD RHEOSTATS

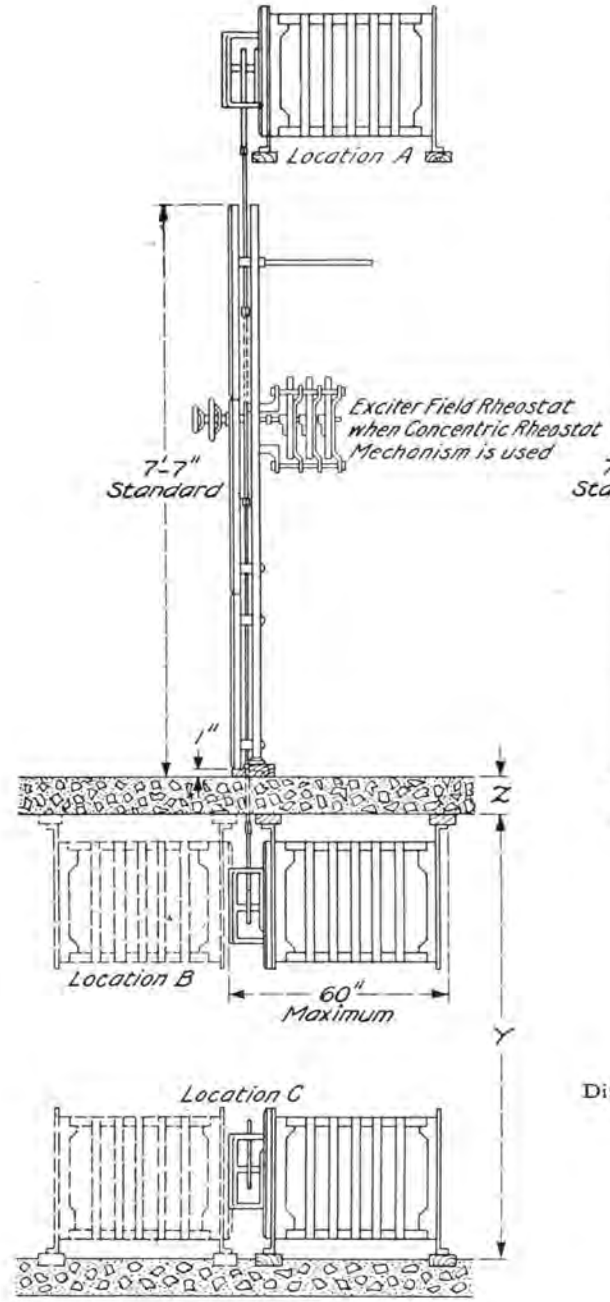

Fig. 8

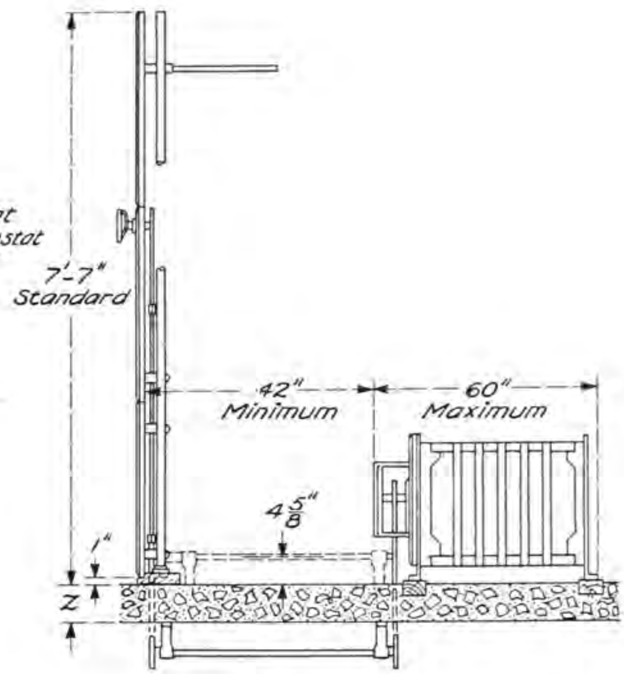

Fig. 9

Dimensions Y and Z should be given with the order

2300 VOLT A.C. SWITCHBOARD ARRANGEMENTS

ALTERNATE LOCATIONS OF CHAIN OPERATED FEEDER REGULATORS

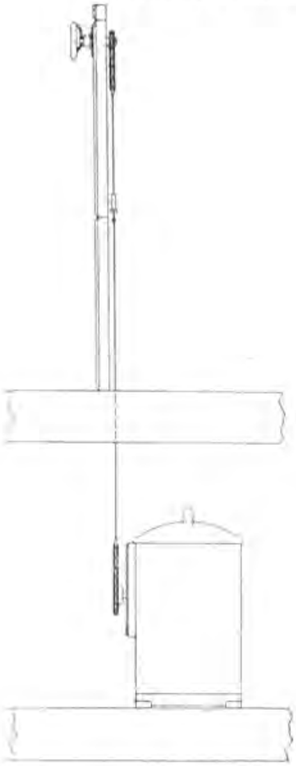

Fig. 10

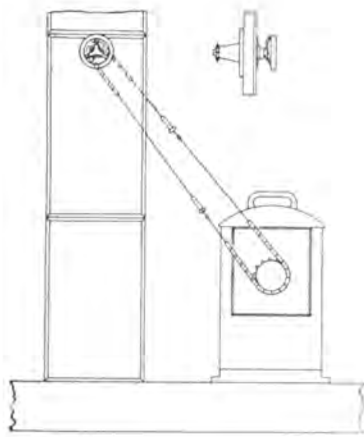

Fig. 11

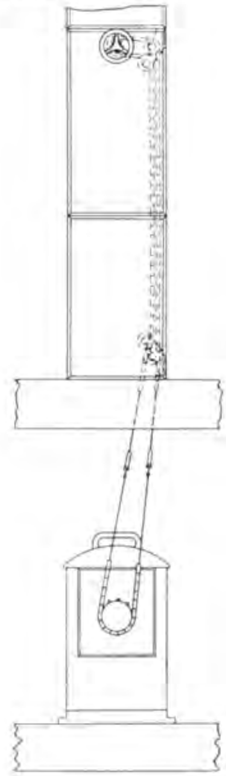

Fig. 12

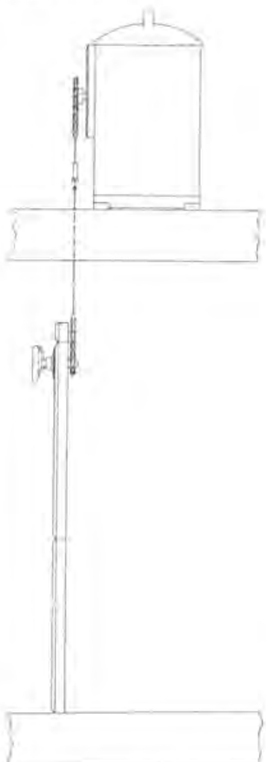

Fig. 13

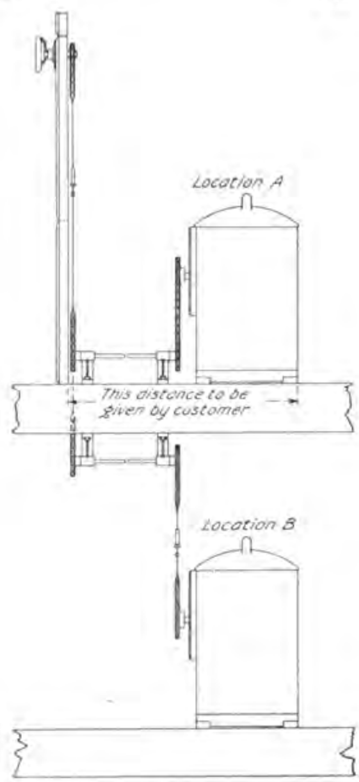

Fig. 14

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:
(Address nearest office.)

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 30 Church Street.
SYRACUSE, N. Y., Post-Standard Building.
BUFFALO, N. Y., Ellicott Square Building.
NEW HAVEN, CONN., Malley Building.
PHILADELPHIA, PA., Witherspoon Building.
BALTIMORE, MD., Electrical Building.
CHARLOTTE, N. C., Trust Building.
CHARLESTON, W. VA., Charleston National Bank Building.
PITTSBURG, PA., Park Building.
RICHMOND, VA., 712 Mutual Building.
ROANOKE, Va., Strickland Building.
ATLANTA, GA., Empire Building.
BIRMINGHAM, ALA., Brown-Marx Building.
MACON, GA., Grand Building.
NEW ORLEANS, LA., Maison-Blanche Building.
CINCINNATI, OHIO, Provident Bank Building.
COLUMBUS, OHIO, Columbus Savings & Trust Building.
CLEVELAND, OHIO, Citizens Building.
CHATTANOOGA, TENN., James Building.
MEMPHIS, TENN., Randolph Building.
NASHVILLE, TENN., Stahlman Building.
INDIANAPOLIS, IND., Traction Terminal Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.)
ST. LOUIS, MO., Wainwright Building.
KANSAS CITY, MO., Dwight Building.
BUTTE, MONTANA, Phœnix Building.
MINNEAPOLIS, MINN., 410-412 Third Avenue, North.
DENVER, COLO., Kittredge Building.
SALT LAKE CITY, UTAH, Newhouse Building.
SAN FRANCISCO, CAL., Union Trust Building.
LOS ANGELES, CAL., Delta Building.
PORTLAND, ORE., Electric Building.
SEATTLE, WASH., Colman Building.
SPOKANE, WASH., Paulsen Building.

For TEXAS and OKLAHOMA Business refer to
General Electric Company of Texas,
Dallas, Tex., Praetorian Building.
El Paso, Tex., Chamber of Commerce Building.
Oklahoma City, Okla., Insurance Building.

FOREIGN:

FOREIGN DEPARTMENT,
Schenectady, N. Y., and 30 Church St., New York, N. Y.
LONDON OFFICE, 83 Cannon St., London, E. C., England.

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.