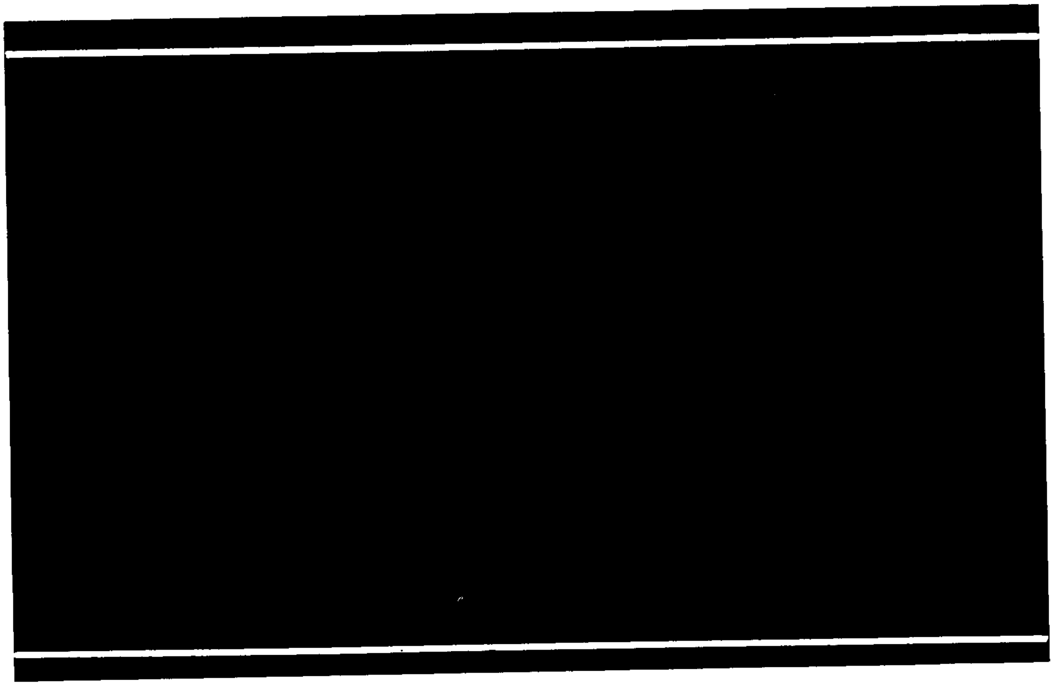

LIGHT-DUTY TYPE CM-44

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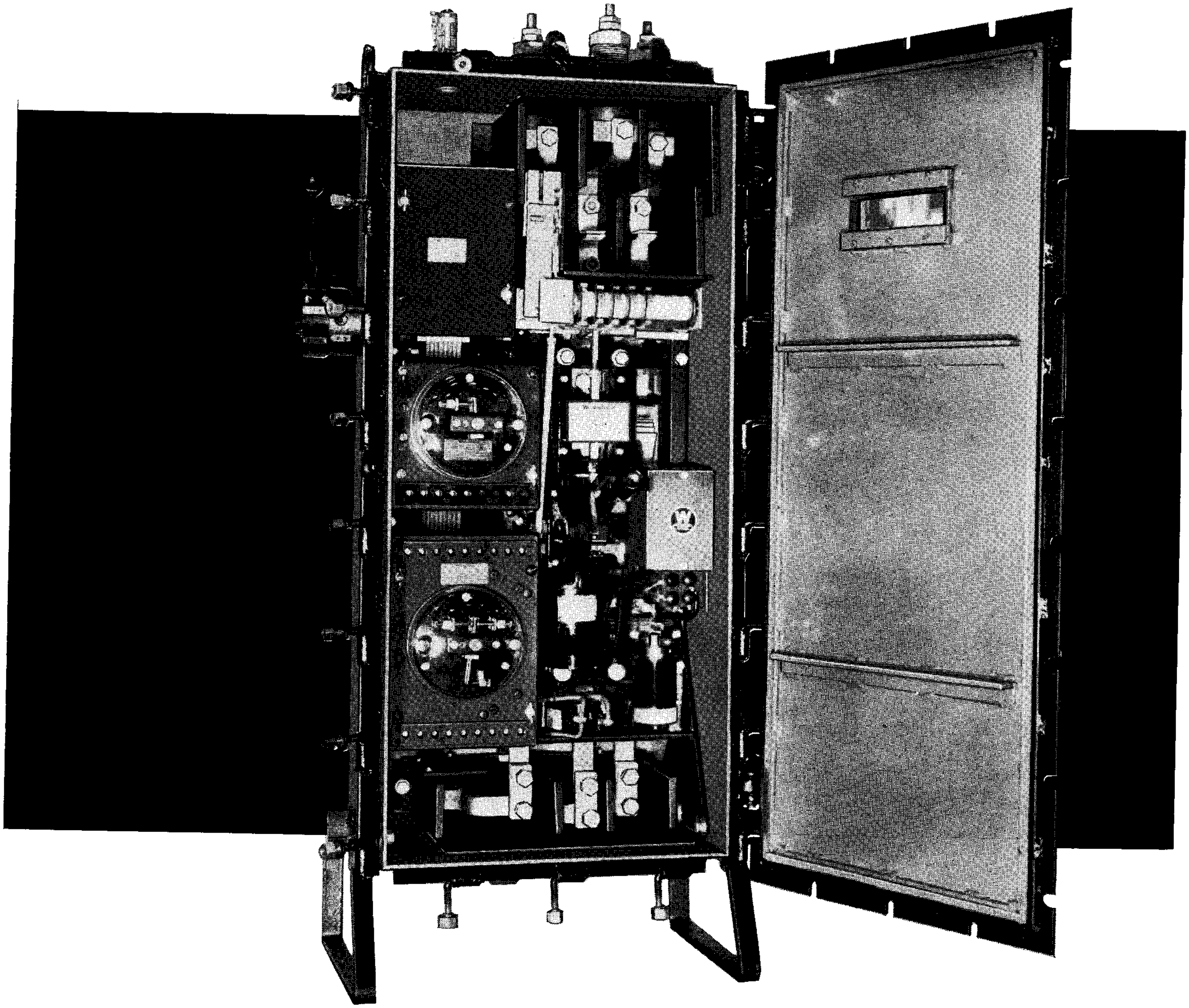


WESTINGHOUSE NETWORK PROTECTORS—LIGHT-DUTY TYPE CM-44

General Application

The increasing use of lighting and heavy appliances, such as ranges, water heaters, washers, refrigerators, and air conditioning equipment is focusing attention on distribution systems serving the medium density overhead and lighter density underground areas. Due to this increase in the use of electric energy in these areas, it is becoming more and more difficult to maintain good voltage regulation, prevent objectionable light flicker, and maintain the continuity of service which consumers are demanding, with the radial systems usually found in these areas.

The marked success of the low voltage a-c. network system in the heavy load density areas has naturally led to its consideration for serving these lighter density areas. Studies of the economics of the situation indicated that, if an inexpensive light-duty network protector were available, the high quality of service rendered by the a-c. secondary network system could be made available in the medium load density overhead areas above about 2500 kv-a. per square mile for about the same or less cost than that of the radial systems usually used. As a result of this work the first light-duty network protectors were developed and built in 1932 for use on overhead secondary network systems. These light-duty protectors consisted of a three-pole air circuit breaker equipped with an a-c. shunt trip and a-c. closing mechanism controlled by the usual network relays all mounted in a weather-proof housing suitable for pole mounting.

The overhead secondary network systems on which these light-duty protectors are used are similar to the underground low-voltage network system except that the 120/208 volt secondary mains and in some cases the primary feeders are overhead circuits. The secondary mains are solidly connected together to form a network grid or mesh from which the customers' services are taken. The secondary grid or network is supplied over a plurality of high voltage feeders, which may be either overhead or underground, through distribution or network transformers as shown in Fig. 1. In such a system the failure of one feeder does not cause an interruption to service since the load is supplied over the remaining feeders. It is apparent, however, that if a short circuit occurs on a primary feeder, even though this feeder is disconnected at the station by the functioning of the overcurrent relays to trip the automatic oil circuit breaker, it is necessary that all network transformers on the feeder be disconnected from the network by

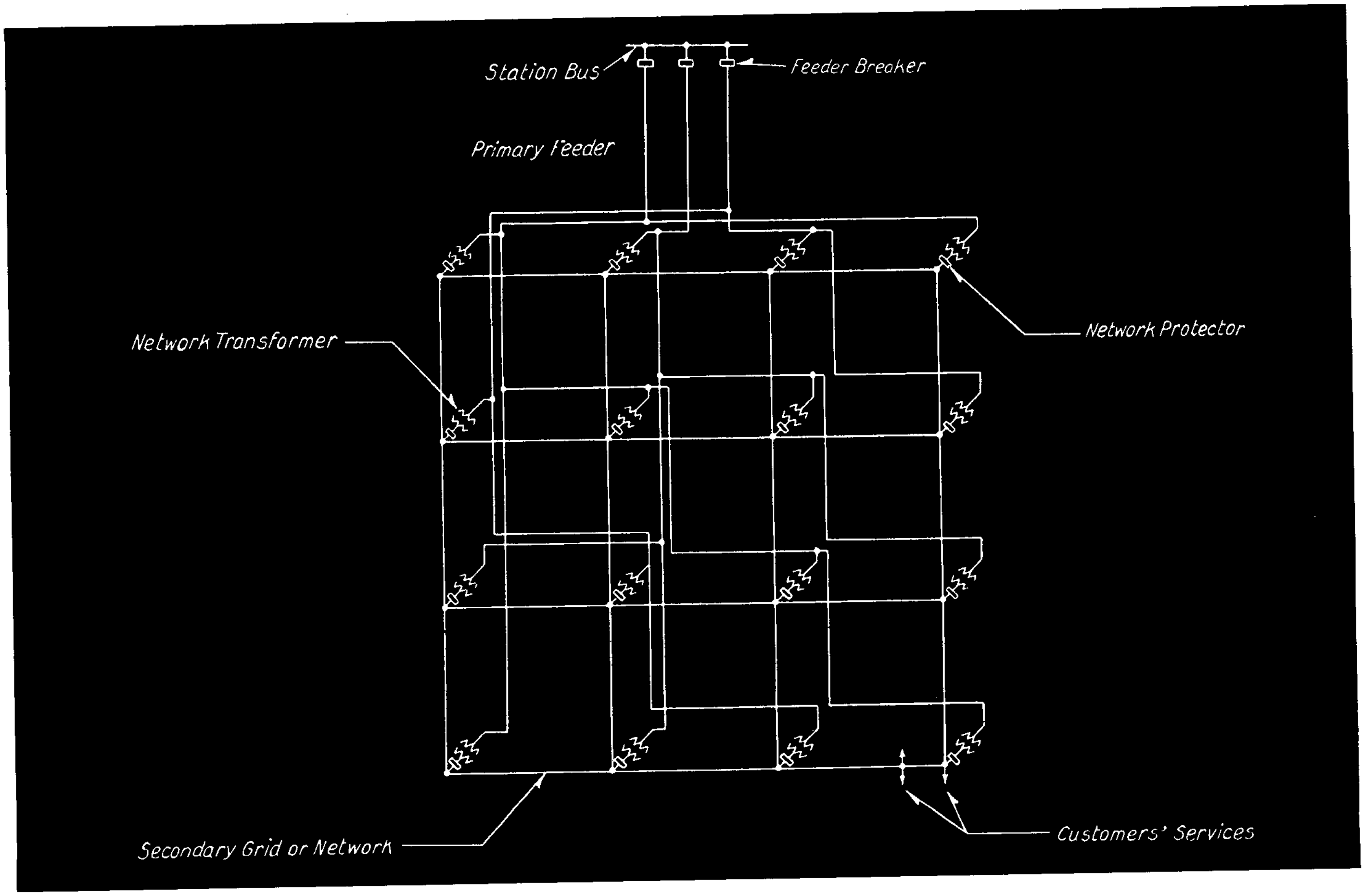


Fig. 1—Schematic Diagram of a Typical A-C. Network System

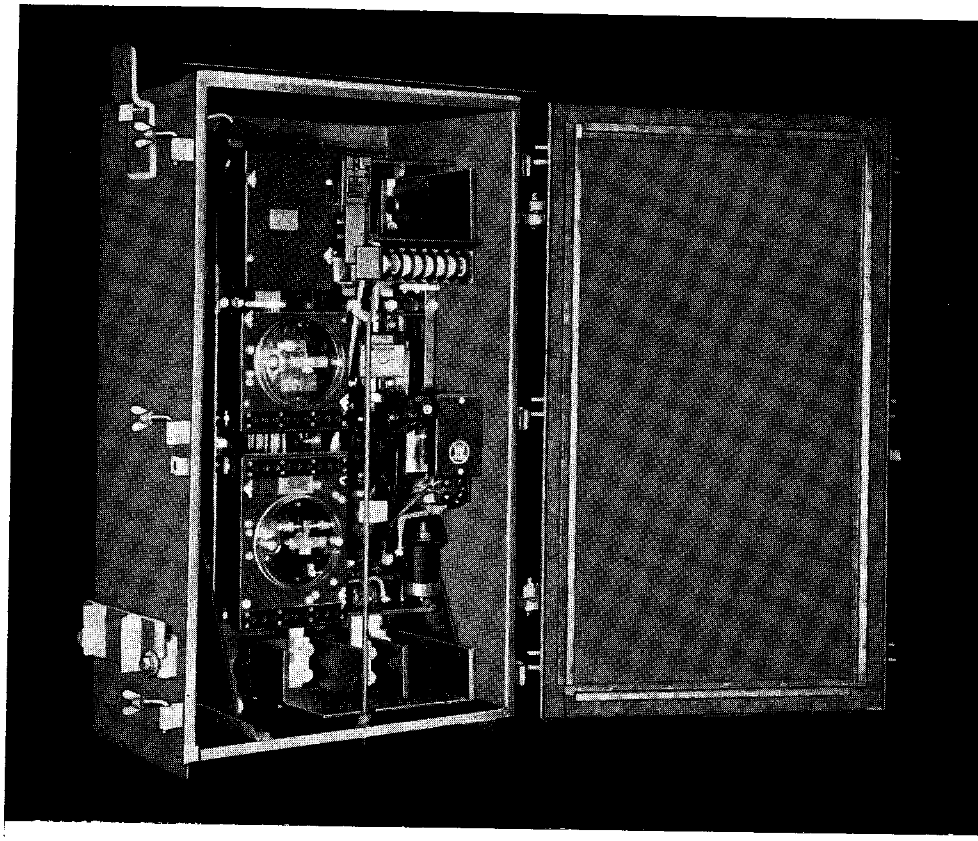


FIG. 2—SAME AS FIG. 3 EXCEPT HOUSING DOOR OPEN. NOTE POLE MOUNTING DETAILS ON SIDE OF HOUSING.

some form of protective device to prevent a backfeed of energy from the network to the fault. This is the function of the network protector.

A light-duty network protector is connected in the secondary leads of each transformer bank, and when a fault occurs on a feeder all of the protectors associated with it open as a result of the flow of power through them from the network to the feeder. The protectors will also open on the small amount of power which flows when the feeder is disconnected at the station and the transformers are excited from the network, if the protectors are given a sensitive reverse current setting as is usually the case. It is thus possible to completely isolate any primary feeder to work on it by merely opening its station breaker. To put a primary feeder back in service the station operator only has to close the station breaker. Then if the secondary voltage of the transformer is slightly higher than and approximately in phase with the network voltage the protector will close and connect the feeder to the network through their associated transformer banks. The network protectors, however, will not close if any of the phases have been crossed while the feeder was being worked on or, if the voltage relations on the two sides of the open protectors are such that power will flow from the network to the feeder when the protectors close.

Special low-loss alloy fuses are furnished as a part of each light-duty network protector to provide back-up protection in case a protector fails to trip when a fault occurs on a primary feeder or in a network transformer. These fuses are rated and designed so that they will not ordinarily blow when a short circuit occurs on the network. See Fig. 5 for characteristics of alloy main fuses. The network system is so designed that secondary faults will burn themselves clear. Fuses in the primary leads of the network transformers are unnecessary and are not used.

Since all customers are supplied from a common secondary grid, the network utilizes the diversity among loads to better advantage than a radial system. The total capacity of the feeders and the transformers need be only large enough so that with one feeder out of service the peak load of the network may be carried without excessive overloading of any part of the system. On a radial system each transformer must supply the peak of its connected load and each feeder must carry the peak load of its transformers. Due to the fact that these peak loads come at different times and the network system is designed to take advantage of this diversity, the total transformer and feeder capacity required is in many cases smaller than in a radial system.

Each load connected to the network is fed from at least two directions and from a number of transformers in parallel. The voltage drop, therefore, is small and the regulation is much better and the possibilities of light flicker are much less than on a radial system. The continuity of service obtained with the low voltage a-c. network system is superior to that provided by any other type of a-c. distribution system and is at least equal to that of a d-c. network system without a storage battery. The low voltage a-c. network system, therefore, gives about the same quality of service as the d-c. network without sacrificing any of the inherent advantages of alternating current distribution.

Naturally, the transformers and protectors used on overhead secondary network systems are smaller and lighter than those used in the heavy duty underground system and they are usually mounted on poles. The most common ratings of transformer banks are 45, 75, 112.5 and 150 kv-a. and the light-duty network protectors associated with them are 200, 300, 450 and 600 amperes respectively. The triplex design of transformer having three single-phase core and coil units mounted one above the other in a single tank is often used. This construction is well adapted for overhead network service as it gives a long narrow tank which makes a neat inconspicuous installation. The network protector may be mounted directly below or to the side of the transformer on the same pole. Single-phase transformers of the conventional type found in radial distribution systems can be used in overhead secondary networks. It will be found, however, that the economic sizes of transformer banks in an overhead secondary network are larger than in a radial system, thus giving a lower transformer cost per kv-a. Transformers having an impedance of about 2.5 to 5.0% are satisfactory for overhead network applications.

About two years after the first light-duty network protectors were built a light-duty protector of the subway type was developed for use in the lighter density underground areas where the use of heavy duty protectors was unnecessary and uneconomical. This plus an open type protector gave a complete line of light duty protectors which is applicable to both overhead and underground secondary networks employing transformer banks of 200 kv-a. or smaller where the maximum current which the protectors may be called upon to interrupt does not exceed 10,000 amperes. Such light duty network systems are usually installed in load areas having a density of 2500 to 7500 kv-a. per square mile. This class of network protectors may also be used at times on the fringes of heavy-duty network systems if conditions are such that their interrupting capacity is adequate and may be expected to remain so for a number of years.

Large and important loads, such as hospitals, theatres, hotels, apartment houses, department stores, public auditoriums, and small industrial plants often require a greater reliability of service than can be obtained by supplying the load over a single primary feeder. This improved service reliability is often provided by means of a second or standby feeder and the necessary changeover equipment for disconnecting the load from the preferred feeder in the event of trouble on it, and for connecting the load to the standby or auxiliary feeder. Any changeover scheme, however, leaves much to be desired from the standpoint of service continuity or cost or both. Light duty network protectors can be used in an improved scheme for serving many such important bulk loads. This scheme uses two or more banks of transformers connected directly to separate primary feeders. These transformer banks are paralleled on the secondary side through the network protectors forming a "spot network," from which the customer's load is fed radially or over loop circuits. These spot networks not only provide better service but are usually less expensive than automatic change-over installations for supplying load of about 300 kv-a. demand or less. Many light-duty secondary networks will start as spot networks. After a few spot networks have been installed to take care of the heavier and more important loads in an area they will be tied together through secondary mains and the smaller loads in the area supplied from these mains. Once started the network system can be extended in small increments as the load in the area grows.

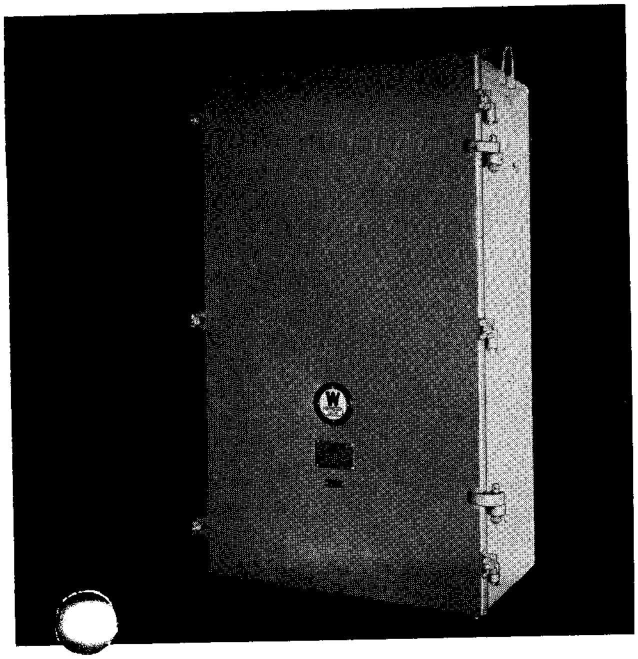


Fig. 3—The Outdoor Weather-Proof CM-44 Network Protector Housing Closed.

Since the introduction of the light-duty network protector about six years ago their use has steadily increased and they are today in service in 52 cities and towns in this country. About 20% of the network protectors manufactured during the last six years have been of the light-duty type. While the light-duty protector was originally developed for pole mounting in overhead areas and a considerable number have been installed in such areas, the majority of these protectors built to date have been of the subway type for use in the lighter density underground areas. Because of the better voltage regulation, improved service continuity, decrease in light flicker, and extreme flexibility of the a-c. secondary network, it is believed that this system will be used much more extensively in the medium density overhead and lighter density underground areas as the use of heavy appliances and better lighting in these areas grows. The present activity plus this anticipated increase in the demand for light-duty network protectors has led to the development of an improved line of light-duty protector designed to sell at as low a cost as possible, since at times it is difficult to economically justify a secondary network in overhead areas and the lighter density underground areas. This line of light-duty protectors known as the type CM-44 is described in detail in the following pages.

Operation

The operation of the network protector is as follows:

A. A short circuit on any one feeder will cause all the network protectors on that feeder to open on reverse energy, providing the totalized power on the three-phase feeder is in the reverse direction.

B. When the feeder cable is repaired properly, the network protectors on that feeder will automatically reclose when the feeder circuit-breaker at the substation is closed, if correct voltage conditions exist at the network transformers.

C. If when repairing the cable, the phases are reversed, the network protectors on that feeder will not reclose.

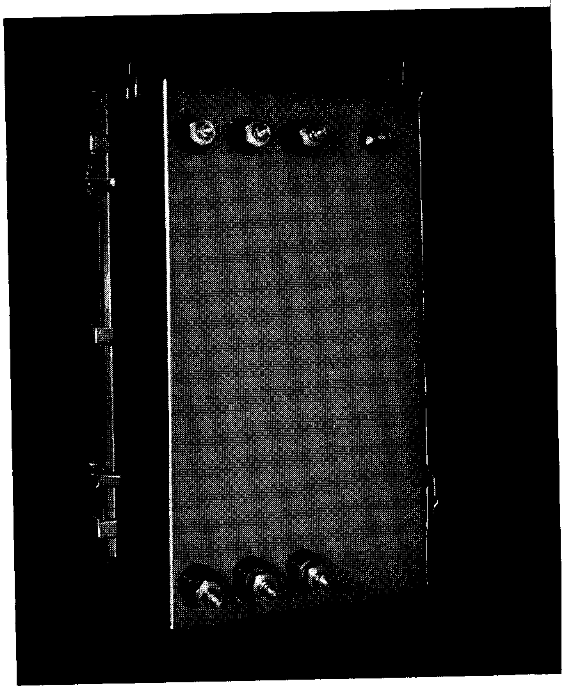


Fig. 4—A Rear View of the Pole Mounting CM-44 Showing Terminal Construction and Ground Stud.

D. Likewise, if a voltage less than network voltage is restored to the feeder, the network protector on that feeder will not reclose.

E. If a feeder from a separate source is to be connected to an energized network, the incoming voltage must be slightly higher than the network voltage and in proper phase relation with it. If a feeder is being connected to a dead network, it is sufficient to have the incoming voltage high enough to operate the closing mechanism.

F. The substation operator can disconnect feeders, by simply opening the feeder circuit breakers thus killing the feeders so that they may be easily worked on. By thus opening the feeders one at a time, service need not be disturbed. Also, at times of light load, the substation operator may load the system more economically by disconnecting some of the feeders. The network protectors open automatically when a feeder breaker is opened, due to the reverse magnetizing energy of the transformers.

G. When the load increases, the substation operator may bring more feeders into service by closing the substation feeder circuit breakers. The network protectors on those feeders will reclose automatically if the transformer voltage is higher than the network voltage by a certain minimum amount and in proper phase relation with it.

H. The network protector fuses serve only as an emergency protection in case of apparatus failure during faults, and as a means of disconnecting the circuit breaker from the network when it is desired to work on the protector. Copper links at the bottom serve to disconnect the associated transformer when complete isolation of the network protector is desired.

Construction

General—The complete network protector is mounted on a welded steel frame-work. The 3-pole "De-ion" circuit breaker is mounted directly on the rear of the frame-work, while the mechanism, relays and control details are mounted in front of the circuit breaker. The breaker itself is of a single break butt contact construction and is equipped with main contacts made of pure silver, protected by "De-ion" arcing chambers. A special operating mechanism is used. which is motor closed. The tripping function is accomplished by an a-c, shunt-trip coil.

The entire operation of the network protector is usually controlled by two relays, one known as the type CN-33, 3-phase master relay and the other as the type CN-J phasing relay. A third relay, known as the type BN, is sometimes supplied when it is necessary to have a reverse current setting higher than normally available in the standard master relay.

The Type CN-33 Network Master Relay—The type CN-33 relay is a three-phase induction relay having three separate electromagnets acting on a single aluminum drum carried on a short horizontal shaft. The three electro-magnets are located radially and equally spaced about the drum with the potential coil and iron assemblies inside the drum and the phasing and current coil and iron assemblies outside the drum. The potential and phasing circuits cooperate when the protector is open to control the making of the master relay "closing" contacts. The potential and current circuits cooperate when the protector is closed to control the making of the master relay "tripping" contacts. The relay contacts are made of pure silver and are arranged for single-pole, double-throw operation.

The entire assembly of electro-magnets, moving element, contacts and terminals, are mounted on a single, flat steel plate. This plate bolts on the front of the cast relay base that completely encloses all parts of the relay which are mounted behind the plate. The drum shaft extends through a hole in a moulded insulation plate located on the flat steel plate. One of the bearings for this shaft is located behind the steel plate and one in front of it. These bearings are of the knife-edge type made of tool steel with the knife edges extending upward to prevent any accumulation of dirt between the bearing surfaces. The moving contacts of the relay are carried directly on that portion of the moving element shaft which extends through in front of the mounting plate, thus eliminating all gears from the relay. The stationary contacts and the stop screw which engages the reverse current adjusting springs are mounted on the front of the moulded insulation plate carried on the flat steel mounting plate. A shallow glass cover is mounted over the moulded insulation plate to protect the pure silver relay contacts, reverse current adjusting springs and front bearing of the moving element shaft.

In addition to the electro-magnets and drum two small permanent magnets for damping the movement of the drum 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. These permanent magnets and a solid stop on the moving element, which limits the movement of the drum to a relatively small angle, prevent bouncing of the relay contacts.

Moulded insulation terminal blocks

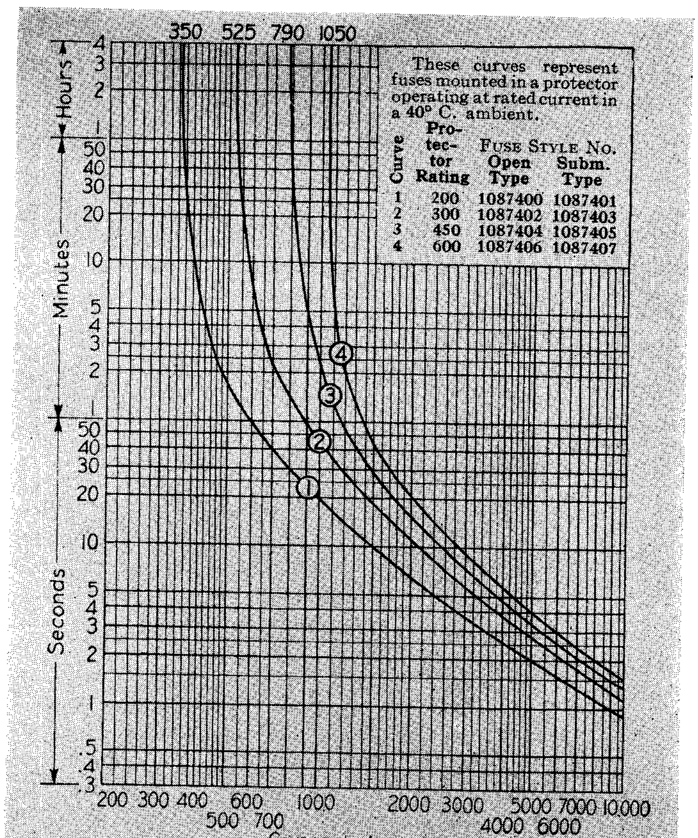


Fig. 5—Current-Time Characteristics of Light-Duty Alloy Fuses for Network Protectors.

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 leads 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 silver plated copper jaws backed up by steel springs located in moulded insulation terminal blocks mounted on the protector. These screws serve as plug or jack type connections, between the relay and protector wiring.

The relay is mounted on two studs and held securely in place by two thumb nuts which, when tightened up, force the terminal screws firmly into engagement with their associated jaws. The heads of all terminal screws are accessible from the front of the relay, and when screwed down in their normal position, they are completely surrounded by part of the moulded terminal blocks through which they pass. This prevents accidental contact with, or shorting between screws. By partially removing the proper terminal screw or screws any circuit or circuits between the relay and protector 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 mounting block so that a test clip can be connected to it under the special 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 protector. The relay can readily be mounted on or removed from the protector without disturbing any leads and without any possibility of connecting it improperly, merely by removing two thumb nuts from the mounting studs. After the relay has been taken off the protector, it can be completely removed from its base for inspection or maintenance without disturbing any parts or wiring details by removing two screws which hold the steel mounting plate on the front of the base.

Operation

There are but two adjustments to be made on the type CN-33 relay, namely, the over-voltage adjustment and the reverse current adjustment. When the relay is completely de-energized the moving contact is held firmly against the stationary closing 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.

By this method a continuous over-voltage adjustment having a range of approximately 1.0 to 5 volts 75° leading the network voltage, or approximately 0.5 to 2 volts in phase with the network voltage, is obtained. Three flat springs, placed side by side, are carried on the moving element shaft directly below the moving contacts. These, in conjunction with an adjustable thumb screw stop which can be located in any one of three tapped holes in its mounting block so that it will deflect one, two or all three of the springs, provide a continuous range of in-phase reverse current adjustment from about 0.2 to 10 per cent of the protector rating in amperes.

Figs. 7, 8 and 9 show the operating characteristics of the type CN-33 network master relay. Curve No. 1 of Fig. 7 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

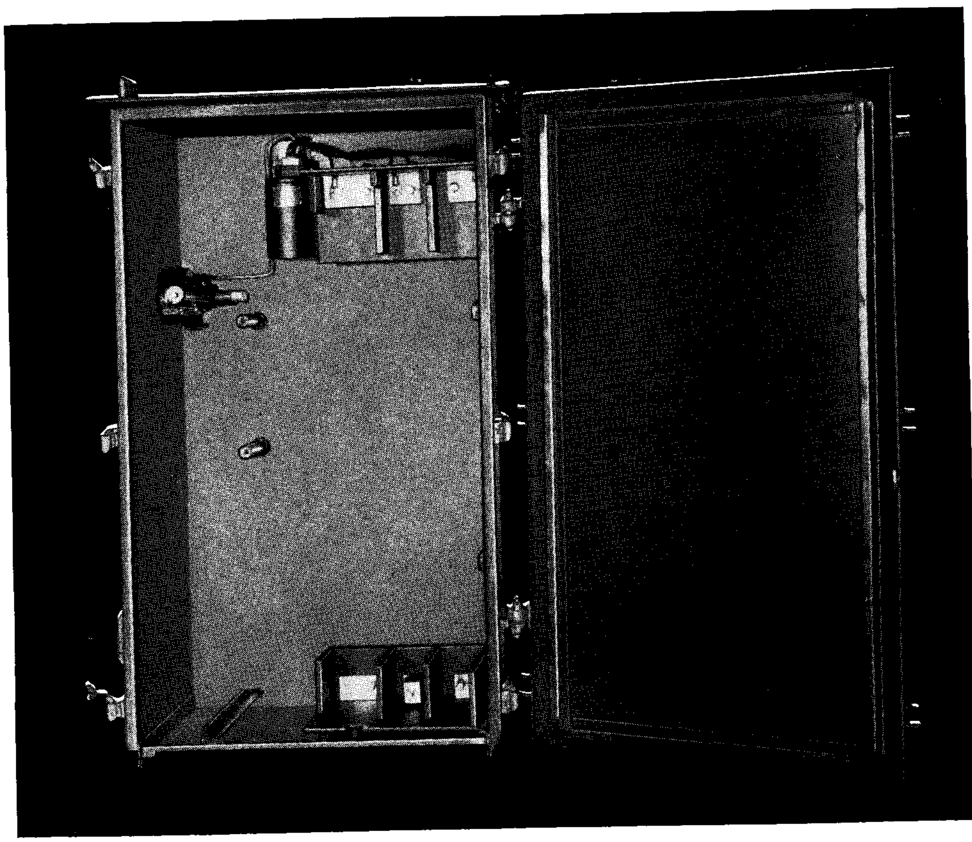


Fig. 6—The Weather-Proof Housing with Roll-Out Unit Removed.
Note operating handle inside housing and provision for mounting standardized roll out unit.
Provision for lightning arrester furnished with this arrangement only.

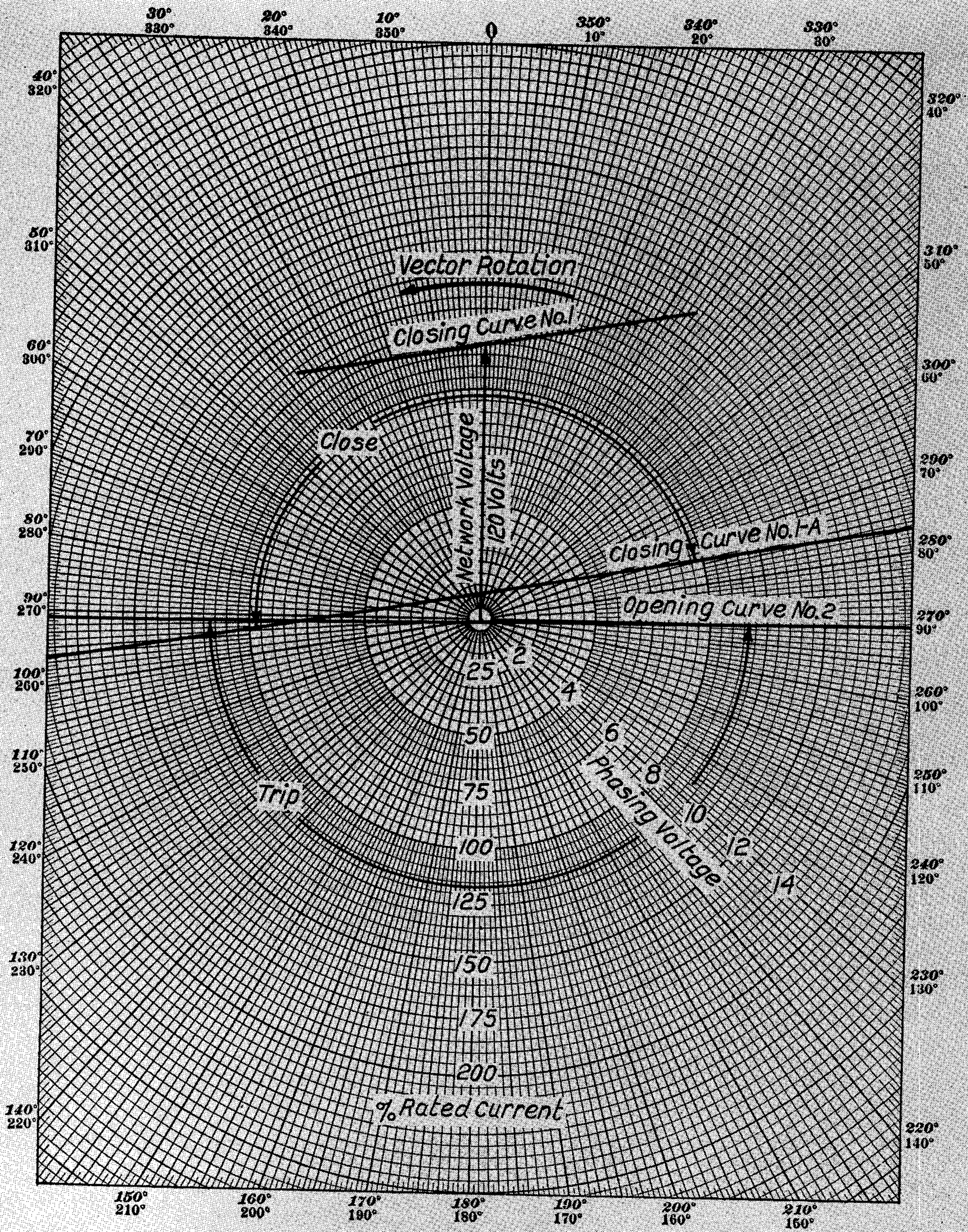


Fig. 7—Closing and Tripping Characteristics of the Type CN-33 Network Master Relay. Balanced Three-Phase Conditions Assumed.

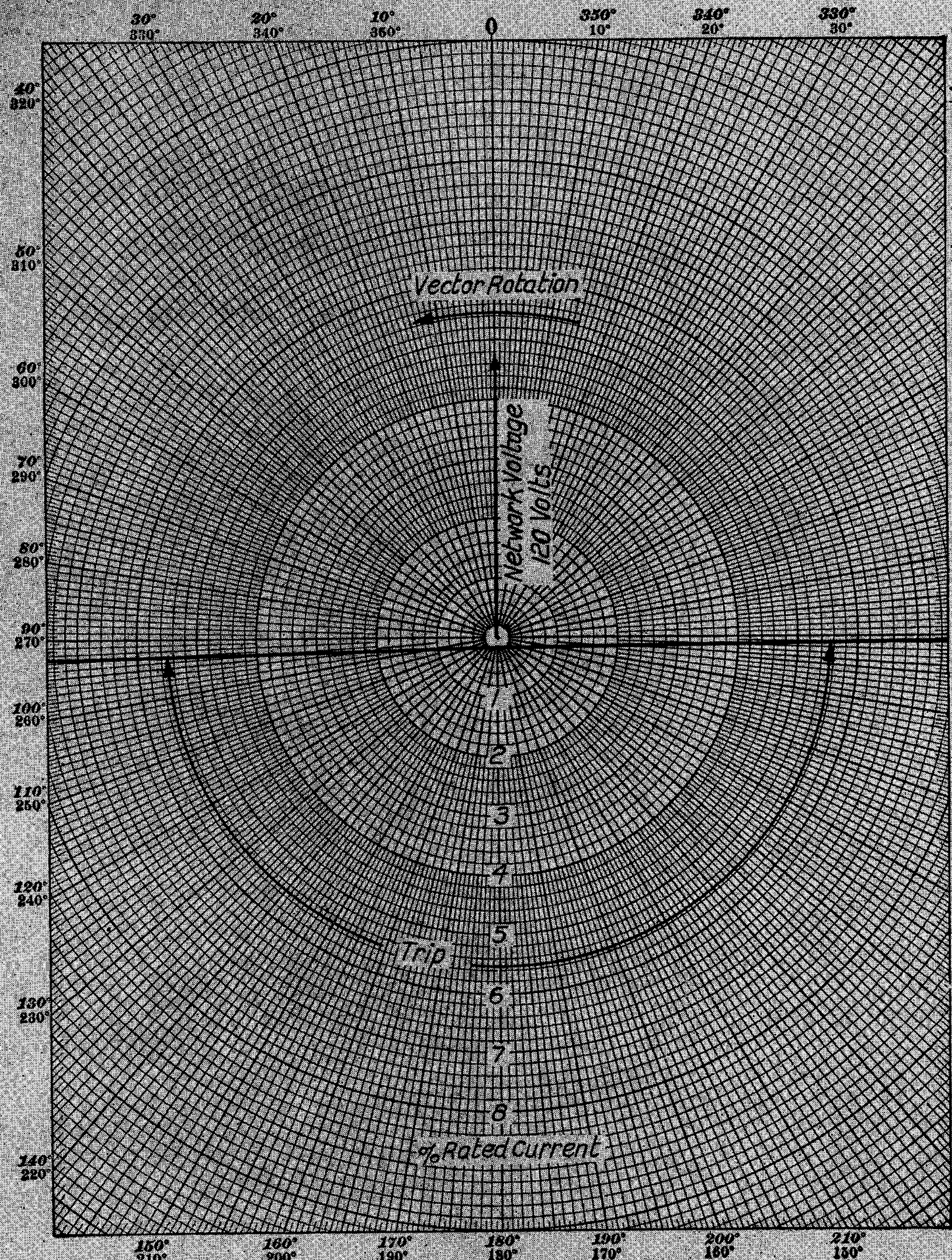


FIG. 8—TRIPPING CHARACTERISTICS OF THE TYPE CN-33 NETWORK MASTER RELAY. BALANCED THREE-PHASE CONDITIONS ASSUMED.

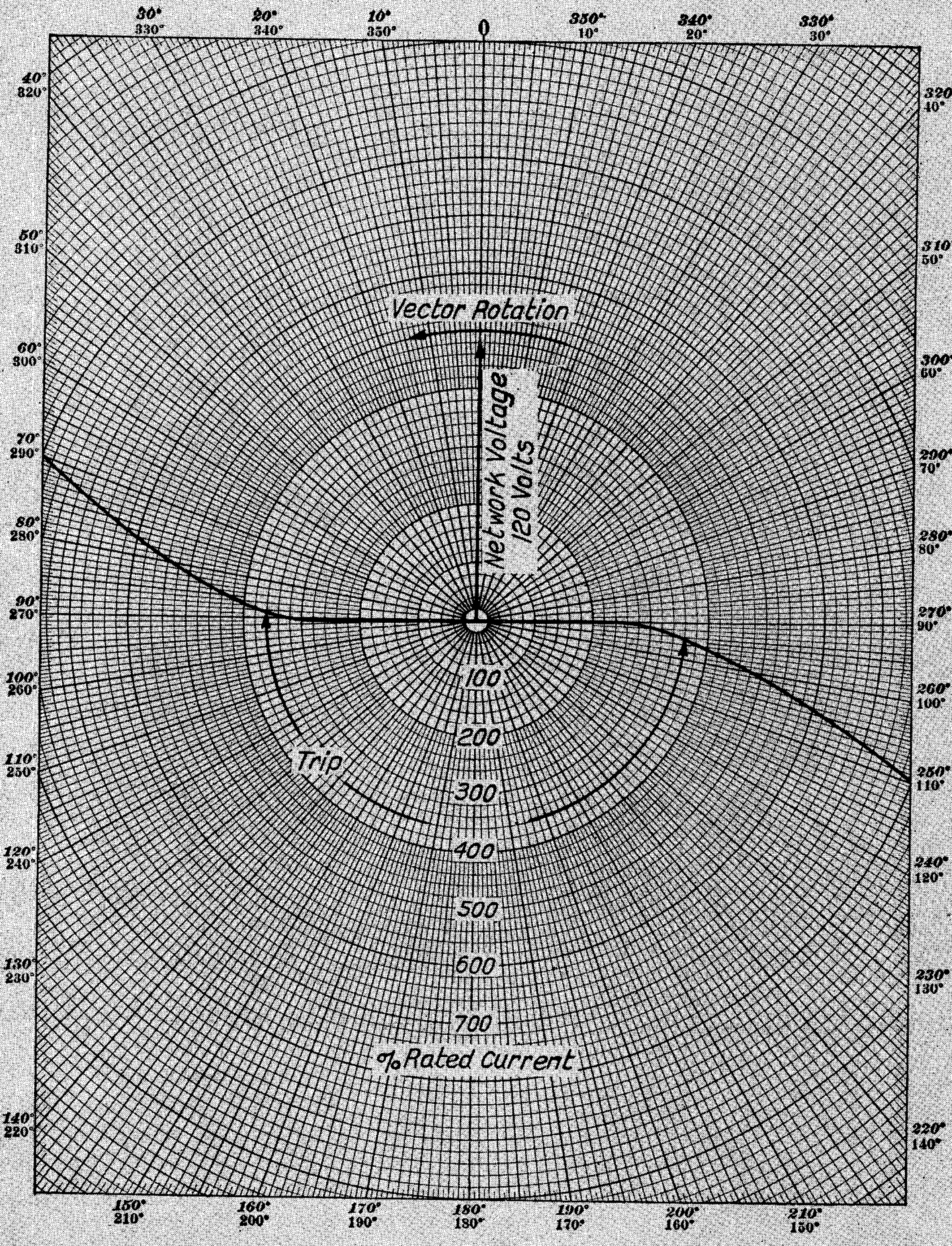


FIG. 9—TRIPPING CHARACTERISTICS OF THE TYPE CN-33 NETWORK MASTER RELAY. BALANCED THREE-PHASE CONDITIONS ASSUMED.

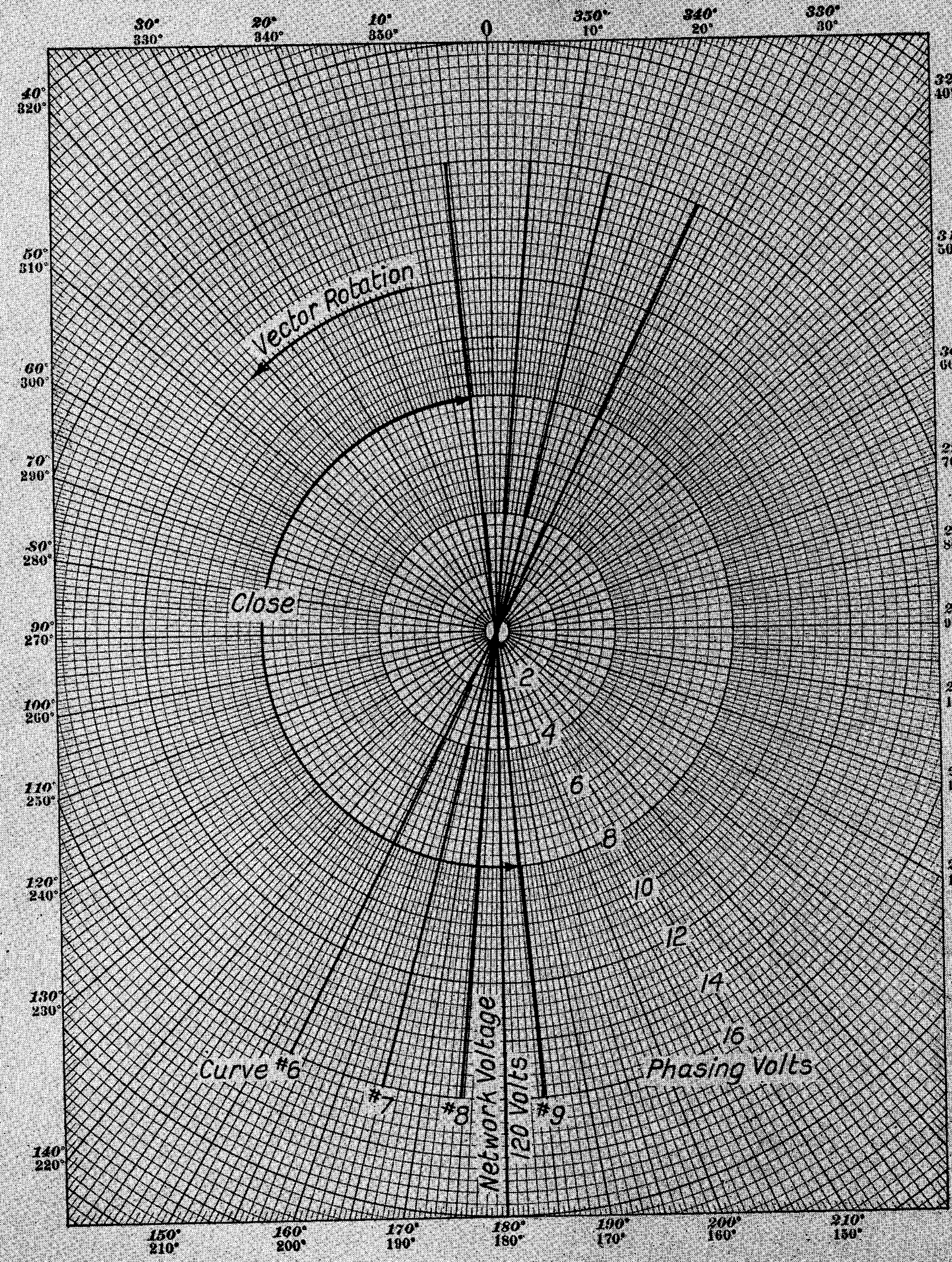


Fig. 10—Closing Characteristics of the Type CN-J Network Phasing Relay.

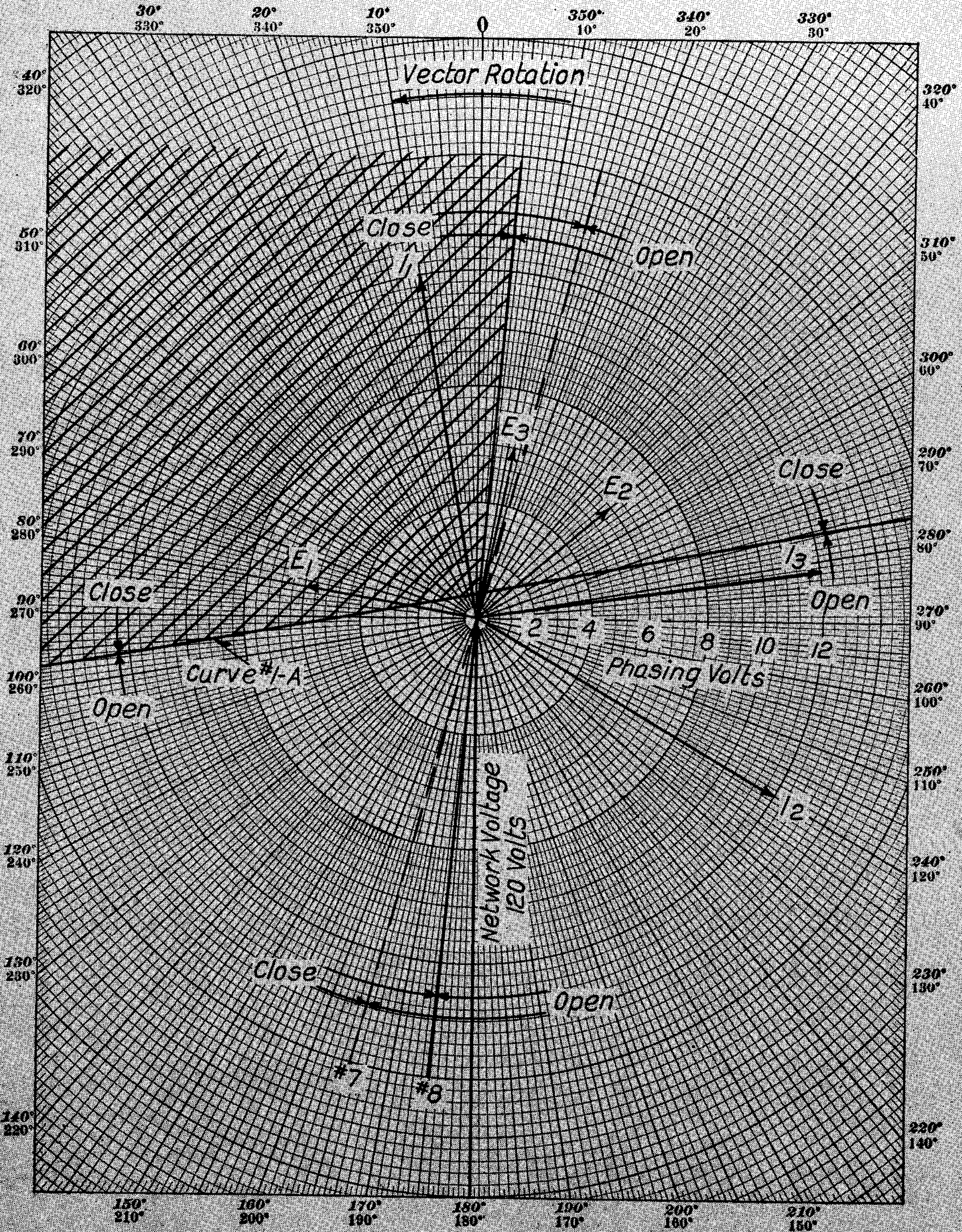


FIG. 11—COMBINED CLOSING CHARACTERISTICS OF THE TYPES CN-33 AND CN-J NETWORK RELAYS.

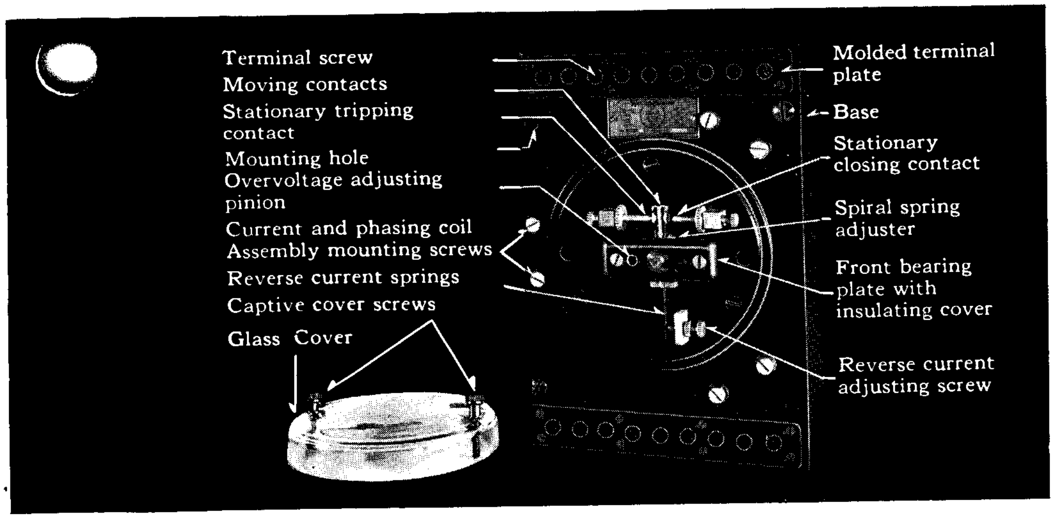


FIG. 12—TYPE CN-33 NETWORK MASTER RELAY. FRONT VIEW WITH GLASS COVER REMOVED

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. 7 that the relay will just close its closing contacts 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. 7. 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 curve shown in Fig. 8 represents a small section of the opening curve just discussed plotted to a much larger scale in order to show the operation of the relay on small current values, such as the magnetizing currents of network transformers. The magnetizing current of a 300 Kv-a. transformer bank will be about 12 amperes per phase minimum at 120 volts and will lag the network voltage reversed between 60 and 76 degrees. A network protector rated at 1200 amperes would be used with such a bank, and it will be seen by referring to the opening curve of Fig. 8 that the relay will operate satisfactorily to trip the network protector when exciting current only is flowing.

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 that part of the feeder charging current which flows through the associated protector. When the charging current predominates over the magnetizing current, the relaying current 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 reversal current does not exceed approximately 250% of the rating of the protector, even if the current is almost 90° out of phase with the network voltage reversed.

Fig. 9 shows the tripping characterisrics of the type CN-33 relay on current values up to 800% of the protector 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.

The Type CN-J Network Phasing Relay—The type CN-J relay is a single-phase induction drum relay having two operating circuits, namely, a potential

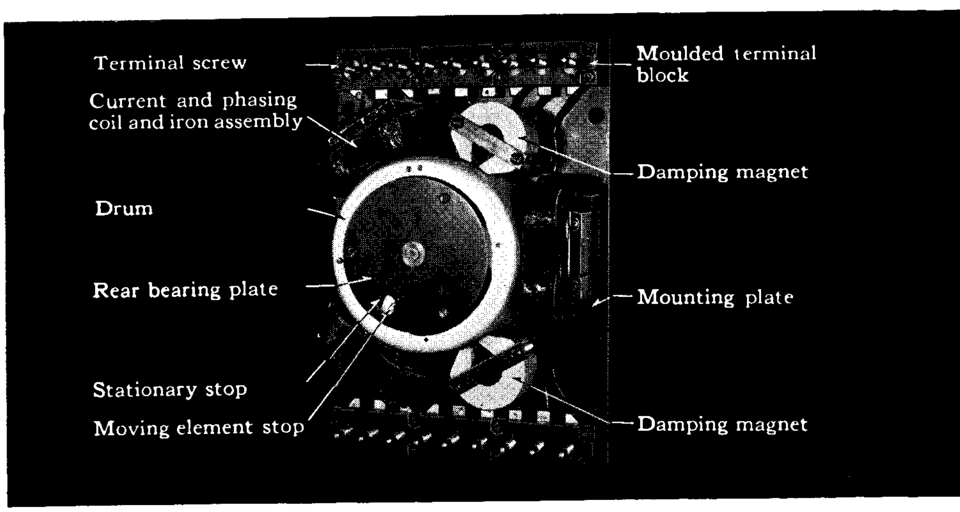


FIG. 13—TYPE CN-33 NETWORK MASTER RELAY. REAR VIEW OF RELAY REMOVED FROM BASE AND WITH REAR BEARING PLATE REMOVED

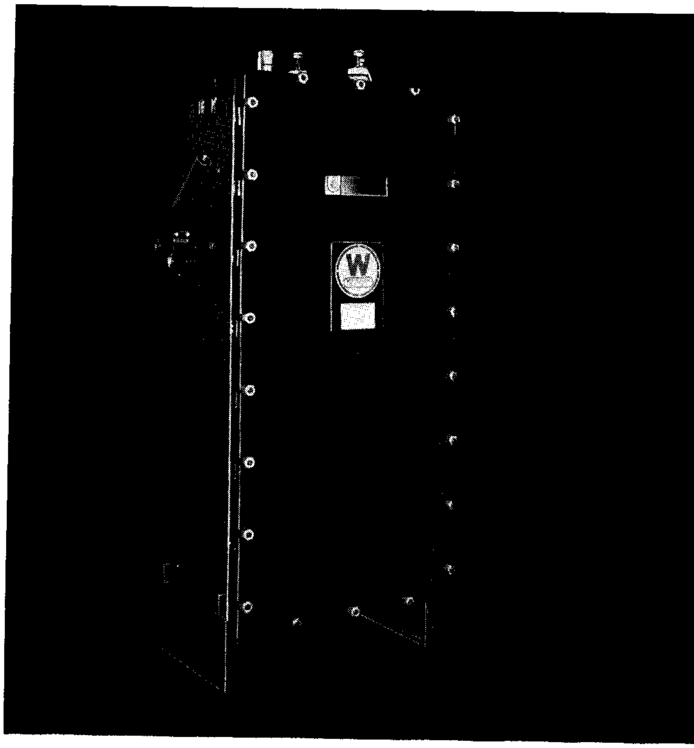


FIG. 17—A 200-AMPERE TYPE CM-44 LIGHT-DUTY NETWORK PROTECTOR ARRANGED FOR TRANSFORMER MOUNTING SUBWAY SERVICE

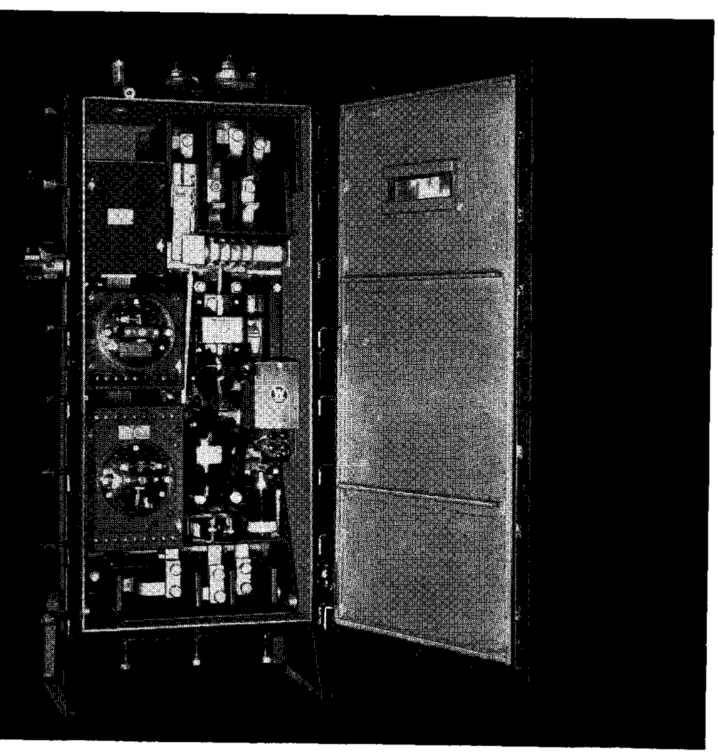


FIG. 18—SAME AS FIG. 17 EXCEPT SHOWING HOUSING DOOR OPEN AND ROLL-OUT UNIT IN POSITION

mounting facilities for the type BN relay so that this relay can be easily installed on the protector at any time should the need for it develoy by merely removing the terminal panel and plugging in the BN relay.

The Circuit Breaker

The circuit breaker part of the CM-44 light duty network protector consists of a standard 3-pole AB "De-ion" circuit breaker mounted directly on the back of the welded steel framework that also supports other details of the completely assembled unit. This is the same breaker unit that is widely applied in switchboard and panelboard work, except that the cover and thermal trip unit have been omitted.

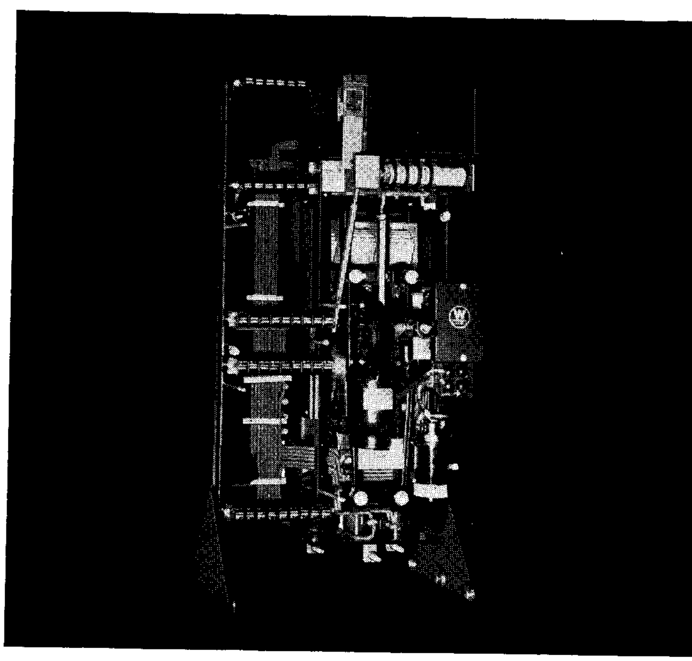


FIG. 19—THE ROLL-OUT UNIT (RELAYS REMOVED). THESE STANDARDIZED UNITS MOUNT IN WEATHER-PROOF OR SUBWAY HOUSINGS OR OPEN-TYPE FRAMEWORKS FOR APPLICATION TO OVERHEAD, UNDERGROUND OR DRY VAULT LOCATIONS

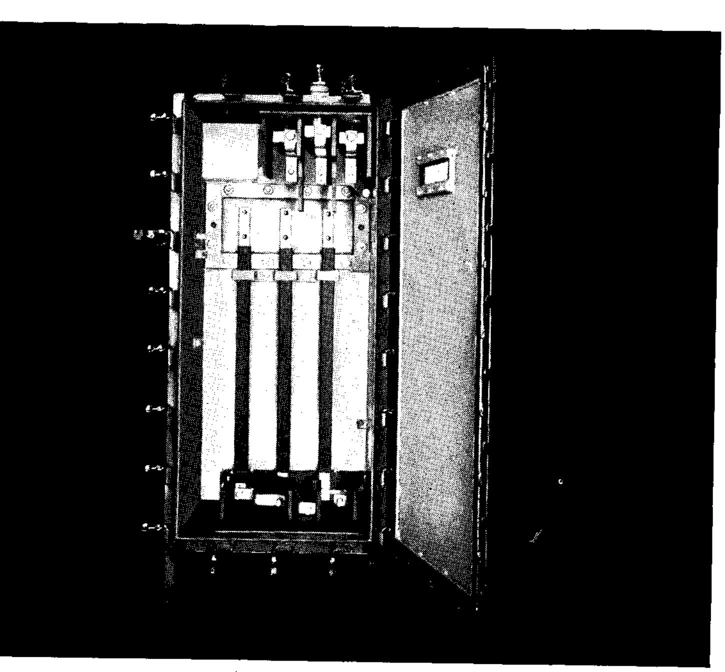


FIG. 20—THE SUBWAY TRANSFORMER MOUNTING HOUSING WITH ROLL-OUT UNIT REMOVED SHOWING BUS AND TERMINAL CONSTRUCTION. THIS HOUSING WILL TAKE ANY AMPERE CAPACITY OF CM-44 UNIT

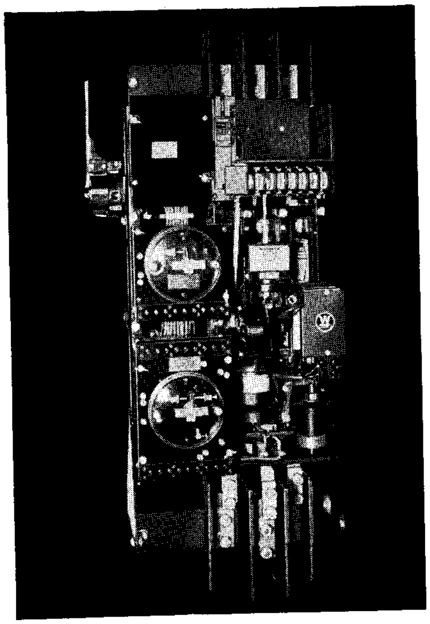


Fig. 21—The Complete 200-Ampere Open Type Wall Mounting CM-44 Network Protector

By using the AB "De-ion" circuit breaker in the CM-44 protector, we obtain a circuit interrupting unit that has a long record of satisfactory field experience behind it. In addition, the breaker incorporates as part of its inherent operating mechanism, such desirable automatic features as mechanically trip free, quick closing and quick break.

The main contacts of the AB "De-ion" circuit breaker are silver and are protected by silver tungsten transfer contacts that transfer the arc under short circuit into the "De-ion" chamber where it is extinguished. The three poles of the breaker are closed simultaneously by the powerful mechanically trip-free toggle mechanism. Each complete pole unit is assembled in the standard Moldarta base which provides the necessary barriers between each phase.

Operating Mechanism

Mounted directly in front of the circuit breaker is a worm and gear motor-driven closing mechanism, that functions in response to the network relays through the motor control relay to close the protector.

Since the necessary toggle mechanism and trip free features are incorporated in the standard breaker mechanism, the motor closing device itself is very simple. It consists only of a motor, a worm on the motor shaft that meshes with a worm gear, and a crank which rotates through 360° on the shaft of this worm gear. On the end of this motor crank is a roller which engages the spring clutch device that couples the motor mechanism to the operating handle of the AB "De-ion" circuit breaker.

The spring clutch (see Fig. 28 and 29) is a device for coupling the motor closing mechanism to the standard hand operating handle of the AB "De-ion" circuit breaker and still provides means for easy mechanical disengagement when the protector is to be operated from the manual operating handle. This spring clutch also gives a flexible coupling between the motor mechanism and the breaker operating lever that permits positive closing and resetting of the breaker without danger of excessive strain on any part. The clutch consists of two castings, one of which is fastened directly to the operating handle of the circuit breaker, and the other which is hinged to the first engages with the roller of the motor mechanism crank. The two castings are held in engagement by a spring and roller arrangement. (See Fig. 28).

When the spring clutch has been disengaged by the manual operation of the protector, it will automatically re-engage when the motor is energized. If the breaker has been tripped by the relays through the shunt trip attachment, the motor once energized, will reset the breaker latch and close the contacts on the next impulse from the network relay. During the closing operation, motor cutoff is provided by a contact on the rotary type auxiliary switch actuated directly by the operating mechanism of the breaker. Since the operating mechanism of the breaker has snap action both closed and open, this transmits the required action to the motor cut-off contact, and eliminates the necessity of any special type of switch to delay motor cut-off until the closing operation has progressed far enough to insure positive closing of the breaker.

Tripping of the protector is accomplished by an a-c. shunt trip device that is energized directly from the main terminals of the protector through the trip contact of the master relay. As previously mentioned, the standard AB "De-ion" circuit breaker has the thermal trip omitted. In place of the thermal trip unit, which is usually supplied with switchboard type AB breakers, there is a trip bar actuated by the shunt trip coil. The a-c. shunt trip coil is designed to operate down to approximately 7% of normal voltage. By referring to any of the accompanying illustrations, it will be noticed that the shunt trip attachment is mounted just to the right of the operating motor mechanism.

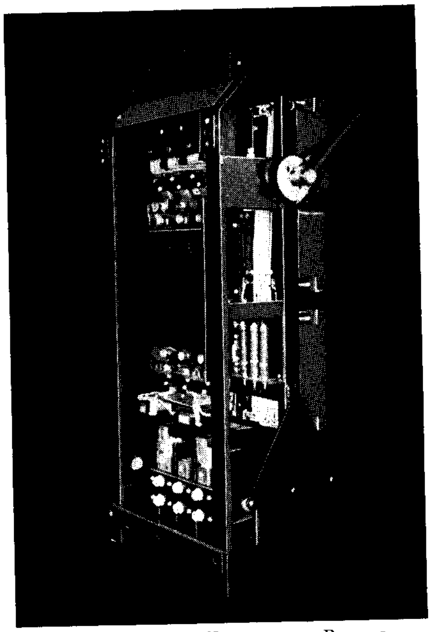


Fig. 22—A Rear View of the Protector Shown in Fig. 21. Note how the framework accommodates the standard roll-out unit

The motor control relay previously referred to, which is energized through the closing contacts of the master and phasing relay, determines the closing voltage of the protector. This motor control relay is set to operate at a voltage considerably higher than the minimum closing voltage of the motor mechanism, so as to be sure that any voltage applied to the motor will be more than enough to positively close the protector. Other details of the protector consist of a mechanical semaphore device that indicates the open and closed position of the protector, controlled directly from the operating mechanism of the breaker. This is the same idea that has proved so successful in connection with the CM-22 heavy duty protector. An operation counter and a rotary type auxiliary switch complete the necessary accessories. One of the contacts on the auxiliary switch operates to cut off the motor circuit, another contact operates to cut off the shunt trip circuit, and three other contacts are used in the master relay circuits.

Manual operation of the protector is effected by means of a manual operating handle that, through a series of links, acts on the operating handle of the circuit breaker. The manual handle has three positions, namely, "closed", "trip", and "automatic". This latter position permits complete control of the protector by the relays.

When the manual operating handle is in the "trip" position, the motor circuit is broken by a switch on the handle. This prevents automatic closing of the

FIG. 23—CM-44 SUBWAY TYPE NETWORK PROTECTOR FOR SEPARATE MOUNTING. Note standard stud type porcelain bushings at top for network leads (non-lead cable), and special wiping sleeves at bottom for lead covered cables from associated transformer

FIG. 24—THE SEPARATE MOUNTING FRAMEWORK IN WHICH IS MOUNTED ANY AMPERE CAPACITY OF ROLL-OUT UNIT

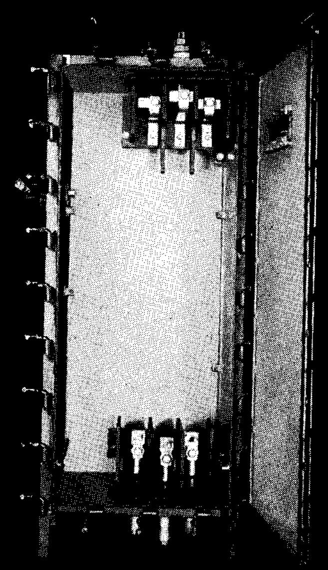


FIG. 25—THE BARE HOUSING OF THE PROTECTOR SHOWN IN FIG. 23

protector when the handle is locked in the trip position. Provision is made for padlocking the handle in any of the three positions.

On submersible type protectors, the manual operating handle shaft extends through a watertight gland in the housing, while on open type protectors, the shaft is supported directly on the protector mounting framework. On the weather-proof pole type protectors, the operating handle is located inside the housing to discourage unauthorized tampering.

Complete Protector

All of the component parts of the complete network protector including the breaker, motor mechanism, relays, and auxiliary details are mounted as a unit on a welded steel framework. This completely assembled unit has been standardized to the extent that the same assembly of protector is applicable to any of the arrangements required to meet the different application conditions. This means that the completely assembled roll-out unit is arranged so that a given ampere rating can be mounted in a separate framework for use in a dry vault where open type construction is permissible; or the same roll-out unit can be mounted in either a weather-proof housing for overhead pole mounting or in a submersible housing for street vault installation.

It will be noted from Fig. 26, that these roll-out unit frames are equipped at the bottom with rollers that greatly facilitate removal from an associated housing. The open type mounting framework previously referred to, is available in either the separate wall mounting type, or transformer mounting type that permits mounting the open type protector directly on the associated transformer. (See Fig. 36). Ventilated sheet steel protective covers are also available to enclose the open type units and protect them from settling dirt and accidental contact. These protective covers also serve to improve the appearance of an open installation.

The weather-proof housing (See Fig. 2, 3, and 4) can be furnished either for pole, cross-arm, or platform mounting.

The subway units are available in either the separate mounted type (See Fig. 24) or for transformer mounting (See Fig. 17). Both the separate mounted and transformer mounted units can be equipped with either stud type porcelain bushings for attaching non-lead cable, or they can be equipped with wiping sleeves for attaching lead covered cables (one per phase).

The standard terminal connections on all protectors connect the leads from the associated transformer to the bottom terminals of the protector and the leads to the network at the top terminals of the protector.

The standardization previously referred to is carried to the point of having only one sized framework or housing that will take any available ampere capacity of roll-out unit. This makes a given roll-out unit entirely interchangeable between open type, weather-proof or subway type protectors.

Rating

The ratings in which the standard CM-44 protectors are built are 200, 300, 450, and 600 amperes in either the open type, weather-proof type, or subway type. These are maximum ratings, and the device is not to be used in a circuit where the current will exceed the rating of the protector. It is an accepted fact that there may be times when the transformers will be called upon to carry overloads for short periods of time and for this reason, it is common practice to apply network protectors in line with the table below:

Transformer	Network Protector
Up to 45 Kv-a. bank, incl.	200 amperes
Up to 75 Kv-a. bank, incl.	300 amperes
Up to 112.5 Kv-a. bank, incl.	450 amperes
Up to 150 Kv-a. bank, incl.	600 amperes

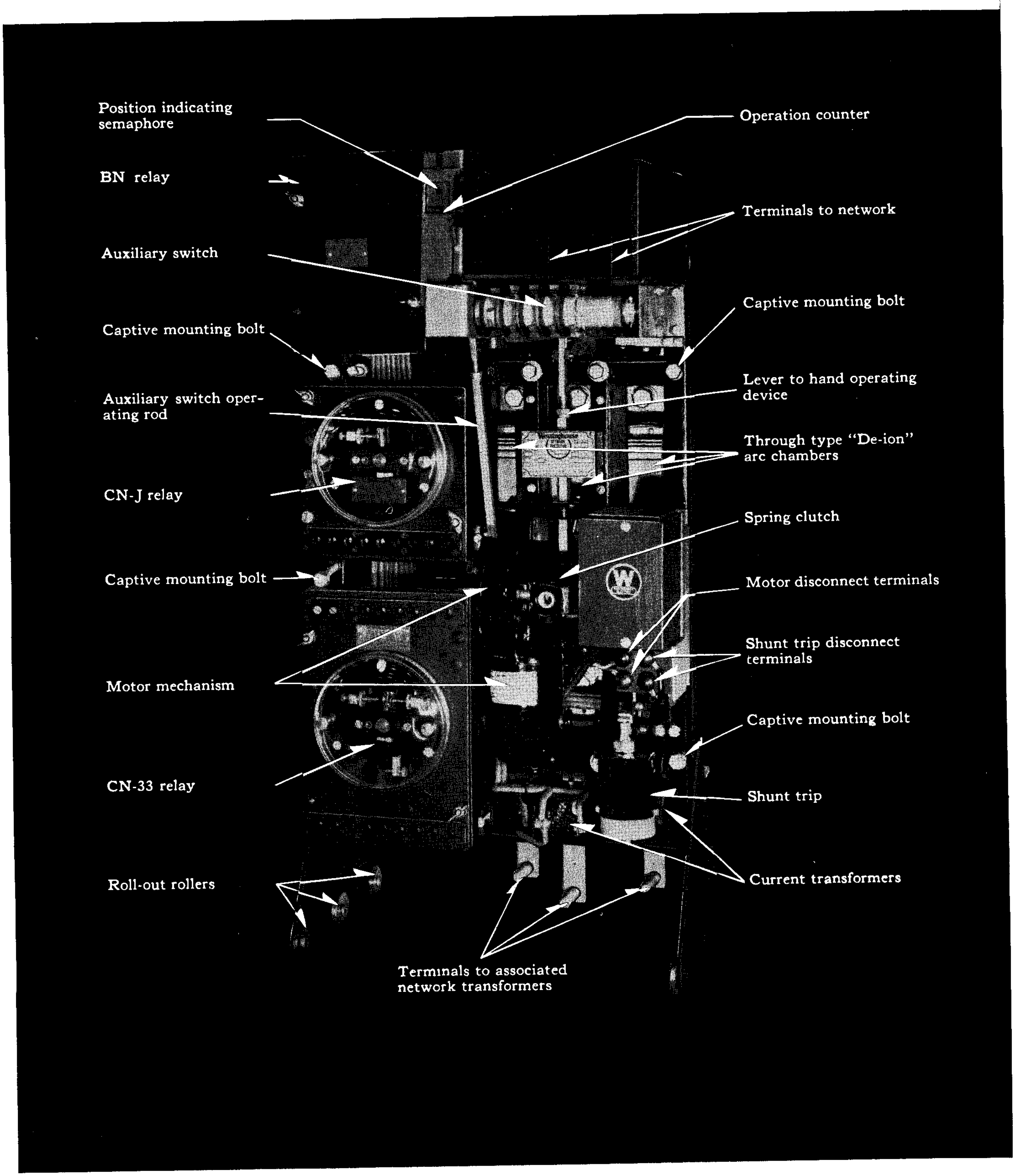


FIG. 26—A 600-AMPERE TYPE CM-44 ROLL-OUT UNIT

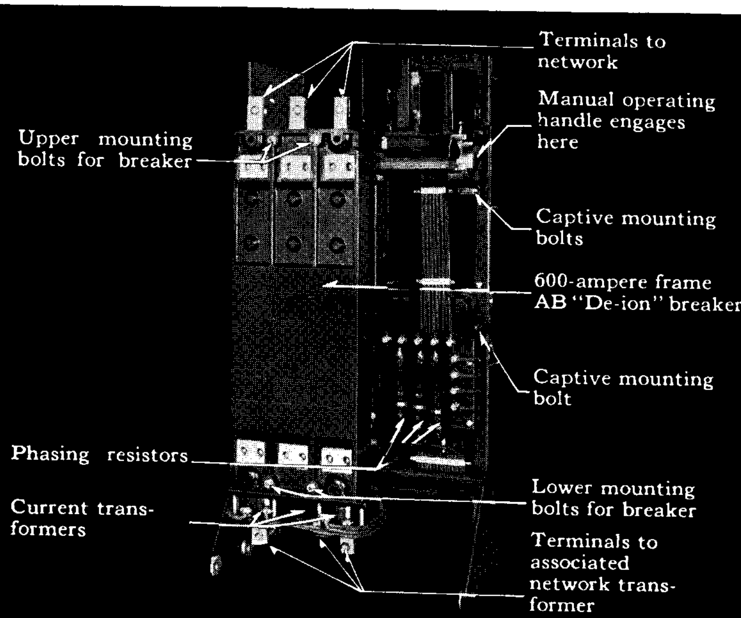


Fig. 27—Rear View of Interchangeable Roll-Out Unit

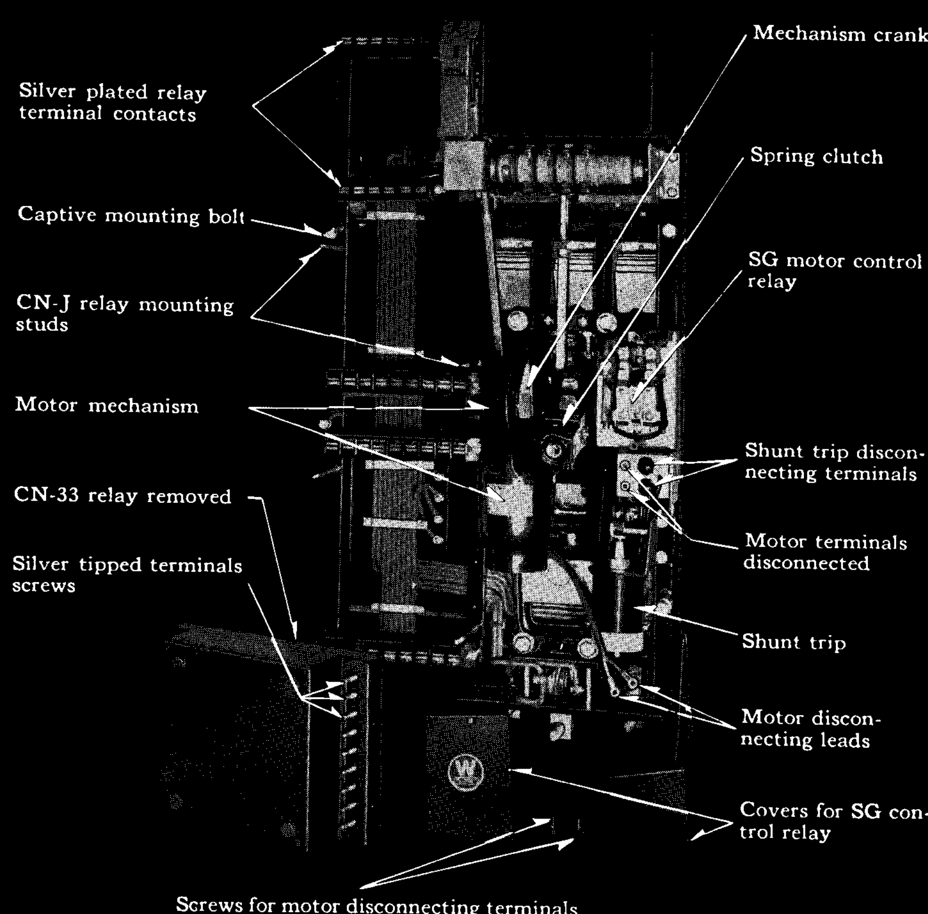


Fig. 28—Details of the CM-44 Roll-Out Unit Shown by Removing Relays and Barriers over SG Relay. Breaker Has Been Opened by Hand (not Tripped) Which Results in Breaker Handle Lever Spring Clutch Being Disengaged from Operating Lever as Shown

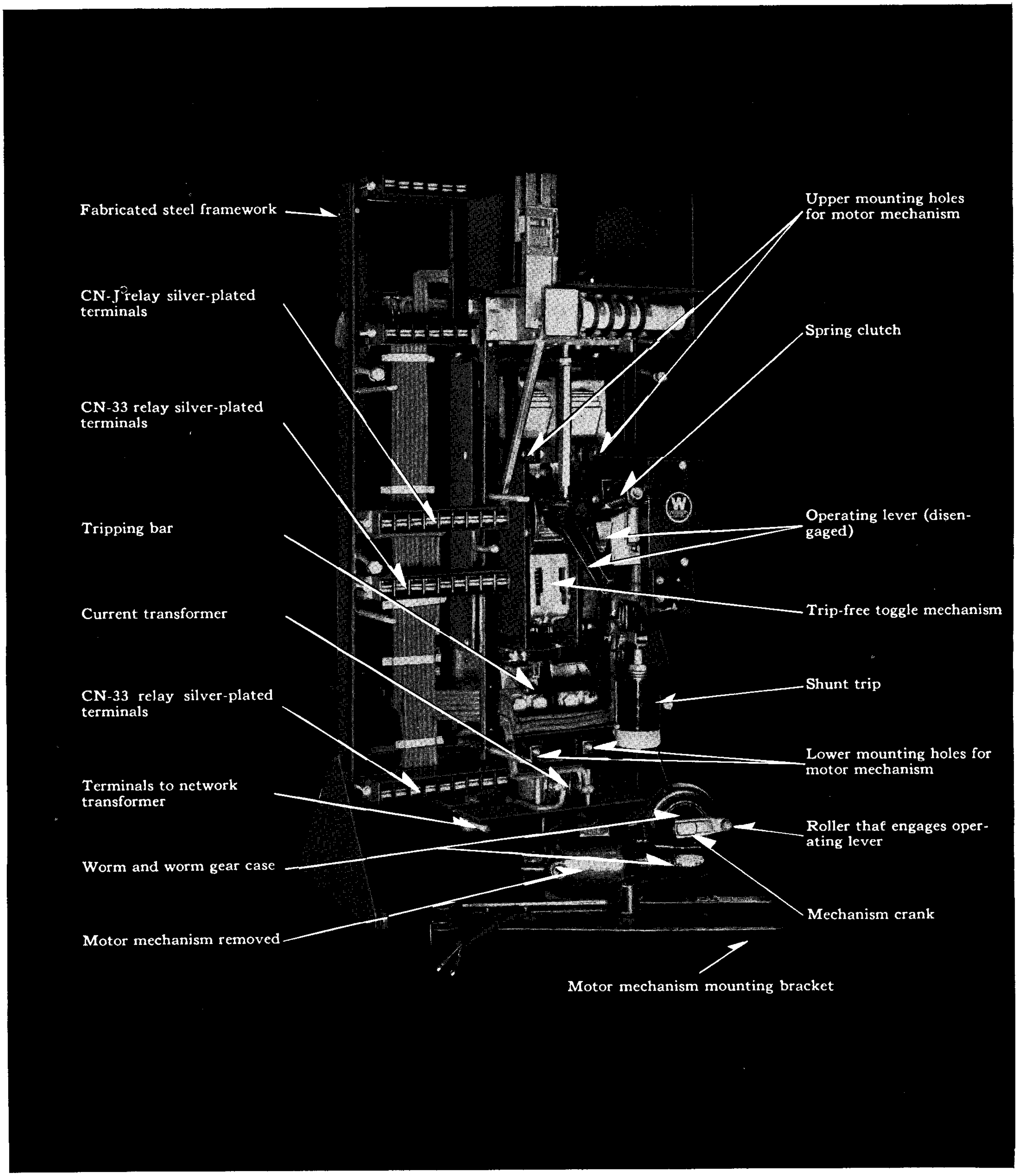


FIG. 29—DETAILS OF THE CM-44 ROLL-OUT UNIT SHOWN BY COMPLETELY REMOVING MOTOR MECHANISM AND DISENGAGING OPERATING LEVER FROM BREAKER HANDLE LEVER

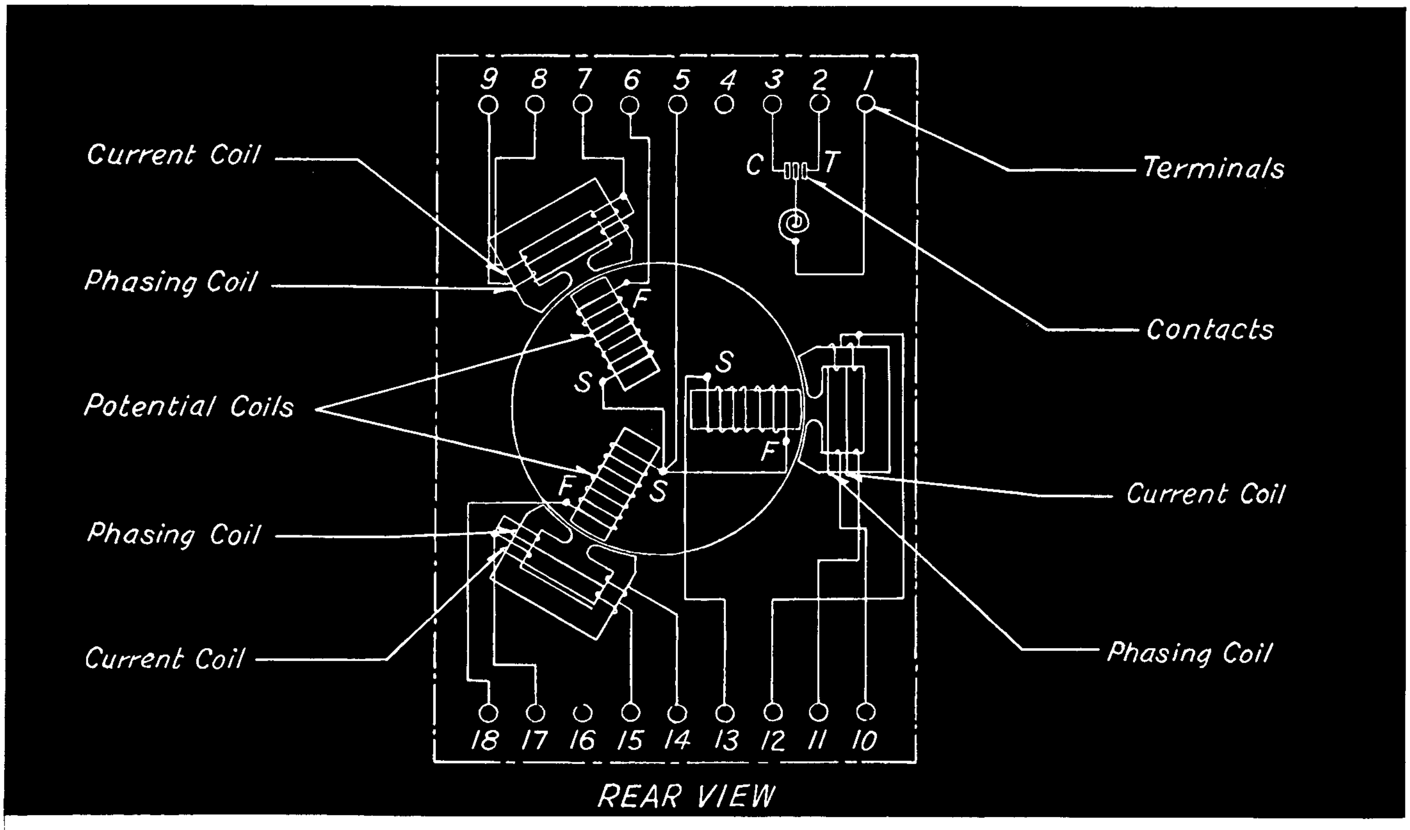


Fig. 30—Wiring Diagram of the Internal Connections of the Type CN-33 Network Master Relay

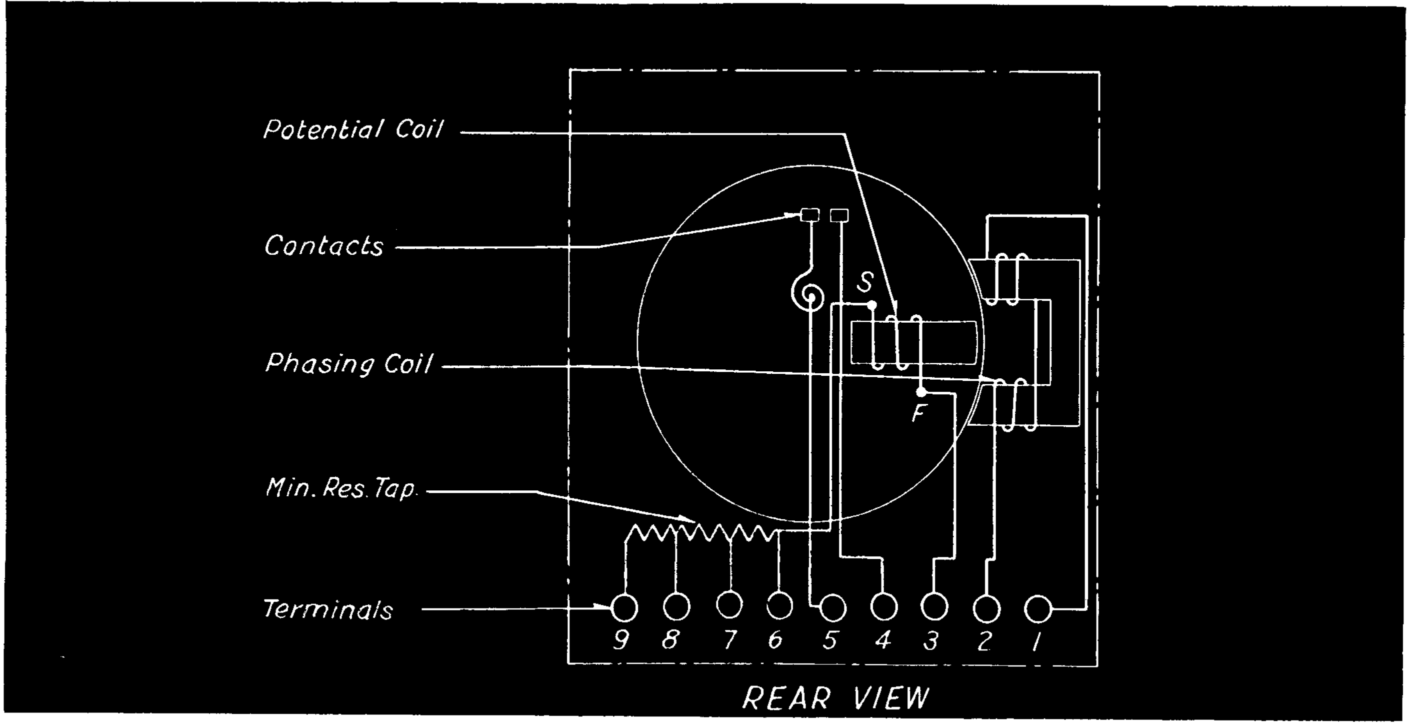


Fig. 31—Wiring Diagram of the Internal Connections of the Type CN-J Network Phasing Relay

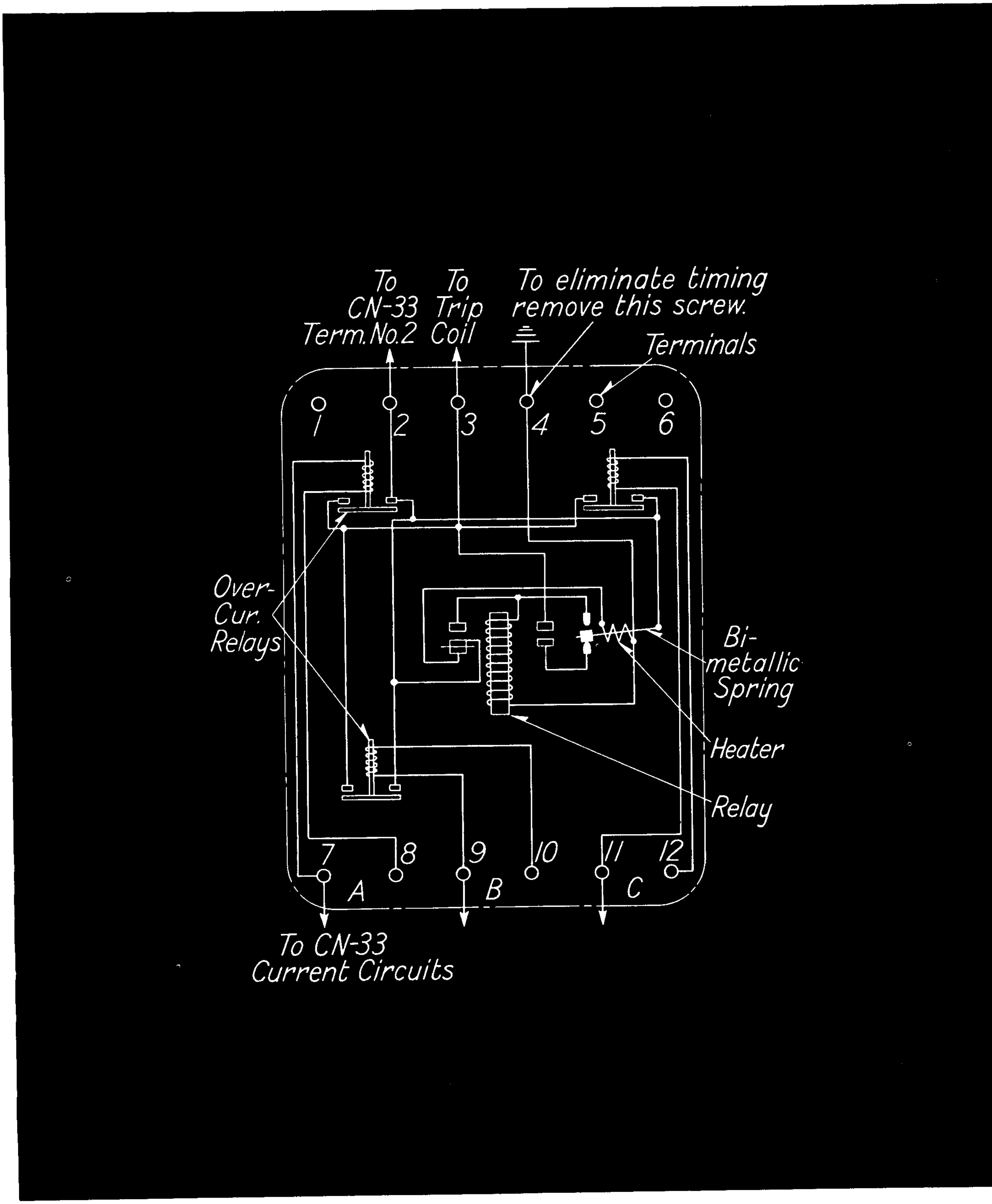


FIG. 32—WIRING DIAGRAM OF INTERNAL CONNECTIONS OF THE BN DESENSITIZING RELAY

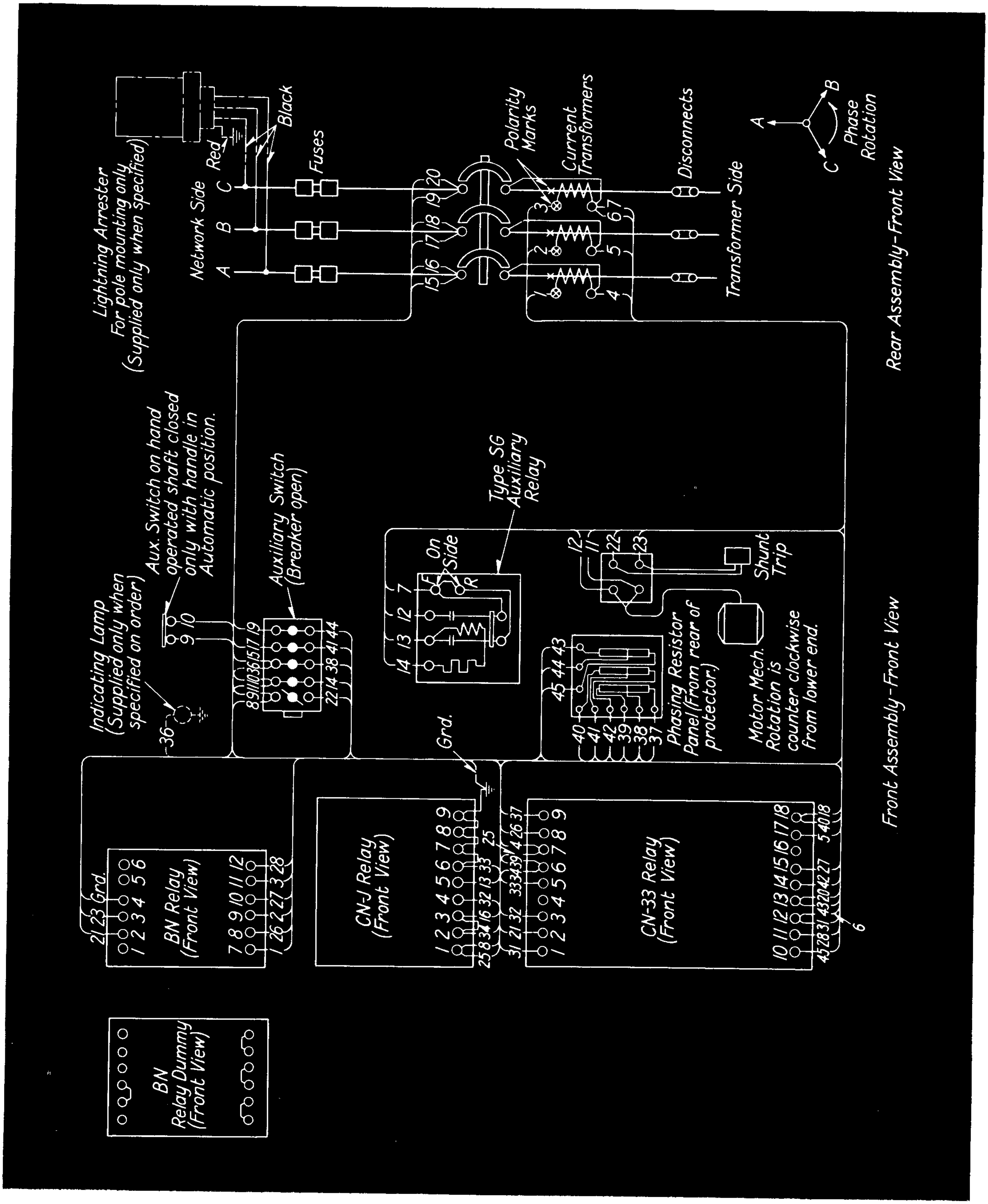


FIG. 33—TYPICAL WIRING DIAGRAM OF TYPE CM-44 NETWORK PROTECTOR ROLL-OUT UNIT WITH TRANSFORMER CONNECTIONS BOTTOM, NETWORK CONNECTIONS TOP

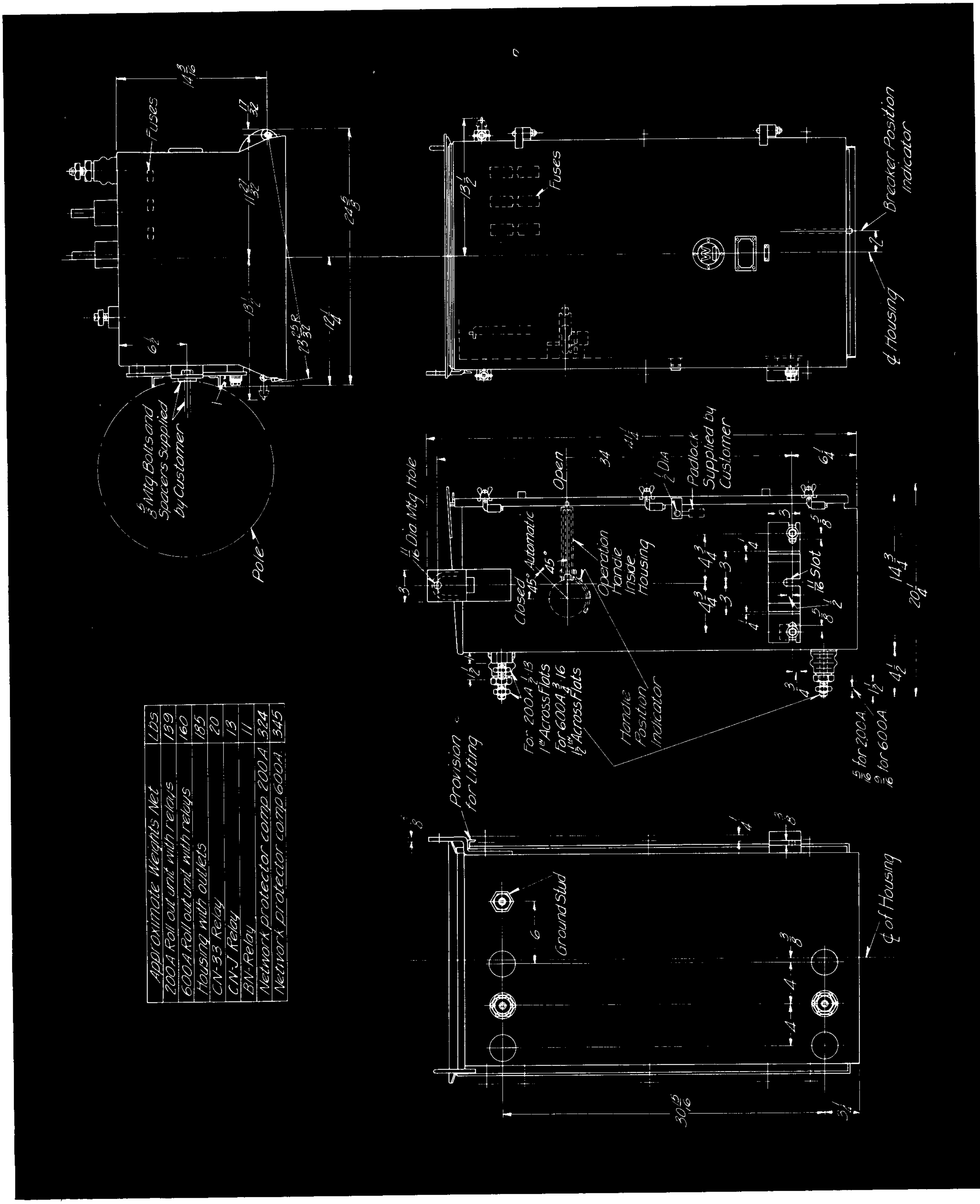


FIG. 34—APPROXIMATE OUTLINE DIMENSIONS OF POLE TYPE CM-44 NETWORK PROTECTOR. (ANY AMPERE CAPACITY)

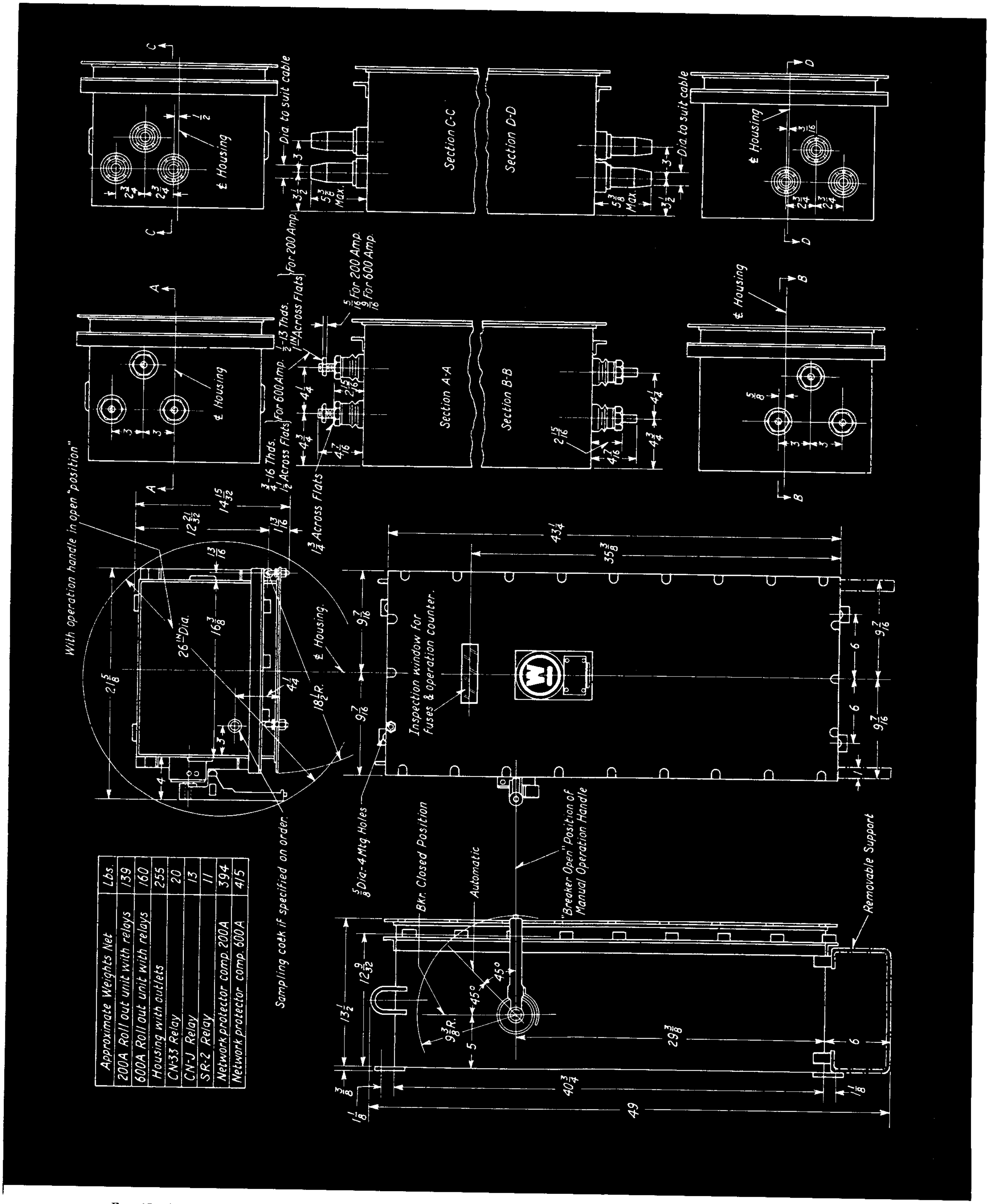
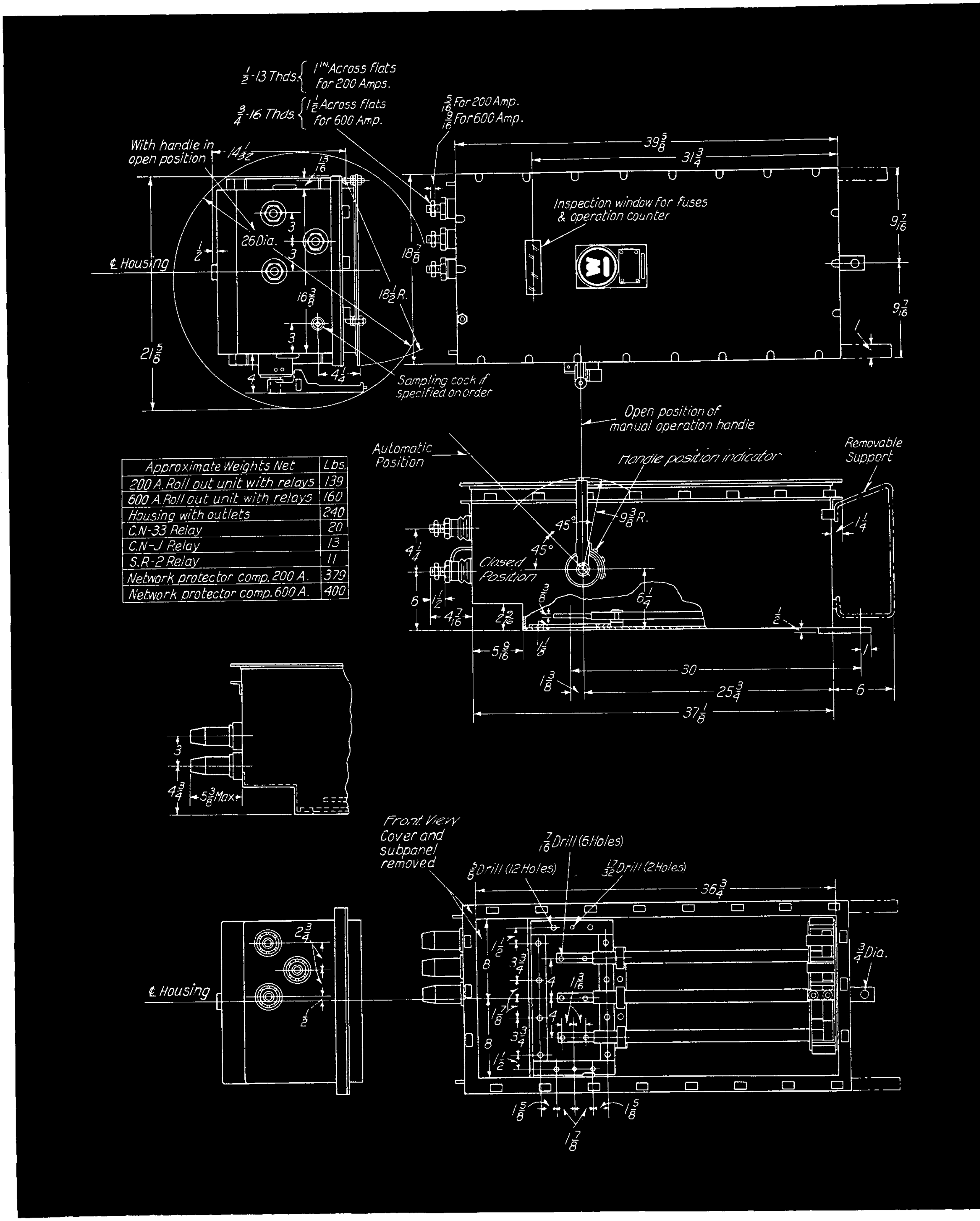


Fig. 37—Approximate Outline Dimensions of Subway Type CM-44 Separate-Mounted Network Protector. (Any Ampere Capacity)



Approximate Weights Net	Lbs.
200 A. Roll out unit with relays	139
600 A. Roll out unit with relays	160
Housing with outlets	240
C.N-33 Relay	20
C.N-J Relay	13
S.R-2 Relay	11
Network protector comp. 200 A.	379
Network protector comp. 600 A.	400

FIG. 38—APPROXIMATE OUTLINE DIMENSIONS OF SUBWAY TYPE CM-44 TRANSFORMER—MOUNTED NETWORK PROTECTOR. (ANY AMPERE CAPACITY)

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BIRMINGHAM, ALA., Moore Handley Hdwe. Co.
BLUEFIELD, W. VA., Superior-Sterling Co.
BUFFALO, N. Y., Buffalo Electric Co., Inc.
CANTON, OHIO, The Moock Electric Supply Co.
‡CHATTANOOGA, TENN., Mills & Lupton Supply Co.
CHICAGO, ILL., Hyland Electrical Supply Co.
CINCINNATI, OHIO, The Johnson Electric Supply Co.
COLUMBUS, OHIO, Pixley Electric Supply Co.
‡DENVER, COL., The Mine & Smelter Supply Co.
‡EL PASO, TEX., Mine & Smelter Supply Co.
ERIE, PA., Star Electrical Co.
HUNTINGTON, W. VA., Banks Miller Supply Co.
KANSAS CITY, MO., Columbian Elec'l Co.
KANSAS CITY, MO., Continental Elec. Co.
LEXINGTON, KY., Tafel Elec. & Supply Co.
LOUISVILLE, KY., Tafel Electric & Supply Co.
MONROE, LA., Monroe Hardware Co.
NASHVILLE, TENN., Tafel Electric & Supply Co.
NEW ORLEANS, LA. Electrical Supply Co.
NEW YORK, N. Y., Times Appliance Co., Inc.
SAN DIEGO, CALIF., The Electric Supplies Distributing Co.
SCRANTON, PA., Penn Elect'l Engineering Co.
YOUNGSTOWN, OHIO, Moock Electric Supply Co.

WESTINGHOUSE ELECTRIC & MFG. CO., LAMP DIVISION
Headquarters—Clearfield Ave., Bloomfield, N. J.

*ALBANY, N. Y., 454 N. Pearl St.
#*ATLANTA, GA., 426 Marietta St.
*BALTIMORE, MD., 118 E. Lombard St.
xBELLEVILLE, N. J., 720 Washington Ave.
zxBLOOMFIELD, N. J., Clearfield Ave.
①*BLOOMFIELD, N. J., Clearfield Ave.
#yBLOOMFIELD, N. J., Clearfield Ave.
*BOSTON, MASS., 10 High St.
①#BOSTON, MASS., 44 Farnsworth St., Boston, Mass.
*BUFFALO, N. Y., 295 Main St.
*CHICAGO, ILL., 20 North Wacker Drive
#CHICAGO, ILL., 2211 W. Pershing Road
*CINCINNATI, OHIO, Third & Elm Sts.
*CLEVELAND, OHIO, 1216 W. 58th St.
*COLUMBUS, OHIO, 85 E. Gay St.
*DALLAS, TEXAS, 209 Browder St.
*DAVENPORT, IOWA, 206 East Second St.
*DENVER, COLO., 910 Fifteenth St.
#*DETROIT, MICH., 5757 Trumbull Ave.
*EMERYVILLE, CALIF., 5915 Green St.
*HOUSTON, TEXAS, 1314 Texas Ave.
*HUNTINGTON, W. VA., 1029 Seventh Ave.
*INDIANAPOLIS, IND., 137 So. Penna. Ave.
*JACKSON, MICH., 212 W. Michigan Ave.
*KANSAS CITY, MO., 101 W. Eleventh St.
#*LOS ANGELES, CALIF., 420 S. San Pedro St.
*LOUISVILLE, KY., 332 West Broadway
*MEMPHIS, TENN., 130 Madison St.
*MILWAUKEE, WISC., 546 North Broadway
*MINNEAPOLIS, MINN., 2303 Kennedy St., N. E.
*NEW ORLEANS, LA., 333 St. Charles St.
①*NEW YORK, N. Y., 150 Varick St.
*OKLAHOMA CITY, OKLA., 850 N.W. Second St.
*OMAHA, NEB., 409 So. Seventeenth St.
①*#ORANGE, N. J., Joyce St.,
*PHILADELPHIA, PA., 3001 Walnut St.
*PITTSBURGH, PA., 306 4th Ave., Box 1017
#PITTSBURGH, PA., 543 N. Lang Ave.
*ROCHESTER, N. Y., 1048 University Ave.
*ST. LOUIS, MO., 411 No. Seventh St.
#ST. LOUIS, MO., 1219 Gratoit St.
①*SALT LAKE CITY, UTAH, 1st South & Main Sts.
*SAN FRANCISCO, CALIF., 1 Montgomery St.
#SAN FRANCISCO, CALIF., 60 Federal St.
*#SEATTLE, WASH., 3451 East Marginal Way
*SYRACUSE, N. Y., 961 W. Genesee St.
①zxTRENTON, N. J., 400 Pennington Ave.
*WASHINGTON, D. C., 1434 N. Y., N. W.

① WESTINGHOUSE ELECTRIC & MFG. CO., X-RAY DIVISION
Headquarters—21-16 43rd Ave., Long Island City, N. Y.

*ATLANTA, GA.,565 W. Peachtree St., N. E.
*BALTIMORE, MD., 118 East Lombard St.
*BOSTON, MASS., 270 Commonwealth Ave.
*CHICAGO, ILL., 14 No. Franklin St.
*CLEVELAND, OHIO, 7016 Euclid Ave.
*DALLAS, TEXAS, 207 Browder St.
*DENVER, COLO., 910 Fifteenth St.
#*DETROIT, MICH., 5757 Trumbull Ave.
*KANSAS CITY, MO., 410 Professional Bldg.
zxLONG ISLAND CITY, N. Y., 21-16 43rd Ave.
*LOS ANGELES, CALIF., 420 S. San Pedro St.
*MILWAUKEE, WISC., 534 North Broadway
*NEW ORLEANS, LA., 427 Baronne St.
*NEW YORK, N. Y., 173 E. Eighty-Seventh St.
*OMAHA, NEB., 117 N. Thirteenth St.
*PHILADELPHIA, PA., 3001 Walnut St.
*PITTSBURGH, PA., 3702 Fifth Ave.
*PORTLAND, OREGON, 1220 S. W. Morrison St.
*ROCHESTER, N. Y., 1048 University Ave.
*SAN FRANCISCO, CALIF., 870 Market St.
*SEATTLE, WASH., 3451 E. Marginal Way

WESTINGHOUSE ELECTRIC ELEVATOR COMPANY
Headquarters—150 Pacific Ave., Jersey City, N. J.

BALTIMORE, MD., 39 West Lexington St.
BOSTON, MASS., 10 High St.
BROOKLYN, N. Y., 58 Schermerhorn St.
BUFFALO, N. Y., 806 Ellicott Sq. Bldg.
CHICAGO, ILL., 222 No. Bank Drive
CINCINNATI, OHIO, Third & Elm Sts.
CLEVELAND, OHIO, 842 Rockefeller Bldg.
◆COLUMBUS, OHIO, 85 E. Gay St.
①DALLAS, TEXAS, 720 Santa Fe Bldg.
◆DENVER, COLO., 1052 Gas & Electric Bldg.
◆DES MOINES, IOWA, 1408 Walnut St.
DETROIT, MICH., 5757 Trumbull Ave.
◆DUBUQUE, IOWA, c-o Roshek Store
◆HARTFORD, CONN., 410 Asylum St.
◆HOUSTON, TEXAS, 2315 Commerce St.
◆INDIANAPOLIS, IND., 551 W. Merrill St.
zxJERSEY CITY, N. J., 150 Pacific Ave.
◆KANSAS CITY, MO., 101 W. Eleventh St.
①◆LANSING, MICH., 522 W. Kilborn Ave.
LOS ANGELES, CALIF., 420 So. San Pedro St.
①◆LOUISVILLE, KY., 1630 Edenside Ave.
①NEWARK, N. J., 17 Academy St.
NEW YORK, N. Y., 9 Rockefeller Plaza
NEW YORK, N. Y., 128 E. 149 St.
PHILADELPHIA, PA., 3001 Walnut St.
PITTSBURGH, PA., 435 Seventh Ave.
◆PORTLAND, ORE., 415 Terminal Sales Bldg.
①◆SACRAMENTO, CALIF., 719 "K" St.
ST. LOUIS, MO., 1601 Ambassador Bldg.
SAN FRANCISCO, CALIF., 1 Montgomery St.
①◆SHREVEPORT, LA.
①◆STEUBENVILLE, OHIO, 551 N. Fifth St.
①◆TULSA, OKLA., 303 East Brady St.
WASHINGTON, D. C., 1112 21st St., N. W.

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY
① Headquarters—40 Wall St., New York, N. Y., U. S. A.

*ARGENTINE, BUENOS AIRES, Cia. Westinghouse Electric Internacional, S. A., Rivadavia 819
①*AUSTRALIA, SYDNEY, Box 2364-EE G.P.O.
*BRAZIL, RIO DE JANEIRO, Caixa Postal 1320
*BRAZIL, SAO PAULO, Caixa Postal 4191
①*COLOMBIA, MEDELLIN, Apartado 43
①*CHILE, SANTIAGO, Casilla 1897
①*CUBA, HAVANA, Apartado 2289
*ENGLAND, LONDON, W.C. 2, 2 Norfolk St., Strand
*INDIA, BOMBAY, Westinghouse Electric Co. of India Ltd., 294A Bazargate St.
*ITALY, MILANO, Piazza Crispi 3
*MEXICO, D. F. Mexico, Cia. Westinghouse Electric Internacional, Edificio la Nacional, Apartado 78 Bis.
*PANAMA, REPUBLIC, Panama, Apartado 742
*PERU, LIMA, Casilla 1685
*PHILIPPINE ISLANDS, Manila, P.O. Box 998
*PUERTO RICO, San Juan, P.O. Box 1748
*SOUTH AFRICA, JOHANNESBURG, Westinghouse Electric Co. of South Africa, Ltd., P.O. Box 6067

BRYANT ELECTRIC COMPANY
Headquarters—1421 State St., Bridgeport, Conn.

*BOSTON, MASS.
zxBRIDGEPORT, CONN., Main Plant, 1421 State St.
xBRIDGEPORT, CONN., Plastics Division Plant, 1105 Railroad Ave.
*#CHICAGO, ILL., 844 West Adams St.
*#LOS ANGELES, CALIF., 420 S. San Pedro St.
*NEW YORK, N. Y., 101 Park Ave.
*#SAN FRANCISCO, CALIF., 325 Ninth St.

WESTINGHOUSE RADIO STATIONS, INC.
①Headquarters—1619 Walnut St., Philadelphia, Pa.

①STATION KDKA, Grant Bldg., Pittsburgh, Pa.
①STATION WBZ, 275 Tremont St., Boston, Mass.
STATION KYW, 1619 Walnut St., Philadelphia, Pa.
STATION WBZA, Hotel Kimball, Springfield, Mass.
STATION WOWO, 925 So. Harrison St., Fort Wayne, Ind.
STATION WGL, 925 So. Harrison St., Fort Wayne, Ind.

CANADIAN WESTINGHOUSE COMPANY, LIMITED
Headquarters—Hamilton, Ontario, Canada

*†#CALGARY, 320 Eighth Avenue, West Calgary, Alberta, Can.
#*EDMONTON, 10127, 104th St., Armstrong Block, Edmonton, Alberta, Can.
#*FORT WILLIAM, 112 McVicar St., Fort William, Ontario, Can.
#*HALIFAX, 158 Granville St., Halifax, Nova Scotia, Can. P.O. Box 204
xz*HAMILTON, Hamilton, Ontario, Can.
*LONDON, 504 Huron & Erie Bldg., London, Ontario, Can.
①*MONTREAL, 720 Dominion Sq. Bldg.
§MONTREAL, 400 McGill St., Montreal, Quebec, Can.
#†MONTREAL, 1844 William St., Montreal, Quebec, Can.
*NELSON, B. C. Can., P. O. Box 70
#*OTTAWA, Ahearn & Soper Limited, P.O. Box 794, Ottawa, Ontario, Can.
*†#REGINA, 2408 Eleventh Ave., Regina, Saskatchewan, Can.
*SASKATOON, 238 First Ave. N., Saskatchewan, Can.
†#*SWASTIKA, Swastika, Ontario, Can.
*†#TORONTO, 355 King St., West, Toronto, Ontario, Can.
*VANCOUVER, 1418 Marine Bldg., Vancouver, B. C., Can.
†#VANCOUVER, 1090 Homer St., Vancouver, B. C., Can.
#*†WINNIPEG, 158 Portage Ave. East, Winnipeg, Manitoba, Can.

①Changed or added since previous issue.
* Sales Office † Service Shop x Works # Warehouse z Headquarters y Executive Office § Merchandising Products Only ‡ Apparatus Products Only
◆ Service Office only