Type CN-33 Network Master Relay
AS USED ON CSP TRANSFORMERS
INSTRUCTIONS

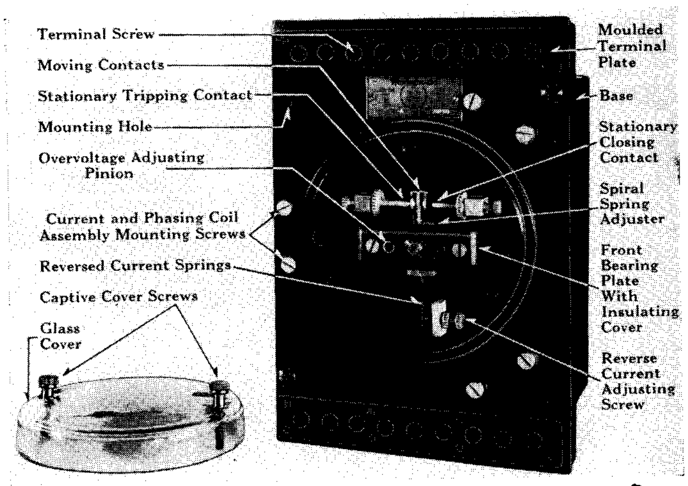

FIG. 1—TYPE CN-33 NETWORK MASTER RELAY. FRONT VIEW WITH GLASS COVER REMOVED.

GENERAL

The characteristics of the type CN-33 Network Master Relay are such that it will operate to make its closing contacts when the voltage on the transformer side of the air switch is approximately equal to or greater than and substantially in phase with the voltage on the network side of the circuit breaker, and to close its tripping contacts when the flow of power is reversed, that is, when the flow of power is from the network to the transformer.

The reverse power setting is sufficiently sensitive so that the CN-33 relay will close its tripping contacts on the exciting current of the transformer if the primary of the transformer should become de-energized so that the transformer is excited from the network side.

As used on CSP power transformers, the CN-33 relay will generally be associated with either a type CN-J phasing relay or a type BN desensitizing relay or with both of these. When the CN-33 relay is used with only the type BN relay, it will in general be used only for reverse power protection and its phasing coils and its closing contacts will not be used.

Note: Whenever the CN-33 relay is removed from the control panel, the air switch must be open and the current transformer terminals on the terminal blocks must be short-circuited before the air switch is reclosed.

CONSTRUCTION

The type CN-33 network master relay shown in Figs. 1 and 2 is a three-phase relay which operates on the induction principle. Its moving element is a comparatively large and sturdy drum drawn from pure sheet aluminum. This drum is carried on a horizontal tool steel shaft which rotates through approximately a 15 degree angle on sturdy tool steel knife-edge bearings. Since this type of bearing can be placed at the exact center of the shaft, friction is reduced to a minimum. The construction is similar to that used in sensitive platform balances. Heavy phosphor bronze retaining rings have been added to encircle the ends of the drum shaft so as to prevent its being thrown off the knife-edges during heavy torque conditions. The stationary bearings have their knife-edges extending upward to avoid the danger of having dirt accumulate between the bearing surfaces. End thrust is taken care of by means of flat polished steel surfaces in the stationary bearing assemblies. The ends of the drum shaft are conical, and one end or the other makes point contact with its associate flat steel surface depending upon the direction of the thrust. The moving element is carried on a flat steel mounting plate. The drum is located behind this plate and its shaft extends through a hole in a moulded insulation plate located on the steel mounting plate. One of the drum shaft bearings is mounted on the back of the steel plate and one is mounted on the front of it.

The relay has single-pole, double-throw contacts all of which are made of pure silver. The moving contact arm is clamped around an insulating hub pressed on that portion of the drum shaft which extends through to the front of the relay mounting plate. This arm carries two spring mounted silver contacts which are electrically one, and three flat steel springs of different lengths which extend down from the shaft 180° from the contacts. These

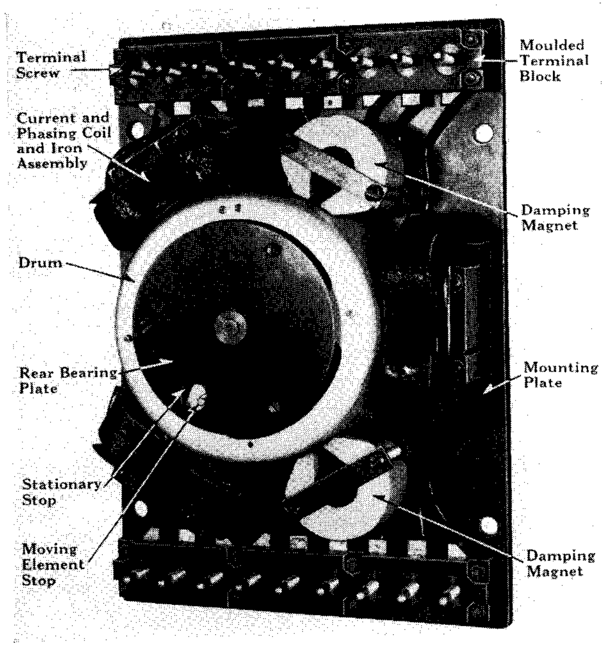

FIG. 2—TYPE CN-33 NETWORK MASTER RELAY. REAR VIEW OF RELAY REMOVED FROM BASE.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

springs are used to adjust the amount of reverse current necessary to close the tripping contacts of the relay. Counter weights are also carried on the moving contact arm so that the moving element is substantially balanced in all positions.

The stationary contacts consist of two hemispherical silver buttons welded on the ends of two brass thumb screws. These two contact screws screw into two brass blocks and are locked securely in place by means of two thumb nuts. The block which carries the stationary closing contact is mounted to the right of the moving contact on the insulation plate through which the drum shaft passes and is stamped with the letter "C". The block which carries the stationary tripping contact is mounted on the same insulation plate to the left of the moving contact and is stamped with the letter "T".

On the lower part of the insulation plate to the right of the three flat steel reverse-current springs is mounted another brass block with three tapped holes in it. This block carries a small thumb screw which acts as a stop to deflect the reverse-current springs. When mounted in the lower hole the screw will deflect one of the springs, in the middle hole two, and in the upper hole all three of the springs. This reverse-current screw is used to vary the amount of reverse current necessary to close the tripping contacts of the relay by varying the amount of deflection and the number of reverse-current springs deflected before the tripping contacts make. When the reverse-current adjustment is made the screw is securely locked in place by means of a thumb nut.

When the relay is completely de-energized the moving contact is held firmly against the closing stationary contact by means of a spiral spring around the moving element shaft. The inner end of this spring is fastened to the moving contact arm and the outer end is fastened to a spring adjuster which is carried on the front of the circular moulded insulation plate. This spring adjuster is of the friction type which has been used on many Westinghouse induction relays for years. Gear teeth on the adjuster engage a pinion, the insulated shaft of which extends through a hole in the front bearing plate. The spring tension is easily adjusted by rotating the pinion with a screwdriver without danger of grounding the spring assembly. This adjustment is located under the glass cover to prevent unauthorized changing of adjustments.

The use of a large diameter drum, two small permanent magnets for damping the movement of the drum, and a solid stop on the moving element which limits the movement of the drum to a relatively small angle have made it possible to eliminate all gears from the relay without getting into difficulty from bouncing of the relay contacts. The elimination of gears simplifies the construction of the relay and removes a source of friction difficulties. The small permanent magnets are carried on the back of the mounting plate where they are protected by the relay base from dust, dirt, and other foreign particles even when the glass cover of the relay is removed. The moving element stop is a heavy pin pressed into one of the spokes of the drum. It operates in a large clearance hole in the rear bearing plate and limits the movement of the drum in both directions by striking the opposite sides of this hole.

The three electromagnets which are carried on the back of the flat steel mounting plate are mounted radially and equally spaced about the drum. Each electromagnet consists of a conventional potential coil and iron assembly mounted inside the drum and a current and phasing coil and iron assembly mounted on the same radial centerline outside the drum. The potential coil is a machine wound coil with a nominal rating of 125 volts but it will operate satisfactorily on any voltage between 100 and 135 volts. A current coil of a few turns of heavy wire is wound directly on each of the two poles of the outer iron assembly over the necessary insulation. The phasing coils which are made up of a large number of turns of small wire are machine wound. One phasing coil is placed on each of the two outer poles over the current coils and securely held in place. The two sections of each electromagnet are thoroughly impregnated with insulating varnish and baked. Lagging is used on the potential coil and iron assembly. Similar lag loops are mounted on the outer or current and phasing coil and iron assembly. These outer lag loops also serve to lag the potential coil flux and effectively limit magnetic unbalances that have made the use of two piece electromagnets difficult in the past.

Each current and phasing coil and iron assembly is securely fastened to the back of the mounting plate by two screws. The relay is so assembled at the factory that the air gaps between the two sections of each electromagnet are symmetrically unbalanced to provide the normal range of overvoltage adjustment. The overvoltage adjustment within this range is made by the geared spring adjuster under the glass cover. If it is ever necessary, the range of overvoltage adjustment can be changed by loosening the two mounting screws of each outer coil and iron assembly and shifting the assembly through a small angle with a wrench (Style No. 1095881). When the desired range is obtained, the mounting screws should be securely tightened.

All parts of the relay located behind the steel mounting plate are completely enclosed in a cast iron base to which the mounting plate is fastened by two large screws. A shallow glass cover is mounted over the circular moulded insulation plate carried on the steel mounting plate. This cover is held in place by two captive thumb screws and serves to protect the relay contacts, reverse-current and overvoltage adjustments, and front bearing of the moving element shaft from dust and dirt.

Moulded insulation terminal blocks are mounted on the two ends of the mounting plate. Silver tipped screws pass through threaded holes in small brass plates which are soldered on the ends of the relay coil and contact leads

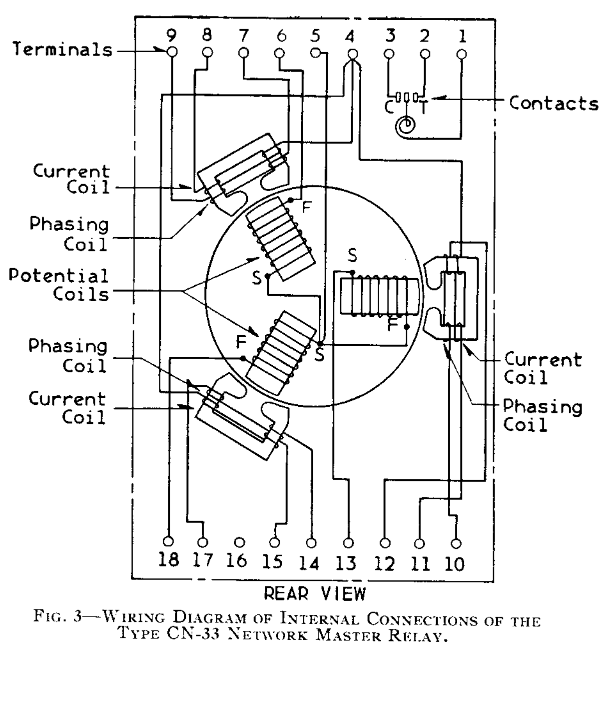

Fig. 3—Wiring Diagram of Internal Connections of the Type CN-33 Network Master Relay.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

and slipped into slots in the moulded blocks. These screws extend on through the terminal blocks and holes in the relay base where their silver tips engage with stationary terminals which are mounted on the panel. These stationary terminals are silver plated copper jaws backed up by steel springs assembled in moulded insulation blocks. The relay terminal screws serve as plug or jack type connections between the relay and protector wiring, but are not used to mount the relay. The relay is mounted on two studs and held securely in place by two thumb nuts which when tightened force the terminal screws firmly into engagement with their associated jaws. These jaw assemblies are free to move somewhat in their moulded insulation blocks so as to be self aligning. The heads of all terminal screws are accessible from the front of the relay, and when they are screwed down in their normal position the heads are completely surrounded on all sides by the moulded terminal blocks through which the screws pass. This prevents accidental contact with or shorting to ground or between screws. By partially removing the proper terminal screw or screws any circuit or circuits between the relay and the panel can be opened. Before the head of a screw becomes flush with the surface of the terminal block the circuit is opened. The screw remains connected to its associated relay circuit, however, even after it is backed out until its head extends above the surface of the moulded block, so that a test clip can be connected to it in the groove around the screw head provided for that purpose. This type of terminal construction allows the terminal screws to be used as test switches and greatly facilitates testing and adjusting the relay when mounted on the panel. The relay can readily be mounted on or removed from the panel without disturbing any leads and without any possibility of connecting it improperly, merely by tightening or removing the two thumb nuts from its mounting studs. After the relay has been taken off the panel it can be completely removed from its base for inspection or maintenance without disturbing any parts or wiring details by removing the two screws which hold the steel mounting plate on the front of the base. The various coils and internal connections of the relay are shown in Fig. 3.

OPERATION

The operation of the type CN-33 relay can best be described by referring to Fig. 4. The figure shows a schematic diagram of the internal and external connections of the type CN-33 relay when used on a three-phase network with a grounded neutral. The control circuits have been omitted to make the picture as clear as possible. When all primary feeders associated with the low voltage network are open, the type CN-33 relay will be completely deenergized and its closing contacts will be held in the closed position by the spiral spring. If the operator at the station closes the breaker on the feeder to which the transformer bank shown in the figure is connected, the air switch will close and connect the transformer to the network since the closing contacts of the relay is closed.

It will be noted that when closing on a dead network the phasing and potential circuits of the relays are in series with normal line-to-neutral voltage applied across them. However, the impedance of the phasing circuits is so much higher than the impedance of the potential circuits that the voltages across the latter are extremely low. Since the phasing coils can produce torque only when the potential coils are energized, the resulting torque will be very small because the potential coil voltages are low and the angle between these voltages and the phasing coil voltages is almost equal to the zero torque angle. What little electrical torque there is will tend to close the closing contacts of the CN-33 relay. For this reason the CN-33 tends to close its closing contacts under all dead network conditions. Therefore, the air switch will close on a dead network regardless of the magnitude of the load connected to the network.

Again referring to Fig. 4, let us start with the condition we had originally, that is, all feeders associated with the network are open. Now suppose that some network feeder, other than the one to which the transformer bank of Fig. 4 is connected, is energized by closing its breaker at the station. The air switch on that feeder will close and connect it to the network as has been explained. This energizes the low voltage network and both the potential and phasing circuits of the type CN-33 relay shown in Fig. 4 become energized at once. The phasing circuits have line-to-neutral voltage impressed across them, but since the voltage on the network side of the air switch is the higher, a very strong opening torque is produced and the moving contact of the relay moves quickly from the closing to the tripping position. The phasing circuits, being connected across the contacts of the air switch are energized when the air switch is open by a voltage which is the vector difference between the transformer secondary voltage and the network voltage. The closing of the station breaker on the feeder to which the transformer bank of Fig. 4 is connected at a time when the secondary voltage of the transformer is appreciably less than the network voltage, will greatly reduce the voltage on the phasing circuits and consequently the tripping torque of the CN-33 relay. If when the feeder breaker is closed the transformer secondary voltages and the network voltages are equal and in phase the voltage across the phasing circuits will be zero, and the phasing coils in conjunction with the potential coils will produce no torque in either the closing or tripping direction. The closing contacts of the relay will not make under this condition, however, because each potential coil when energized alone produces a torque in the tripping direction slightly greater than the closing torque produced by the spiral spring. This torque or bias in the tripping direction, developed when only the potential coils are energized, is obtained by moving the outer coil and iron assemblies of the relay slightly so as to unbalance the air gaps, and is used to fix the range of overvoltage adjustment. With zero volts across the phasing circuits the moving contact of the relay will remain over toward the stationary tripping contact and may deflect the reverse current adjusting spring some but not enough to make the trip circuit. If when the feeder breaker at the station is closed the transformer secondary voltage is appreciably higher than the network voltage, the phasing coils in conjunction with the potential coils will produce a torque which will cause the moving contact of the CN-33 relay to make with the stationary closing contact and close the air switch, thus connecting the transformer bank to the network.

The instant the air switch closes, current starts to flow from the transformer into the network. This causes current to flow in the current coils of the relay, and produce a torque in the closing direction. The air switch will remain closed even if conditions change so that there is no current flowing through it. As the current decreases to zero, the moving contact will move away from the stationary closing contact and take up a position somewhere between it and the stationary tripping contact and may deflect the reverse-current adjusting spring a certain amount. When the feeder is disconnected from the station bus by tripping its circuit breaker, the transformers will be magnetized from the network. This flow of exciting current from the network to the transformer bank will cause enough current to flow in the current coils of the type CN-33 relay to produce a tripping torque sufficient to deflect the reverse-current adjusting spring until the moving contact completes the relay trip circuit, if the relay has a sensitive setting. In this way the feeder is disconnected from the network when the station breaker is opened. The action of the relay is just the same if a fault develops in the transformer or feeder, except the tripping torque will be much greater and the time of operation shorter.

The design of the phasing circuits must be such that the relay will make its closing contacts with one volt or less impressed across them. However, when the network is energized and the feeder breaker at the station is open, there will be full line-to-neutral voltage across

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

the phasing circuits. There is the possibility of the transformer voltage being reversed due to an error in making connections and this would place twice normal line-to-neutral voltage across the phasing circuits when the feeder breaker is closed. In order to protect the phasing coils over this wide range of voltages and to assist in securing the desired phase-angle characteristics, a tapped resistor is placed in series with each pair of phasing coils. These phasing resistors are mounted on the panel external to the relay in order to decrease the amount of heat liberated in the relay case so as to keep the temperature of the relay coil within proper limits. The total value of each resistor is 3100 ohms with the tap taken off at 1200 ohms from one end and 1900 ohms from the other. When the air switch is open the 1900 ohm sections of the resistors are shorted by auxiliary switches leaving 1200 ohms in series with each pair of phasing coils. The full 3100 ohms is inserted in each phasing circuit by the opening of the auxiliary switches when the air switch closes. This extra resistance is inserted to assist in getting the desired phase angle characteristics in the relay and to reduce the heating in the phasing coils when the air switch is closed.

Figs, 5, 6, 7 and 8 show the operating characteristics of the type CN-33 network master relay. Curve No. 1 of Fig. 5 shows the closing characteristics of the relay. Lines drawn to it from the origin at various angles with the network voltage represent in both magnitude and phase position the transformer voltages which will produce a torque in the relay just sufficient to cause its closing contacts to make. The closing contacts will also make and connect the transformer to the network if the transformer voltage terminates above the closing curve. Any transformer voltage which does not terminate on or above the closing curve will produce a relay torque in the tripping direction which prevents the closing contacts from making and the network protector will remain open. The curve No. 1-A in the same figure shows a small section of the closing curve plotted to a much larger scale so as to show the characteristics of the relay for the values of phasing voltage at which it normally operates. Lines drawn from the origin to this curve represent in magnitude and phase position the phasing voltage, that is, the voltage across the open contacts of the network protector necessary to produce a torque in the relay just sufficient to make its closing contacts. The upper end or line potential end of the network voltage vector is at the origin in this case. The network voltage vector cannot be shown in its true relation to this curve because of the large scale to which the curve is plotted. It will be noted by referring to Curve No. 1-A of Fig. 5 that the relay will just close its closing contacts

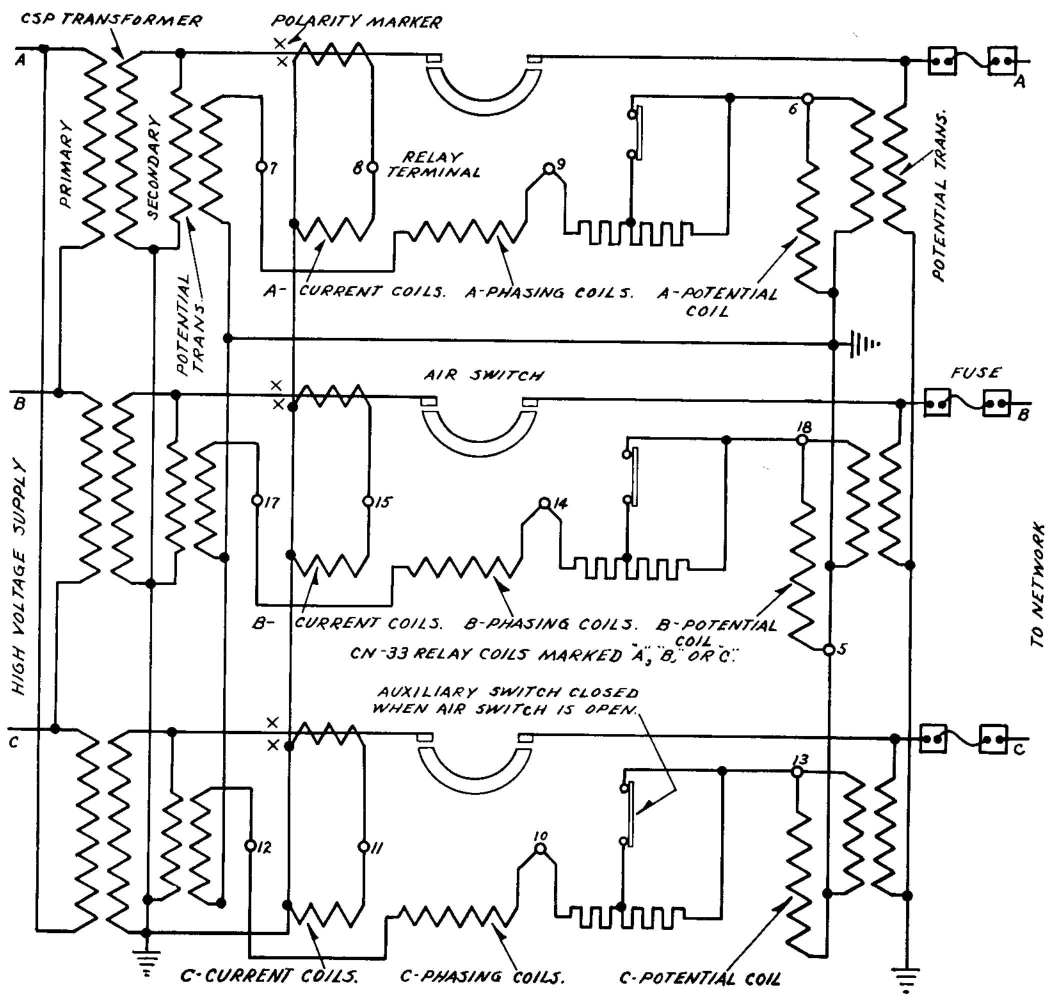

FIG. 4—SCHEMATIC DIAGRAM OF INTERNAL AND EXTERNAL CONNECTIONS OF TYPE CN-33 AND CN-J NETWORK RELAYS USED ON A THREE-PHASE NETWORK WITH A GROUNDED NEUTRAL —CONTROL CIRCUITS OMITTED.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

with approximately 0.8 volt across the phasing circuit in phase with the network voltage. When the phasing voltage leads the network voltage by 75°, it requires about 2.0 volts to close the closing contacts. This voltage at 75° leading, however, means only a very small angle between network and transformer voltages. This can readily be appreciated when it is pointed out that 10 volts across the phasing circuit leading the network voltage by 90° will throw the network and transformer voltages less than 5° out of phase.

The opening characteristics of the type CN-33 relay are shown by Curve No. 2 of Fig. 5. Lines drawn from the origin to curve No. 2 represent in magnitude and phase position the line currents which will produce a torque in the relay just sufficient to cause its tripping contacts to make. The tripping contacts will also make and disconnect the transformer from the network if the line current terminates below the opening curve. If, however, the line current does not cross the opening curve but terminates above it, the relay will close its closing contacts and maintain them closed as long as the line current amounts to one or two per cent of the protector rating. The curves shown in Figs. 6 and 7 represent a small section of the opening curve just discussed plotted to much larger scales in order to show the operation of the relay on small current values, such as the magnetizing currents of network transformers.

On systems where the voltage of the primary feeders is fairly high, such as 11,000 volts or above, the charging current of the feeder and high tension cables must be considered. When the station breaker is open this charging current will flow through the network transformer bank. In such cases, therefore, the current on which the relay must operate is not the magnetizing current of the transformer bank alone, but the vector sum of the magnetizing current and the feeder charging current. When the charging current predominates over the magnetizing current, the current on which the relay must operate is a leading reversal rather than a lagging reversal. By referring to the opening curves discussed, it will be seen that the relay will operate equally as well on leading reversals as on lagging reversals, providing the leading reverse current does not exceed approximately 250% of the rating of the relay even if the current is almost 90° out of phase with the network voltage reversed.

Fig. 8 shows the tripping characteristics of the type CN-33 relay on current values up to 800% of the relay rating, such as are encountered under short circuit conditions. The bend in the curve is caused by the saturation of the current transformers used with the relay. This bend in the opening curve at the higher values of current improves the action of the relay under certain short-circuit conditions. It will be noted that this curve is taken with normal voltage, that is, 125 volts on the potential coils of the relay, however, curves taken with small values of voltage on the relay potential coils are essentially the same shape.

ADJUSTMENTS AND TESTS

There are only two adjustments to make on the CN-33 relay, namely, the overvoltage closing adjustment and the reverse-current tripping adjustment.

The normal range of overvoltage adjustment as set at the factory is 0.5 to 2.0 volts in phase with the network voltage or approximately 1.2 to 4.7 volts, 75° leading the network voltage. This range has been found to be sufficient for most network applications. If it is ever necessary the range may be changed by loosening the mounting screws and shifting the outer coil and iron assemblies individually. Smooth overvoltage closing adjustment within this range is made by changing the spiral spring tension by means of the geared adjuster, the shaft of which extends through the front bearing support. The adjuster has a screwdriver slot in a cupped-recess and is insulated from the control circuits to prevent grounds when making adjustments. The overvoltage adjustment within the range should be made with all elements energized as in normal operation. When making overvoltage adjustments of any kind the current coils of all energized elements should be connected across the secondaries of network current transformers. The rating of the transformers used will not affect the adjustment.

The reverse-current tripping adjustment is made by varying the position of the reverse-current stop or adjusting screw. To set for small values of reverse current the adjusting screw should be placed in the lower tapped hole of its supporting block, for medium values it should be located in the middle hole, and for the higher in phase values up to 10% of the protector rating it should be placed in the upper hole. Moving the reverse-current adjusting screw to the left increases the amount of reverse current necessary to close the tripping contacts of the relay and moving it to the right decreases this amount. When this adjustment is made, the reverse-current adjusting screw should be locked securely in place by means of the thumb nut provided for this purpose. The reverse-current tripping adjustment should be made with current flowing through the primaries of all three current transformers in series supplying the current coils of the relay, with all three potential coils energized, and with all three phasing coil circuits short-circuited through the 3100 ohms of their respective phasing resistors.

It should be noted that when the air switch is closed and carrying no load, a certain amount of deflection of the reverse current adjusting spring may be caused by the potential bias used to obtain the overvoltage setting. Thus it is possible with an incorrect setting of the reverse-current adjusting screw for the relay to close its tripping contacts and open the air switch when there is no load current flowing. When the relay has been properly adjusted as described and the potential coils of all elements are energized, a current of approximately three times the three-element reverse-current setting is required through any one current transformer to close the tripping contacts. If the current and potential coils of only one element are energized, a current of about eight times the reverse-current setting is required to close the tripping contacts of the relay. This value will vary depending upon the overvoltage setting used. If the overvoltage setting is greater than 2 volts 75° leading the network voltage this value will be less, and if the overvoltage setting is less than 2 volts 75° leading, this value will be more than about eight times. These data regarding the tripping action of the relay with one element only energized are given not as representing a practical condition, for in practice all three elements are subjected simultaneously to magnetizing currents and potential coil voltages, but to avoid confusion when it is desired to check the action of any one element alone. For a given reverse-current setting the current necessary to close the tripping contacts of the relay will vary practically in direct proportion to the rating of the network current transformers being used.

It should be remembered that the overvoltage adjustment is independent of the reverse-current adjustment, but the reverse-current adjustment is by no means independent of the overvoltage adjustment. Therefore, the overvoltage adjustment should always be made first. With the relay set to operate on a given value of current and voltage, increasing the overvoltage adjustment will materially decrease the amount of reverse current required to close the tripping contacts of the relay. Changing the initial tension on the spiral spring will affect both adjustments. The spring is adjusted at the factory as described later and this adjustment should not be changed except when changing the overvoltage adjustment.

Fig. 9 shows the test diagram which should be used for checking the ranges of adjustment and for adjusting the type CN-33 relay in the laboratory. The air core reactor, Style No. 491701, shown on the diagram is designed so that the voltage drop across it leads the current flowing through it, and in this case the potential coil voltage, by 75°. The amount of voltage drop across the reactor, which is the voltage impressed across the phasing circuit, is determined by the ammeter shown in

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

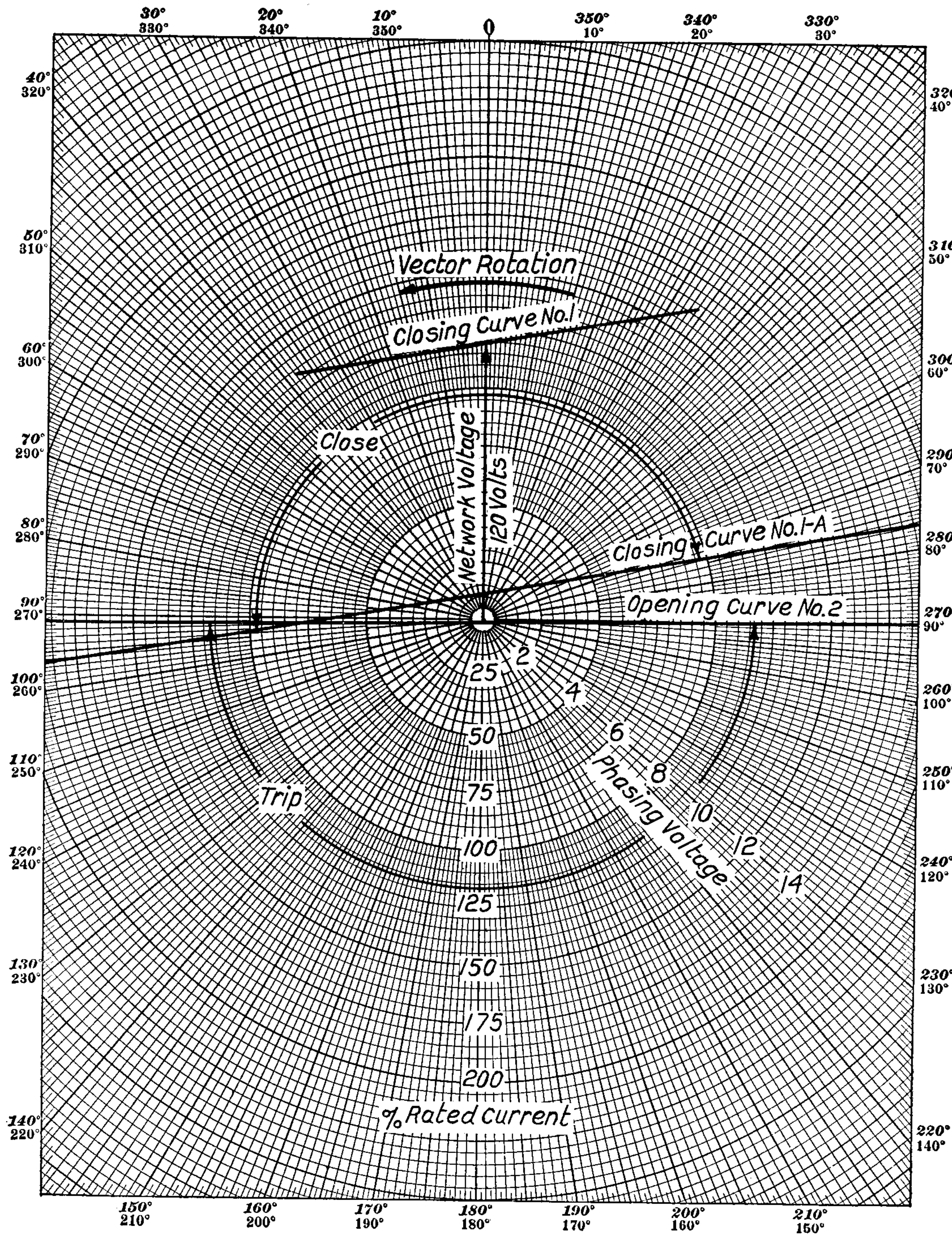

Fig. 5—Closing and Tripping Characteristics of tyhe Tpe CN-33 Network Master Relay. Balanced Three-Phase Conditions Assumed.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

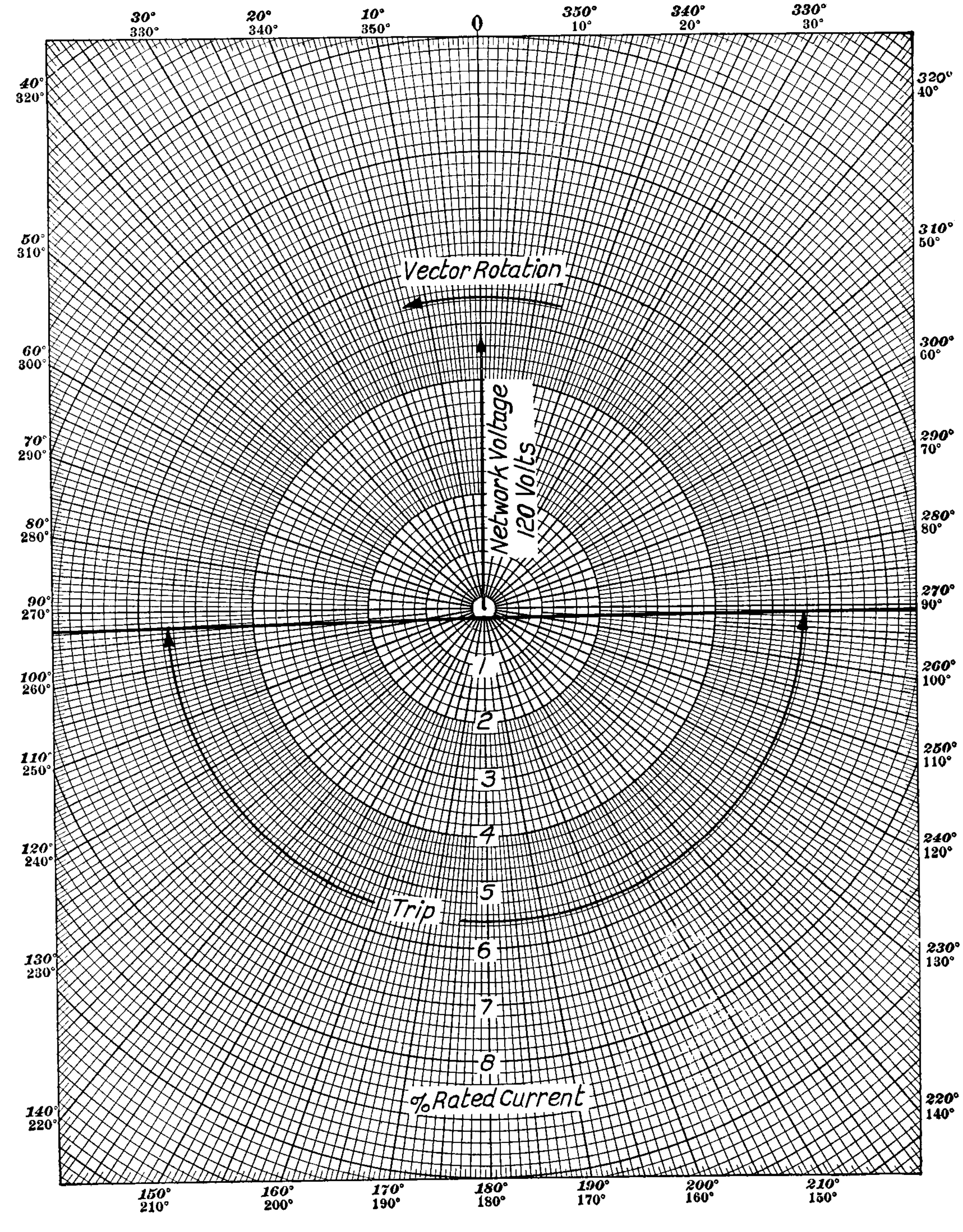

FIG. 6 TRIPPING CHARACTERISTICS OF THE TYPE CN-33 NETWORK MASTER RELAY. BALANCED THREE-PHASE CONDITIONS ASSUMED.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

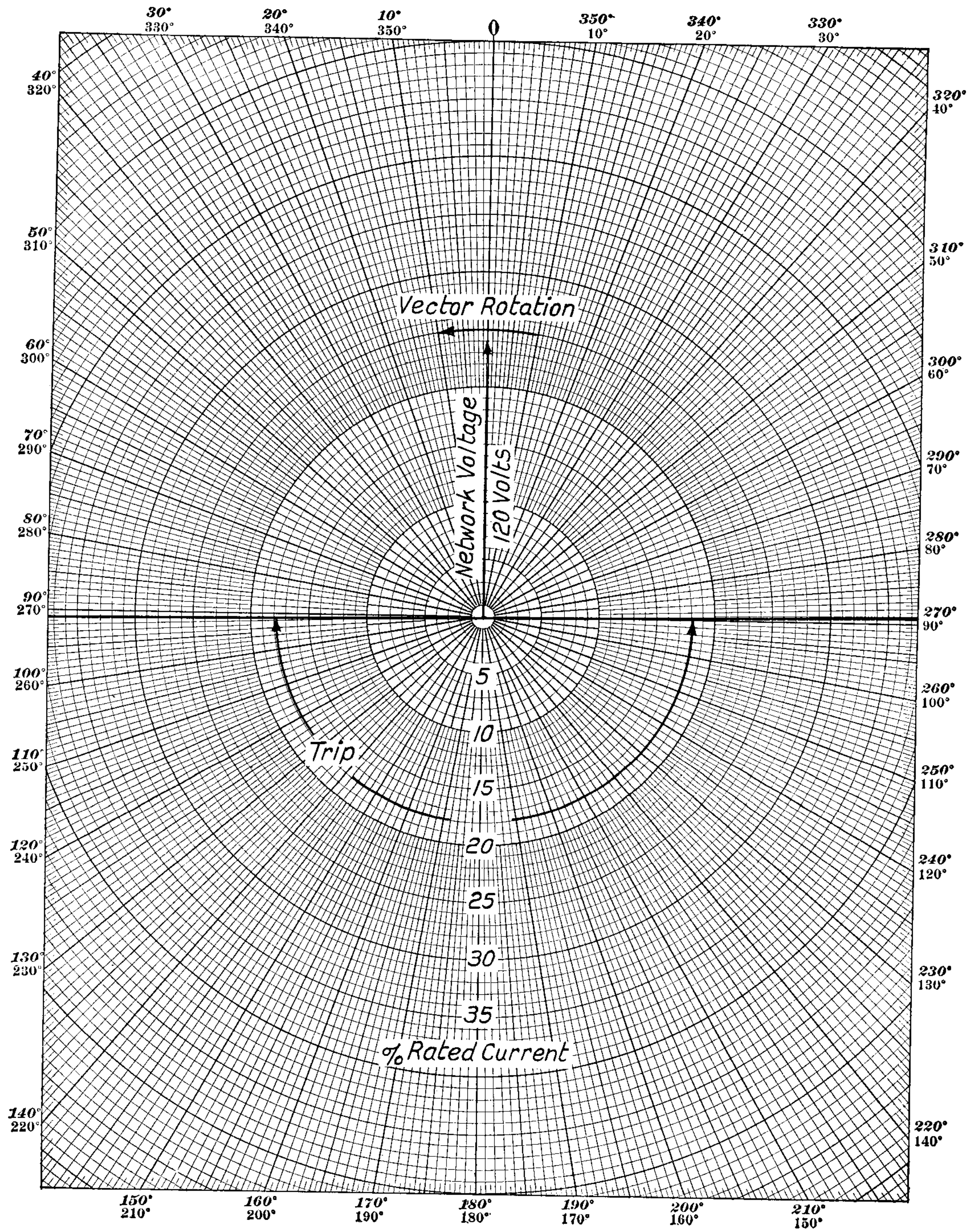

FIG. 7—TRIPPING CHARACTERISTICS FO THE TYPE CN-33 NETWORK MASTER RELAY. BALANCED THREE-PHASE CONDITIONS ASSUMED.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

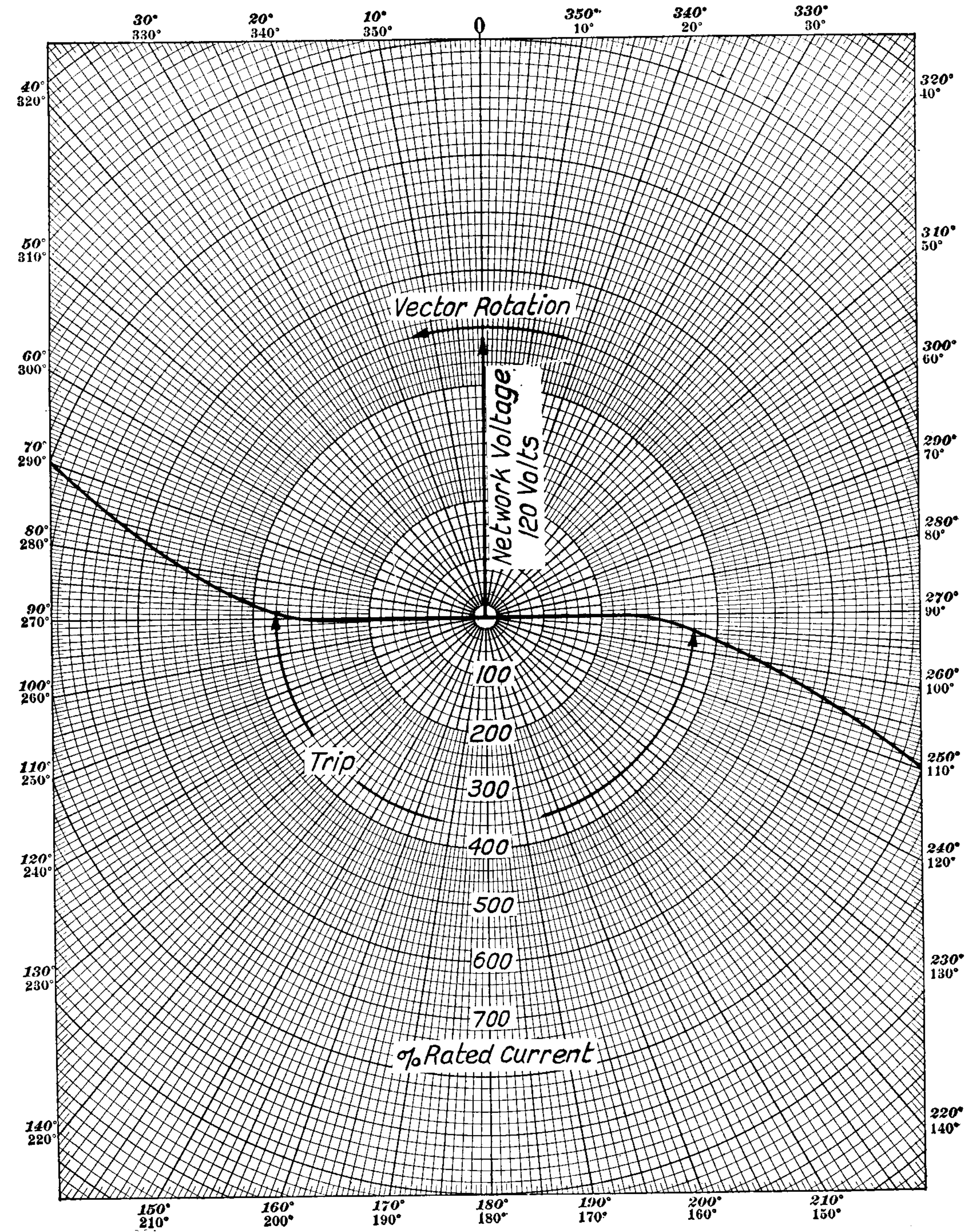

FIG. 8—TRIPPING CHARACTERISTICS OF THE TYPE CN-33 NETWORK MASTER RELAY. BALANCED THREE-PHASE CONDITIONS ASSUMED.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

the circuit and can be adjusted by means of the variable resistance load. The above reactor, which is used at the factory in making overvoltage adjustments, has an impedance of approximately 8 ohms. A similar reactor (Style No. 1059225) having a lower impedance of approximately 0.9 ohm is available, and its use will somewhat reduce the range of currents to be controlled and metered. Care must be exercised in mounting the reactor to avoid changing its impedance. It should be mounted with non-magnetic materials away from iron or steel. If it is desired to check or change the setting of the relay when one of these reactors is not available, a non-inductive resistor of 1 to 3 ohms resistance may be substituted for the air core reactor and the setting made at the equivalent values of in-phase voltage. The equivalent in-phase voltage setting for any 75° leading setting is approximately equal to the 75° leading setting divided by 2.35, as can be determined by referring to closing curve No. 1-A of Fig. 5 since the entire curve is raised or lowered parallel to the position shown by changing the overvoltage setting of the relay. The use of the reactor is somewhat preferable since it approximates the usual operating conditions, and since ammeter errors and inaccuracies in reading the meter will introduce a smaller voltage error than in the equivalent in-phase adjustment. The resistance of the leads from the current transformers to the current terminals of the relay is important. Each lead should be about 55 inches of 0.081 inch copper wire. The current transformers used are 600/5 ampere ratio, such as are supplied on 600 ampere, type CM-44, light duty, network protectors. The resistors used for adjusting the current through the current transformers and reactor should be non-inductive. This resistance load bank and the necessary ammeters are shown in detail in Fig. 10.

The following is a brief description of the proper method of testing the type CN-33 relay. Connect the relay exactly as shown in Fig. 9. First, see that the relay is mounted straight in a vertical plane and that the moving element is free from friction. Then check the position of the moving contacts on the drum shaft. These contacts should move equi-distance from a vertical line through the center of the shaft when the drum is rotated till it strikes its stop in both directions. Adjust the two stationary contact screws to deflect the contact springs until the back of the contact almost touches the main supporting arm when the drum is rotated to its two extreme positions. Securely lock the contact screws in position by means of their associated thumb nuts. The end play of the shaft should be adjusted to approximately 0.005 inch. This completes the necessary mechanical inspection.

Next, close switches "M", "A-A_1", "B-B_1", "C-C_1", "P" to the side marked 2, and "Y" to the side marked "OV" and adjust the spiral spring to obtain the required three-phase closing adjustment. Any adjustment from 1.2 to 4.7 volts leading the network voltage 75 degrees should be obtained. The equivalent adjustment for voltages in phase with the network voltage will be approximately the 75 degree leading value divided by 2.35. This may be checked by substituting a 1 to 3 ohm non-inductive resistor for the air core reactor in the test circuit. Only in very rare cases should it be necessary to change the overvoltage closing range by loosening the mounting screws and shifting the outer coil and iron assemblies.

With the overvoltage closing adjustment completed, next check the polarity of each current circuit independently. To check the polarity of the element "A" current circuit close switches "M", "S", "A-A_1", "P" to the side marked 1 and "Y" to the side marked "R.C." Pass approximately 25 amperes through the primaries of the current transformers and see that the moving contact of the relay moves positively toward the stationary tripping contact. Repeat this polarity check in a similar manner for elements "B" and "C" using switch "B-B_1" in place of switch "A-A_1" when checking element "B" and switch "C-C_1" when checking element "C". With switches "M", "S", and "P" closed as described above open switch "Y" and close switches "A-A_1", "B-B_1" and "C-C_1" and check the reverse-current tripping range of the relay. Set the reverse current stop or adjusting screw in each of its three tapped holes to deflect the reverse-current spring or springs so that they will just fail to throw the moving contact to the closing position when it is suddenly released from its maximum tripping position. With the reverse-current adjusting screw in each of these three positions close switch "Y" to the side marked "RC" and pass enough current through the primaries of the current transformers to just make the tripping contacts of the relay as indicated by lamp "T". Currents of more than 4, 24 and 60 amperes should be required to just close the tripping contacts of the relay with the reverse current adjusting screw in its lower, middle, and upper tapped holes, respectively. The sensitive reverse current trip setting should be made with the adjusting screw in its lower hole. Pass 1.2 amperes through the primaries of the current transformers and adjust the stop screw so that the tripping contacts just close. With the relay set to close its tripping contacts when 1.2 amperes at 180° to the potential coil voltage is flowing through the primaries of the 600 ampere current transformers, securely lock the reverse current adjusting screw in position by means of the thumb nut provided for this purpose. Then check the setting by interrupting the circuit through the primaries of the current transformers, closing the circuit again with all resistance in and gradually increasing the current through the circuit until the tripping contacts make. When the relay closing adjustment is set for very small values of voltage, it should be noted that the drum will not move far enough for the reverse-current spring to engage its stop screw until the current circuit is energized to produce a tripping torque.

RECOMMENDED SETTINGS

Experience indicates than an overvoltage closing adjustment of approximately 0.8 volt in phase (2 volts 75 degrees leading) and an in phase reverse current tripping setting of 0.2 per cent of the protector rating are correct for a majority of CN-33 Relay installations. The factory adjustments normally are made at these values. In some cases, however, it will be necessary or advisable to modify these adjustments to meet particular conditions, and the relay is provided with adjustments so that this may be readily done by the customer. For example, the magnetizing energy taken by a particular design of transformer may permit the use of a higher reverse current setting than recommended above. In this connection it should be remembered that the relay should always be given the highest reverse current setting which will allow positive relay operation on reverse energy flow when its associated primary feeder breaker is opened. This will eliminate a number of unnecessary air switch operations and reduce wear and maintenance. There may be certain locations on network systems where, particularly at times of light load, too frequent operation of the air switches will occur due to large fluctuating shunt loads on the network, elevator regeneration, etc., if the relays are given the usual sensitive reverse current setting. Increasing the reverse current setting of the relays at these locations to an in phase value equal to 10% of their rating or even less will often eliminate the unnecessary operations.

Care must be exercised in using high reverse current settings. The relay settings used should be only just high enough to prevent too frequent operation of the air switches. If only a few relays associated with each primary feeder are given a high reverse current setting, when the station breaker on a primary feeder is opened those air switches whose relays have sensitive settings will trip; then all of the charging current of the feeder and the magnetizing current of the transformers connected to the feeder will flow from the network through the few air switches whose relays have high settings, thus causing them to open and completely disconnect the feeder from the system. Obviously, if the relays on too many air switches are given high reverse cur-

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

rent settings, there will not be enough current through each of the air switches to cause them to trip and the feeder will not be disconnected from the network.

INSTALLATION

The type CN-33 relay will generally be shipped in place on the control panel of the CSP Power Transformer. It should be thoroughly inspected to see that none of the parts have been bent or broken in transit and that they are free from friction. The relay should also be checked to see that all locking, reverse current, and contact screws are securely tightened or locked in place by their associated thumb nuts.

If any of the above inspections indicate that the relay has been subjected to severe shipping stresses so that the adjustments may have changed, the relay should be taken to the laboratory and checked according to the instructions given in the section on maintenance.

MAINTENANCE

Note—When the CN-33 relay is removed from its control panel for maintenance, the transformer air switch must be open and the current terminals on the terminal blocks mounting the CN-33 relay must be short-circuited before the switch is reclosed.

The construction of the type CN-33 network master relay has been made as simple and sturdy as possible. All parts have been made readily accessible to facilitate inspection and repairs. After the relay is properly installed and adjusted, it will require little attention. Whenever it is found necessary to inspect the air switch, the relay should also be checked to see that it is free from friction and that its contacts are properly adjusted and not badly burned.

A periodic inspection of all air switches should be maintained to see whether any units have failed to close when the feeder to which they are connected was energized. Such a failure can be detected either by finding the air switch open or by comparing records of its operation counter readings. Failure of the air switch to close may be due to any of the following causes:

1—Improper voltage conditions, that is, the network voltage is higher than the transformer voltage, or the transformer voltage is lagging the network voltage so that the phasing relay prevents the pro-

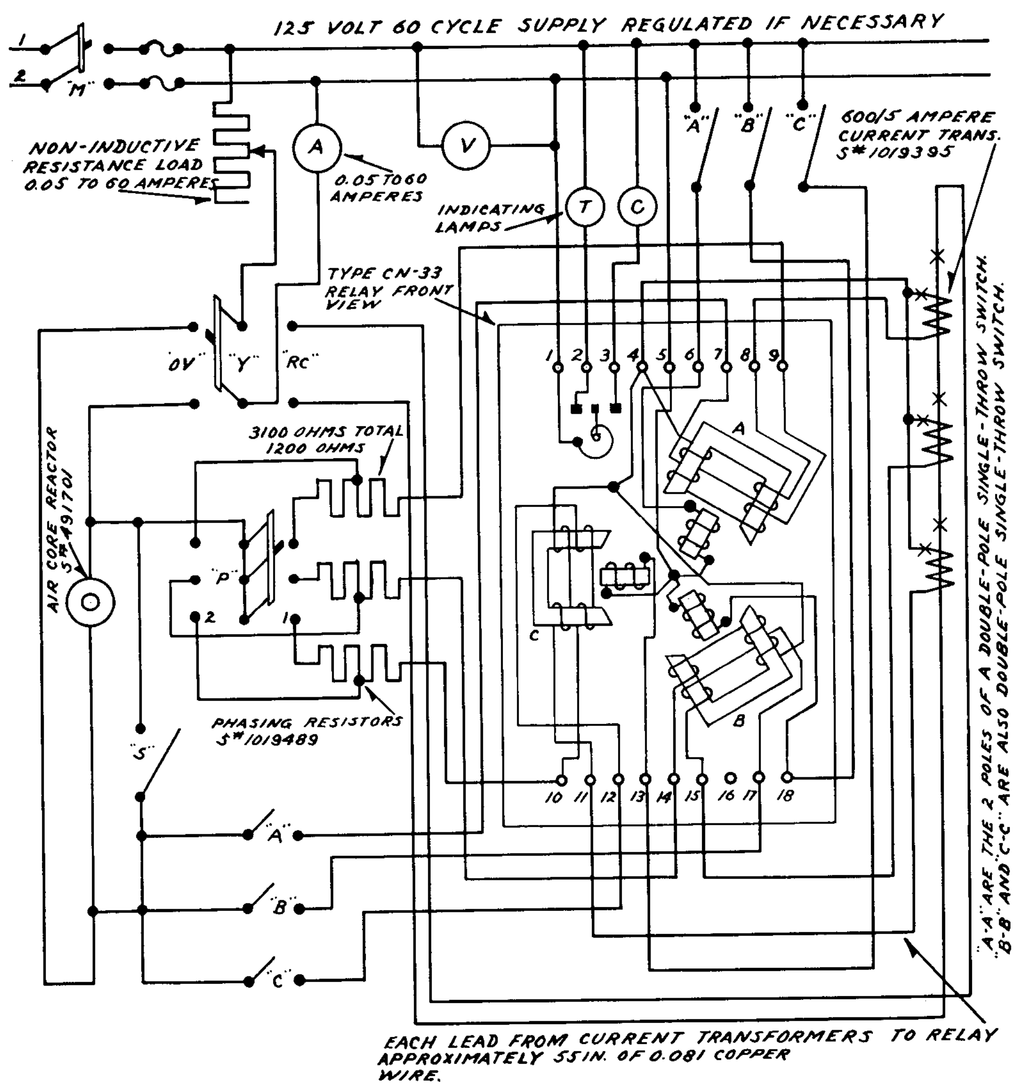

Fig. 9—Test Connections for Single-Phase Test and Adjustment of the Type CN-33 Network Master Relay.

Type CN-33 Network Master Relay—Continued

INSTRUCTIONS—Continued

tector from closing. Failure to close because of such voltage conditions does not constitute a faulty operation.

2—Failure of the network breaker or its operating mechanism.

3—Failure of the network phasing relay.

4—Failure of the network master relay.

Failure of the type CN-33 relay to close under proper voltage conditions may be due to friction, to dirty or improperly adjusted contacts, to an open phasing circuit, or to too high an overvoltage closing adjustment. Friction in the relay may be caused by leads rubbing on the drum, by foreign material collecting on the damping magnet, by the inner support of the spiral spring rubbing on the spring adjuster, or by an accumulation of dirt on the knife-edge bearings. Should it become necessary to clean the bearings, it is advisable to oil them with less than a drop of light mineral oil. Westinghouse oil number 6258-3 is recommended. The silver contacts should be cleaned with a very fine file or burnishing tool. The use of sand or emery paper should be avoided as particles may become imbedded in the silver and prevent the closing of the relay control circuits under minimum torque conditions. The possibility of the phasing circuits being opened is mentioned, not because they are fragile or likely to cause trouble, but because the phasing coils are wound with smaller wire than the other coils in the relay, and because the phasing resistors may burn out or be accidentally broken. When an air switch has failed to close, the relays should be inspected to see that they are free from friction and that their contacts are in good condition. The overvoltage closing adjustments should then be checked as described under "Adjustments and Tests". If these are found to be correct and the phasing relay is properly adjusted it will be necessary to look elsewhere for the cause of the failure. Should the breaker and operating mechanism also be found to be all right, the failure to close was undoubtedly due to the voltage conditions which existed on the system at the point where the air switch is installed.

Failure of an air switch to open, assuming it has been properly applied, can be due only to the failure of the breaker, operating mechanism, or master relay to function. Should an air switch fail to open when its associated feeder breaker is opened, the fact can be detected at once by a voltage indication on the feeder at the station. The type CN-33 relay may fail to close its tripping circuit due to friction, to dirty or improperly adjusted contacts, to too high a reverse current setting, or to a change in its tripping characteristics. The reverse-current trip setting may change if the reverse current stop screw is not securely locked in place by its thumb nut. If the outer coil and iron assemblies are not securely fastened by their locking screws they may be shifted inward by magnetic forces and slightly increase the reverse-current setting. The tripping curve of the relay would be rotated several degrees counter-clockwise if the protector auxiliary switches failed to open the shunt circuits across a portion of the phasing resistors. Such a failure is, of course, almost impossible on a correctly wired installation.

The preceding is not given as a list of troubles which anyone may expect to encounter with the type CN-33 relay, but is given merely as a guide to help in locating the causes of any improper operations of the network protectors which may occur.

RENEWAL PARTS

The type CN-33 network master relay is made as simple and rugged as possible and will not normally require replacement parts. If parts should be required, they should be ordered from the nearest Westinghouse Electric and Manufacturing Company District Office or direct from the Sharon, Pa., Works giving a description of the part required and the serial number or stock order number as stamped on the transformer nameplate.

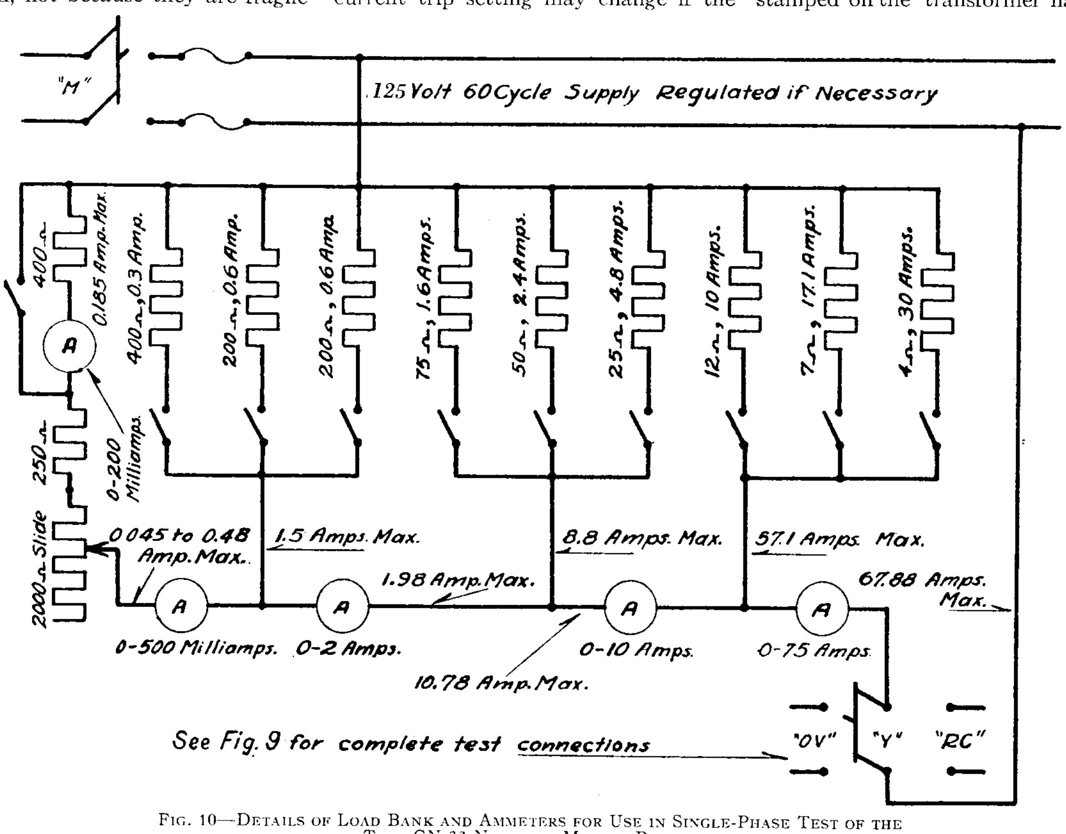

FIG. 10—DETAILS OF LOAD BANK AND AMMETERS FOR USE IN SINGLE-PHASE TEST OF THE TYPE CN-33 NETWORK MASTER RELAY.

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