Westinghouse

Liquid Slip Regulators

INSTRUCTION BOOK

Westinghouse Electric & Manufacturing Company
East Pittsburgh Works East Pittsburgh, Pa.
I. B. 5197

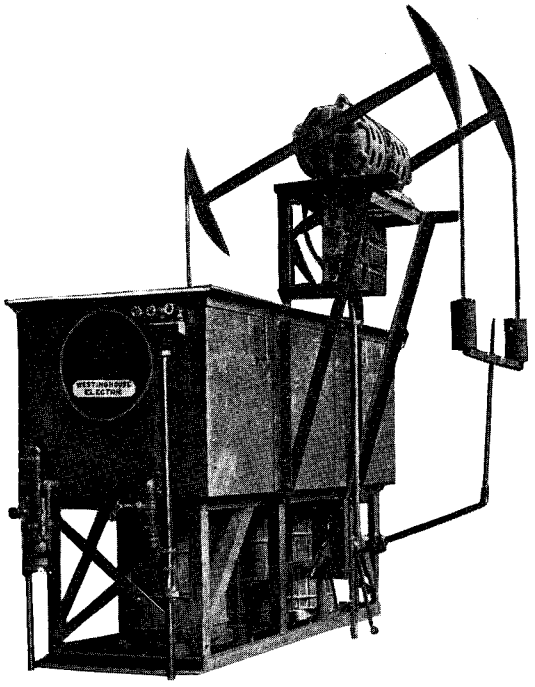


Fig. 1—Size 5 Liquid Slip Regulator with Panel Mounted Hand Reset

Westinghouse

Liquid Slip Regulators

DESCRIPTION

The Westinghouse liquid slip regulator is an automatic controller connected in the secondary circuit of a wound-rotor induction motor to vary the resistance in order to limit the current input to the motor to a predetermined value. By varying the resistance in the secondary of the induction motor, a fly-wheel on the motor shaft can be made to give up the additional energy above the average required on the peak load and absorb energy during the light part of the load cycle. The operation of these regulators is very nicely illustrated by the curves, Figs. 2 and 3.

The liquid regulator is shown in cross section in Fig. 4. It consists of a sheet steel tank to the bottom of which are attached three (3) insulated cells. At the bottom of each cell is a stationary electrode. In the upper part of the tank is located a cooling coil. The three movable electrodes are suspended from two arms on the ends of the torque motor shaft mounted at the top of the tank. The shaft to which these arms are attached is mounted in ball bearing trunnions and the arms are provided with adjustable counterweights. On this shaft is mounted a torque motor consisting of either a single or double wound-rotor induction motor. This motor is supplied with energy from series transformers, as illustrated in Fig. 5. The torque of this motor balances the weight of the electrodes so that at light load the electrodes descend in the liquid and reduce the resistance in the secondary of the motor circuit. This tends to increase the current and establish equilibrium. If the current increases above a fixed value, the torque of the regulating motor increases sufficiently to separate the electrodes. This increases the resistance in the secondary of the main motor and re-establishes equilibrium. Standard series transformers are provided with taps in the secondary, such that the normal 16 amperes for the torque motor (32 amperes for the No. 5 regulator) is obtained with 80 per cent, 100 per cent, 125 per cent or 150 per cent of the full load on the main motor.

A finer adjustment can be made by changing the counter balance weights on the electrode arms.

In case of failure of voltage, an auxiliary arm is released which increases the counterbalance weight and separates the electrodes to their maximum distance apart. This arm is released by a low-voltage magnet. In some

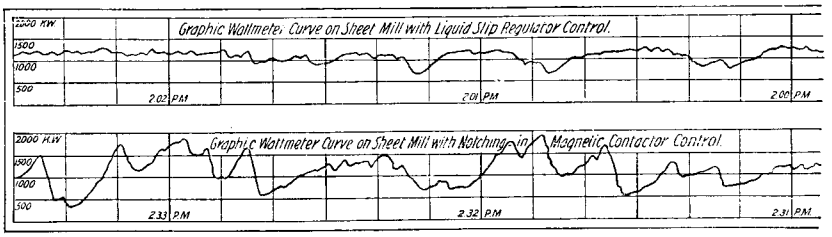


Fig. 2—Curves Showing the Load Conditions on a 1500-Horsepower Sheet-Mill Motor Operated by a Liquid Slip Regulator and by a Notching Relay Magnetic Controller Under Similar Mill Requirements. The Curves Record a Maximum Peak of 1900 Kilowatts for the Magnetic Control and 1300 Kilowatts for the Regulator, and for the Extreme Conditions, the Peak was Reduced from 2400 to 1700 Kilowatts

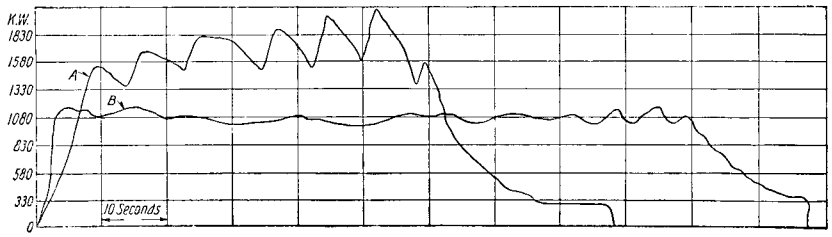


Fig. 3—Curve A Was Taken When Starting a 2000-Horse-Power Plate-Mill Motor With Magnetic Control. Curve B Shows the Same Motor Starting Under Load Operated With a Liquid Regulator

regulators the arm is reset by hand; in others, electro-magnetic means are provided for resetting.

Installation of Regulator—When a regulator is installed, means should be provided for draining the electrolyte out of the regulator for the purpose of investigation and repairs. This can be done most conveniently by providing a pit under the regulator of sufficient capacity to hold all of the electrolyte. Where this is not convenient, barrels or auxiliary tanks should be provided for this purpose and the regulator set high enough above the ground so that it is convenient to use these auxiliary tanks.

The electrolyte, when it is drained off, may either be discharged into a sewer or drain, or it may be pumped back into the regulator. The use of a small electrically-driven pump makes it very easy to place the electrolyte back in the regulator and is recommended wherever it is practicable to install it. Where a pit is provided under the regulator, a connection should be made to the sewer or drain and provided with a valve so that the electrolyte can be readily disposed of when it is not desirable to return it to the regulator.

Provision should be made for cleaning out the regulator when the electrolyte is drained off and also for cleaning out the pit before the electrolyte is placed in it. This can be readily done by an ordinary hose connection.

A tee connection with a valve is provided in the regulator cooling coil so that fresh water can be added to the electrolyte solution to replace that lost by evaporation or steaming. When installed the piping should be arranged so that the circulating water can be turned off and the cooling coils cleaned by the introduction of compressed air. Steam should not be used, since it cakes the scale on the piping instead of blowing it out.

The electrolyte should be drawn off the regulator and a thorough inspection made at regular intervals, depending upon the frequency of service. These inspections should be made at

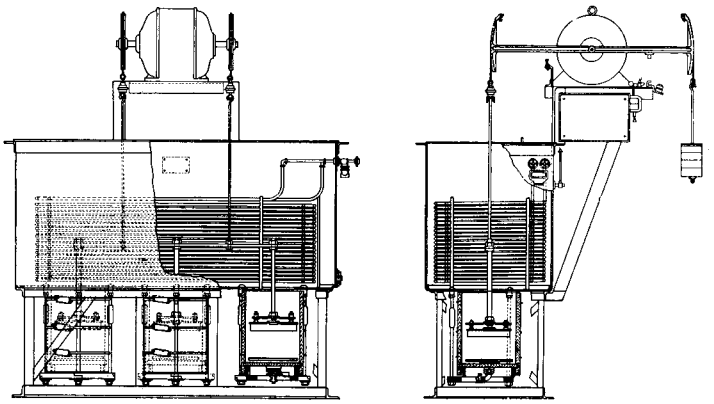


Fig. 4—Cross Section of Liquid Slip Regulator

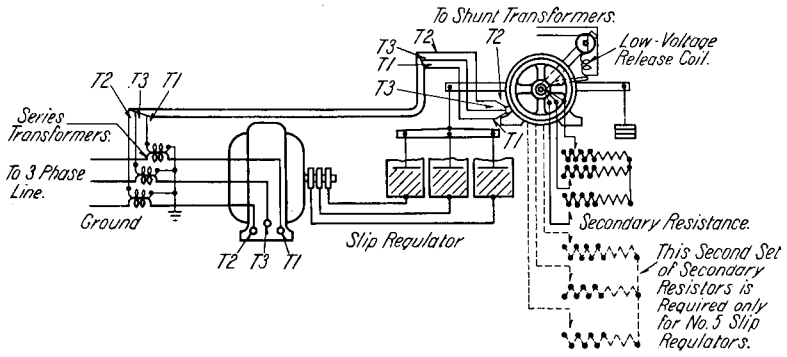


Fig. 5—Diagram of Connections

Note—Shunt transformers for low-voltage release should always be connected across motor terminals. When motor is arranged for reversing, the series transformers must be on the line side of the reversing switch.

least every three months or oftener where the service requirements are severe.

Insulated Cells in Bottom of Regulator—These insulated cells are attached to the bottom of the tank by means of tension rods. A rubber gasket is placed between the top of the cell and the under side of the tank to make a tight joint. This gasket is a rubber tube especially made for this purpose. When a cell is removed a new rubber gasket should be used to insure a satisfactory joint.

If any leakage should occur between staves of wooden cells, the cell should be scraped clean and a heavy coat of asphaltum paint applied.

The stationary electrode is attached to the bottom of the pot or cell in the following manner:

The electrode is screwed and soldered to a hollow metal stud, Fig. 6, which passes through the bottom of the cell and is provided with rubber washers in order to make a tight joint. This stud is held in place by large brass contact nuts which also clamp the motor terminal to the stud. At the bottom of the stud is a drain cock for draining the electrolyte from the cell.

Where it is necessary to replace one of these cells quickly the following procedure may be followed:

With the regulator is supplied an iron plate larger in diameter than the openings in the bottom of the tank, over the cells. Remove the cross bar carrying the moving electrodes, together with the electrodes, and place the plate over the opening in the tank just above the cell which it is desired to remove. A rubber gasket on the under side of the plate insures a tight fit to prevent the electrolyte from leaking when the cell underneath is removed. A new cell can now be substituted, after which the valve in the top of the plate is opened allowing the electrolyte to run into the new cell. This breaks the seal and permits the plate to be easily removed. The regulator should be installed so that room is left on the side opposite the wiring to remove the pots.

The wires from the collector rings on the main motor are attached to the bottom of the cells, one collector ring to each. The conduit for the leads should be brought up at the center, and outside of one side of the regulator. The wires for the torque motor and other attachments on the top of the regulator can be brought in another conduit to the center of the same side of the regulator. This should preferably be on the side on which the torque motor is mounted.

Adjustment of Electrodes—The details of the electrode are shown in Fig. 6. These electrodes are provided with means for adjustment. When the regulator is set up ready for operation, the three movable electrodes should be adjusted to give the same separation between them and the stationary electrodes. Otherwise, the secondary current of the main motor will be unbalanced at small values of slip. The electrodes should be adjusted to come within $\frac{1}{16}$-inch of each other. This can be done as follows: With the electrode arm lowered so that the moving electrodes are in their lowest position, screw the electrodes down by means of the adjusting nuts until they just touch the stationary electrodes. Then by turning the adjusting nuts one complete revolution to the right the moving electrodes will be raised $\frac{1}{16}$-inch from the stationary electrodes.

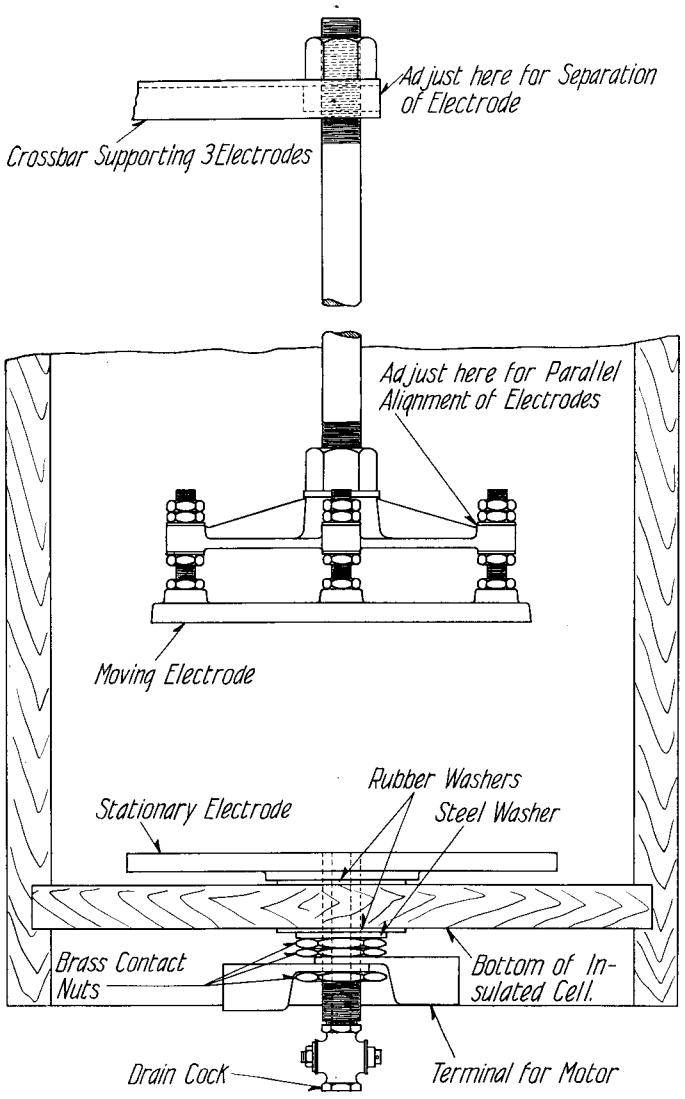


Fig. 6—Cross Section of an Insulated Cell Showing Arrangement of Electrodes

Note—The moving electrode shown is for the No. 5 regulator. The No. 4 regulator is similar in construction to the No. 5. The No. 2 regulator has a smaller electrode and therefore does not need to be adjusted for alignment.

Spare Parts—It is very important to carry a reasonable supply of spare parts for this regulator. The principal item is the insulated cell or pot at the bottom of the regulator. A set of spare cells should be carried complete with the stationary electrode mounted in them. The style numbers of these cells are as follows:

Regulators No.	Wooden Cells Style No.
2	287370-B
4	268382-A
5	287373-A

Electrolyte—The electrolyte is made of a solution of sodium carbonate (Na_2CO_3) using as pure water as is obtainable. The density of this solution should be such that the motor takes 75 per cent of full load current when the primary breaker is closed and the solution is cold, and the electrodes are raised to the maximum position.

Sodium carbonate is obtainable commercially in two forms: Namely, sal soda and soda ash, the difference between these two being in the amount of water of crystallization they contain. Sal soda contains approximately

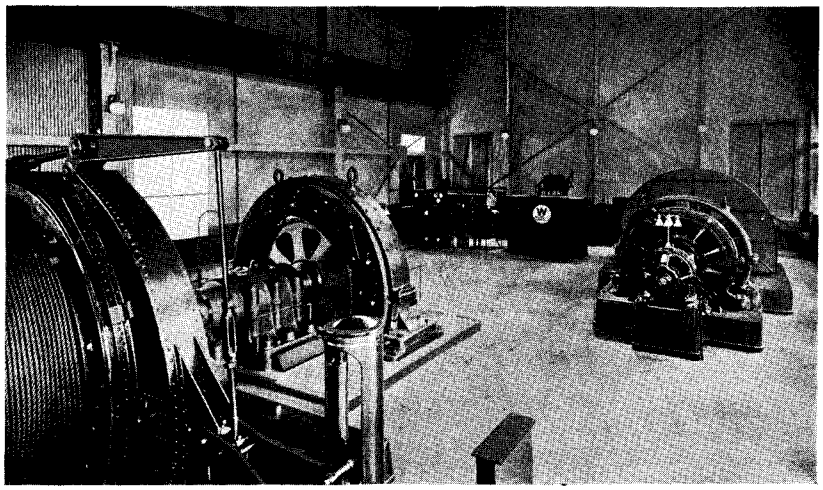


Fig. 7—Liquid Slip Regulator Used in Connection With the Hoisting Equipment at the North Butte Mining Co.

35 per cent to 40 per cent of sodium carbonate (Na_2CO_3) while soda ash contains from 95 per cent to 99 per cent of Na_2CO_3.

To determine the density of solution required: Fill the tank with water to about 6 inches of the top and add ½ to 1 per cent of soda ash or about 1 to 2 per cent of sal soda dissolved in hot water. These percentages are to be taken by weight. That is, add ½ to 1 pound of soda ash to 100 pounds of water. If it is found that the starting current should be larger, more soda should be added. After a 3 per cent solution of sodium carbonate is obtained, further addition of this material will only slightly affect the resistance. The largest variations of resistance are obtained between 0 and 1 per cent solution.

MAXIMUM WATER CAPACITY OF REGULATORS

Regulator No.	Lbs. of Water
2	2500
4	8000
5	19000

Torque Motor—The following points should be observed in connection with the torque motor:

1. Note that all parts move freely throughout the range of travel.

2. All of the resistance as supplied should be connected in the circuit. This is just the right amount of resistance to make the torque motor exert its maximum torque under normal operating conditions. With this resistance connected in the motor circuit, the voltage across the primary of the motors will be 110 volts on 25 cycles, or 250 volts on 60 cycles with the normal 16 amperes in the No. 2 or No. 4 and 32 amperes in the No. 5 regulator flowing through the primary windings.

3. On starting, note that the direction of rotation of the torque motor is such that the electrode plates will be moved away from each other.

4. Balance the electrodes for normal full load on the driving motor by adjusting the counter-weights.

Low-Voltage Release—The low-voltage release feature is a device for increasing the counter-weights on the balance arms of the regulator (when voltage fails) thereby moving the electrodes apart and inserting all of the resistance of the regulator in the secondary of the driving motor. This prevents starting the driving motor with the electrode plates together. Care should be taken to connect the shunt transformer from which power is taken for this release inside of the circuit-breaker which supplies power to the driving motor. By this means the low-voltage release will be caused to operate every time the circuit is broken to the driving motor. The release is reset by a hand lever after the main circuit-breaker has been closed.

Automatic Reset—In the automatic reset regulator, a reset device is provided such that when the primary of the main motor is opened the electrodes automatically separate, thus inserting all the resistance in the secondary circuit. This is accomplished in the following manner: When the circuit-breaker is opened

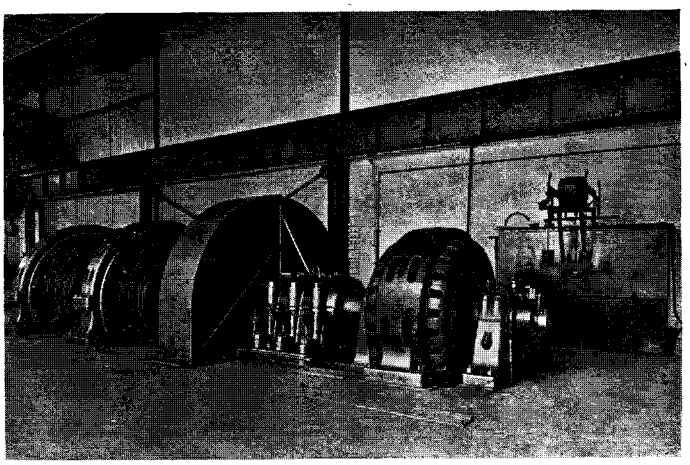


Fig. 8—Liquid Slip Regulator Control Used With the Driving Equipment for 34-Inch Reversing Blooming Mill, Steel Company of Canada

an auxiliary contact is closed which energizes the magnet of a three-pole contactor. This contactor connects the torque motor to the line through small transformers, and the electrodes are raised to their highest position. In this position the rotating arms engage a latch, and at the same time a contact is operated which disconnects the torque motor from the line. The lockout coil on the circuit-breaker is also energized, so that the circuit-breaker may be closed. The electrodes being raised, the complete resistance is now in the secondary circuit, and the equipment is ready for a new start. When the circuit-breaker is closed, the latch engaging the rotating arms is released, and the electrodes may be lowered.

Cooling Coil—The cooling coil should be cleaned out at stated intervals. Where the water contains considerable sediment or impurities, this cleaning should be done frequently. The coils can be cleaned by blowing them out with compressed air (steam should not be used.) The operating temperature of the electrolyte should not exceed 80 degrees Centigrade, and the cold water circulating through the cooling system should keep the temperature of the electrolyte below this point which is sufficiently below the boiling point to prevent the steaming of the liquid. The amount of water required is approximately 5 to 5½ gallons per horsepower-hour absorbed by the regulator. The hp. hours can be determined from the complete load cycle by the following formula:

HP—Horsepower of motor.
a—Full load torque.
b—Starting torque.
c—Starting time in minutes.
d—Number of starts per hour.
e—Regulating torque or torque when running at reduced speed.
f—Per cent speed reduction.
g—Number of minutes per hour during which speed regulation is required.

Then the horsepower-hours absorbed equals

$$\left(\frac{HP.}{2} \times \frac{b}{a} \times \frac{c}{60} \times \frac{d}{1}\right) + \left(\frac{HP.}{1} \times \frac{e}{a} \times \frac{f}{100} \times \frac{g}{60}\right)$$

Reversing Service—When the driving motor is connected to the line through switches in such a way that its direction of rotation may be reversed, care should be taken to have the series transformers for the torque motor connected to the line side of the reversing switches. This is to provide against reversing the direction of rotation of the torque motor. Care should also be taken that the resistance in the regulator is not so low that excessive current will flow when reversing. The maximum voltage across the terminals of the motor secondary will be doubled when the motor is reversed at full speed.

Protection from Cold—In the winter time, freezing can be prevented by lagging the regulator tank when the equipment is shut down for a short period of time. Before the apparatus is shut down, the circulating water can be turned off to insure the electrolyte being at a fairly high temperature when the motor is taken off the line.

Where the regulator is shut down for long periods of time, grid resistors can be used for supplying heat to the liquid. Under no cir-

cumstances should the electrolyte be allowed to freeze.

Starting—To start the motor, the regulator should first be examined to see that all parts are in proper working order, as described in the preceding pages.

The low-voltage release should hold the electrodes at their maximum separation. Examine the connections to the torque motor to see that this motor is in circuit and the torque is in the correct direction. This can be done by having an attendant hold the plates apart by means of the counter-weight and then closing the primary circuit of the large induction motor. By moving the counter-weight up and down a short distance by hand, an attendant can determine whether the torque motor is exerting its torque in the proper direction. If this torque is correct the main motor can be allowed to accelerate to full speed. This will be done automatically if the attendant raises the low-voltage arm, latching it by means of the magnet in its upward position.

After the motor is in operation, ammeter readings should be taken to see that the counter-weight is properly adjusted to give the average current value necessary for the particular application.

During the acceleration, the starting current should be noted and the soda solution adjusted to insure sufficient starting current.

Where the motor is reversed, care should be taken to keep the density of the soda solution as low as possible so as to limit the current peak at the instant of reversing.

Adjustment of Load—Standard series transformers are provided with taps for adjusting the load at which the regulator will operate. These taps are on the secondary windings and are arranged to deliver the normal 16 amperes for the torque motor (32 amperes for the No. 5 regulator) at 80%, 100%, 125%, or 150% of full load on the main motor.

Further adjustment can be made by varying the counter-weights on the regulator. Care should be taken, however, not to reduce the counter-weights to such an extent that the no-voltage trip mechanism will not operate, or to increase the weights to the point where the regulator will become sluggish.

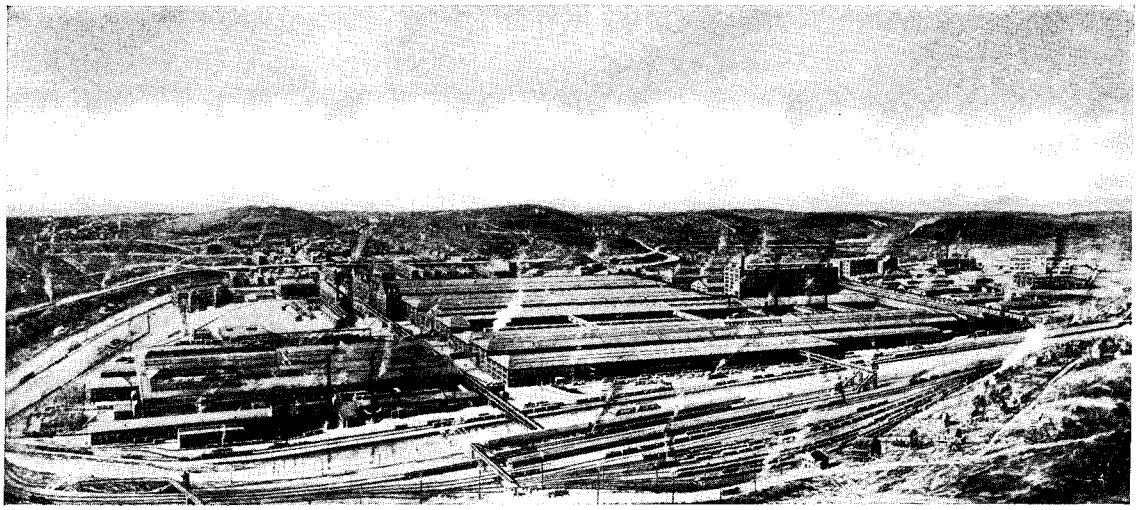
REPAIRS

For the convenience of its customers the Westinghouse Company has established repair shops in some of the larger cities located in various sections of the country. These shops are equipped with the most modern facilities for making reliable repairs promptly. The workmen employed in these shops are the same high class mechanics as those employed in the manufacturing of the original finished products. An advantage of better work and a saving of time and expense results from having Westinghouse apparatus repaired in Westinghouse shops. Address communications, however, to the nearest district sales office; see list on inside back cover.

Requests for instruction tags, booklets, repair parts or communications with regard to Westinghouse apparatus should give complete **nameplate readings.** In the case of motors and generators, the information should comprise the type letters, horsepower, voltage, etc., and also the serial number which is stamped on the nameplate and on the end of the shaft. When requesting duplicate copies of instruction tags, drawings, etc., give only the number of the tag or other publications.

Save the shipping notices sent when the apparatus is shipped as they give the number of our shop order ("S. O."). This is an excellent means of identification and assists in quickly locating records regarding parts.

INDEX



The Company's Works at East Pittsburgh, Pa.

Westinghouse Products

A few of the Westinghouse Products are listed below and will furnish some idea of the great variety of electrical apparatus manufactured by the Company and the many extensive fields for their use.

For Industrial Use

Instruments
Motors and controllers for every application, the more important of which are: Machine shops, woodworking plants, textile mills, steel mills, flour mills, cement mills, brick and clay plants, printing plants, bakeries, laundries, irrigation, elevators and pumps.
Welding outfits
Gears
Industrial heating devices, such as: Glue pots, immersion heaters, solder pots, hat-making machinery and electric ovens.
Lighting systems
Safety switches

For Power Plants and Transmission Lines

Circuit-breakers and switches
Condensers
Controllers
Control switches
Frequency changers
Fuses and fuse blocks
Generators
Insulating material
Instruments
Lamps, incandescent and arc
Lightning arresters
Line material
Locomotives
Meters
Motors
Motor-generators
Portable Power Stands, 110 volts
Rectifiers
Regulators
Relays
Solder and soldering fluids
Stokers
Substations, portable and automatic
Switchboards
Synchronous converters
Transformers
Turbine-generators

For Transportation

Locomotives
Railway equipment
Marine equipment

For Mines

Lamps
Locomotives
Motors for hoists and pumps
Motor-generators
Portable substations
Switchboards
Line material
Ventilating outfits

For Farms

Fans
Household appliances
Motors for driving churns, cream separators, corn shellers, feed grinders, pumps, air compressors, grindstones, fruit cleaning machines and sorting machines.
Generators for light, power and heating apparatus.
Portable Power Stands, 32 Volts
Radio Apparatus
Transformers

For Office and Store

Electric radiators
Fans
Arc lamps
Incandescent lamps
Small motors for driving addressing machines, dictaphones, adding machines, cash carriers, moving window displays, signs, flashers, envelope sealers, duplicators, etc.
Ventilating outfits

For Electric and Gasoline Automobiles and the Garage

Battery charging outfits
Charging plugs and receptacles
Lamps
Instruments
Motors and controllers
Small motors for driving lathes, tire pumps, machine tools, polishing and grinding lathes.
Solder and soldering fluids
Starting, lighting and ignition systems, embracing: Starting motor generators, ignition units, lamps, headlights, switches, etc.
Tire vulcanizers

For the Home

Electric ware, including: Table stoves, toasters, irons, warming pads, curling irons, coffee percolators, chafing dishes, disc stoves, radiators and sterilizers.
Automatic electric ranges
Fans
Incandescent lamps
Radio Apparatus
Small motors for driving coffee grinders, ice cream freezers, ironing machines, washing machines, vacuum cleaners, sewing machines, small lathes, polishing and grinding wheels, pumps and piano players.
Sew-motors

Westinghouse Electric & Manufacturing Company

East Pittsburgh, Pa.

WESTINGHOUSE SALES OFFICES

ALBANY, N. Y., Journal Bldg.
ATLANTA, GA., Westinghouse Elec. Bldg., 426 Marietta St.
BAKERSFIELD, CAL., 2224 San Emedio St.
BALTIMORE, MD., Westinghouse Elec. Bldg., 121 E. Baltimore St.
BIRMINGHDM, ALA., Brown-Marx Bldg., 2000 First Ave.
BLUEFIELD, W. VA., The Commercial Bank Bldg., Federal & Commerce Sts.
BOSTON, MASS., Rice Bldg., 10 High St.
BRIDGEPORT, CONN., Bruce & Seymour Streets.
BUFFALO, N. Y., Ellicott Square Bldg., Ellicott Square.
BURLINGTON, IOWA, 315 North Third St.
BURLINGTON, VT., 43 N. Champlain St.
BUTTE, MONT., Montana Electric Co. Bldg., 52 East Broadway.
CANTON, OHIO, (Box 292-Mail and Telegrams)
CEDAR RAPIDS, IOWA, 1705 C Avenue, E. (Mail P.O. Box 1067)
CHARLESTON, W. VA., Kanawha National Bank Bldg., Capitol and Virginia Streets.
CHARLOTTE, N. C., Commercial Bank Bldg., 200 S. Tryon St.
CHATTANOOGA, TENN., Tenn. Elec. Power Co. Bldg., Market and 6th Sts.
CHICAGO, ILL., Conway Bldg., 111 W. Washington Street.
CHICAGO, ILL., Clerical Division, 2211 W. Pershing Road.
CINCINNATI, OHIO, Westinghouse Elec. Bldg., Third and Elm Sts.
CLEVELAND, OHIO, Station "B". W. E. & M. Co. Bldg., 2209 Ashland Rd. S. E.
COLUMBUS, O., Interurban Terminal Bldg., Third and Rich Sts.
DALLAS, TEX., Magnolia Bldg., Akard and Commerce Streets.
DAYTON, O., Reibold Bldg., 14 West Fourth Street.
DENVER, COLO., Gas & Electric Bldg., 910 Fifteenth St.
DES MOINES, Iowa, 608 Securities Bldg., 416 W. Seventh St.
DETROIT, MICH., Westinghouse Elec. Bldg., 1535 Sixth St.
DULUTH, Minn., 511 Alworth Bldg., 306 West Superior St.
ELMIRA, N. Y., Hulett Bldg., 338-342 E. Water St.
EL PASO, TEX., Mills Bldg., Oregon and Mills St.
FORT WAYNE, IND. 3143 Broadway.
FRESNO, CAL., Griffith-McKenzie Bldg., J and Mariposa Sts.
GRAND RAPIDS, MICH., 422 Kelsey Bldg.
HAMMOND, IND., (Mail—P.O. Box 238; Telegrams—1188 Garfield St.)
HARTFORD, CONN., 220 Market St.
HOUSTON, TEX., Union National Bank Bldg., Main St. and Congress Ave.
HUNTINGTON, W. VA., Westinghouse Electric Bldg., Cor. Second Ave. and Ninth St.
INDIANAPOLIS, IND., Westinghouse Elec. Bldg., 820 N. Senate Ave.
ISHPEMING, MICH., 507 N. 5th St.
JACKSON, MICH., 704 Peoples National Bank Bldg.
JACKSONVILLE, FLA., Union Terminal Building, East Union and Ionia Sts.
KANSAS CITY, MO., Orear-Leslie Bldg., 1012 Baltimore Ave.
LITTLE ROCK, ARK., 2311 State Street.
LOUISVILLE, KY., Marion E. Taylor Bldg., 312 Fourth Ave.
LOS ANGELES, CAL., Westinghouse Elec. Bldg., 420 S. San Pedro St.
MADISON, WIS., 315 First Central Bldg.
MEMPHIS, TENN., Exchange Bldg., 130 Madison Ave.
MIDDLESBORO, KY., (P.O. Box 518)
MILWAUKEE, WIS., First National Bank Bldg., 425 E. Water St.
MINNEAPOLIS, MINN., Northwestern Terminal, 2303 Kennedy St. N. E.
NEWARK, N. J., 38-40 Clinton St.
NEW HAVEN, CONN., Liberty Bldg., 152 Temple St.
NEW ORLEANS, LA., Maison Blanche Bldg., 921 Canal St.
NEW YORK, N. Y., G. Benenson Investing Bldg., 165 Broadway.
NIAGARA FALLS, N. Y. Gluck Bldg., 205 Falls Street.
NORFOLK, VA., 1122 National Bank of Commerce Bldg., 300 Main St.
OKLAHOMA CITY, OKLA., Tradesman's National Bank Bldg., Main & Broadway Sts.
OMAHA, NEB., 1102 Woodman of the World Bldg., 1319 Farnam St.
PEORIA, ILL., 214 Cooper St.
PHILADELPHIA, PA., Widener Bldg., 1325-1329 Chestnut St.
PITTSBURGH, PA., Union Bank Bldg., 306 Fourth Avenue.
PORTLAND, MAINE, 61 Deering St.
PORTLAND, ORE., Porter Bldg., Sixth and Oak Sts.
RALEIGH, N. C., 803 N. Person St.
RICHMOND, VA., Room 912 Virginia Rwy. and Pr. Bldg., Seventh and Franklin Sts.
ROCHESTER, N. Y., Chamber of Commerce Bldg., 119 E. Main Street.
ROCK ISLAND, ILL., 2319 Third Avenue.
SACO, MAINE, R. F. D. No. 2.
ST. LOUIS, MO., Westinghouse Elec. Bldg., 717 So. Twelfth St.
SALT LAKE CITY, UTAH, Walker Bank Bldg., Second South and Main Sts.
SAN ANTONIO, TEXAS, 1105 Denver Blvd.
SAN FRANCISCO, CAL., First National Bank Bldg., 1 Montgomery St.
SEATTLE, WASH., Westinghouse Elec. Bldg., 3451 E. Marginal Way.
SPOKANE, WASH., Old National Bank Bldg., Riverside & Stevens Sts.
SPRINGFIELD, ILL., Public Service Bldg., 130 S. Sixth St.
SPRINGFIELD, MASS., 82 Worthington Street.
SYRACUSE, N. Y., University Bldg., S. Warren and E. Wash. Sts.
TACOMA, WASH., W. R. Rust Bldg., S. 11th and Commerce Sts.
TERRE HAUTE, IND., 735 Maple Ave.
TOLEDO, O., Ohio Bldg., Madison Avenue and Superior Street.
TUCSON, ARIZ., Immigration Bldg., 90 Church Street.
TULSA, OKLAHOMA, P. O. Box 1511.
UTICA, N. Y., 408 Pine St.
*WASHINGTON, D. C. Hibbs Bldg., 723 Fifteenth St., N. W.
WICHITA, KANSAS, 3809 East English St.
WILKES-BARRE, PA., Miner's Bank Bldg., W. Market and Franklin Sts.
WORCESTER, MASS., Park Bldg., 507 Main Street.
YOUNGSTOWN, O., Home Savings and Loan Bldg., Federal & Chestnut Sts.
Hunt-Mirk & Company, San Francisco, Cal., 141 Second St., Marine Dept., Special Pacific Coast Representatives.
The Hawaiian Electric Company, Ltd., Honolulu, T. H.—Agent

*Government business.

WESTINGHOUSE AGENT-JOBBERS

ATLANTA, GA., Gilham-Schoen Electric Co.
BALTIMORE, MD., H. C. Roberts Electric Supply Co.
BIRMINGHAM, ALA., Moore-Handley Hardware Co.
BLUEFIELD, WEST VIRGINIA, Superior Supply Co.
BUFFALO, N. Y., McCarthy Bros. & Ford
BUTTE, MONTANA, The Montana Electric Co.
CHICAGO, Ill., Illinois Electric Co.
CHARLOTTE, N. C., Carolina States Electric Co.
CLEVELAND, OHIO, The Erner Electric Co.
COLUMBIA, S. C., Mann. Elec. and Supply Co., Inc.
DENVER, COLO., The Mine & Smelter Supply Co.
DETROIT, MICH., Commercial Electric Supply Co.
EL PASO, TEXAS, The Mine & Smelter Supply Co.
ERIE, PA., Star Electrical Co.
EVANSVILLE, IND., The Varney Electrical Supply Co.
HOUSTON, TEXAS, Tel-Electric Co.
HUNTINGTON, WEST VIRGINIA, Banks Supply Co.
INDIANAPOLIS, IND., The Varney Electrical Supply Co.
JACKSONVILLE, FLA., Pierce Electric Co.
KANSAS CITY, MO., Columbian Electrical Co.
LOS ANGELES, CAL., Illinois Electric Co.
LOUISVILLE, KY., Tafel Electric Co.
MEMPHIS, TENN., The Riechman-Crosby Co.
MILWAUKEE, WIS., Julius Andrae & Sons Co.
NEW HAVEN, CONN., The Hessel & Hoppen Co.
NEW ORLEANS, LA., Electrical Supply Co.
NEW YORK, N. Y., Alpha Electric Co.
OMAHA, NEB., The McGraw Co.
PHILADELPHIA, PA., H. C. Roberts Electric Supply Co.
PITTSBURGH, PA., Robbins Electric Co.
PORTLAND, ORE., Fobes Supply Co.
RICHMOND, VA., Tower-Binford Electric & Mfg. Co.
ROCHESTER, N. Y., Rochester Electrical Supply Co.
SALT LAKE CITY, UTAH, Inter-Mountain Electric Co.
SAN FRANCISCO, CAL., Fobes Supply Co.
SCRANTON, PA., Penn. Electrical Engineering Co.
SEATTLE, WASH., Fobes Supply Co.
SIOUX CITY, IOWA, The McGraw Co.
SPOKANE, WASH., The Washington Electric Supply Co.
ST. LOUIS, MO., The McGraw Company.
ST. PAUL, MINN., St. Paul Electric Co.
SYRACUSE, N. Y., H. C. Roberts Electric Supply Co.
TAMPA, FLA., Pierce Electric Co.
WASHINGTON, D. C., H. C. Roberts Electric Supply Co.

WESTINGHOUSE SERVICE SHOPS

ATLANTA, GA.	426 Marietta Street
BALTIMORE, MD.	501 East Preston Street
BOSTON, MASS.	12 Farnsworth Street
BRIDGEPORT, CONN.	Bruce Ave. and Seymour Street
BUFFALO, N. Y.	141-157 Milton Street
CHICAGO, ILL.	2201 W. Pershing Road
CINCINNATI, OHIO	Third and Elm Streets
CLEVELAND, OHIO	1255 West Fourth Street
DENVER, COLO.	1909-11-13-15 Blake Street
DETROIT, MICH.	1535 Sixth Street
HARTFORD, CONN.	220 Market Street
HUNTINGTON, W. VA.	9th Street & Second Ave.
INDIANAPOLIS, IND.	814-820 N. Senate Ave.
JOHNSTOWN, PA	47 Messenger Street
LOS ANGELES, CAL.	420 S. San Pedro Street
MINNEAPOLIS, MINN.	2303 Kennedy St., N. E.
NEW YORK, N. Y.	467 Tenth Avenue
PHILADELPHIA, PA	30th and Walnut Streets
PITTSBURGH, PA.	6905 Susquehanna Street
PROVIDENCE, R. I.	393 Harris Ave.
ST. LOUIS, MO.	717 South Twelfth Street
SALT LAKE CITY, UTAH	573 W. Second South Street
SAN FRANCISCO, CAL.	1400 Fourth Street
SEATTLE, WASH.	3451 East Marginal Way
UTICA, N. Y.	408 Pine Street

WESTINGHOUSE MARINE SERVICE PORT ENGINEERS

NEW ORLEANS	1028 South Rampart Street
NEW YORK	160 Seventh Street, Brooklyn
PHILADELPHIA, Westinghouse Electric and Manufacturing Co.	South Philadelphia Works
SAN FRANCISCO	1400 Fourth Street
SEATTLE	3451 E. Marginal Way

CANADIAN COMPANY

CANADIAN WESTINGHOUSE COMPANY, LTD., Hamilton, Ontario

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY

165 BROADWAY, NEW YORK, U. S. A.

Westinghouse Press
Printed in U.S.A.