Westinghouse

Type SA-3 Solenoid-Operated Mechanism for Oil Circuit-Breakers

INSTRUCTION BOOK

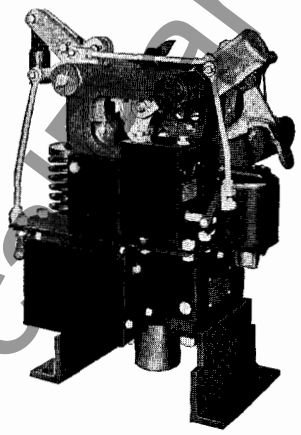

FIG. 1—TYPE SA-3 SOLENOID-OPERATING MECHANISM

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TABLE OF CONTENTS

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Introduction

This mechanism is the direct-current solenoid type. It operates on standard direct-current control voltages or, when equipped with a Rectox unit, on alternating-current. It is a mechanically full automatic mechanism, trip free in all positions.

Application may be made to indoor or outdoor breakers within the limits of power of the mechanism. For indoor service, it is mounted on the foundation or on the breaker structure. For outdoor service it is placed in a weatherproof metal box with enclosed connections to the breaker.

A control relay is supplied with the mechanism to handle the closing coil current. The necessary tripping devices form a part of the mechanism. A cut-off switch and the desired auxiliary contacts are mounted on the mechanism and mechanically connected to the linkage. A Veeder counter is supplied to record the number of operations. A position indicator connected to the breaker lever is also supplied.

Shipment and Storage

Whether the mechanism is shipped as a part of the breaker or separately, it is carefully inspected, tested and packed at the factory and should be received in good condition. It should be inspected for damage caused in shipment when received.

If the mechanism is to be stored for any length of time, it should be kept in a clean dry place, protected from dirt and moisture. The insulation particularly should be kept dry and reasonable care should be exerted to prevent it being damaged.

Unpacking should be done carefully so as to avoid damage. Care should be taken to remove all parts from the packing material. An instruction book and identification tags should accompany each mechanism.

Operation

Fig. 7 indicates the various parts of the mechanism as referred to. Referring to Figs. 7, 8, and 9, the breaker is connected to the bell crank lever by the pull rod end which is as shown in Fig. 7 for down pull. It can also be connected for vertical or horizontal pull. The bell crank lever is linked to the trip free lever which is inside the closing lever. The closing lever is connected direct to the moving core. In closing, as the core rises the closing lever and trip free lever, acting together, rotate clockwise about their fulcrum, pushing up on the toggle link and thus rotating the bell crank lever counter-clockwise about its fulcrum. In the closed position the locking lever slips under the pin in the moving core eye bolt and holds the mechanism closed. The right hand end of the trip free lever has a roller which is held down by the trigger. Behind the trigger, to hold it in place, is a toggle formed of a link and the tripping lever. In tripping, the trip rod rises, strikes the trip lever rotating it clockwise. This releases the roller on the trip free lever from the trigger. The trip free lever then rotates counter-clockwise about the pin in the eye bolt. This allows the toggle link to move down, and the bell crank lever to rotate clockwise opening the breaker. The mechanism is then in the position shown in Fig. 8. The trip free lever in rotating, kicks the locking lever out from under the core pin and the linkage drops back to the position shown in Fig. 9, the roller re-engaging with the trigger. The mechanism is then ready for the next operation. Should the trip be energized at any point in the closing stroke, the breaker would be released as previously explained.

It will be noted that no dash pots are used on this mechanism.

An accelerating spring is provided on the rear of the mechanism to increase the speed of opening of the breaker. This spring acts on the bell crank lever. Ordinarily the standard spring is used but in certain applications a special spring is supplied to meet the particular requirements of the breaker.

Fig. 6 shows a typical wiring scheme for d-c. operation. This scheme includes a Type S-1 trip free control relay. Moving the control switch to the "close" position energizes the operating coil on the relay which closes, energizing the closing coil, and closing the breaker. When the closed position is reached, the release coil is energized through the cut-off contacts of the 2-pole switch which is operated by the closing lever. This releases the latch on the relay and allows it to open, even though the operat-

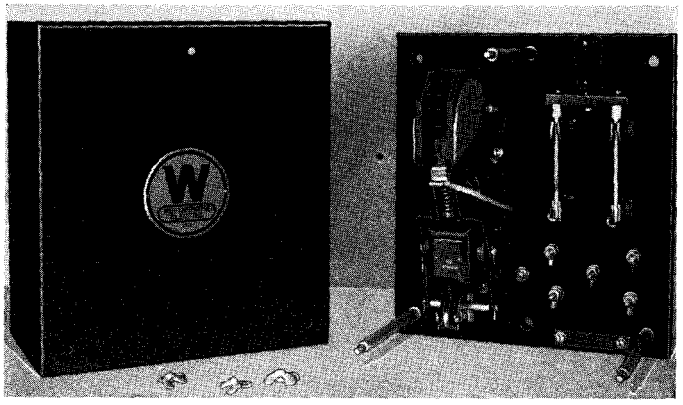

FIG. 2—CONTROL PANEL AND COVER

ing coil is still energized. The relay cannot be closed to energize the breaker closing coil again until the control switch is turned to the neutral position. To trip, the control switch is turned to the trip position energizing the trip coil through the auxiliary switch which is operated by the bell crank lever. As the breaker opens, the trip coil is de-energized by this switch. The 2-pole knife switch is arranged to isolate the breaker from the control circuit.

Hand closing is provided by means of a removable lever which is inserted in a socket of the closing lever. The breaker may be tripped free of the hand closing lever the same as it is from the closing core.

The auxiliary switches are Type W rotary switches. The 2-pole switch is connected to the closing lever and thus moves with the core. It serves to cut-off the closing coil when the cores come together in closing and also provides an extra contact. The 6 or 10-pole switch is connected to the bell crank lever and moves with the breaker. Two sets of contacts, connected in series, are used to de-energize the trip coil and to allow is to be energized when the breaker is closed.

Latch Checking Switch

The latch checking switch is intended primarily for use on circuits where automatic reclosures are desired. It is designed so that the reclosing circuit is not completed until the solenoid mechanism levers have reached the retrieved positions.

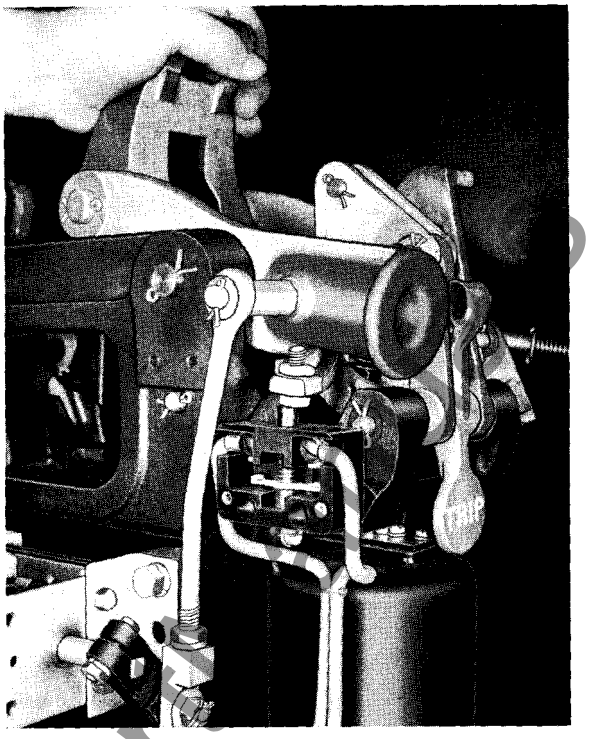

FIG. 5—SA-3 NORMAL LATCHING POSITION

When the mechanism has been tripped out, the trip lever is locked out by means of a locking lever until the trip free lever has returned to the retrieved position, at which point the latching lever is disengaged, allowing the switch operating lever to retrieve and close the contacts of the plunger type switch.

Adjustments

Fig. 3 shows the switch contacts in the closed position with a clearance of $\frac{1}{16}$ to $\frac{3}{16}$ inch between the top of the plunger and the head of the adjusting screw. This clearance is important

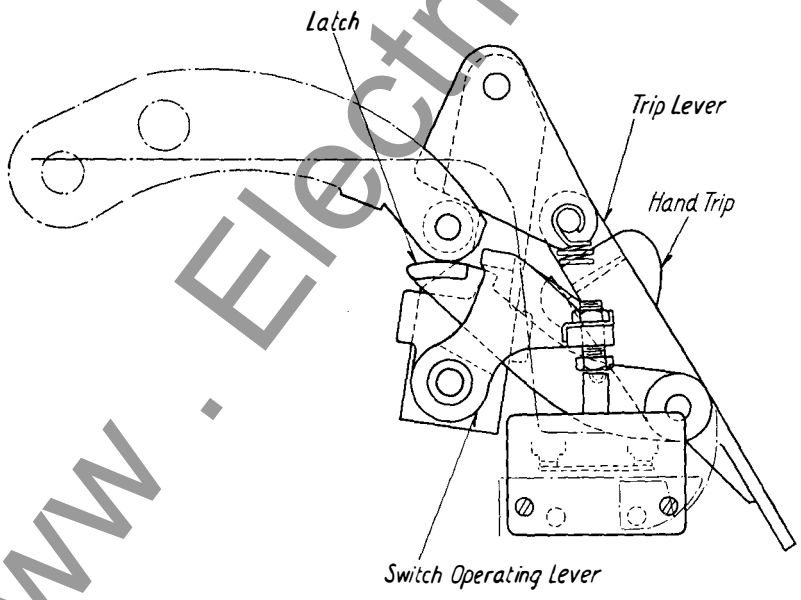

FIG. 3

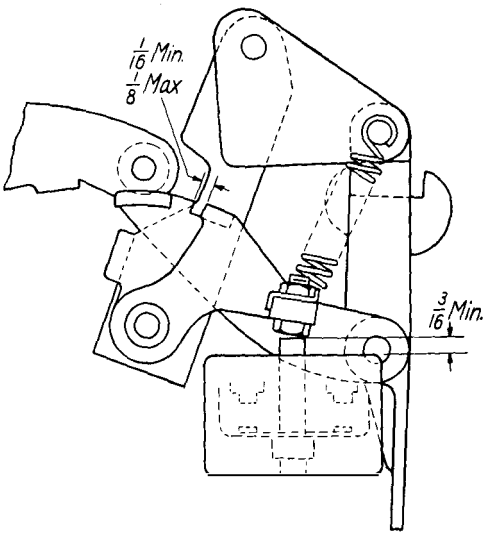

FIG. 4

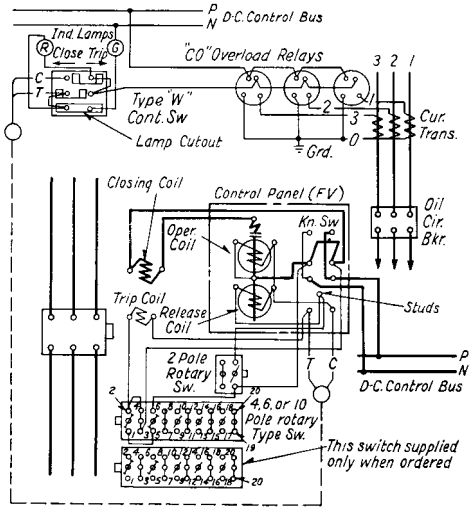

FIG. 6—TYPICAL WIRING DIAGRAM FOR MECHANISM

and must be maintained in order to insure good contact. The adjusting screw may be turned in or out as required to secure the clearance specified. After final adjustments have been made be sure that the lock-nut is securely locked in place.

Fig. 4 shows the switch operating lever in the maximum open position with the contacts of the switch open. In this position there should be a clearance of $\frac{1}{16}$ to $\frac{1}{8}$ inch between the latch and the switch operating lever. The top of the plunger should also be extending approximately $\frac{3}{16}$ inch minimum above the top of the switch. This dimension should not be less as the plunger will go solid and damage the switch beyond repair.

Fig. 5 shows the normal latching position. Failure to latch out may be due to incorrect angle on latch, insufficient clearance at latching point, or a combination of both.

Tripping Devices

The tripping latch consists of a trigger, which has been hardened and ground, engaging a roller on the trip free lever. This is a slip-off trigger, that is, the surface of the trigger which engages the roller is ground at such an angle that it tends to slip off. It is held engaged by a toggle formed by a pair of links and the tripping lever. This toggle is held slightly over center, against a stop, by the tripping lever spring. When the trip rod strikes the trip lever it breaks this toggle and allows the trigger to slip off. When the mechanism retrieves, the toggle is broken by the roller striking the links on each side of the trigger. A bumper spring is provided on the tripping lever so the toggle will not be disturbed by the closing operation.

Shunt Trip—The standard shunt trip consists of a magnetic circuit, coil, and a stationary and moving core, the upper end of which extends out through the top. A bracket on the bottom retains the moving core and limits its travel to about one inch. A thin brass washer prevents the cores from coming tight together.

4-Coil Trip Attachment—This tripping device, illustrated in Fig. 10, is to be used when transformer trips coils, capacitor trip, or undervoltage release is required. Space is provided for a total of four trip coils, including shunt trip, overload trip, with or without inverse time attachment or direct trip, and undervoltage trip. Only three direct trips and one under-voltage trip can be used. Otherwise, any combination up to four may be obtained.

The trip attachment is bolted to the mechanism in the place of the standard shunt trip. It is flexibly mounted so that the shock of operation will not jar the tripping devices. Referring to Fig. 10, the trip rod is located under the trigger. The trip rod is held down by a toggle linkage which engages it in the notched portion. This linkage consists of links and a U lever which are normally down over center. When the linkage is struck in the center from below, the toggle is broken, the latch pin moves to the right and the trip rod is forced upward by the trip rod spring.

This toggle linkage is located right over the four tripping devices. An "H" shaped bar rests on the four bushings through which the trip rods slide. The

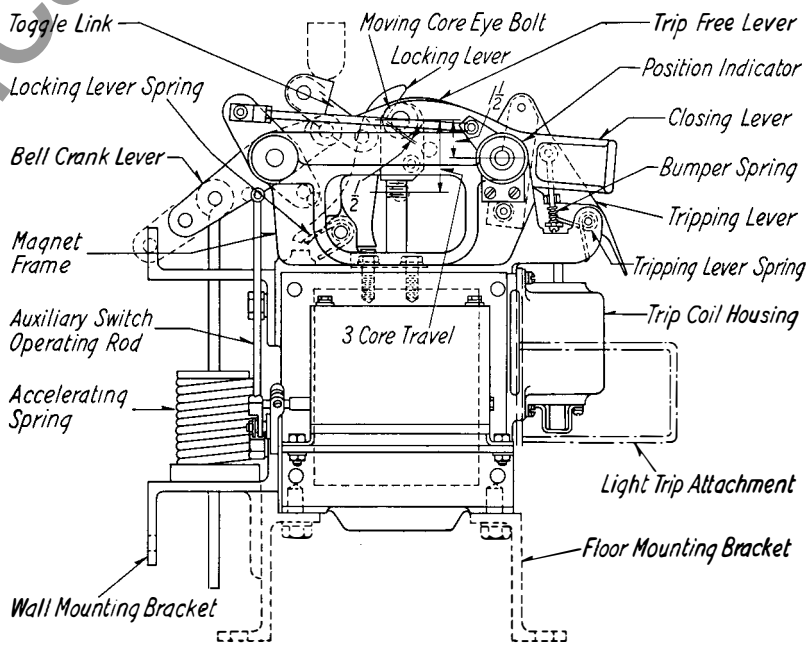

FIG. 7—TYPE "SA" 3-INCH SOLENOID MECHANISM DETAILS

operation of any one of the trips tilts up that corner of the "H" bar and raises the center enough to push the toggle up over center. In case one or more of the trips is omitted, a dummy bushing is used and the operation of the others is not affected.

As already explained, the force to trip the breaker comes from the trip spring. After tripping, and before another operation can take place, the trip rod must be reset. This is accomplished by the reset rod which is connected to the mechanism closing lever. The reset rod operates a reversing lever at the bottom, which in turn acts on the lower end of the trip rod, through a tube when the breaker is tripped, the reset rod rises and the trip rod which has just hit the trigger lever is moved downward and engaged with the latching pin. Then, on closing, the reset rod moves down and the lower end of the trip spring moves upward. Thus it stays until the breaker is tripped again.

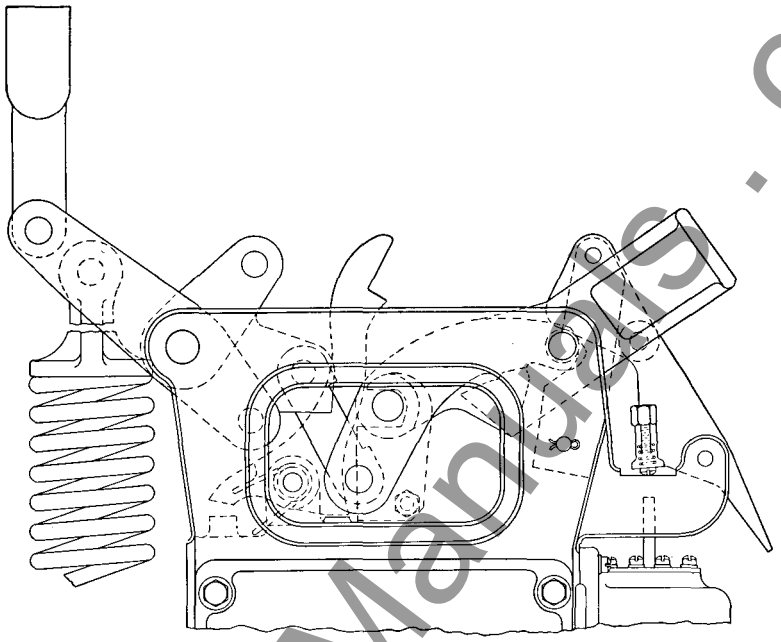

FIG. 9—MECHANISM—OPEN

Undervoltage Trip—The undervoltage device is mounted in the left hand rear space. A separate magnetic circuit surrounds the coil so that positive action of this part of the device is obtained. When the coil is energized the upper core is held down against the stationary core against the pull of the spring which is bias across the diamond shaped toggle device just below the mounting bracket. When the voltage across the undervoltage coil falls to a value of from 60 to 40 percent of normal, the undervoltage coil is no longer able to retain the upper core against the force of the spring. The spring then causes the core to rise and drives the trip against the trip bar.

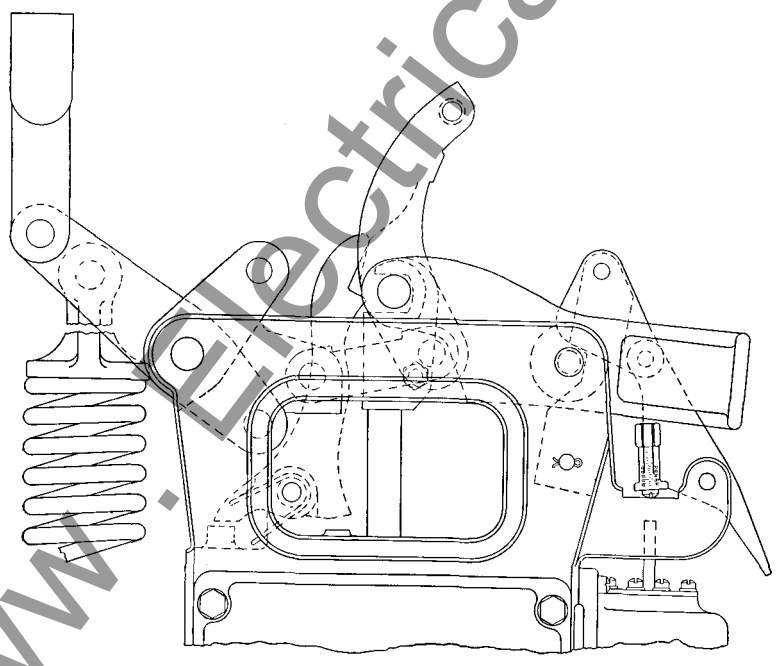

FIG. 8—MECHANISM—TRIPPED FREE

As the breaker returns to the open position the movement of the resetting rod and the reversing lever draws the diamond shaped toggle downward, bringing the undervoltage coils together. At the end of the stroke a small latch engages the inner end of the diamond shaped toggle to prevent the undervoltage release from tripping the breaker until the closing position of the breaker is reached. This latch is released by the rising of the reversing lever during the closing stroke of the breaker as it compresses the tripping spring.

5-Ampere Transformer Trip on Overload Trip—This is shown by Fig. 11 and is a duplicate of the shunt trip except for the coil. It is calibrated for tripping current of from 5 to 9 amperes. It is set to pick up and trip at 5 amperes. The setting is changed by raising or lowering the moving core, by means of the screw which extends from the lower end of the tube cap. The screw is secured by a locking nut which should be loosened before adjusting and retightened after setting is correct. Lowering the plunger gives higher pick up and current values and raising the plunger gives lower values.

Inverse Time Element Trip—Fig. 12 shows an attachment which can be adapted to a 5-ampere overload where tripping is not desired unless overload

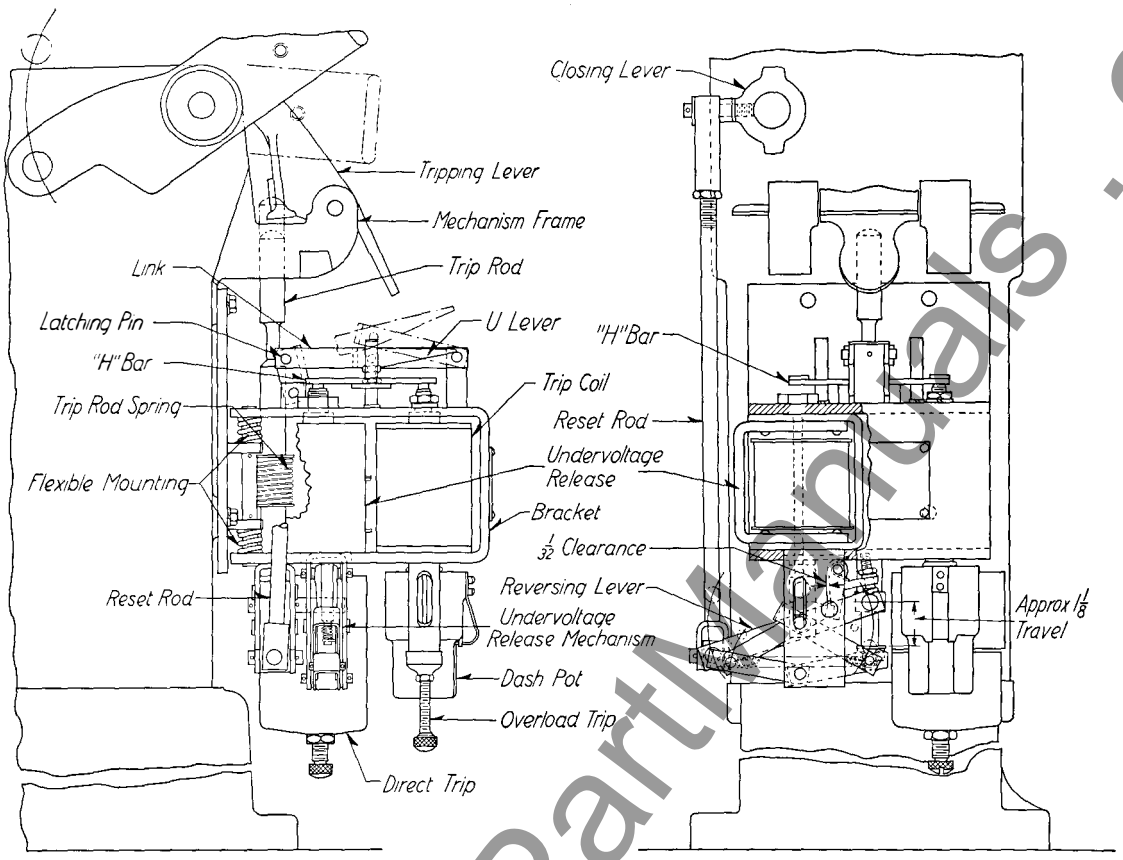

FIG. 10—FOUR COIL TRIPPING ATTACHMENT

continues for a predetermined length of time. The calibration is inscribed on the dashpot and is varied by screwing the pot into the cover.

The time is varied by changing the number of holes in the bottom of the piston uncovered by the diaphragm. Instantaneous resetting is possible because the check valve action of the washer at the time of tripping varies inversely with the amount of overload and directly with the variation in the viscosity of the oil. Fig. 13 shows variations of the time with the variations of the overload and the effect of changed temperature on the standard dashpot oil as supplied with the dashpot.

THE INVERSE TIME LIMIT ATTACHMENT should not be used when temperature is below 15°C. unless special oil is provided for dashpot.

Direct Trip Attachment—For low temperature which makes the dashpot unreliable, or where a definite time delay in tripping is desired, the trip with the attachment shown in Fig. 15 is available. This is used with a 5 ampere transformer trip and is connected as shown schematically for one phase in Fig. 14.

The device consists essentially of two concentric coils wound to oppose each other with a suitable magnetic circuit and a flat plate armature fastened to the lower end of the trip core. The outer or holding coil, with leads marked 3 and 4, is connected in series with the transformer trip coil and the CO relay operating coil. The current flowing in this coil serves to hold and seal the flat plate

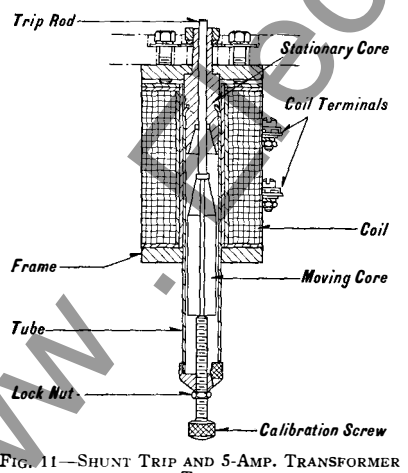

FIG. 11—SHUNT TRIP AND 5-AMP. TRANSFORMER TRIP

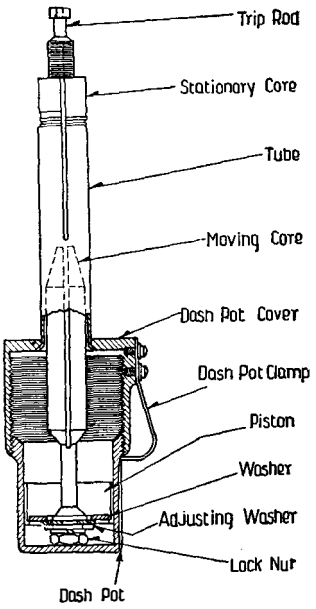

FIG. 12—INVERSE TIME ELEMENT TRIP

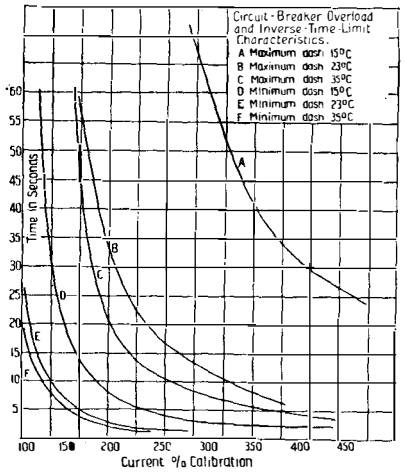

FIG. 13—CURVES FOR INVERSE TIME ELEMENT

armature to the pole pieces. The inner or secondary coil, with red leads, marked 1 and 2, is connected to the CO relay contacts and is short circuited by the action of this relay. When short circuited by the relay, the current induced in this circuit serves to set up a flux opposed to that holding the armature which is released allowing the transformer trip to function. An adjusting screw, balance spring and adjusting pin are provided to balance weight of the moving parts so that the armature will just touch the pole pieces when no current is flowing.

The armature and pole pieces must be kept clean and free from foreign matter as the breaker would be tripped out without functioning of relays if armature is not properly seated. Care must be observed in cleaning that the non-magnetic plating which covers the flat plate armature is not removed or injured. The pole pieces and the armature are accurately flat and care should be taken that the armature is not bent by mishandling, if it is removed for any reason. Variation in time delay with this device is obtained by adjusting the CO relays, The transformer trip and coils are the same as for the 5 ampere transformer trip.

Adjustment

When the mechanism is shipped from the factory attached to the breaker, it has been thoroughly inspected, adjusted and tested and no changes should be necessary. If it is to be assembled in the field certain relations must be obtained.

When setting up and connecting the breaker and mechanism, be sure the leverages and travel relations indicated on the assembly drawings are maintained. In the closed position the connecting rods should be adjusted to allow clearance at the breaker stops. The core should have approximately $\frac{1}{16}''$ overtravel, after latching, with the breaker stops still clear. In the open position the breaker should rest on its bumpers with clearance at the mechanism stop. After setting up, check the complete operation. Operate electrically and be sure that there is not an excessive amount of slamming.

The auxiliary switches are adjustable both in stroke and position. These switches are adjusted and set at the factory and should be correct. Certain conditions may necessitate a change in the cut-off switch adjustment as it is rather particular. However it is not always the cause of the mechanism failing to latch should this occur.

Should it be necessary to change contacts on the auxiliary switch from closed to open or vice versa in a given position, remove the switch and take the rotor out and remove the bolt in the end of the shaft opposite the lever. Take off the parts and rotate to the new position. Be sure to replace all parts in the proper relation and tighten up. Then check the operation of the switch when connected.

The control relay is adjusted and tested at the factory. The contacts should be kept clean by using sandpaper occasionally. **Never use emery cloth.** Coils can be identified by the style number stamped on them.

The shunt trip should require no adjustment. It should be kept tight and its mounting bolts should not be allowed to loosen as there is a definite relation to maintain between the trip rod and the tripping lever.

The 4 coil tripping attachment when used is mounted in place of the shunt trip. If shipped with the mechanism, it is tested and adjusted at the factory. If it is shipped separately to replace the shunt trip in the field, the shunt trip is removed and it is bolted on. The shoulder screw is put in the closing lever and the resetting rod put on.

With the mechanism trigger held in the open position the hand closing lever of the breaker should be moved slowly to the closed position. Before reaching the closing position, the latch of the mechanism can be released and the toggle latch disengaged. See that with the solenoid mechanism latch out of the way, the trip rod rises $\frac{7}{8}''$. With the mechanism in the closed position the distance from the cross head of the under side of the bracket should be $\frac{13}{16}''$ as indicated in Fig. 10. The resetting rod should be adjusted to obtain this dimension.

Raise any one of the tripping cores slowly by hand. The clearance between the screw in the "H" bar and the pin in the center of the toggle latch should not be over $\frac{1}{32}''$.

In the open position of the breaker check to see that the undervoltage release is drawn downward so that the

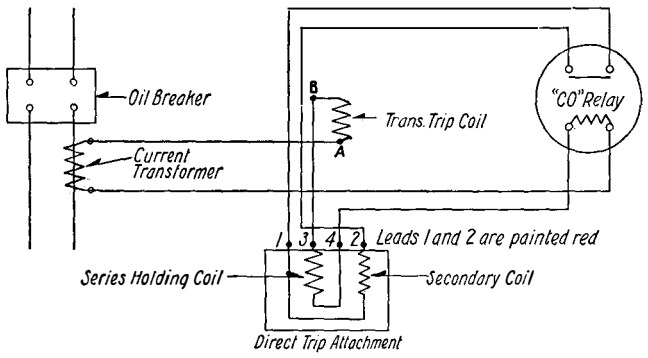

FIG. 14—SCHEMATIC DIAGRAM OF CONNECTIONS FOR DIRECT-TRIP ATTACHMENT

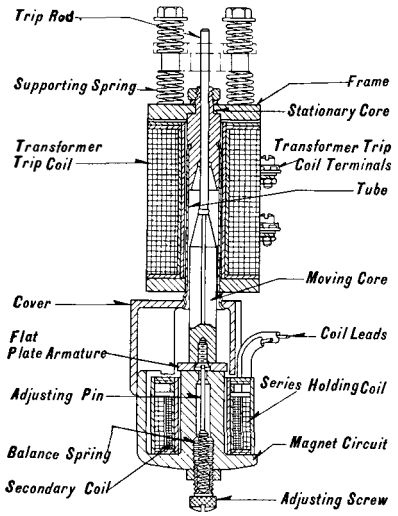

FIG. 15—OVERLOAD WITH DIRECT TRIP ATTACHMENT

lockout trigger engages positively. The screw on the inner end of this trigger should be adjusted so that with the mechanism in the closed position the latching surface of the trigger clears the end of the diamond shaped toggle by $\frac{1}{32}''$ as shown in Fig. 10.

The adjustment of the tripping devices on the 4 coil attachment is explained under the heading of Operation.

Inspection

The electric solenoid closing mechanism contains a number of moving joints and operating parts all of which are subject to wear or sticking, if not kept in the proper condition. It is desirable to inspect the mechanism at regular intervals and be assured of its good condition by making a number of operations, regular adjustments and repair. It is desirable to apply a light lubricating oil to the various pins but it should not be done to the extent of causing the joints to become gummed or sticky. It is necessary to keep the moving parts, particularly the trigger and switches, clean and free from foreign matter.

In case there is any trouble in operation, the mechanism should be taken out of service at once and put into the proper condition. The circuit-breaker is highly dependent on the proper functioning of the mechanism and therefore it should always be kept in good condition.

Rectox Rectifiers

General—This rectifier is designed to deliver direct-current at the amperage and voltage stamped on the name plate at any commercial frequency. The normal value of a-c. voltage at which the rated d-c. output may be obtained appears on the name plate.

The complete unit consists of a full wave rectifying element, adjustable series resistor in the a-c. line, a fuse in each a-c. line and suitable mounting plate or enclosing tank.

The rectifier units should not be immersed in oil.

See Fig. 1 for schematic diagram of the complete rectifier.

Operation—This rectifier is designed for intermittent operation only and must not be used to supply other loads than the breaker solenoid.

Unless otherwise indicated on the name plate the a-c. voltage must not be applied to the rectifier for longer than one second nor more than 10 operations within a five-minute period.

The rectifier rating must not be exceeded, as for instance by the operation of two solenoids at once.

Maintenance and Adjustment

Fuses—Use fuses having rating of approximately $\frac{3}{8}$ of the maximum d-c. load current drawn by the breaker solenoid. Fuses of this rating are used in order to protect the rectifying unit in case load should remain connected to the outfit for longer than the permissible time.

Resistor—The resistor is included as a means of compensating for variables such as line voltage, lead resistance, rectifier resistance, temperature, breaker mechanism variation, etc.

When the rectox is shipped from the factory it is set to give proper breaker operating speed at rated a-c. line voltage. When installing, the breaker closing time should be checked to see that correct operation is obtained, since line voltage conditions may be different from those at the factory. This should be done by means of a cycle counter after all mechanical and dashpot adjustments have been checked.

If closing time is incorrect, the series resistor in the rectox assembly must be adjusted.

To obtain quicker breaker operation, reduce the series resistance.

To obtain slower breaker operation, increase the series resistance.

Note—No further adjustment of the series resistor should be necessary except as may be required by the normal aging of the rectifier unit. Approximately 30 days after the unit has been installed, the breaker closing time should again be checked under the same conditions of supply voltage as existed during installation. Adjustment to take care of any change during the first 30 days, is again made by means of the series resistor. Following this adjustment, no further attention should be necessary except at normal periods of breaker maintenance, say every 6 months.

Current and Voltage Measurements—Measurements of rectifier output voltage and current can be made only by means of an Osiso, oscillograph, or coded meter, as the time required to use ordinary indicating instruments may damage the rectifier. Measurement of the closing time of the breaker, with a cycle counter, is usually sufficient indication of the rectifier output.

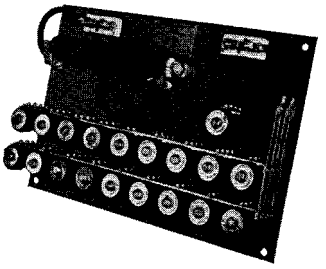

FIG. 16—PLATE-MOUNTED RECTOX FOR A-C. OPERATION

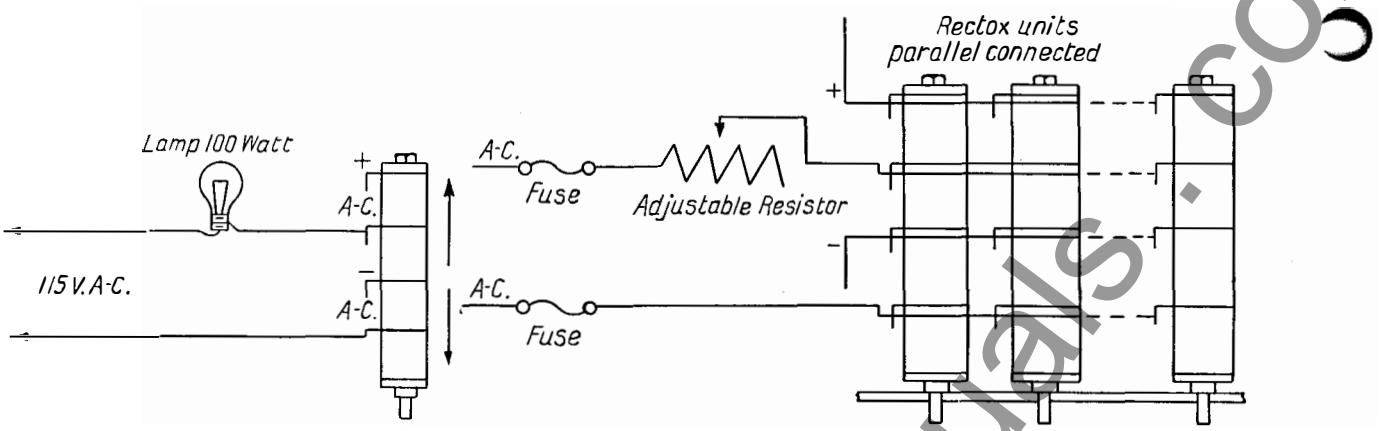

FIG. 17 FIG. 18

Investigation of Troubles—If the unit fails to close the breaker, proceed as follows:

a. Check the a-c. supply source to see that adequate voltage is available when the full load is being drawn.
b. Check the Rectox fuses to see that they are not blown.
c. Inspect all connections to see that none is open.
d. If all of the above appear to be satisfactory then probably a Rectox unit has failed unless the breaker mechanism is out of adjustment.

A. The failed unit may be detected as follows:

a. Disconnect the Rectox from the a-c. and d-c. circuits.
b. Apply 110 volts a-c. with a 100 watt lamp in series to the a-c. terminals of the rectifier for not more than one second.
c. If the lamp lights, one or more of the individual stacks have failed.

B. By means of the same test the particular unit or units that have failed can be picked out.

a. Disconnect all the units from each other.
b. Apply to the a-c. terminals of each stack in turn the 110 volt a-c. with the 100 watt lamp in series as before.
c. All units which light the lamp should be removed.

Emergency Operation—If an emergency exists, defective units can be removed and remaining units reconnected and put back into service temporarily. Some adjustment of the series resistor may be necessary to get the proper output. Replacement of failed units should be made as soon as possible.

Renewal Parts Data

Recommended Stock of Renewal Parts
TYPE SA-3 SOLENOID-OPERATED MECHANISM
For Oil Circuit Breakers
For Illustration of Parts See Figure 3

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 shut-downs 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 replacement.

Mechanisms in use up to and including		1	5	
Name of Part	No. Per Mechanism	Recommended for Stock		Style No. of Part
Mechanism Without Coils	1	0	0	... ...
Closing Lever	1	0	0	546 015
Trip Free Lever	1	0	0	546 016
Moving Core	1	0	0	998 441
Moving Core Eye Bolt	1	0	0	546 014
Stationary Core with Brass Sleeve	1	0	0	998 442
Tripping Lever	1	0	0	... ...
Bumper Spring	1	0	1	584 274
Tripping Lever Spring	1	0	1	546 018
* Tripping Lever Roller	1	0	0	940 210
* Trip Moving Core	1	0	0	562 132
* Trip Stationary Core	1	0	0	562 133
* Latch	1	0	0	546 037
Locking Lever	1	0	0	546 023
Locking Lever Spring	1	0	1	546 017
Accelerating Spring	1	0	1	... ...
Type W Auxiliary Switch—2 Pole	1	0	0	1 105 178
* Moving Contact Segment	2	0	1	545 626
* Stationary Contact Finger	4	1	4	519 279
Type W Auxiliary Switch—10 Pole	1	0	0	676 966
* Moving Contact Segment—Large	2	0	1	545 837
* Moving Contact Segment—Small	8	1	4	545 626
* Stationary Contact Finger	20	4	20	519 279
* Operation Counter	1	0	0	1 166 922
*Latch Checking Switch	1	0	0	1 114 956
†Closing Coil	1	0	0	†
†Trip Coil	1	0	1	†

* Not listed on illustration.
† When ordering, specify identification number stamped on part.
Parts indented are included in the part under which they are indented.

ORDERING INSTRUCTIONS

When ordering Renewal Parts, always specify the name of the part wanted as shown on the illustrations in this Instruction Book, giving Shop Order Number, and the type of Mechanism, as shown on the nameplate. For example:

One Tripping Lever, for Type SA-3 Solenoid Operated Mechanism, S. O. 28-F-283, shown in Instruction Book 5567, Figure 3.

To avoid delays and misunderstanding, note carefully the following points:

1. Send all correspondence and orders to the nearest Sales Office of the Company.

2. State whether shipment is to be made by freight, express or parcel post. In the absence of instructions, goods will be shipped at our discretion. Parcel post shipments will be insured only on request. All shipments are at purchaser's risk.

3. Small orders should be combined so as to amount to a value of at least $1.00 net. Where the total of the sale is less than this, the material will be invoiced at $1.00.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Headquarters—306 4th Ave., Pittsburgh, Pa. P.O. Box 1017

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#DENVER, COLORADO, 1700 Sixteenth St.
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†HOUSTON, TEXAS, 2315 Commerce Ave.
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†#NEWARK, N. J., Haynes Ave. & Lincoln Highway
xNEWARK, N. J., Plane & Orange Sts.
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#NEW ORLEANS, LA., 527 Poydras St.
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①#ST. LOUIS, MO., 710 N. Twelfth Blvd., c/o Central Terminal Co.
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①†SALT LAKE CITY, UTAH, 346 A Pierpont Ave.
①#SALT LAKE CITY, UTAH, 520 West Second South St.
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¶*SAN FRANCISCO, CALIF., 1 Montgomery St.
§SAN FRANCISCO, CALIF. 1355 Market St.
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Where address and P. O. box are both given, send mail to P. O. box, telegrams to address indicated.

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Westinghouse Electric Supply Company—Headquarters—150 Varick St., New York, N. Y.

Fully equipped sales offices and warehouses are maintained at all addresses.

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ST. PAUL, MINN., 145 East Fifth St.
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①Changed or added since previous issue.