Westinghouse

Type UHS High Speed "De-ion" Circuit-Breaker

INSTRUCTION BOOK

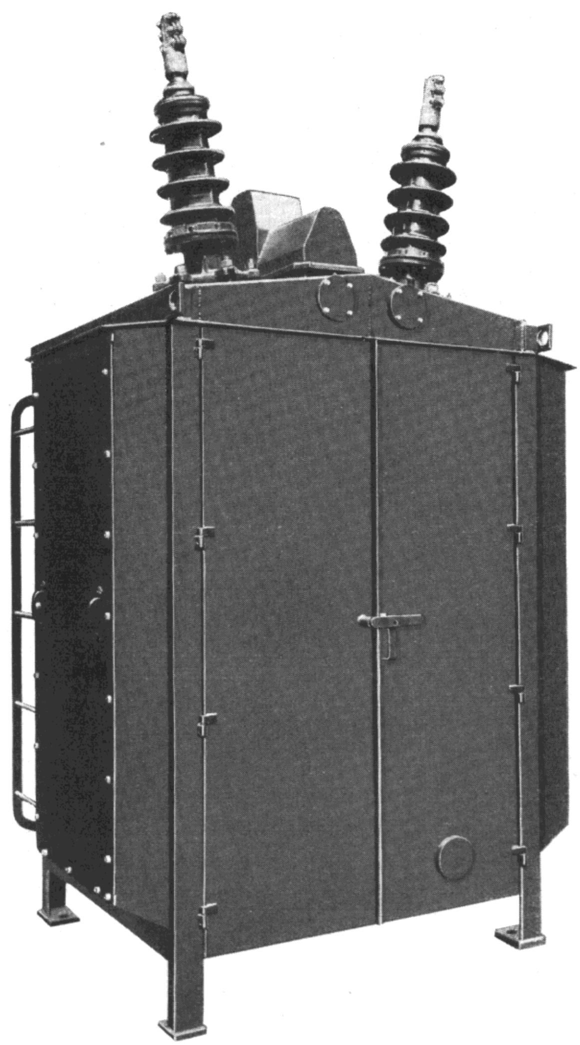

Fig. 1—Type UHS "De-ion" Circuit-Breaker Unit Complete

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I. B. 5583

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Type UHS High Speed "De-ion" Circuit-Breakers

General

The alternating current high speed "De-ion" circuit breaker is designed for single phase service on line feeders of a railway system. Short circuit current in such feeders, if allowed to persist, may result in serious damage to contact lines and car equipment as well as form a hazard to operating personnel and passengers. These effects, together with the effect of prolonged short circuits, on synchronous machines and the inductive interference with parallel communication and signal circuits, are very much reduced when the duration of short circuit is limited by a circuit breaker having high speed interrupting characteristics. The breaker is designed for use on single phase, 25 cycle circuits up to 15000 volts and will carry 1500 amperes continuously at rated frequency or 2400 amperes for ½ hour.

The high speed "De-ion" circuit breaker opens very quickly, drawing the arc in air and driving it, by means of a magnetic blow-in field, into the deionizing chamber where it is extinguished. The moving contact, lift rod, link and trip free lever, made of high grade materials, as light as possible, are arranged to trip free of the closing linkage and mechanism. They are accelerated by a powerful spring arranged concentrically with the lift rod. The remainder of the linkage is of heavier construction and moves more slowly in operation.

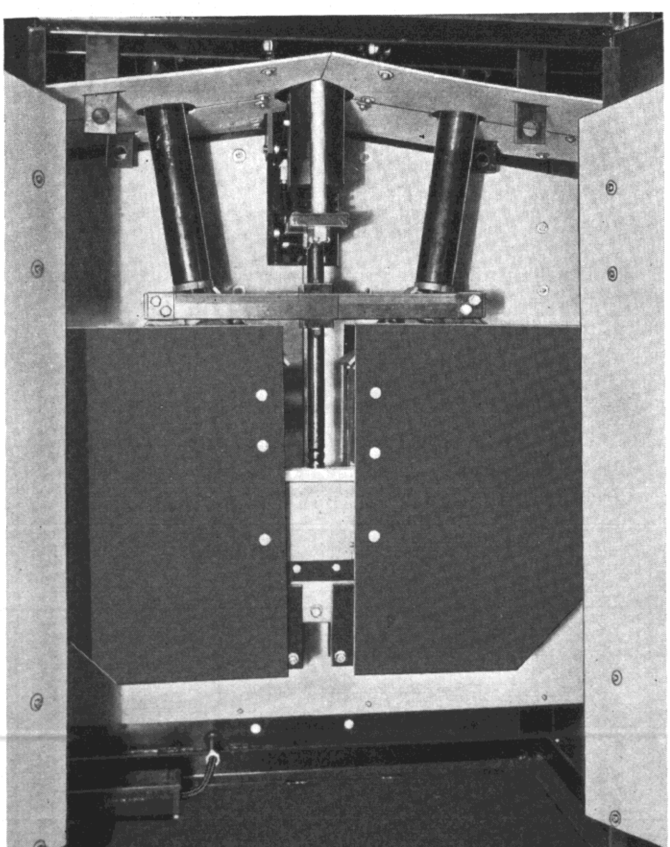

Fig. 2—Close-up View of Contacts

Description

Mechanical Parts

Referring to figure 3 (breaker shown in closed position) by energizing the trip coil, the armature raises, pulling the trigger upward. This allows the latch to move back and disengage the roller on the trip free lever. This lever rotates clockwise about the middle pin, allowing the moving contact to move downward. The heavy accelerating spring starts the contact very quickly and accelerates it to about half stroke where the lower spring seat strikes the bumper weight. The contact continues to travel downward until the upper rod end strikes the upper spring seat. This happens at the normal open position or after six inches of travel. The contact is then retarded and brought to rest by compression of the accelerating spring between the upper rod end and the lift rod guide. It is brought to rest about 2¾ inches below the normal open position. By the time the contact comes to rest, the lift rod guide which is held up by the relatively light bumper spring is moving downward. This relieves the compression on the accelerating spring so that it does not cause the contact to rebound. The bumper weight travels on down at relatively low velocity, striking the lower leather bumper and being retrieved to its normal position by the bumper spring. In the open position, the upper rod ends rests on the upper spring seat, holding the moving contacts in the normal position.

The switch lever is operated by the lugs on the lower spring guide which extends out through slots in the bumper weight. The lever rests on top of these lugs, and when the breaker is opened, it rotates clockwise by the force of the switch linkage spring. In closing, it is rotated counter-clockwise by the lugs on the lower spring guide. This switch lever operates the trip coil cutout contactor and the 10 pole auxiliary switches.

Figure 3 shows the contact operating linkage in the closed position. The toggle, formed by the bell crank lever

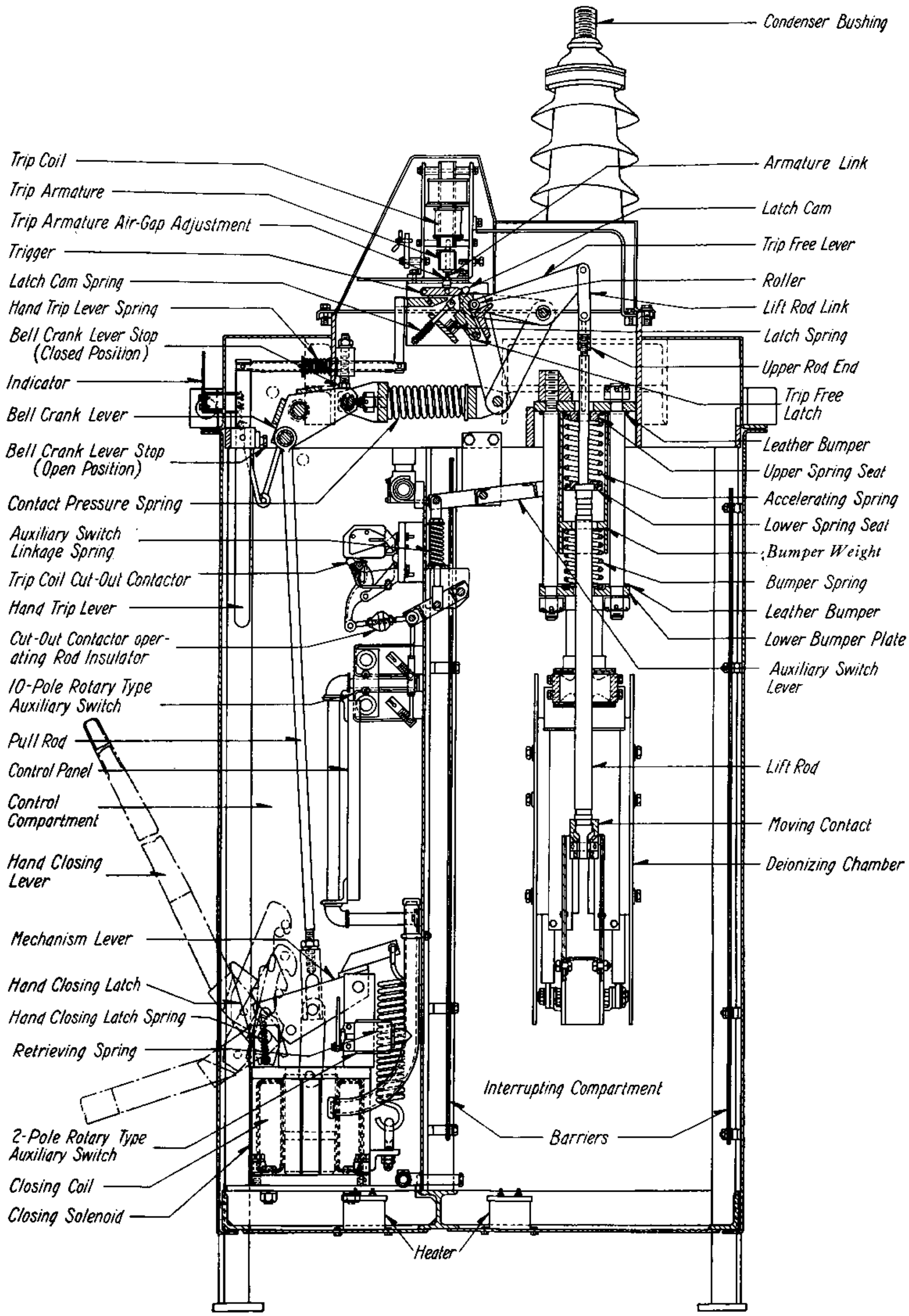

Fig. 3—Outline, Showing Breaker in Closed Position

and the linkage carrying the contact pressure spring, is above center. When the breaker is tripped, the pressure on this toggle is released and the retrieving spring on the closing solenoid raises the pull rod, rotating the bell crank lever clockwise and breaking the toggle. This lowers the pin at the middle of the trip free lever and allows the roller and latch to engage, thus retrieving the trip-free lever. There is a cam which raises the trigger to allow the roller to engage with the latch.

The electric closing solenoid, mounted on the floor of the control compartment, has a lever which is pivoted on the frame and carries the retrieving spring and two-pole auxiliary switch. There is no trigger on the closing mechanism. The hand closing device is a two-bite arrangement operating on the mechanism lever. From the open-position, the mechanism lever is pulled down until it engages the hand closing latch. Then the second "bite" of the hand closing device is engaged and is pulled down to the closed position. This latch is used only for hand closing and is normally pulled forward out of the way. The hand-closing lever is normally removed from the mechanism.

The hand trip lever is located inside the control compartment just above the closing mechanism. Pulling this lever outward acts through a linkage to raise the trigger and trip the breaker.

The indicator for showing the position of the breaker contacts is coupled to the bell crank lever and shows position of the contacts from the outside of the housing above the door of the control compartment.

The breaker is enclosed in a metal housing with hinged doors in the front and rear. Removable covers are provided on each side of the breaker for access to the interrupting compartment and on top of the breaker for access to the trip mechanism. These covers are bolted in place and are provided with gaskets. A lifting device is furnished for handling the deionizing chambers.

All "De-ion" circuit breakers are supplied with low capacity heaters, one mounted in each compartment, for use in preventing moisture and condensation on the insulating parts. The use of the heater should be determined chiefly from experience with atmospheric conditions in the particular locality in which the breaker is installed.

Deionizing Chamber

Figure 4 shows a cross-section and end view of one of the deionizing chambers. These chambers consist of stacks of alternately arranged sheets of metal and insulation. The sheets are rectangular with a throat cut in them on the side towards the center of the breaker. Each stack is in five sections between which the edge wound field coils are placed.

The arrangement of the deionizing chambers and contacts are shown in figure 5. During interruption of short circuit, the arc is drawn between the arcing contacts and transferred to the arcing horns at the throat of the deionizing chamber. It is then drawn into the chamber by the magnetic field of the

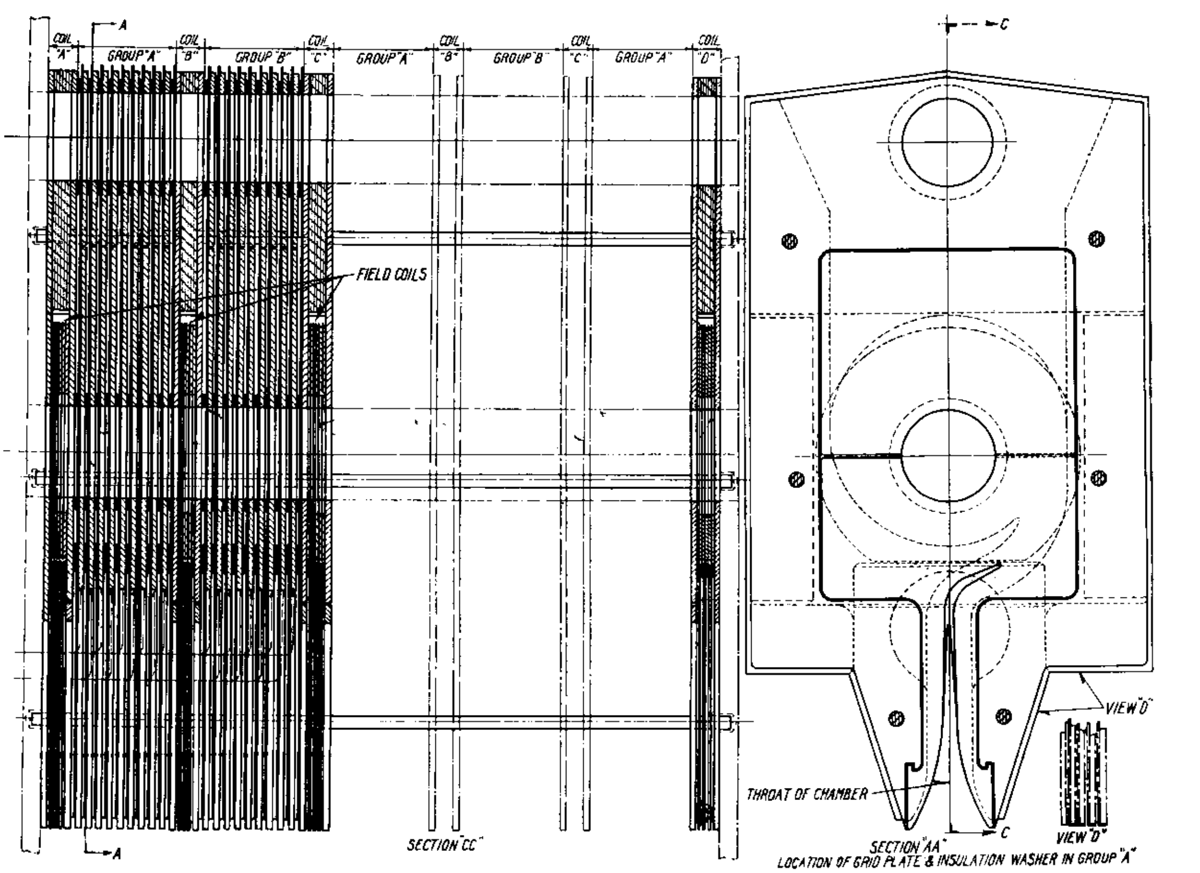

Fig. 4—Outline, Showing Cross Section and End View of Deionizing Chambers

blow-in circuit. The throat leads the arc into the chamber and diverts it to one side in the first section and to the opposite side in the second section and so on. The field coils become energized by the presence of the arc and produce radial fields in the sections. These fields are so arranged as to cause the arc to rotate about the center in opposite directions in alternate sections. The arc moves at very high velocity, so fast that it passes over the sheets of metal without burning them. When the zero point in the alternating current wave is reached, the arc is prevented from re-establishing by the rapid deionizing of the air in the conducting space. This is due to the particular arrangement of the conducting surfaces.

Installation

In installation, the breaker can be handled by a crane with chain hooks attached to the four lifting lugs at the four upper corners of the housing. The complete breaker weighs 6250 lbs. as shown on the name plate. The unit should be securely bolted down to the foundation by bolts through the holes in the four feet. It should be shimmed level. Packing and bracing should be removed before any attempt is made to operate the breaker.

Control conduit connections should be made to the holes provided in the bottom of the control compartment. Keep clear of the operating parts when the breaker is closed or tripped.

Connections of the buses to the studs are made according to the means provided.

Adjustments

The circuit-breaker will be completely adjusted and tested at the factory and will be shipped completely assembled. When it is received, it will be necessary to remove the bracing, which is put in for shipping purposes, before the breaker can be operated. No adjustments should be needed and none should be changed unless it is obvious that they are wrong. In operation, there are certain adjustments that must be right for proper operation.

The bell crank lever open position stop adjustment above the control compartment is important; it must be set to stop the contact operating linkage when it retrieves to the open position. Otherwise, this blow will be taken by the trigger parts and damage will result. This stop should be set to have as little clearance as possible and still allow the breaker to reset properly. The proper setting is approximately 3/8 inch.

The bell crank lever closed position stop should be adjusted so that center of the toggle (formed by the bell crank and link carrying the contact pressure springs) is above center approximately 1/4 inch. Be sure this stop is tight at all times.

The setting of the trip armature air gap should be as small as possible, still making sure that it will lift the trigger clear of the latch when the air gap is closed electrically. Such a setting will be obtained with approximately 5/16 inch air gap. The slotted link connecting the trigger and armature should be down so the pin in the trigger is at the top of the slot in the link. This will allow the armature to get into motion and strike a hammer blow on the trigger.

Trip coil cut-out switch operating lever should clear the driving lugs on the lower spring guide when the breaker is open. This relieves the spring guide of undue strain and causes the switch linkage to be stopped on the rod end under

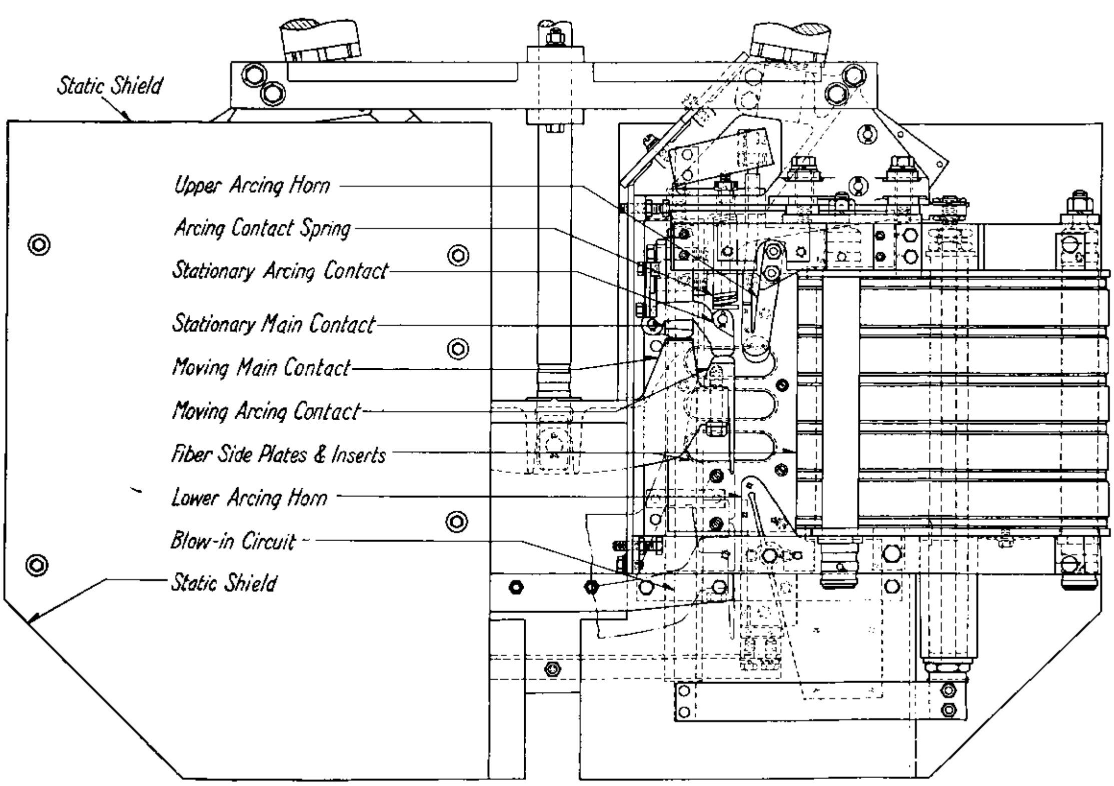

Fig. 5—Outline, Arrangements of The Deionizing Chambers and Contacts

the spring, which is designed for this purpose. This adjustment is made by removing the rods inside the switch linkage spring and rotating the rod ends.

The retrieving spring on the back of the closing solenoid must be properly tightened at all times. It must be tight enough to retrieve the mechanism properly in operation. The adjustment is at the bottom.

Contacts are brought to their proper position, when assemblying by the lift rod being screwed into the upper rod end the proper amount. It is then pinned in place. To maintain pressure with variation in the contact surfaces, the nuts on the rods through the contact pressure springs are adjusted to clear the end of the bracket by approximately 1/8 inch. This adjustment should be maintained at all times.

Trip coil cut-out contactor must be adjusted so as to close when the breaker closes. The linkage is such that it goes slightly over center when the breaker is closed. If not properly set, it is possible for the contacts to close as the breaker closes and then to open slightly. It is important that this be avoided.

The length of the auxiliary switch operating rods and the radii of the operating levers are adjustable. The switches should be set so that the fingers make full contact with the segment in both open and closed position of main breaker contacts.

The closing coil cut-out switch is a standard 2 pole rotary type switch mounted on top of the solenoid mechanism. It is adjusted at the factory to cut off at the proper time for proper operation. This adjustment should not be changed. It will be found that the proper setting is such that the finger is just beginning to cover the segment of the pole used when the breaker is closed. Too early contact will cause the breaker to fail. Adjustment is provided both in length of the rod and radius of the switch lever. The second pole of this switch is not used.

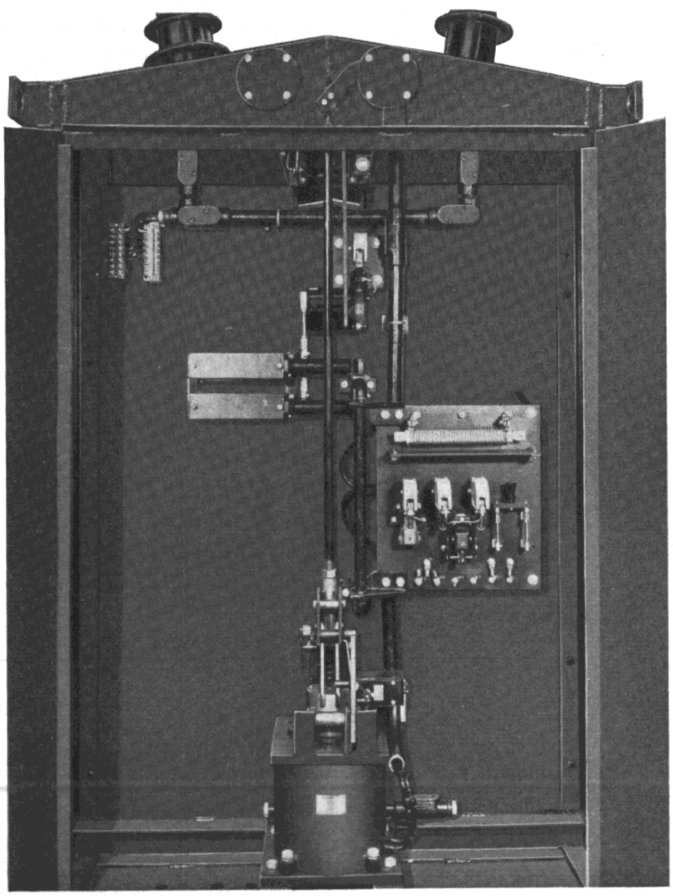

Fig. 6—Looking Into Control Compartment of Breaker Unit

Inspection and Maintenance

A regular systematic inspection should be made of this breaker to insure proper functioning at all times. The various adjustments described should be checked at intervals. The frequency of inspection should be determined by the severity of duty to which the breaker is subjected.

The surfaces of all insulating parts should be kept clean at all times. Accumulation of foreign matter should be avoided as far as possible. Keep the breaker clean and do not leave tools or other material inside the housing. See that bolts, nuts and set screws are tight at all times. Note evidence of excessive wear or improper operation of the various parts. Be sure that the operating parts are free and in good working condition at all times. Periodic application of light lubricating oil to the working parts is advisable. The main bearings of the contact operating linkage are equipped with alemite fittings and should be greased occasionally. The contacts should be inspected at intervals to make sure that they are in good condition and that they are under pressure when the breaker is closed. In case the service is severe, it may be necessary to replace the arcing contacts and arcing horns at intervals. Referring to figure 5, to remove the contacts, or other parts inside of the chamber, remove the micarta shields on the side towards the door by taking out the five bolts which hold each shield in place. The wooden blocks inside of the shield are then removed by slackening back on the clamping screws at the top and bottom and removing the four mounting screws. This much disassembly will allow a thorough inspection of the contacts and permit removal and replacement of the stationary and arcing contacts. To remove the moving contacts (breaker in the open position) remove the front tie bar and copper connection at the bottom. Take out the pin in the center of the contact and remove it.

If it is necessary to remove the arcing horns, the shields and wooden blocks are removed from the arc chutes on the other side. The upper arcing horn is removed by taking out the four screws that hold it in place. The lower horns may be removed by taking out the two screws which hold it in place and removing the copper connection below.

If it is necessary to remove the lift rod the two nuts under the lower bumper plate are removed, allowing the lift rod guide and springs to slide down. This is done with the breaker in the open position. The trip free lever is then pried down by means of a bar, compressing the contact pressure springs until the pin in the upper rod end is below the guide track. This pin is then removed and the lift rod taken out from below. The same procedure is followed in replacing it. When the wooden blocks are replaced, be sure the tapered surface fits snugly against the laminations in the stack with the fish paper sheet between them.

Removal of Deionizing Chamber

Should it become necessary to remove the deionizing chambers they are arranged to be raised or lowered by means of the lifting device which extends down from the roof above each chamber. This device consists of a bar with the outer end squared mounted in bearings suspended from the roof. The chambers each weigh approximately 500 lbs. A one-inch rope should be used and a loop formed through the lifting holes in the top frame of the chamber. Several turns of the rope should be put around the bar and the free end held by two men. In this way the stack can be lowered after removing the supporting bolts. To raise it into place, the same system is used and the lifting done by turning the bar at the squared end with a large wrench.

Renewal Parts

The following is a list of the Renewal Parts and the quantities of each that we recommend should be stocked by the user of this apparatus to minimize interrupted operation caused by breakdowns. The parts recommended are those most subject to wear in normal operation or those subject to damage or breakage due to possible abnormal conditions.

This list of Renewal Parts is given only as a guide. When continuous operation is a primary consideration, additional insurance against shutdowns is desirable. Under such conditions more renewal parts should be carried, the amount depending upon the severity of the service and the time required to secure renewals.

Recommended Stock of Renewal Parts for Breaker and Mechanism

For illustrations See Figs. 3 and 5

Name of Part	No. Per Breaker	Recommended for Stock		
Breakers in use up to and including		1	5	15
Moving Contact Complete	1	0	0	1
Moving Main Contact	2	0	1	2
Moving Arcing Contact	2	2	6	12
Lift Rod	1	0	1	1
Stationary Main Contact	2	0	1	2
Stationary Arcing Contact	2	2	6	12
Arcing Contact Spring	2	0	1	2
Condenser Bushing	2	0	0	1
Upper Arcing Horn	1	0	1	2
Lower Arcing Horn	1	0	1	2
Leather Bumper	2	0	0	2
Accelerating Spring	1	0	0	1
Bumper Spring	1	0	0	1
Upper Spring Seat	1	0	0	1
Lower Spring Seat	1	0	0	1
Trip Free Lever with Link	1	0	0	1
Trip Free Latch	1	0	0	1
Trip Free Latch Spring	1	0	0	1
Latch Cam	1	0	0	1
Latch Cam Spring	1	0	0	1
Trigger	1	0	0	1
Roller	1	0	0	1
*Spring Guide on Resetting Cam	1	0	0	1
Contact Pressure Spring	1	0	0	1
Switch Linkage Spring	1	0	0	1
Hand Trip Lever Spring	1	0	0	1
Hand Closing Latch Spring	1	0	0	1
Retrieving Spring	1	0	0	1
Static Shield	2	0	2	4
Barriers for Inside of Housing	2	0	1	2
Fibre Side Plates and Inserts	2	0	1	2
*Armature Link	1	0	0	1
Trip Coil Cut Out Contactor	1	0	0	1
*Contact for Cut Out Contactor	2	1	4	6
Cut Out Contactor Operating Rod Insulator	1	0	0	1
10 Pole Rotary Type Auxiliary Switch	1	0	0	1
2 Pole Rotary Type Auxiliary Switch	1	0	0	1
Trip Coil	1	0	1	1
Closing Coil	1	0	0	1

*Not listed on illustrations.
Parts indented are included in the part under which they are indented.

Type MZ Relay

General

The Type MZ Instantaneous Impedance Relay, the Type MT Time Delay and Instantaneous Relay, and the associated Transient Shunt are used for the sectionalizing of 12,000-volt trolley lines on multiple-track railways, in connection with special high-speed circuit-breakers. For convenience, a schematic diagram has been prepared showing all the external connections to one set of relays, controlling one circuit-breaker. See diagram figure 7. One MZ relay, one MT relay and two transient shunts are required for each circuit-breaker.

The Type MZ relay has three elements, an impedance element, a directional element and a load-compensating device for the impedance element, all in one case. The contacts of the impedance element are connected in series with the contacts of the directional element so that the tripping circuit is not made complete until both sets have closed. The current coil of the impedance element is connected in series with one winding of the directional element and then to a current transformer in the trolley line. The other winding of the directional element is connected to a current transformer in the sub-station bus which feeds all the trolley lines on one side of the station. There is a reactance coil connected in parallel with the current coil of the impedance element. This reactance coil is called a "transient shunt" and is proportioned so that it shunts practically all unsymmetrical currents from the relay coil.

The load-compensating element is a rheostat connected in series with the restraining coils of the impedance element in order to change its setting to compensate for load current which may exist on the line at the time of short-circuit. At no load, the full amount of resistance is connected in series, and as the load current begins and rises the resistance is cut out proportionately by moving brushes which are operated by an induction disc magnet.

This induction disc element has a watt winding in order that its torque may have a linear relation to the amount of current flowing. It is not calibrated in watts but in amperes, since it operates upon the current coil of the impedance relay. It is not designed as a correct wattmeter; that is, it does not have maximum torque when the voltage and current applied to its windings are exactly in phase. There is a resistance and also a condenser connected in series with the potential coil so that the combination will give the relay maximum torque when there is an angle of 60 degrees between the line voltage and current. This 60 degree angle is approximately the impedance power factor angle of the overhead contact wire and rail circuit.

Description

Case and Cover—The Type MZ relay is rectangular, the same size as the standard Type CR directional overcurrent relay. The cover is made in two parts, one a rim of cast metal, and the other a standard glass cover. The metal rim is not fastened to the base and can be lifted off after the glass cover is removed. The removal of this rim gives access to the relay for repairs and adjustment.

Impedance Element—The upper right-hand part of the relay is the impedance element. It consists of three coils with independent magnetic circuits and a common armature, which is a piece of sheet steel bent at a small angle so that it can rock back and forth between the upper and the lower magnetic poles. The armature is mounted on a shaft midway between the upper

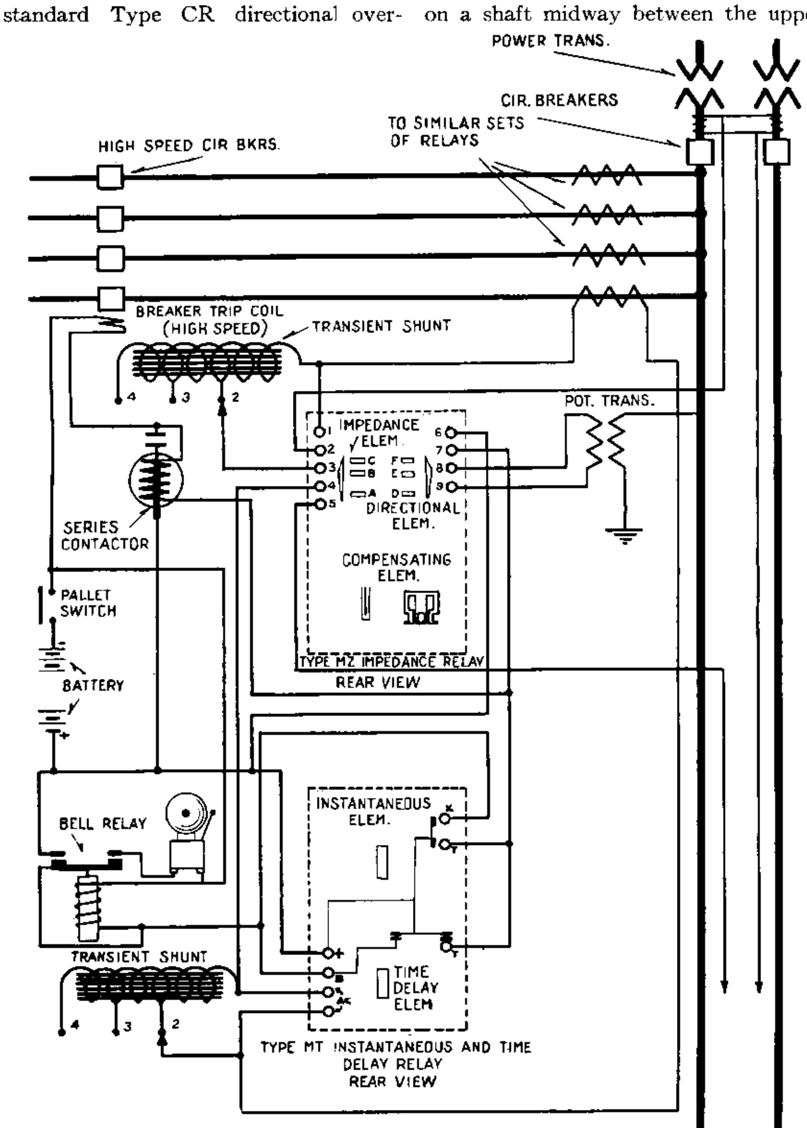

Fig. 7—Schematic Diagram Showing Connections to One Set of Relays Controlling One Circuit-Breaker

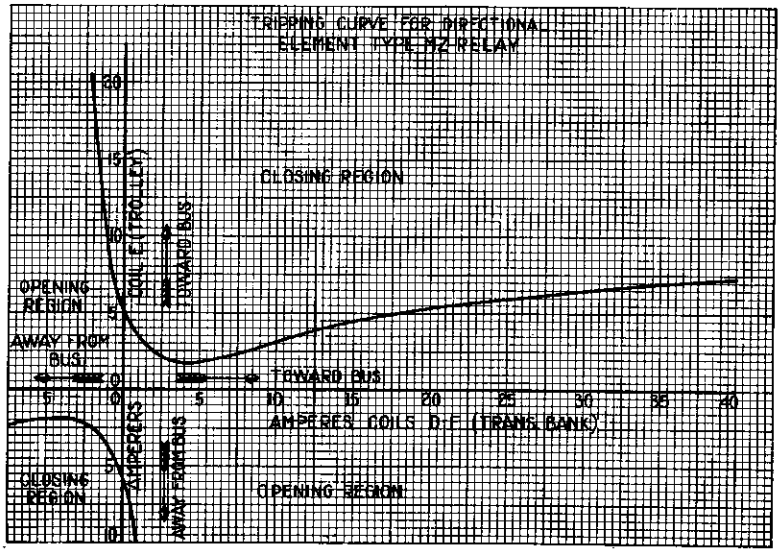

FIG. 8—TRIPPING CURVE FOR DIRECTIONAL ELEMENT TYPE MZ RELAY

and lower poles. There is no restraining spring. The armature is carefully balanced by means of weights on a stud just above the shaft. At the top of this element is a cam marked off in numbered divisions. A screw is provided for clamping the cam firmly in any desired position. The numbers are arbitrary but when referred to a calibration curve, they indicate (in conjunction with the taps on the lower coil) the impedance required to trip the armature and close the contacts.

The lower coil is the current coil, tending to cause the relay to trip, while the two upper coils are the restraining coils, connected across the voltage transformer.

Directional Element—The upper left-hand part of the relay is the directional element, consisting of a three-legged electromagnet with three coils and a small rocking armature pivoted at the center in the same way as the armature of the impedance element. There is an air-gap adjusting screw at the upper end of this armature. There is also a restraining spring provided to assist in obtaining the desired characteristic tripping curve.

At the lower end of both the impedance element armature and the directional element armature are moving contacts, which bridge the gap between two stationary contacts when the element trips. There is an operation indicator provided in the contact circuit to show that the breaker has been tripped by the relay. The moving contacts are made of a silver-graphite composition, and the stationary contacts are of a silver-tungsten mixture. The graphite is necessary because of the unavoidable arcing present which would weld metal-to-metal contacts. The metal member reduces the arc flame, and the tungsten content enables the metal to stand up without melting.

Contact Rating—The contacts can handle the current of approximately 150 amperes which flows momentarily when the breaker trips, but they should not carry more than 15 amperes continuously. Since the contacts are set very close together for high-speed operation, they must not break more than one ampere at 110 volts.

Contact Adjustment—The stationary contacts are mounted on an insulating bridge and made adjustable so that a separation of $\frac{1}{32}$ of an inch can be obtained no matter where the armature happens to be set for proper operation of the relay. Setting these contacts for proper separation is the last step in the operations of resetting and recalibrating the relay.

Load-Compensating Element—The lower half of the case is occupied by the load-compensating element. This is a small induction-disc electromagnet with a permanent magnet for damping the disc movements. There are a resistance tube and a condenser for adjusting the power factor of the potential winding as described in the fore-going general description. There is a tap block with seven holes for changing the operating current of the element, and also a long resistance tube which has twenty tap lead wires. These tap leads run to a terminal block at the top of a small commutator drum mounted on top of the induction element co-axially with the disc shaft. On this commutator are twenty silver bars, each connected to a tap lead wire from the resistor. Silver-tipped brushes rub on the bars and are mounted so as to be turned from bar to bar by movements of the induction disc.

Operation

Refer to the diagram, figure 7. The lower coil (A) of the impedance element is connected in series with the current transformer from the trolley line. There is in parallel with this coil a transient shunt. This shunt is designed sufficiently large that it will not saturate magnetically at less than approximately 25 amperes at 25 cycles. The continuous current capacity of this shunt is approximately 20 amperes, which is four times as much as any current which it can be called upon to carry continuously in this application.

The two upper coils (B and C) of the impedance element are the restraining coils and are connected in parallel across the potential transformer.

The directional element has three coils (D, E and F) reading from bottom to top. The coils D and F are connected in series, while the coil E has separate terminals. The coils D and F are connected to a secondary circuit of a current transformer connected in the substation bus. The coil E is connected in series with coil A and both are fed from the secondary of the current transformer in the trolley circuit. There are no transient shunts around the windings on the directional element. The characteristics of this element are such that when the currents in the two windings are exactly in phase the armature will trip at and above approximately three amperes, 25 cycles, in each winding. If the polarities are reversed relative to one another, the armature will not trip at any values physically possible to the trolley system. See figure 8.

A load-compensating resistance R_p is connected in series with restraining coils B and C of the impedance element. At no load there is the full resistance of 343 ohms in the circuit. At approximately ½ ampere (current tap No. 1) current, the disc begins to move and the brushes leave the first commutator bar, reducing the resistance. At and above five amperes, the last bar is reached and all of the resistance Rp is short-circuited. When the current falls approximately 10 per cent, the brushes will begin to return towards the no-load position.

Tests and Adjustments

Impedance Element—Refer to figure 9, which shows the preferred scheme of test connections. If three-phase power supply is not available, an alternative scheme for single phase power supply is shown in figure 10. Two adjustments are provided for setting the impedance element. One is a cam which changes the position of the armature when held by restraining voltage, and the other is a connector block for changing connections to three taps on the current coil A. Following is a table showing impedance settings obtainable with the various cam and tap combinations, for a particular relay. Each relay is slightly different from all others on account of manufacturing variations, and should be set according to its actual calibration table.

IMPEDANCE CALIBRATION TABLE

Following is the actual calibration table of a particular relay.

Relay Serial Number	Cam Mark Number	Ohms to Trip Current Coil Tap Number A-1	A-2	A-3
1126191	1	4.2	3.1	1.5
	2	6.5	4.2	2.0
	3	7.9	5.0	2.5
	4	9.5	6.4	3.0
	5	11.2	7.6	3.6
	6	12.7	8.6	4.0
	7	14.7	9.8	4.8
	8	17.3	11.5	5.6

To check calibration, it is only necessary to apply voltage and vary the current, or vice versa, until the armature trips. The phase shifter shown in diagram figure 9, is required to match the 60-degree power factor angle of the trolley lines. It should be set at 60 degrees lead of voltage ahead of current and left so during the test. Figure 10 shows a special loading reactor having about 60 degrees power factor angle. In this scheme of connections, the current must be constant and the voltage varied by the voltage regulator. Either method, varying the voltage, or varying the current, will set the relay correctly. Use formula $E = ZI$.

Directional Element—This element should never require adjustment unless a different chracteristic curve is desired. In making the adjustment, the air-gap screw at the top end of the armature is moved and set first so that the high D-F current end of the curve figure 8. comes about right. Then the spring tension is set to give minimum tripping on 5.5 amperes in coil E only.

Load Compensating Element—Only one adjustment is provided for the load-compensating element, changing the strength of the spiral spring. It is necessary, in addition to checking the calibration, to see that the connections to the resistor Rp are correct and that there is neither too much or too little pressure between the silver brushes and the silver commutator bars.

Brush pressure is adjusted by delicate bending of the brush wires with tweezers. There must be positive contact, with minimum pressure. Too much pressure is very detrimental because of the friction which tends to cause lag in the movements of the disc and inaccuracy in its following the variations of current in the windings. Bend the brush wires very slightly until obtaining the minimum pressure that still permits the brush to make contact with all the bars.

The best way to check the continuity of the circuit is to apply 110 volts to terminal 8 and 9 of the relay, and connect a volt meter from terminal 8 to tap lead wire #20 where it is soldered to the connection part on top of the commutator structure. The meter should indicate a new value of voltage when each new bar is reached as the brushes move around the commutator drum. After one brush is set, place a piece of thin paper between it and the bars, and set the second brush the same as the first. Then remove the paper.

To check the calibration, set the voltage at 110 on the potential coil and put current tap screw in #1 hole. Vary the current by means of the non-inductive rheostat. Adjust spring tension until brushes leave the first bar at ½ ampere and reach the 20th and last bar at 5 amperes plus or minus 2½ per cent. The position of the brushes varies directly as the current varies. If any change in the spring setting is required, it can be made by loosening the screw which clamps the spring and moving this clamp slightly. Then retighten the screw. Such a change should rarely be necessary.

The Current Taps are numbered from 1 to 7. Their ratings in terms of full-scale amperes are shown in the table below.

Tap	Full Scale Amps. at 110 Volts
1	5.0
2	7.5
3	10.0
4	15.0
5	20.0
6	30.0
7	40.0

The tap setting to be used is determined as follows: This tap setting must be changed whenever the impedance element setting is changed. For example: Assume that the impedance element is set to 1.58 ohms. Correcting for the transformer ratios of 12000/120 and 1200/5, the impedance at the relay is 1.58 times 2.4 or 3.8 ohms. Tripping current is 110/3.8 or 29.0 amperes. ~~To compensate for a five ampere load~~

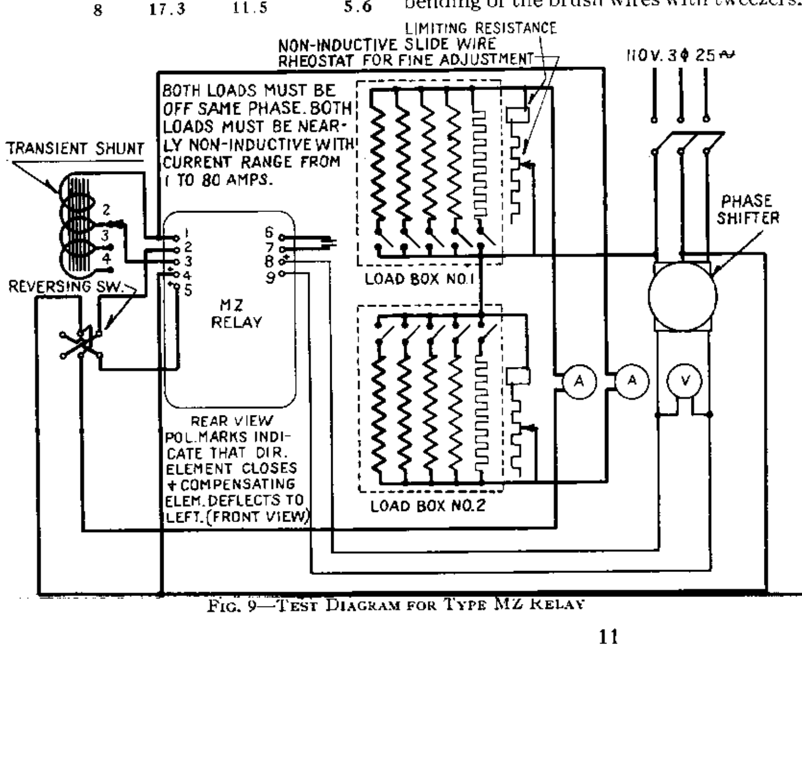

Fig. 9—Test Diagram for Type MZ Relay

current, the current in the potential coils must be increased in the ratio 29.0 plus 5.0 over 29.0. The impedance of the restraining coil circuit with R_P all in is 743 plus j100 or 750 ohms. Multiplying by 29.0/34.0 gives 640. The resistance component of this impedance is 632 ohms. The permanent resistance in this circuit outside of R_P is 400 ohms. 632 minus 400 leaves 232 ohms which must remain in R_P for proper compensation of the five-ampere load current. To make this compensation, the silver brushes must move to bar number 7 on R_P with 5 amperes in the current winding and 110 volts on the potential coil, with 60 degrees power factor angle. Tap number 4 is required on the current winding to accomplish this.

Type MT Relay

General

The Type MT relay consists of two simple clapper-type over-current elements, one of which has an aluminum disc and damping magnet to give a slight time delay. Each element has two contacts, one for bell alarm and one for tripping the breaker direct. The bell contacts are of silver and the trip contacts are the same graphite-silver and silver-tungsten combination used on the MZ relay. The contacts of both elements have independent terminals on one side, to permit the use of separate bells and the control of separate breakers. There are two operation indicators, one for each element.

Description

The Type MT relay has the same design of case as the MZ relay. There are two coils, connected in series, with a resistance to improve the power factor. The upper element is the instantaneous one, and the lower element has time delay. Both elements are restrained by permanent magnets instead of by springs, in order to get high-speed silent operation. Calibration is marked in amperes on a plate which mounts the permanent magnet. This magnet is placed in a soft steel shell to shield it from being demagnetized by the heavy alternating currents in the coils. Adjustment is made by sliding the permanent magnet laterally in the slots in its mounting plate.

The time delay of the lower element is obtained by the disc, which is damped by the permanent magnets. The magnet armature closes instantly and in doing so bends a flat steel spring, which then pushes a rod which is pivoted to a crank at the top of the disc shaft. In order to prevent false operations under load, it is essential that this element

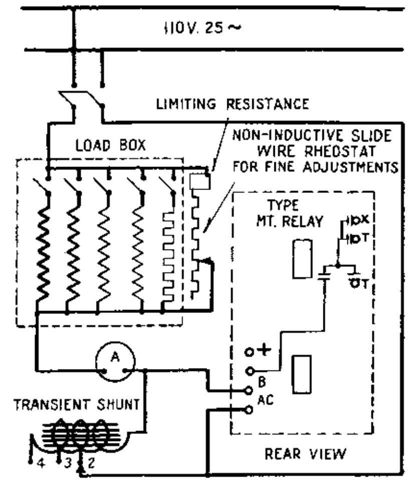

Fig. 11—Test Diagram for Type MT Relay

always release at slightly below pick up. Four flat springs are provided to give just the right tension-deflection curve necessary for this high drop-out characteristic. These flat springs push on and tend to open the magnet armature through four aluminum push rods.

Tests and Adjustments

Ordinary changes in the settings of the elements are made by loosening the screws which hold the round permanent magnet drums in place, and shifting the magnets to right or left, as required.

To check or to change the calibrations, connect the relay as shown on figure 11, with a transient shunt in parallel with the a-c. terminals. Vary the current by means of the load box and check the calibration marked on the permanent magnet supporting plates.

The air gap in each magnetic circuit when coils are de-energized is set by means of the nuts on the threaded shanks of the permanent magnet armature screws. Contacts should open about a maximum of $\frac{1}{16}$ inch on the upper element and the armature gap of the lower magnet should be about $\frac{3}{32}$ inch. A wider gap gives too slow operation.

Note: The permanent magnet armature screw heads must always be parallel with the sides of the slot in the permanent magnet shell through which they pass, and approximately central in that slot.

Note: Due to bearing friction, the elements of this relay will trip on less current, if suddenly applied, than that required if slowly increased. Calibration is always made on suddenly applied current.

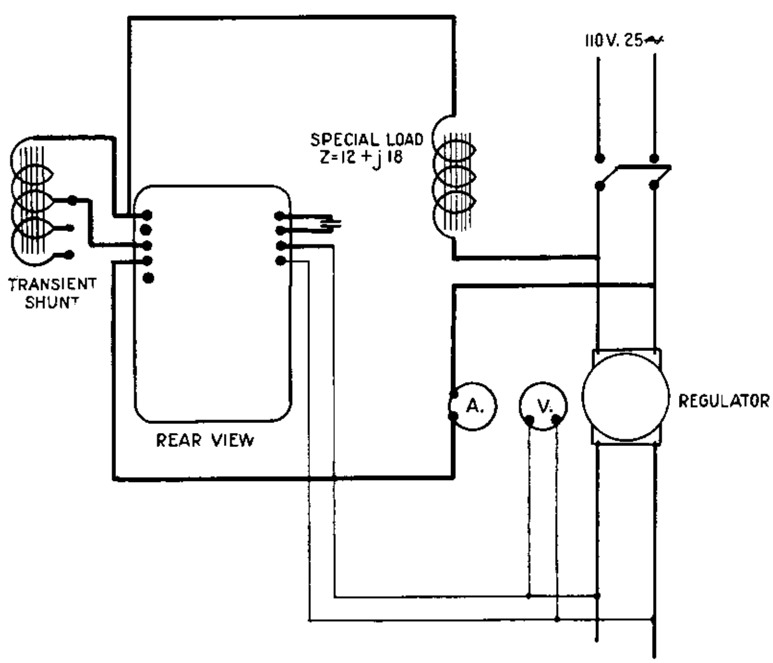

Fig. 10—Special Diagram for Testing Impedance Element (Only) on Single Phase

Directional element may be tested per Fig. 9, on either single or three-phase circuits as only one phase is used.