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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CA-6 PERCENTAGE DIFFERENTIAL RELAY

FOR BUS AND TRANSFORMER PROTECTION

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type CA-6 percentage-differential relay is designed for the differential protection of multi-circuit buses. It has three restraining elements, each of which has two windings intended to be energized from the secondaries of current transformers in separate circuits connected to the bus. It has one operating electromagnet energized thru an external auxiliary saturating current transformer in accordance with the current flowing in the differential connection of the current transformers. Taps controlling the sensitivity of the relay are incorporated in the external transformer, there being no taps in the relay proper.

This relay has variable percentage characteristics which means that the operating coil current required to close the relay contacts, expressed in per cent of the total restraint current, varies with the magnitude of the restraint current. The relay sensitivity is high, corresponding to a low percentage ratio, at light currents, and its sensitivity is low, corresponding to high percentage unbalance, at high currents. The relay is made sensitive at low currents in order that it will detect light internal faults on the bus being protected. At the same time, however, its reduced sensitivity at the higher currents allows the various current transformers involved to depart from their true ratio to a large extent without causing false tripping of the relay for external faults.

The variable percentage characteristics are particularly advantageous when severe saturation of current transformers is caused by the d-c. component of asymmetrical short circuits. In the case of buses located close to generating stations where the d-c. component is particularly troublesome, the breakdown in ratio of the current transformers will be much greater than would ever be expected from a consideration of the usual ratio curves of the current transformers involved. It is for these cases that the type CA-6 relay is particularly intended.

For satisfactory protection of a generating station bus the following conditions must be satisfied:

1. There should be a restraining element provided for each major source of fault current. In addition, all those circuits connected to the bus which have no appreciable back feed for a fault on the bus (these being called feeders) should be treated as one outgoing circuit. One restraining element should be provided for this group. This may involve the use of more than one relay per phase. A more detailed discussion of this requirement appears under the heading, "Operating Characteristics and Connections."

2. The current transformer ratio must be such that the maximum internal fault current, expressed in terms of the secondary, does not exceed 100 amperes rms symmetrical. Currents in excess of this value approach a point on the characteristic curve where the excess of operating torque over restraining torque is diminished resulting in increased time of operation.

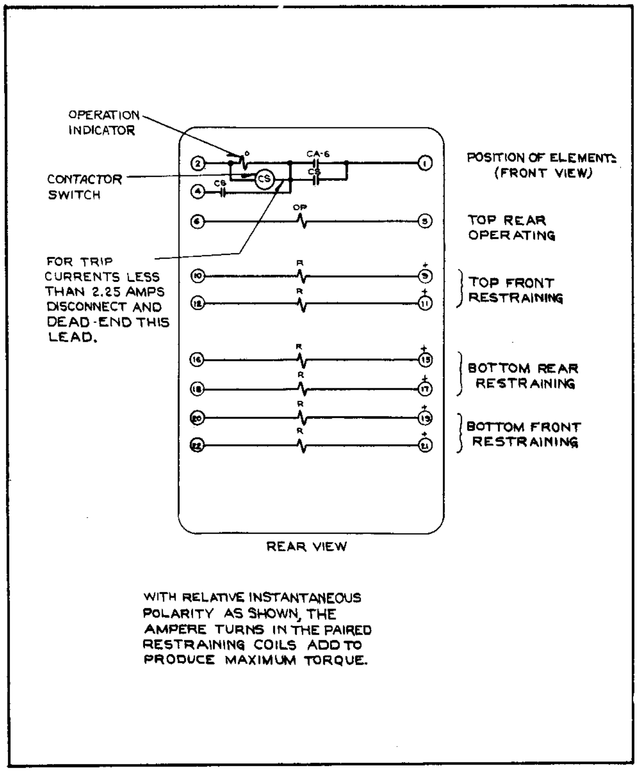


Fig. 1—Internal Schematic of the Type CA-6 Relay in the Standard Case.

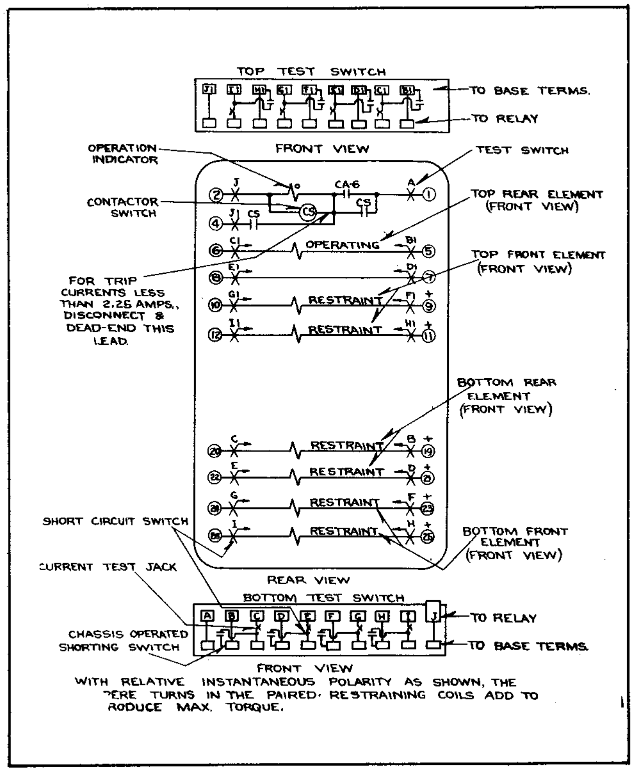


Fig. 2—Internal Schematic of the Type CA-6 Relay in the Type FT Case.

3. The current transformers must be good enough so that no appreciable a-c. saturation is experienced for the maximum external symmetrical fault current. This means that the magnetizing current of the current transformers carrying the total external fault current of 100 amps. should not exceed 1 ampere in terms of the secondary. Current transformers just meeting this requirement will saturate severly when a d-c. component is present. However, the characteristics of the relay are such that the errors in secondary current produced by d-c. saturation will not cause false operation on external faults.

In the case of sub-stations located at a sufficient electrical distance from large generating stations so that the d-c. component of asymmetrical fault currents is negligible due to the resistance of the circuit, the relay may be applied as long as the a-c. saturation characteristics of the current transformer come within the limits imposed by the variable percentage characteristics of the relay. For example, if the characteristic curve shows that a current of 30 amperes in the operating coil will just close the relay contacts for a particular condition, then the magnetizing current of the current transformer carrying the maximum current must be limited to less than 30 amperes.

While the Type CA-6 was originally developed as a bus differential relay, it has been adapted to be used as a transformer differential relay. This adaptation is a separate style relay involving the addition of an instantaneous trip attachment (see Figures 3 and 4) and a stronger spiral control spring. The instantaneous trip attachment is intended to operate on internal faults in the order of 100 amps. (secondary) or higher because, when a transformer bank is connected to a high capacity bus, it is difficult to keep the maximum internal fault currents down to the 100 ampere value as noted under item 2. Thus, the instantaneous attachment assures prompt tripping at excessively high current values. At the same time, the instantaneous element should not have a setting substantially lower than 100 amperes (secondary) in order to avoid

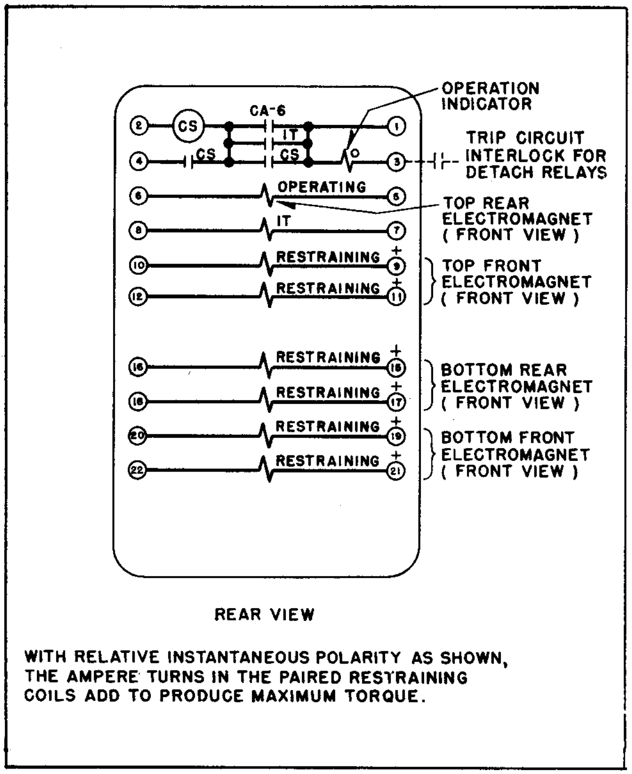


Fig. 3—Internal Schematic of the Type CA-6 Relay with an Instantaneous Trip Attachment in the Standard Case for use with a Magnetizing Inrush Tripping Suppressor for Transformer Fault Protection.

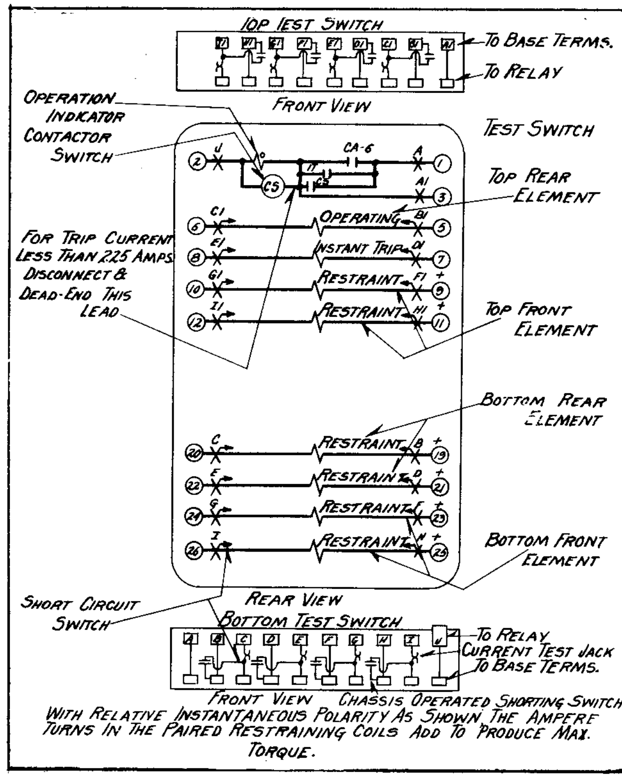


Fig. 4—Internal Schematic of the Type CA-6 Relay with an Instantaneous Trip Attachment in the Type FT Case for use with a Magnetizing Inrush Tripping Suppressor for Transformer Fault Protection.

a possible false operation for external faults. The stronger spiral control spring is provided in order that the relay may be given a higher minimum trip setting, as noted under "Adjustments and Maintenance." This is required because of the magnetizing inrush problem associated with power transformers. In the more difficult cases, it is necessary to provide a magnetizing inrush tripping suppressor.

CONSTRUCTION AND OPERATION

The type CA-6 relay consists of three restraining elements (six restraining windings) one operating element, a contactor switch, and an operation indicator.

The relay operates on the induction-disc principle and consists of four electromagnets operating on two discs which are fastened to the same shaft. Three of the electromagnets are restraining elements with two separate restraining windings connected to receive the secondary currents from the various current transformers. The fourth electromagnet is the operating element whose untapped winding is connected to receive the differential or unbalance current thru an auxiliary adjusting transformer. Taps are provided on the adjusting transformer to control the sensitivity of the relay.

The two induction discs are mounted on a vertical shaft. The lower bearing for the shaft is a steel ball riding between concave sapphire jewel surfaces. A pin bearing is used on the upper end of the shaft.

The moving contact assembly is attached to a Micarta bushing on the disc shaft. When the moving contact strikes the stationary contact, the moving contact spring deflects to provide a wiping action. The electrical connection from the moving contact is made thru the spiral spring to the spring adjuster.

The stationary contact consists of a right angle bracket fastened to the element frame thru a Micarta insulating block. A contact

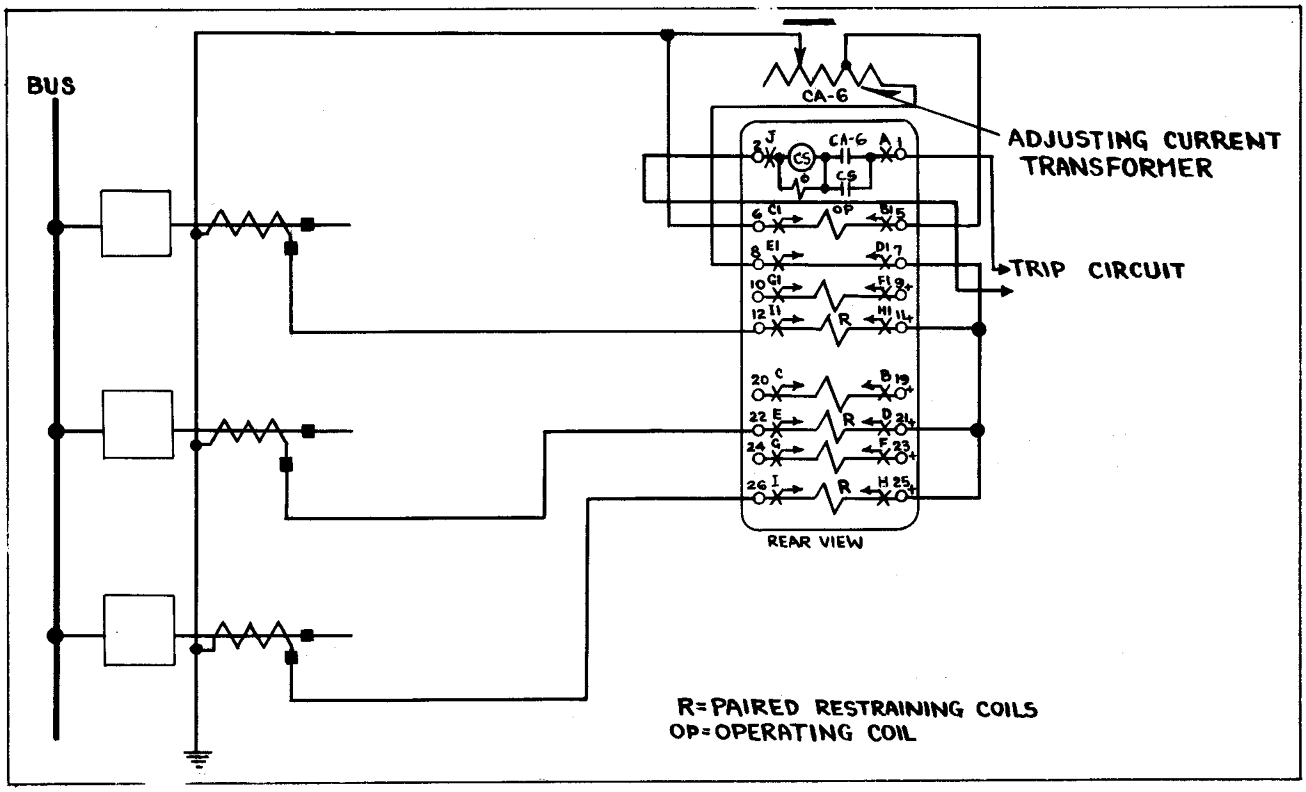


Fig. 5—Single Line Schematic Diagram of one Type CA-6 Relay for the Protection of a Three Circuit Bus.

screw projects thru the outer end of the bracket and provides adjustable contact separation.

The two lower electromagnets and the upper front electromagnet are restraining elements. The upper rear electromagnet is the operating element. Each restraining element has two windings brought out to separate terminals, Figure 1. The winding on the operating electromagnet is also brought out to a separate pair of terminals.

By referring to the internal wiring diagram, Figure 1, a current of 5 amperes in at terminal 9 and out of terminal 10 will produce a definite amount of restraining torque, as indicated by Figure 9. Similarly, a current of 5 amperes flowing in at terminal 11 and out of terminal 12 will produce an equal amount of torque. If both of these currents flow at the same time with the polarity as indicated in Figure 1, their effect will be additive and they will produce the same torque as though 10 amperes were flowing in one winding alone. Conversely, if equal currents flow in these two coils, but in opposite directions, their ampere turns will cancel and no torque will be produced. The same discussion applies to the other two restraining elements in the relay.

Referring to Figure 9, the tap values indicated on the torque curves for the operating coil indicate the 60 cycle current values flowing thru the external adjusting current transformer required to close the relay contacts against a restraint amounting to 70 cmg. (Centimeter-grams). This value has been so chosen because it represents the maximum restraint torque which can be obtained for an internal fault amounting to 100 amperes symmetrical rms. in terms of the secondary. This is the maximum torque which can be obtained with 100 amperes, when the relay has been connected in line with the principles set forth on Figure 7. Thus, with an internal fault of 100 amperes secondary, if the number 38 taps were being used, the margin of safety of the relay for correct tripping is the difference between 100 and 38 amperes or 62 amperes net. In the case of the #12 tap, a greater safety factor obtains, that is, with 100 amperes rms.

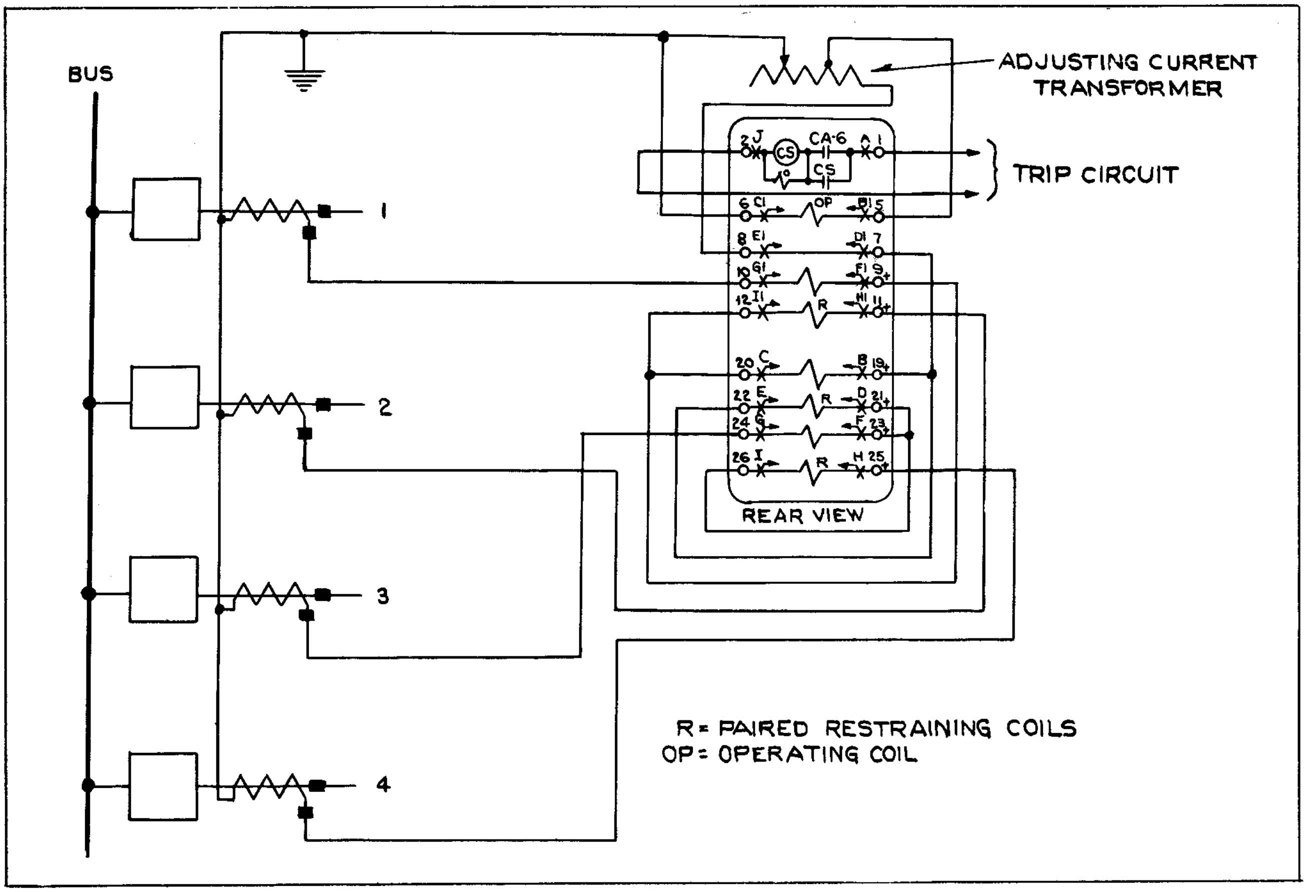


Fig. 6—Single Line Schematic Diagram of one Type CA-6 Relay for the Protection of a Four Circuit Bus.

symmetrical internal fault current developing 70 cmg. restraint in the relay, the #12 tap of the operating coil circuit will develop enough torque at 12 amperes to just balance this restraint. In this case the safety factor to insure correct tripping would be 100 - 12 = 88 amperes.

The contactor switch is a small solenoid type d-c. switch. A small cylindrical plunger with a silver disc supported on its lower end rides up and down on a vertical guide-rod in the center of the solenoid coil. The guide-rod is fastened to the stationary core which in turn screws into the element frame. When the coil is energized, the silver disc moves upward bridging three cone-shaped stationary contacts. Two of the contacts are used to seal in the main contacts.

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring restrained armature releases a white target which falls by gravity to show the completion of the trip circuit. The indicator is reset from outside the case by a push rod assembly in the cover stud.

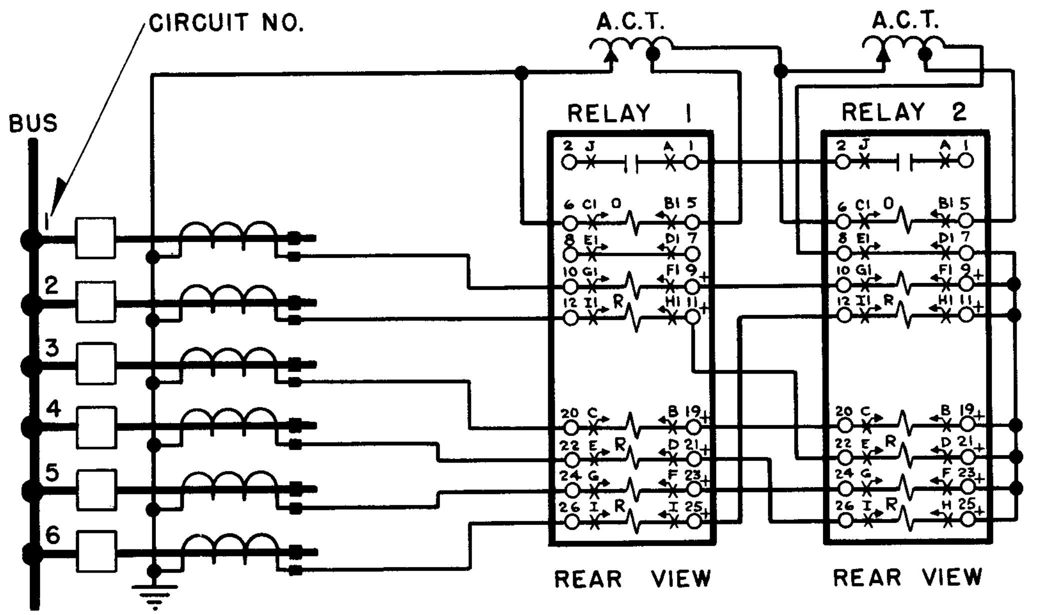
CHARACTERISTICS AND CONNECTIONS

The relay is adjusted by the following taps on the saturating adjusting transformer of Figure 15:

12 - 19 - 25 - 38

These tap values are the 60 cycle amperes required in the operating coil circuit to close the relay contacts against a 70 cmg. restraint.

The application of one relay per phase is limited generally to buses with three circuits is shown in Figure 5, However, one relay per phase can be used for a four circuit



R = PAIRED RESTRAINING COILS; O = OPERATING COILS.
A.C.T. = EXTERNAL ADJUSTING CURRENT TRANSFORMER.

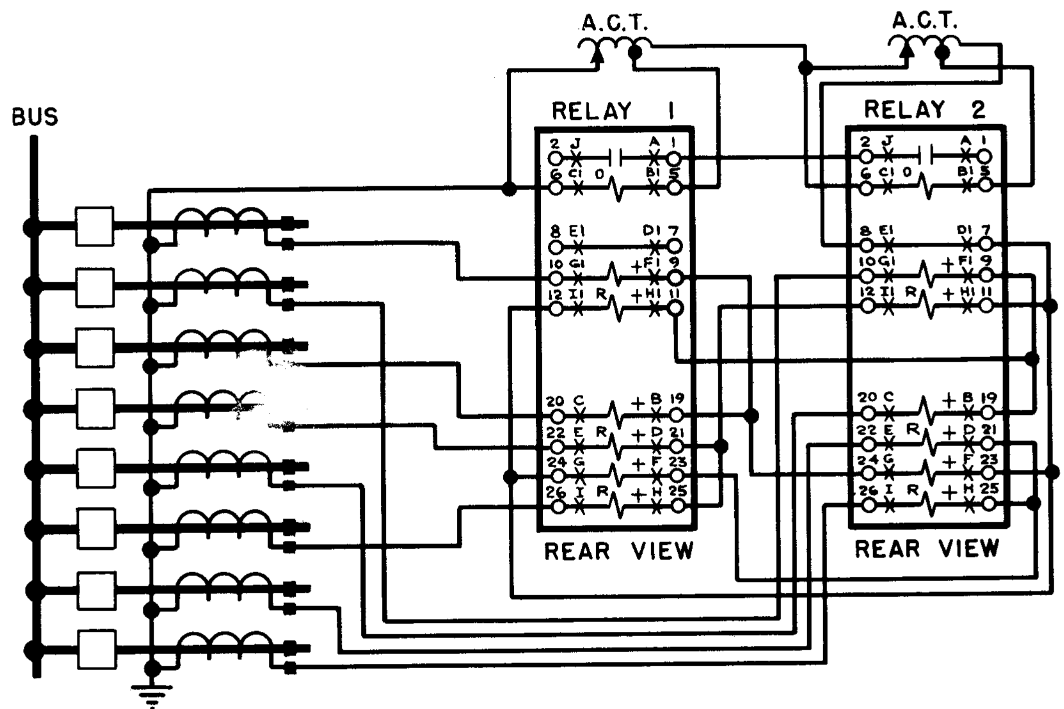
NOTES:
1. EACH CIRCUIT ENERGIZES TWO RESTRAINING COILS.
2. EACH RESTRAINING ELEMENT ENERGIZED BY TWO CIRCUITS.
3. OF THE SIX RESTRAINING ELEMENTS, NO TWO ARE ENERGIZED BY THE SAME PAIR OF CIRCUITS.
4. WITH RELATIVE INSTANTANEOUS POLARITY AS SHOWN ON THE RELAYS, THE AMPERE TURNS IN THE PAIRED RESTRAINING COILS ADD TO PRODUCE MAXIMUM TORQUE.

Fig. 7—Single Line Schematic Diagram of two Type CA-6 Relays for the Protection of a Six Circuit Bus.

bus by the special connections shown in Figure 6. Here each circuit is run through two restraint coils on different elements so as not to cancel restraint on the energized circuits when any combination of circuits is out-of-service. For either case the three or four circuits may be sources of fault power or any one be a group of feeders with no appreciable backfeed of fault power.

Where there are 5 or more circuits or groups of circuits, two relays per phase are generally required. The application of two relays per phase for the protection of a six circuit bus is shown schematically in Figure 7.

Figure 7 shows schematically the application of two relays per phase for the protection of a six-circuit bus. In this way two relays having three restraining elements each furnish a total of six restraining elements for the protection of a six-circuit bus so that a restraining element is available for each circuit. This is sometimes necessary in order that adequate restraint may be obtained for all conditions of system operation. Referring to this diagram, it will be seen that if an external short-circuit exists on circuit #2, and if there is a source of power on circuit #1 only, because of system-operating conditions at the time, then it will be observed that current flowing in circuit #1 and out circuit #2 will produce a total cancellation of restraint in relay #1. It is for reasons such as this that only one relay per phase, even though is has six separate restraining coils, is not always sufficient for a six-circuit bus. Upon examining the conditions affecting relay #2, however, it is seen that current flowing in circuit 1 and out circuit 2 gives full restraint in each of two restraining elements so that for this condition



R = PAIRED RESTRAINING COILS; O = OPERATING COILS.
A.C.T. = EXTERNAL ADJUSTING CURRENT TRANSFORMER.
NOTE: WITH RELATIVE INSTANTANEOUS POLARITY AS SHOWN ON THE RELAYS, THE AMPERE TURNS IN THE PAIRED RESTRAINING COILS ADD TO PRODUCE MAXIMUM TORQUE.

Fig. 8—Single Line Schematic Diagram of two Type CA-6 Relays for the Protection of an Eight Circuit Bus.

relay #2 has the proper amount of restraint. For this particular condition relay #1 would act as a sensitive overcurrent relay and could probably close its contacts if there should be slight difference in the output of current transformer #1 and current transformer #2. However, relay #2, having full restraint, would not close its contacts. Since the contacts of the two relays are in series, correct blocking of tripping action for an external fault is thus secured.

In any one given application where the sources of current connected to the bus are of different capacities, it is advisable that the largest of these sources energize separate restraining elements in at least one of the two relays per phase.

Figure 8 shows the schematic connections for the protection of an 8 circuit bus with two type CA-6 relays per phase. This arrangement has been carefully worked out to provide adequate restraint under all possible system operating conditions.

In the case of a 9-circuit bus, for example, in which four of the circuits are feeders over which there is no appreciable back-feed in case of an internal fault, the four feeder circuits may be paralleled on the secondary side of their current transformers and treated as one feeder. This in effect reduces such a 9-circuit bus to an equivalent 6-circuit bus insofar as the number of relays per phase is concerned. In many cases where there are more than six sources of current per bus sections, it is still possible to use a maximum of two type CA-6 relays per phase. This is because due consideration of the relative sizes of the

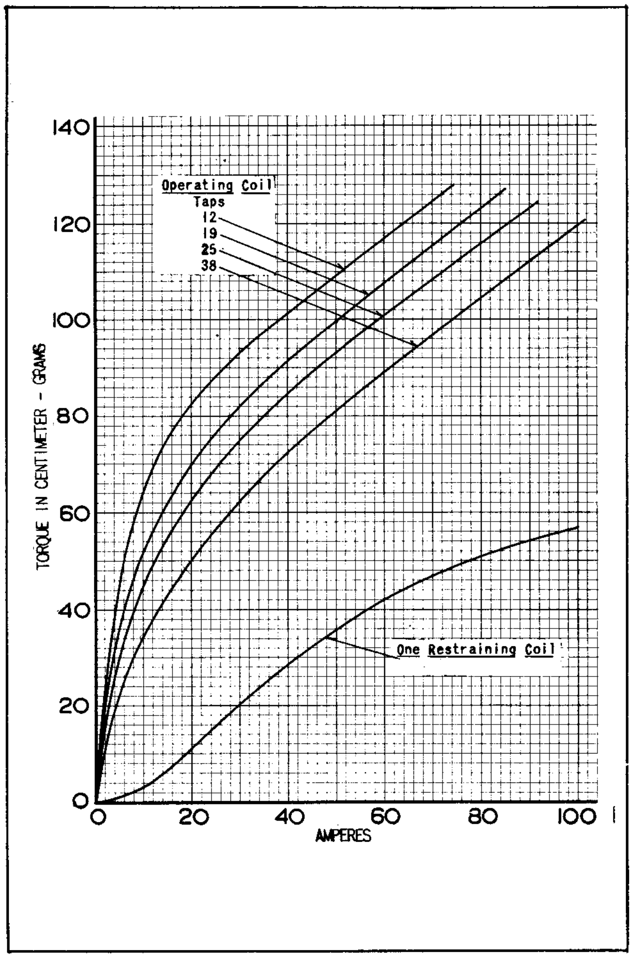


Fig. 9—Typical Torque Curves of the Operating and Restraining Coils for High Values of Current.

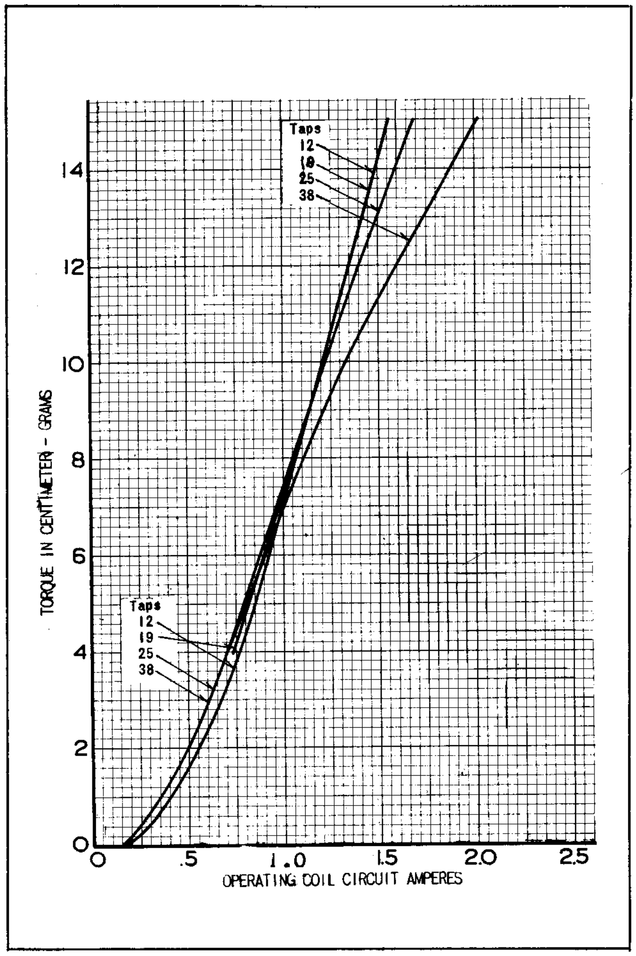


Fig. 10—Typical Torque Curves of the Operating Coil for Low Values of Current.

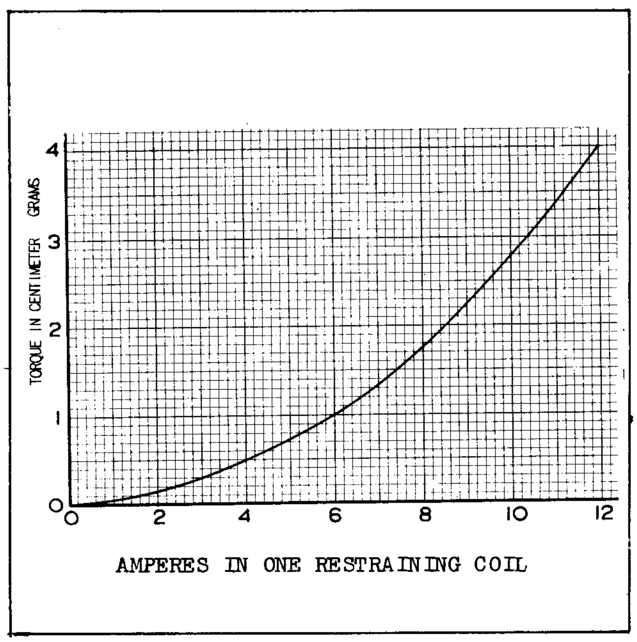


Fig. 11—Typical Torque Curves of the Restraining Coils for Low Values of Current.

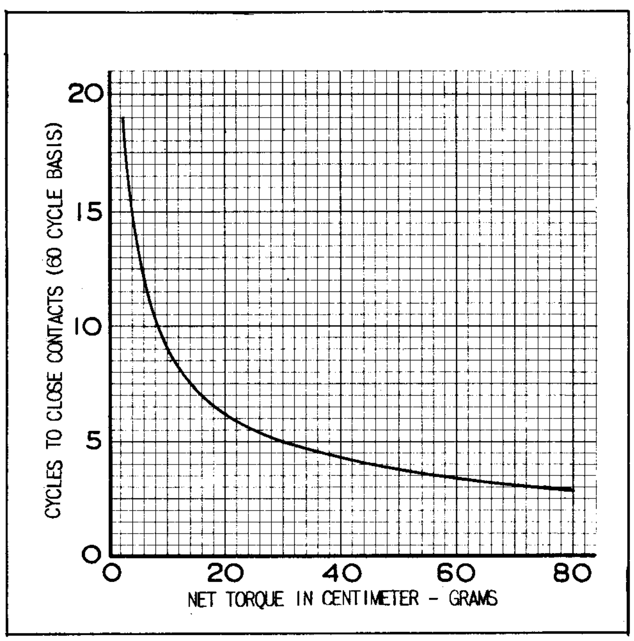


Fig. 12—Typical Net Torque—Time Curves.

various sources together with minimum operating conditions will often times show that some of the sources may be paralleled on the secondary side of the current transformers.

The usual method of plotting operating characteristics of percentage differential relays it to plot the operating coil current required to close the contacts against restraining coil current. In the case of the type CA-6 relay, however, there are many different possible conditions which may exist as regards the number of sources of current connected to the bus at any one time. Also, the location of the external fault is variable, hence there are a large number of operating characteristic curves which could be plotted for the relay depending upon conditions. One solution is to plot the minimum and maximum conditions. The preferable means of determining the operating characteristic of this relay is to utilize the torque-current curves as shown in Figures 9, 10, and 11. In this way, the particular system to which the relay is to be applied may be studied to determine that operating condition which will give the least restraining torque in one relay out of the two per phase which has the most restraining torque. When this has been determined, the torque curves for the operating coil will show how much error current may flow in the differential circuit without causing false operation. The torque curves may also be used to determine the tripping current required for minimum fault. It must be remembered that load current flowing during minimum fault will also produce restraint and must be taken into consideration.

The torque curves, Figure 10, do not start at the origin because of the initial spring tension. It is not recommended that a smaller spring tension be used. The spring tension may be increased, if desired, by means of the spring adjuster, but this should not be increased to a point where more than 0.4 amperes is required to operate the relay, when it is energized through the operating winding only. This current is to be measured in the input circuit to the external adjusting transformer. To increase the minimum pick-up above 0.4 ampere a stronger spring must be used. In any case it is not recommended that the minimum pick-up be increased above 1.25 amperes.

Time of operation of the relay is shown in Figure 12. To use this curve, determine the total restraining torque (3 restraint elements in addition to the spring tension, which is .15 cmg. for the condition shown on Figure 10) and subtract this from the operating coil torque to determine the net torque in cmg. This curve applies only for a contact spacing of 1/4 inch.

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches <u>first</u> before opening any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward.

This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position for test as well as on its back or sides for easy inspection and maintenance.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections, by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing in Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are opened so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above under "Electrical Circuits."

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external connections are shown in the several figures in this leaflet. The contactor switch and operation indicator are connected in parallel. This circuit has a resistance of approximately 0.25 ohms and is suitable for trip currents above 2.25 amperes d-c. It is recommended that the trip circuit draw at least 4 or 5 amperes d-c. This can be done by connecting a suitable loading resistor in parallel with the auxiliary multi-contact tripping relay.

The main contacts of the relay will safely close 30 amperes at 250 volts d-c. and the switch contacts will safely carry this current long enough to trip a breaker.

ADJUSTMENTS AND MAINTENANCE

Detail Tests.

The proper adjustments to insure correct operation of the relay have been made at the factory and should not be disturbed after receipt by the customer. However, if for any reason the adjustments have been changed or the relay taken apart for repair, the following instructions should be followed in reassembling and calibrating the relay.

Adjust the top bearing screw to have approximately .002" clearance between it and the shaft. Adjust the stationary contact so that 1/4 inch contact separation is obtained when the moving contact is held in the maximum open position.

The tension of the spiral spring should be adjusted so that the contacts just close when .14 ampere is flowing thru the #38 tap, or when .17 ampere is flowing thru the #12 tap. With the relay totally deenergized, the spring tension should reset the contacts to the full open position. The resetting time will be fairly slow because of the damping effect of the permanent magnets. If the contacts fail to reset with this spring tension adjustment, then the moving parts should be inspected for friction or interference.

Relays intended to include a power transformer in the differential zone differ from the above in that they are equipped with a stronger spiral control spring. The setting range thus provided is from .75 amperes to 1.25 amperes when using the #19 tap. This relay may be calibrated for minimum trip current within this range as dictated by the requirements of the particular application, remembering that if too low a current setting is used, trouble may be experienced on magnetizing inrush.

Adjust the contactor switch for a travel of

3/32 inch between the silver disc and the stationary contacts. With the plunger in the operated position adjust for a clearance between the plunger and the stationary core of approximately one turn of the stationary core and lock the core in place.

Block the relay contacts closed and pass 2.25 amperes through the trip circuit (terminals 1 and 2.) Both the operation indicator and the contactor should operate. Adjustments of the operation indicator may be made by moving the bracket carrying the target in and out after loosening the two screws on the under side of the assembly. After such adjustment the travel of the armature should be checked to see that it is sufficient to unlatch the target.

The polarity of the restraining coils, as indicated on the wiring diagram, Figure 1, should be checked if any rewiring has been done.

The effectiveness of the three restraining elements will vary within ± 10% limits with respect to each other when compared against a given current in the operating element. Since the restraining elements are wound and assembled to the same specifications, the variations observed are due to variations in the magnetic characteristics of iron and other minor details which it is impossible to control. The variation between elements is within reasonable limits, however, and is no cause for concern.

To check the calibration, pass 33 amperes through the three restraining elements in series using only one coil per element. See Figure 14. Reference to Figure 9 shows that this develops 23-1/3 cmg. per element or a total of 70 cmg. restraint. Pass current from a 220 volt a-c. source through the primary of the auxiliary transformer. The current required on the various taps to just balance this restraint torque (70 cmg.) should be as follows.

Tap	Amperes
38	36 to 40
25	24.5 to 28
19	18.5 to 20.5
12	11.5 to 13.5

The above values are obtained with the relay and transformer cold, and with no initial tension on the spiral control spring. When this test is complete, the spiral control spring should be adjusted for the proper minimum trip setting as previously discussed. Note that heating of the restraining circuits has very little effect when heated due to normal current flow and since the operating circuit normally carries no current, it is important to prevent over-heating of the operating coil or auxiliary transformer during test.

All contacts should be periodically cleaned with a fine file. S#1002110 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The burden of each restraining coil is .75 volt-amperes, 70% power factor at 5 amperes, 60 cycles. The burden of the operating coil circuit, including the external adjusting transformer is variable, depending upon the current flowing thru it. Under normal system operation it introduces no burden at all in the current transformer circuit because of the fact that no current flows in the differential circuit. Under minimum tripping conditions, the burden of each operating coil circuit varies from 9 to 11 ohms at approximately 90° lag, depending upon the tap. This sounds like an excessive burden, but it is not at all serious because current transformers which are otherwise satisfactory for this application will have no difficulty in forcing a few tenths amperes thru two 11 ohm coils in series. Under maximum internal fault conditions, when all of the current must flow thru the operating coils, the burden is reduced to approximately 1 ohm, because of saturation.

Figure 13 shows the variation in burden of the operating coil circuit for different current values.

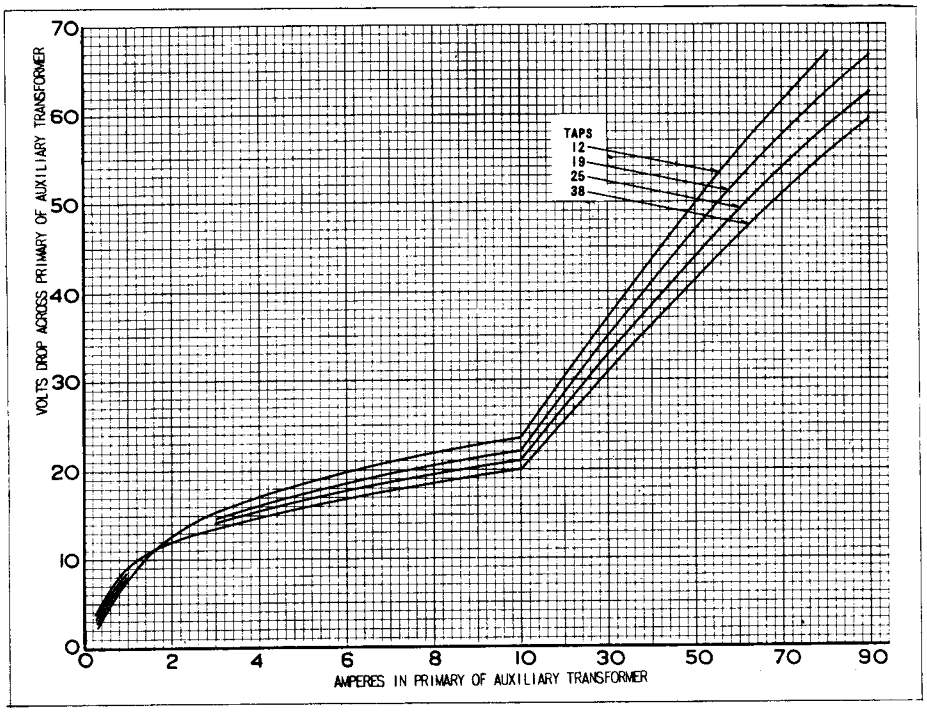


Fig. 13 —Typical Volt-Ampere (Burden) Characteristics of the Operating Coil Circuit.

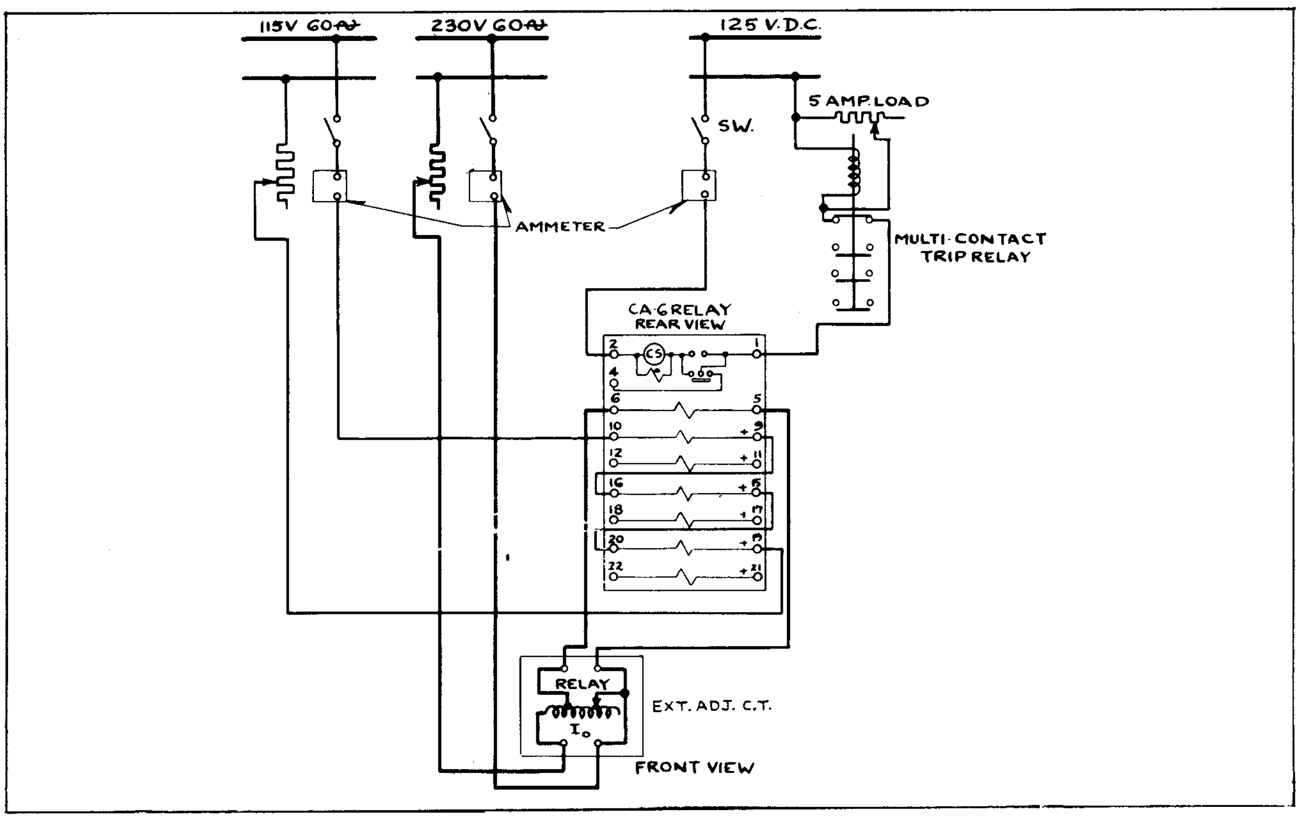


Fig. 14—Diagram of Test Connections for the Type CA-6 Relay.

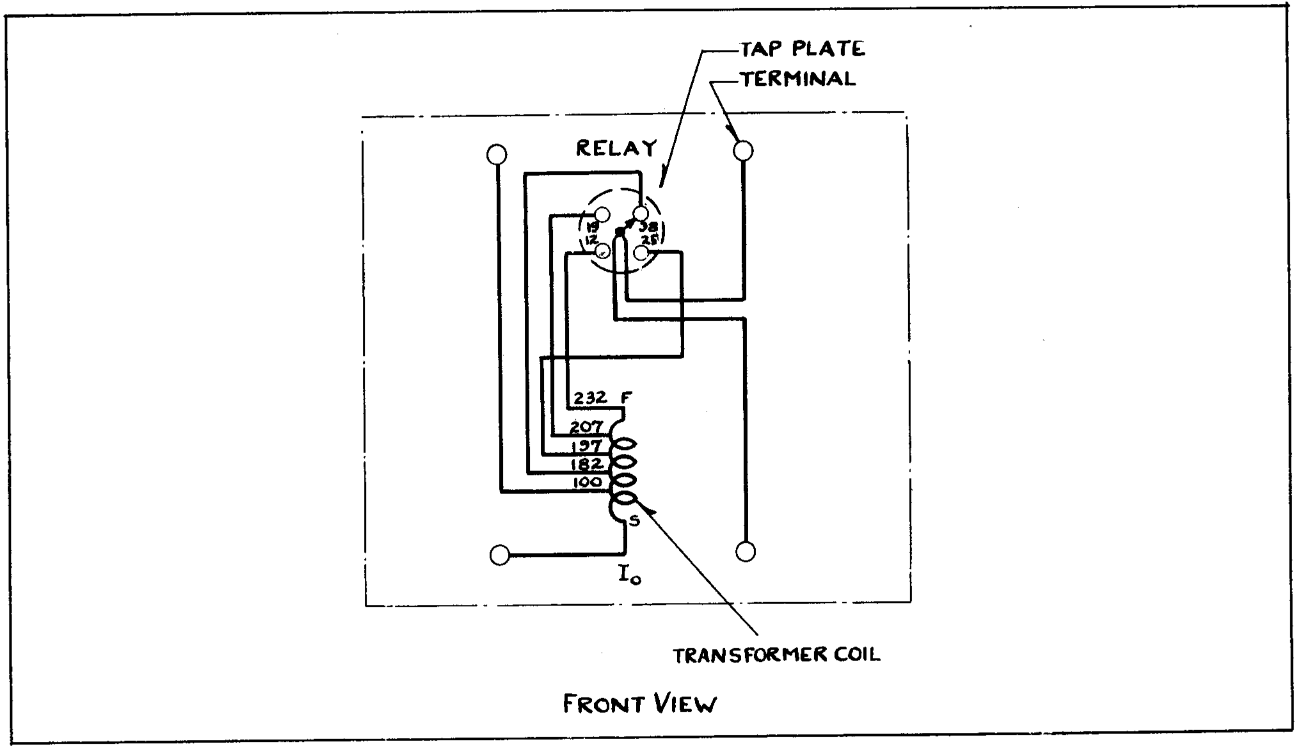


Fig. 15—Internal Wiring Diagram of the Saturating Adjusting Transformer for the Operating Coil.

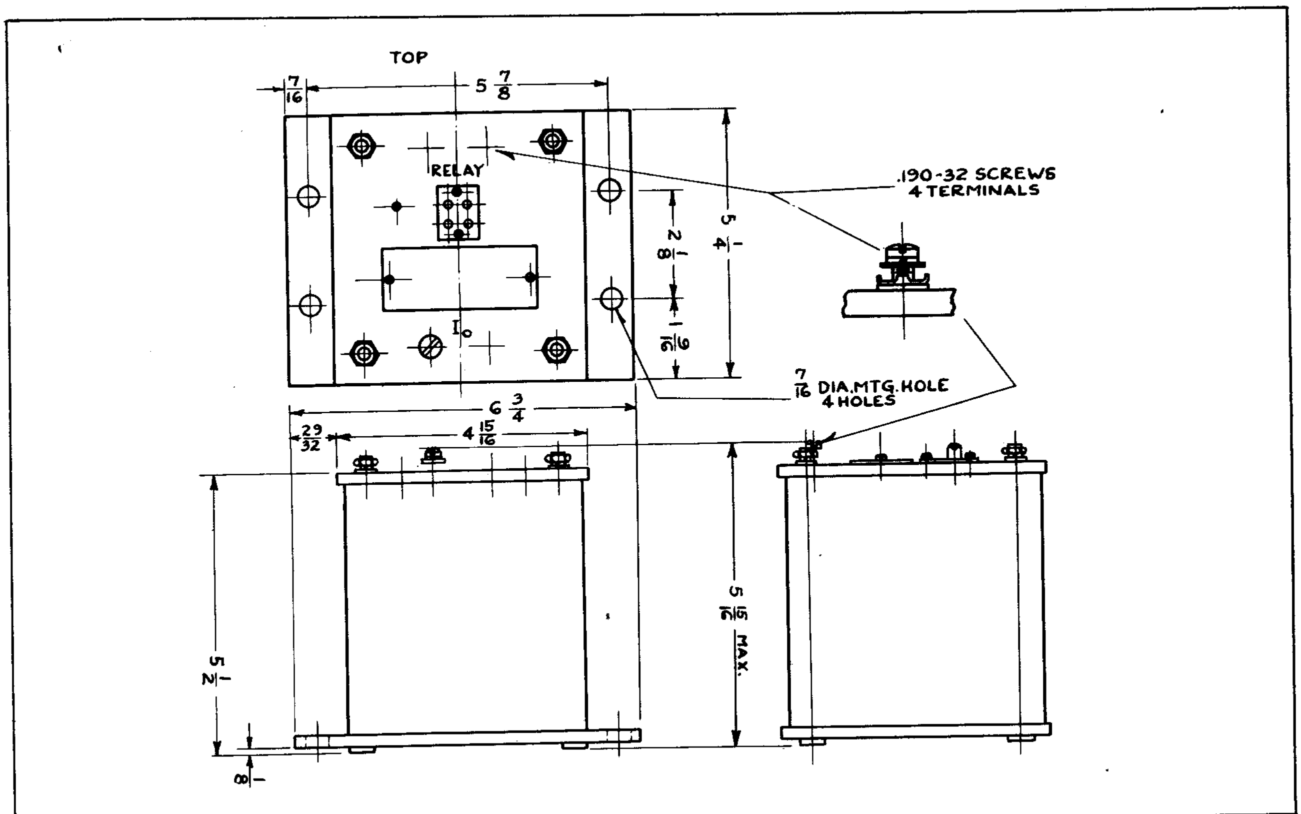


Fig. 16—Outline and Drilling Plan for the Adjusting Transformer. For Reference Only.

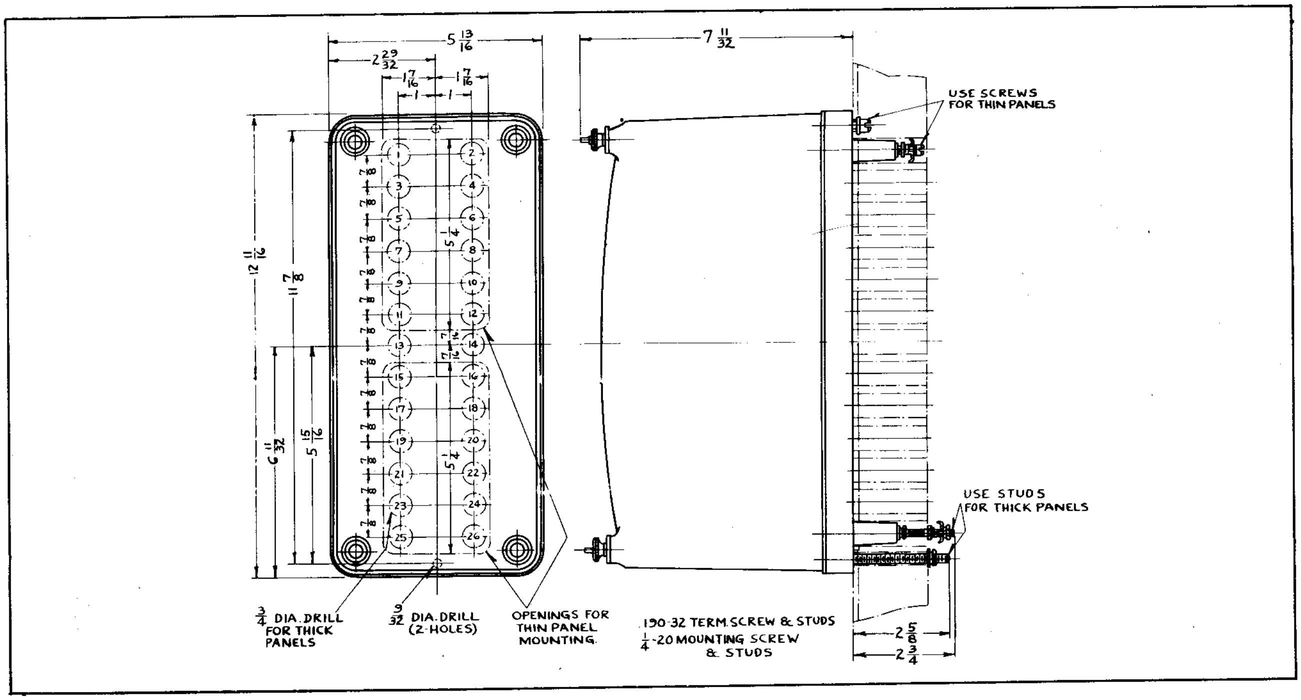


Fig. 18—Outline and Drilling Plan for the Standard Projection Type Case. For Reference Only.

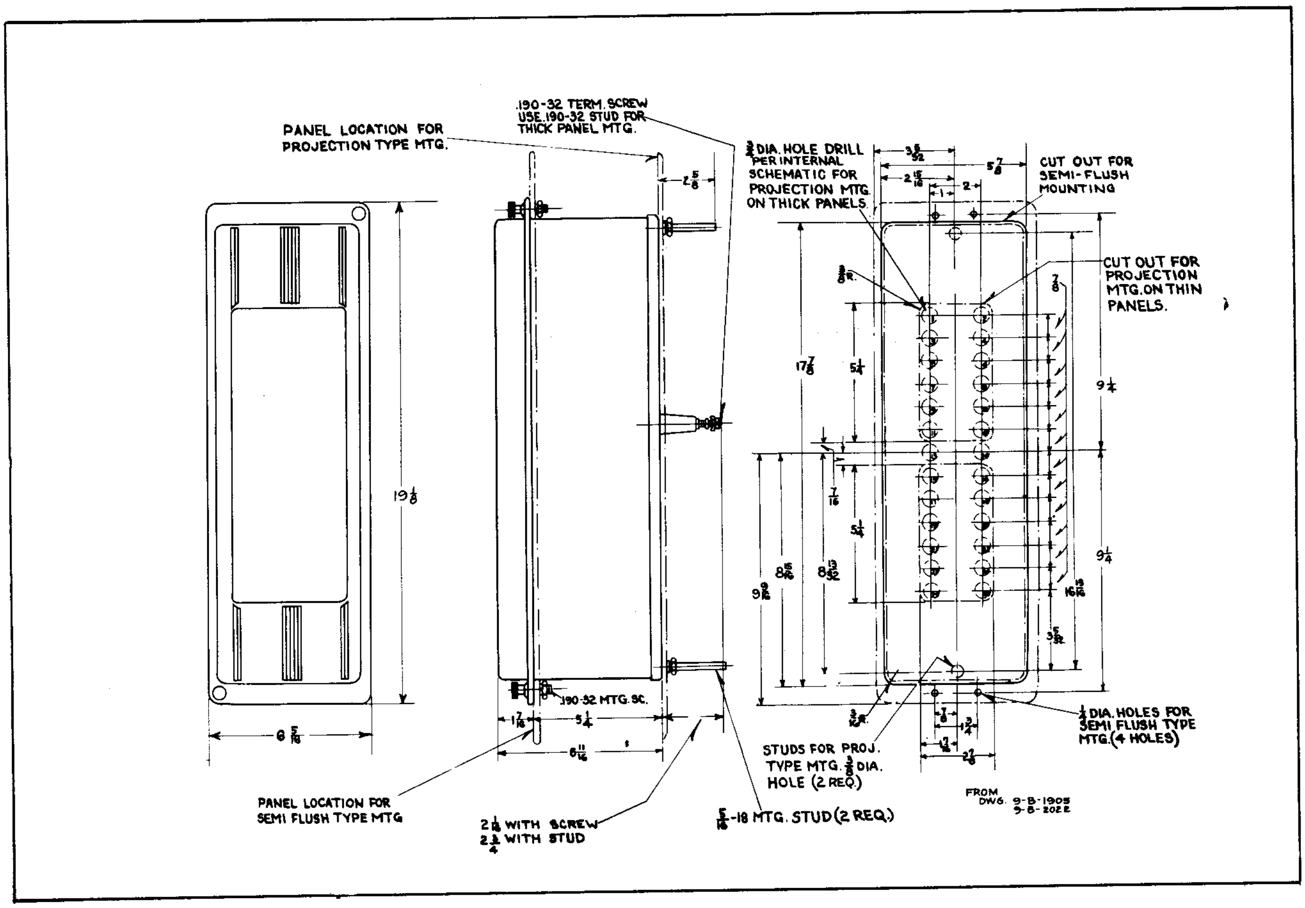


Fig. 19—Outline and Drilling Plan for the M20 Projection or Semi-Flush Type FT Flexitest Case. For Reference Only.

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