Westinghouse
Types CO-1 and CO-2 Oil Circuit-Breakers

Instruction Book 5236

Westinghouse Electric & Manufacturing Company
East Pittsburgh Works East Pittsburgh, Pa.

INDEX

Westinghouse
Types CO-1 and CO-2 Oil
Circuit-Breakers

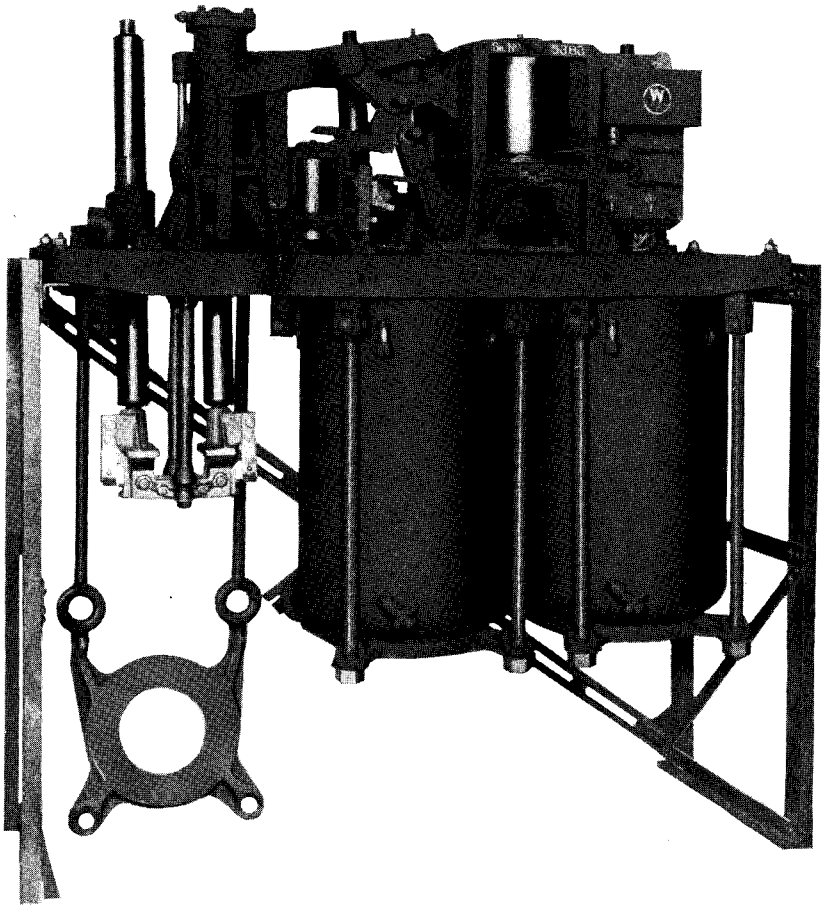


Fig. 1—Type CO-2 Oil Circuit-Breaker, 1200 Amps.—25,000 Volts

GENERAL CONSTRUCTION

The Type "CO" line of oil circuit-breakers is especially adapted for heavy power house service, and is built in capacities up to 2,000 amperes and voltages up to 25,000 volts. The general construction of all the breakers (Shown in Fig. 1) is the same. Standard breakers are three pole, electrically operated, completely assembled on a common steel base and with all adjustments made before leaving the factory.

INSTRUCTIONS FOR UNPACKING

Care should be used in unpacking to see that no damage is done to delicate parts. Clean all parts of apparatus free from excelsior, etc. Examine mechanism parts for breakage, distortion, or anything else that might cause improper operation. Examine condenser terminals to see that they have not been injured by nails or bruises. Examine tank linings when same are furnished for signs of mechanical injury or damage by moisture.

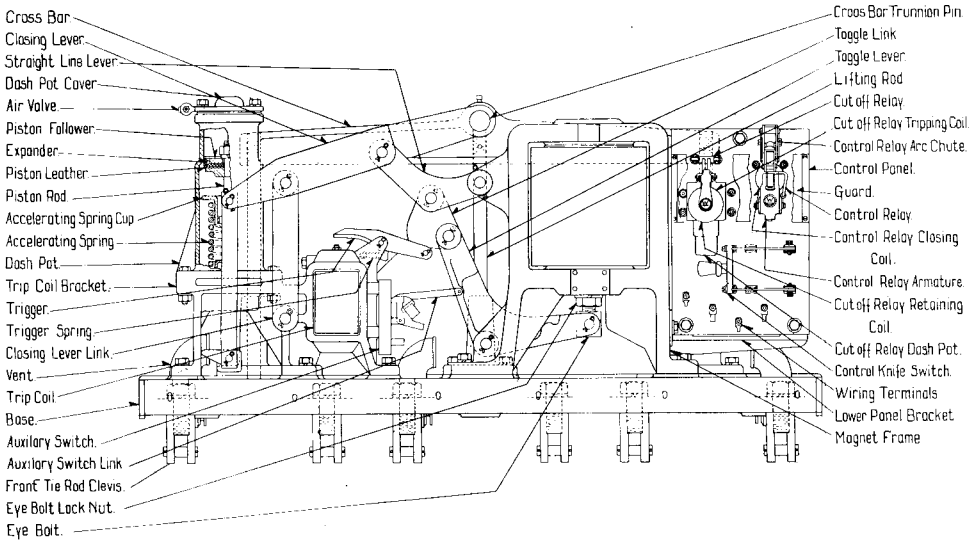


Fig. 2—Type CO-1 Operating Mechanism

Be sure that there is no foreign matter in the tanks that might float in the oil or dissolve in it. Check to see that all packing blocks are removed from the mechanism, and remove the wooden blocks from the contacts. Electrical mechanism especially should be gone over carefully to remove particles of dirt from cores, dash pots, auxiliary switches, and to see that same are in proper operating condition.

GENERAL OPERATION OF THE BREAKER

Figure 2 shows the operating mechanism for all Type "CO" breakers. The moving closing core pulling on the toggle lever lifts the cross bar through the closing lever, straight line lever and toggle link. The trigger catches the latching surface on the toggle link to hold the breaker closed. The opening operation is performed by the shunt trip core striking the trigger lever, thus releasing the toggle mechanism and allowing the accelerating device to force the breaker rapidly to the open position.

CONTACT ADJUSTMENT

Figure 3 shows the parallel path form of brush contact used on modern "CO" breakers. When closing the breaker, the arcing tips should touch approximately 1¼ inches to 1½ inches from the end of the stroke. When the breaker is completely closed and latched, the contacts of all phases should exert a firm positive pressure on their complete surfaces against the stationary contact feet, and the inside leaves should be definitely lifted away from the center blocks. On the other hand, the brushes must not be pulled up so far that the outside leaves commence to lose their contact against the stationary contact feet. The arcing tips must make positive contact for at least ¾ of an inch after the main brush has parted from the contact foot, but it is not necessary that arcing contacts open together all over their surfaces. The function of the arcing tips is to shunt the current after the main contacts have parted. They are not relied on to carry current while the main contact is in position.

Adjustment of the contacts is made by the screw threads provided on the steel lifting rod which gives half turn adjustment. When replacing stationary contact feet, the threads on the contact rod allow for vertical adjustment.

As the contacts on all "CO" breakers are adjusted at the factory, it should only be necessary before placing a breaker in operation to go carefully over the adjustments, clean up the contact surfaces with fine emery. Only in case the original adjustments have been impaired in shipment, or otherwise, should it be necessary to change the contact setting.

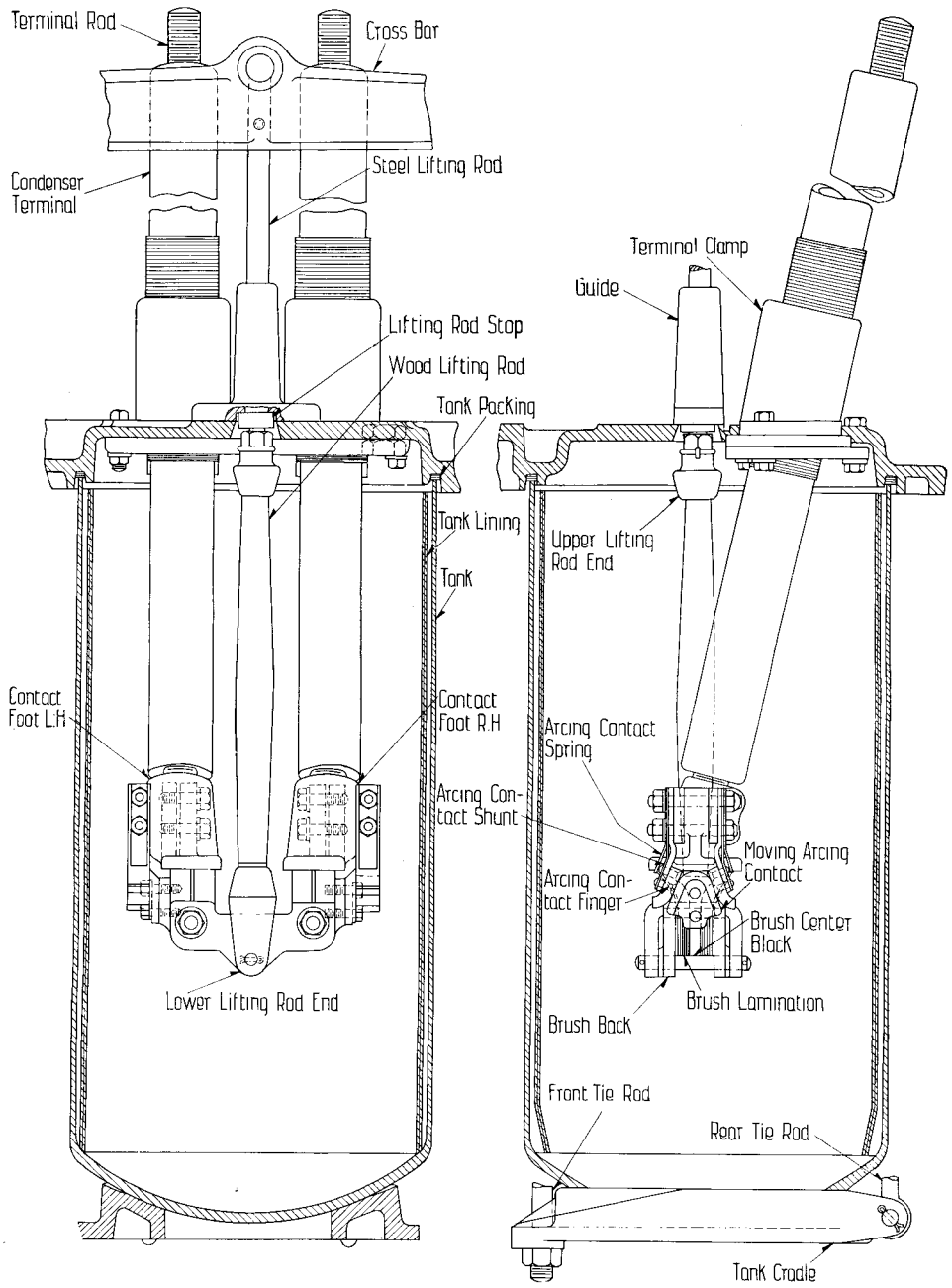


Fig. 3—Type CO-1 Oil Circuit-Breaker Unit

MECHANISM ADJUSTMENT

The mechanisms of the "CO" breakers are adjusted and locked before leaving the factory. When installing a breaker, it should not be necessary to change any of these adjustments. However, should it be necessary to install new parts at any time during the life of a breaker, or if adjustments have been impaired, the following instructions should be rigidly observed.

It is of great importance that the toggle linkage formed by the toggle lever and the toggle links shall have its proper relationship so that upon tripping of the breaker the linkage will break away freely allowing the cross bar and main closing lever to fall to the open

position. The toggle is set in the factory so that when the moving closing core bottom is against the stationary core of the magnet, the latching surface on the toggle link overtravels the roller on the trigger approximately $\frac{1}{32}$ of an inch. When the breaker is closed and latched, the center line of pin "A" should fall approximately $\frac{1}{4}$ of an inch to the right of a line drawn between center line of pin "B" and "C". Adjustment of the toggle and latch is obtained by rotating the moving closing core on the eye bolt in the toggle lever. Be sure to lock the nuts on the eye bolt after making an adjustment. Do not allow more than $\frac{1}{16}$ inch overtravel between the closing cores when the breaker is in the latched position. Keep all pin fits involved well lubricated to prevent any possibility of the toggle not breaking quickly when the breaker is tripped.

LIFTING ROD GUIDES

The steel lifting rods, which are fastened to the cross bar and lift the moving contact elements, should slide freely in the lifting rod guides when the breaker is opened and closed. If, for any reason, there should be binding of the rods in these guides the guides can be shifted slightly by loosening the bolts which attach them to the main base. Tighten the bolts carefully after adjusting.

SOLENOID MECHANISM

The closing operation of the Type "CO" breaker is secured by means of an electric solenoid shown in figure 2, the coil of which is excited from a D-C. control circuit. By pulling the moving core upward against the stationary core moves the breaker mechanism to the closed position.

This solenoid is equipped with a dash pot device for minimizing the shock to the structure caused by the rapid closing of the breaker. The dash pot is formed by the air space between the moving and closing cores and is sealed air tight by the leather washer and expander. The joint between the stationary core and the brass core tube is sealed by a packing.

The expander consists of a slotted bronze disc which presses the leather against the brass tube so that while sliding freely during the opening and closing strokes of the breaker, the leather maintains an air tight joint against the tube. The leather washers on the metal expander are held in the end of the moving closing core by means of the piston follower. A steel pin is fastened through the follower, the expander and the leather washer into the moving closing core, thus preventing the turning of these three items. The metal sleeve is fastened to the stationary closing core by means of screws and the joint between the two is packed to make it air tight.

Should it become necessary to remove the moving closing core from the metal sleeve, it can be replaced readily by first forcing a tube of the same inside diameter down over the leather, and then lining up the two tubes so that the leather slides freely.

An adjustable air valve is placed in the top of the stationary core so that the escapement of air from the closing core dash pot can be regulated. Turning the valve screw to the **right** raises the ball off its seat and permits the more easy escape of air, thus reducing the cushioning effect and allowing more speedy closing. Turning the valve screw to the **left** drops the ball onto its seat and limits the escapement of air from the dash pot, thus cushioning the closing action of the breaker. This closing core dash pot should be adjusted for each particular breaker to give the best closing operation with the control voltage that will actually be used.

ACCELERATING DEVICE

The accelerating device for type "CO" breakers shown at the left of Fig. 2 consists essentially of a powerful spring operating in a cyclinder and connected up by a linkage to the operating mechanism. This spring is compressed in the closed position of the breaker, and when the latch is released the spring forces the mechanism rapidly to the open position. On the latter part of the opening stroke, also, the spring is again compressed to the desired amount, which is much less than its pressure when the breaker is closed, for the purpose of balancing the weight of moving parts when the breaker is in the open position..

This accelerating device is also equipped with an air dash pot consisting of a follower on the piston rod, a leather washer and a metal expander for holding the leather washer against the sides of the dash pot piston. The dash pot head is equipped with a ball valve

which allows a regulated escapement of air from the dash pot on the end of the opening stroke of the breaker. Regulation of this valve is obtained by an adjusting screw, rotation of the screw to the **right** causing the ball to be lifted from its seat and aiding the exhaust of air from the dash pot and rotation of the screw to the **left** causing the ball to return to its seat thus closing up the valve opening. This dash pot and valve are similar to those described in connection with the closing cores.

INSTALLATION OF ELECTRIC SOLENOID AND ACCELERATING DEVICE

The following points should be carefully checked upon installation of the mechanism:

(1) That all parts are free from dirt and grit and operate freely.

(2) That the air dash pot between the moving closing core and stationary core is in good condition.

(3) That the backlash of the trigger is correct.

(4) That the eye bolt which regulates the overtravel of the latch is set correctly and locked.

(5) That the tripping core upon being raised disengages the trigger from the toggle link over the range of control voltage specified.

(6) That the signal switches make proper contact in both the open and closed position of the mechanism, and that all small wiring connections to them are well made.

(7) That when the electric mechanism is in the open position, the cross bar rests against the bumpers.

(8) That in the closed position of the breaker, the metal stops on the lifting rods clear the base by approximately $\frac{1}{16}$ of an inch.

MAINTENANCE OF CLOSING MECHANISM AND ACCELERATING DEVICE

The following parts should be checked from time to time to insure that the mechanism remains in the operating condition which is obtained when it is installed:

(1) That the black lash on the latch is correct.

(2) That the air dash pots are functioning properly. The leather washers should be kept oiled by drops of oil which will not coagulate or gum. It is essential that the leather be kept pliable, but that it not be flooded with oil because it will cause the softening of the leather. Arcticammonia, or a mixture obtained by warming vaseline and cylinder oil, is recommended for this purpose.

(3) The air valve be kept clean and free from dirt.

(4) The bolts holding the stationary closing and tripping cores should be checked up to see that none of them has been loosened.

(5) The auxiliary switches should be examined to see that they are making contact properly and the contacts wiped with a small amount of vaseline. The connections to the auxiliary switches should be checked to see that none of them has become loosened.

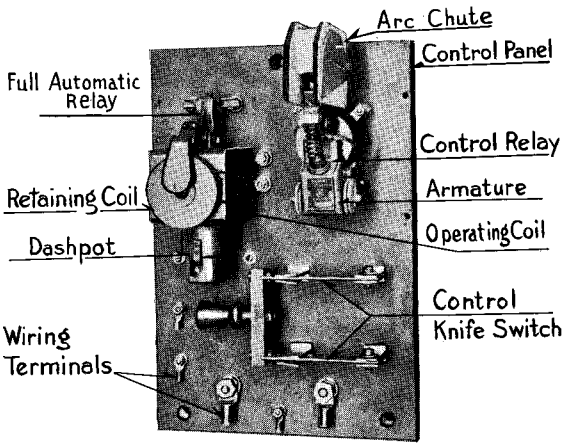


Fig. 4—Control Relay Panel

CONTROL RELAY PANEL

Type "CO" breakers are provided with a control relay panel (see Fig. 4) for operation in connection with the electric mechanism. This panel consists essentially of a control relay, a full-automatic relay, a knife switch for opening the main control circuit, and terminals for complete circuit breaker control wiring. The control relay has a coil which is energized from a control switch on the switchboard when it is desired to close the circuit breaker. The action of this coil closes the main control relay contacts which causes current to flow through the main solenoid of the breaker so that it operates. When the circuit breaker reaches the latter part of its closing stroke, the auxiliary switch on the breaker excites the operating coil of the full-automatic relay which interrupts the circuit of the control relay coil.

The action of the full-automatic relay in opening the coil of the control relay is retarded by the action of the dash pot thus giving the circuit breaker ample time to close and latch before the control relay is de-energized and its main contacts opened and current removed from the main closing solenoid.

Upon operation of the full-automatic relay the armature is thrown to a sealed position and is retained there so long as the control switch at the switchboard is held in the position to close the breaker.

The function of the control relay, therefore, is to relieve the control switch at the switchboard of the large amount of current necessary to close these large breakers. The function of the full-automatic relay is to remove energy from the main closing core by de-energizing the coil of the control relay as soon as the breaker has been properly latched. This action also makes the breaker ready to trip instantly should an overload or short circuit exist on the main power line when the circuit breaker is closed. The action of the retaining coil is to prevent re-establishment of the full-automatic relay contacts should an operator hold the control switch on the switchboard, in the closed position and thus prevent pumping of the circuit-breaker.

The two pole knife switch is provided so that the main control wires of the circuit breaker can be interrupted in case it is desired to work on the mechanism, thus preventing either closing or tripping from a distant point.

ADJUSTMENT AND OPERATION OF CONTROL RELAY PANEL

To make sure that this control panel is in proper operating condition, the following points should be checked:

(1) The control relay should pick up and close its contacts on minimum closing voltage.

(2) The full-automatic relay operating coil must open the relay contacts when energized by minimum voltage.

(3) The retaining coil must hold the armature and the full-automatic relay contacts in the open position when energized by minimum voltage after the contacts have been opened by the operating coil.

(4) The retaining coil must not open the full-automatic relay contacts when excited by maximum voltage. The full-automatic relay must be so adjusted that the circuit-breaker positively latches before the closing coil is demagnetized when operated over the full range of control voltage. Adjustment of this relay plunger consists of rotating the outer piston to raise or lower the plunger in its air gap.

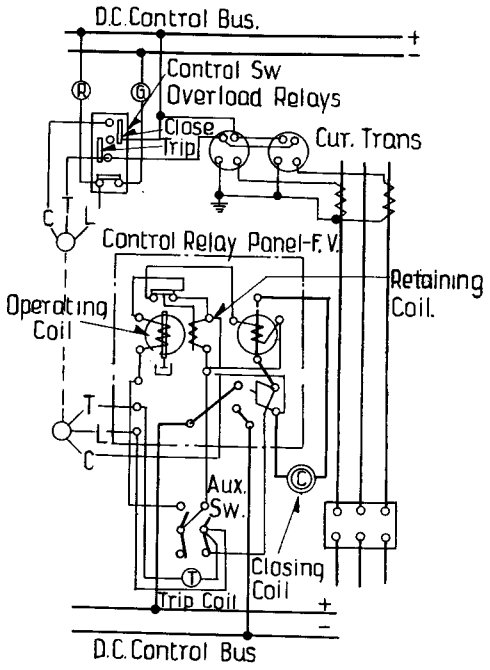


Fig. 5—Control Diagram

Figure 5 shows the complete control connections for an electrically-operated type "CO" breaker using a control relay panel.

MAINTENANCE OF CONTROL PANEL

The following points should be checked from time to time to insure proper operation of this control relay panel:

(1) That all parts are free from dust and dirt and operate freely.

(2) That the control relay contacts are in good condition.

(3) That the cutoff relay plunger is properly adjusted as outlined above.

INSPECTION AND MAINTENANCE OF TANK STRUCTURE

Each tank, before a breaker is placed in service, should be thoroughly cleaned and free from moisture. The tank liner should be inspected and be free from mechanical damage. Fill all tanks to the level in the

gauges on the gauge glass with the oil specified by the manufacturers for use with this breaker. Do not use oils that are not authorized by the breaker manufacturer. Pull up all tank supports firmly so that the tank gasket is compressed in order that oil will not be thrown from around the gasket in case of a short circuit.

Periodic inspections should be made of the interiors of tank structure, and the frequency of these inspections should vary with the severity of service to which the breaker is exposed. Test the main contacts at these inspection periods to see that neither the stationary nor the moving contacts have been burned or pitted in such a way that good contact service is not secured. Check the arcing tips to see that they have not burned away to a point where burning might ensue on the main contacts in case of a heavy short circuit. If necessary, renew the arcing tips. Test the tank linings for signs of serious burning due to arcs. Take dielectric tests of the oil to see that it is reasonably good for circuit-breaker work.

If a breaker has opened an unuaually severe short circuit, or for some reason has shown signs of distress, it will probably be advisable to inspect it at the earliest convenience.

See instructions for care of insulating oil.

CONDENSER TERMINALS

The terminals furnished with type "CO" breakers are of the protected end condenser form and are not easily damaged. They should not be stored under a leaky roof, where water may drip upon them, or in any damp place. Before placing a breaker in service, clean off any accumulation of dirt with oily waste.

CARE OF INSULATING OIL

Deterioration in Use—All insulating oils through arcing

INSULATING OILS. The Westinghouse Electric and Manufacturing Company assumes the responsibility of oil circuit-breaker operation only, when the insulating oil employed is in accordance with its recommendation. WEMCO-A oil should be used in all indoor breakers and may be used in outdoor breakers where the temperature will not be lower than 0 degrees Centigrade (32 degrees Fahrenheit.) Where a heavier oil than WEMCO-A is desired, WEMCO-B oil may be used under same conditions. Where lower temperatures may be encountered, WEMCO-C oil should be used.

This carboni- e bottom of the anism located in e interior of the ever the amount sary to do so. electric strength therefore, that led with new oil rated insulating oils can be filtered and dried by the use of a Westinghouse Oil Drying and Purifying Outfit.

Storage—All Westinghouse insulating oil for circuit-breaker use is shipped either in soldered tin cans or sealed drums provided with screw bungs which are sealed before shipment, or in tank cars used exclusively for the purpose. All oil in drums which are not sealed, all oil in sealed drums, which has been stored exposed to the weather, and all oil shipped in tank cars should be tested before using by taking a sample from each container. Drums stored out of doors should always be placed on their sides, never turned up on end, and the bung should always be turned down. The chimes should never be allowed to lie in pools of water, nor should water be allowed to stand on the heads when the drums are in a vertical position. Outdoor storage of oil is always hazardous and should be avoided if possible. When storing drums out of doors, protection against direct precipitation of rain or snow should be provided.

Handling—Extreme precautions are required to insure that all containers and any apparatus therein are absolutely dry when oil is transferred to it from a drum, soldered can, or tank car. A drum of cold oil when taken into a warm room will "sweat" and the resulting moisture on its outer surface may mix with the oil when drawing it from the drum. The containers should always be allowed to stand long enough to reach room temperature before breaking the seals. Tank cars should never be emptied during wet weather. Any vessels used in transferring oil should be absolutely dry and free from any foreign matter, especially metallic or carbonaceous particles.

Filtering—Although the drums are thoroughly washed and dried at the refinery before filling, a certain amount of scale is generally loosened inside in transit. This must be removed by passing the oil through two layers of ordinary finely woven cotton cambric which has been thoroughly washed to remove the sizing, and then dried. The cloth may be stretched across a funnel of large size. The oil will pass through the cloth more rapidly if slightly warmed. If the funnel does not discharge directly into the tank of the circuit-breaker, the oil should not be returned to an

empty drum unless it is known to be thoroughly clean and dry. The thoroughness of the filtering should be determined by dielectric test.

Detection of Moisture—It is impossible to over-emphasize the effects of relatively small amounts of moisture in the oil in high voltage breakers, and the serious effects which such moisture may have on breaker operation from breakdown on voltage surges or on interrupting short circuits. The amount of moisture which will seriously lower the insulating value of the oil is of the order of one part in twenty thousand. This is too small an amount to be detected by settling out or by the well-known hot metal test. It can only be done by a dielectric test. The Westinghouse Electric and Manufacturing Company manufactures a special device for this purpose, and furnishes instructions for its use.

Removal of Moisture—Moisture may be entirely removed by passing the oil through a Westinghouse Oil Drying and Purifying Outfit. When this outfit is not available, the oil may be dried in a fairly satisfactory, although slow and inconvenient, manner by passing it through a bag of clean dry lime and filtering afterwards to remove particles of suspended matter. It is not advisable to use various other methods, such as passing hot dry air through the oil, on account of the diffculty of entirely removing all moisture from the air, or heating the oil for a considerable length of time on account of the liability of injuring the oil during the heat treatment.

Oil Maintenance—It is vital for the successful operation of high voltage breakers not to use oil in them which is not especially treated for the puspose. Only oil that carries the recommendation of the breaker manufacturer should be used.

Maintenance of Oil Level—Great care should be exercised to see that the oil level is kept at the proper height in the gauge glass. Considerable alteration of this level may be caused by evaporation, rupturing of heavy short circuits, or possibly leakage from the breaker structure in case of defects or injury.

Improper oil level may result in hazardous operation from flashover of switching, or failure to properly open heavy short circuits.

REPAIR PARTS

When ordering repair parts, specify the name of the part wanted as shown in the illustrations in this book, give the number of the breaker, for example: One closing lever link for Type "CO-2" breaker, S.O. 69B86 as shown in Instruction Book No. 5236. The shop order number of the breaker will be found stamped on the nameplate.

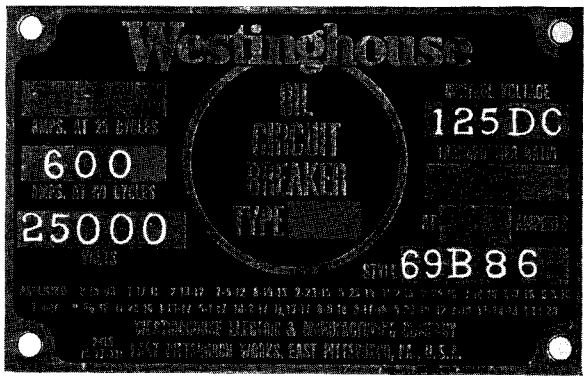
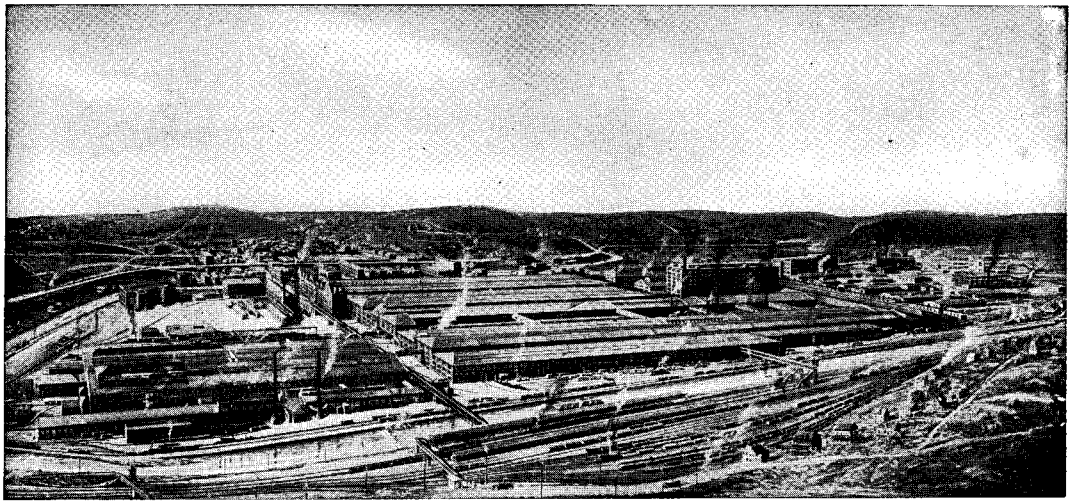


Fig. 6—Nameplate



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 DISTRICT OFFICES

ALBANY, N. Y., Journal Building.
ATLANTA, GA., Candler Bldg., 127 Peachtree St.
BALTIMORE, MD., Westinghouse Bldg., 121 E. Baltimore St.
BIRMINGHAM, ALA., Brown-Marx Bldg., 2000 First Ave.
BLUEFIELD, W. VA., Law and Commerce Bldg., Federal and Raleigh Streets
BOSTON, MASS., Rice Building, 10 High St.
BUFFALO, N. Y., Ellicott Square Bldg., Ellicott Square.
BUTTE, MONT., Montana Electric Co. Bldg., 52 East Broadway.
CHARLESTON, W. VA., Kanawha National Bank Bldg., Capitol and Virginia Streets.
CHARLOTTE, N. C., Commercial Bank Bldg., 200 S. Tryon St.
CHATTANOOGA, TENN., Hamilton National Bank Building, 701 Market St.
CHICAGO, ILL., Conway Bldg., 111 W. Washington Street.
CINCINNATI, O., Westinghouse Bldg., Third and Elm Sts.
CLEVELAND, O., Swetland Bldg., 1010 Euclid Ave.
COLUMBUS, O., Interurban Terminal Bldg., Third and Rich Sts.
DALLAS, TEX., Magnolia Bldg., Akard and Commerce Street.
DAYTON, O., 14 West Fourth Street.
DENVER, COLO., Gas and Electric Bldg., 910 Fifteenth St.
DES MOINES, IOWA., 608 Securities Bldg., 412 W. Seventh St.
DETROIT, MICH., 1535 Sixth Street.
DULUTH, MINN., Alworth Bldg., 306 West Superior St.
EL PASO, TEX., Mills Bldg., Oregon and Mills St.
FRESNO, CAL., J and Mariposa Streets.
HOUSTON, TEX., Union National Bank Building, Main and Congress Streets.
HUNTINGTON, W. VA., Westinghouse Electric Building, Corner Second Avenue and Ninth Street.
*Government business exclusively.
INDIANAPOLIS, IND., Traction Terminal Bldg., Illinois and Market Sts.
JACKSONVILLE, FLA., Union Terminal Warehouse, East Union and Ionia Streets
KANSAS CITY, MO., Orear-Leslie Bldg., 1012 Baltimore Ave.
LOUISVILLE, KY., Paul Jones Bldg., 312 Fourth Ave.
LOS ANGELES, CAL., 418 So. San Pedro Street.
MEMPHIS, TENN., Exchange Bldg., 130 Madison Ave.
MILWAUKEE, WIS., First National Bank Bldg., 425 E. Water St.
MINNEAPOLIS, MINN., 2303 Kennedy Street, N. E.
NEW ORLEANS, LA., Maison Blanche Bldg., 921 Canal St.
NEW YORK, N. Y., City Investing Bldg., 165 Broadway.
NIAGARA FALLS, N. Y., 205 Falls Street.
PHILADELPHIA, PA., Widener Bldg., 1325-1329 Chestnut St.
PITTSBURGH, PA., Union Bank Bldg., 306 Wood St.
PORTLAND, ORE., Northwestern Bank Bldg., Broadway and Morrison Sts.
RICHMOND, VA., Virginia Rwy. and Pr. Bldg., Seventh and Franklin Streets
ROCHESTER, N. Y., Chamber of Commerce Bldg., 119 E. Main Street.
ST. LOUIS, MO., 300 N. Broadway.
SALT LAKE CITY, UTAH, Walker Bank Bldg., Second Street, South and Main Sts.
SAN FRANCISCO, CAL., First National Bank Bldg., 1 Montgomery St.
SEATTLE, WASH., Westinghouse Bldg., 3451 E. Marginal Way.
SYRACUSE, N. Y., University Bldg., 120 Vanderbilt Square.
TOLEDO, O., Ohio Bldg., Madison Ave and Superior St.
TUCSON, ARIZ., Immigration Bldg., 90 Church Street.
WASHINGTON, D. C., *Hibbs Bldg., 723 Fifteenth St., N. W.
WILKES-BARRE, PA., Miner's Bank Building, W. Market and Franklin Streets,
The Hawaiian Electric Company, Ltd., Honolulu, T. H.—Agent

WESTINGHOUSE AGENT JOBBERS

ATLANTA, GA., Gilham Schoen Electric Co.
BIRMINGHAM, ALA., The 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.
CINCINNATI, OHIO, The Johnson Electric Supply Co.
CLEVELAND, OHIO, The Erner Electric Co.
DENVER, COLO., Mine & Smelter Supply Co.
DETROIT, MICH., Commercial Electric Supply Co.
EL PASO, TEXAS, Mine & Smelter Supply 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., Satterlee Electric Co.
LOS ANGELES, CAL., Illinois Electric Co.
LOUISVILLE, KY., Tafel Electric Co., Inc.
MEMPHIS, TENN., Riechman-Crosby Co.
MILWAUKEE, WIS., Julius Andrae & Sons Co.
NEW HAVEN, CONN., Hessel & Hoppen Co.
NEW ORLEANS, LA., Electrical Supply Co.
NEW YORK, N. Y., Alpha Electric Co.
OKLAHOMA CITY, OKLA., United 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, Intermountain Electric Co.
SAN FRANCISCO, CAL., Electric Rwy. & Mfrs. 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. JOSEPH, MO., Columbian Electrical 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.
WICHITA, KANSAS, United Electric Co.

WESTINGHOUSE SERVICE SHOPS

ATLANTA, GA.:.....Cor. Markham and Mangum Sts.
BALTIMORE, MD.....501 East Preston St.
BOSTON, MASS.....12 Farnsworth St.
BRIDGEPORT, CONN....Bruce Ave. and Seymour St. Stratford
BUFFALO, N. Y.....141-157 Milton St.
CHICAGO, ILL.....32 South Peoria St.
CINCINNATI, O.....Third and Elm Sts.
CLEVELAND, O.....1255 West Fourth St.
DENVER, COLO.....1909-11-13-15 Blake St.
DETROIT, MICH.....1535 Sixth St.
HARTFORD, CONN.....220 Market St.
HUNTINGTON, W. VA.....9th Street and 2nd Ave.
JOHNSTOWN, PA.....47 Messenger St.
LOS ANGELES, CAL.....2019 Bay St.
MINNEAPOLIS, MINN.....2303 Hennedy St., N. E.
NEW YORK, N. Y.....467 Tenth Ave.
PHILADELPHIA, PA.....214-220 North 22nd St.
PITTSBURGH, PA.....6905 Susquehanna St.
ST. LOUIS, MO.....12th and Gratoit Sts.
SALT LAKE CITY, UTAH.....573 W. 2nd St. So.
SAN FRANCISCO, CAL.....1400 Fourth St.
SEATTLE, WASH.....3451 East Marginal Way.
SPRINGFIELD, MASS.....82-86 Worthington St.

WESTINGHOUSE MARINE SERVICE PORT ENGINEERS

BALTIMORE.....109 South Street
NEWPORT NEWS.....Foot Warwick Pier
NEW ORLEANS.....921 Canal Street
NEW YORK.....596 Court Street, Brooklyn
PHILADELPHIA.....1442 Widener Bldg.
SAN FRANCISCO.....141 Second Street
SAVANNAH.....406 E. 39th Street

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.