INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES CH-3 AND CHV-3 THREE PHASE POWER DIRECTIONAL RELAY

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

APPLICATION

The type CH-3 relay is a three phase induction type three element power directional relay. The type CHV-3 relay is similar to the type CH-3 except that it has a fourth element for voltage restraint.

These relays are used to obtain directional discrimination and are usually installed with fault detector elements such as induction overcurrent relays. Both relays may be used for directional ground protection.

On systems where the minimum current in the faulted conductor is at least twice the maximum load current flow (with no voltage restraint on the relay) so that if the fault current and load currents are in opposition, the former will always predominate and give a net torque on the relay in the correct direction. Stated another way, the minimum line-to-ground current must be at least three times the maximum load current for correct ground fault protection. Low ground current occurs most frequently on impedance grounded systems. Where positive directional indication cannot be obtained under all system conditions, it is recommended that a separate ground directional relay be used.

The type CHV-3 relay is used for both directional phase and ground fault protection with an auxiliary relay used to remove voltage restraint during ground faults. The voltage restraint element prevents operation of the relay under load conditions. The type CH-3 relay connected as a watt relay is used to provide sensitive reverse power protection for rotating equipment.

On systems with a large number of solidly grounded neutrals it is possible for heavy currents to flow in all three phases during a line to ground fault. This sometimes results in incorrect operation of the single phase directional relay not associated with the faulted phase. In these cases the type CH-3 or CHV-3 relay can be used, because the torque produced by all three elements is added mechanically, and the line to ground fault produces a predominating torque from the faulted phase to correctly indicate the direction of the fault.

A common application of the type CHV-3 relay is the directional comparison d-c pilot wire protection scheme for transmission circuits. The operating requirements in this case are the same as outlined above except that the contacts of the relays are in the pilot wire circuit.

CONSTRUCTION AND OPERATION

The type CH-3 relay consists of three directional elements and two contactor switches. The type CHV-3 relay consists of three directional elements, one voltage restraint element and two contactor switches. One variety of the type CHV-3 relay includes also a ground fault detector element.

Directional Element

Each of these elements is an induction disc type element operating on current and voltage. Two of the elements are mounted on opposite

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*Denotes change from superseded issue.

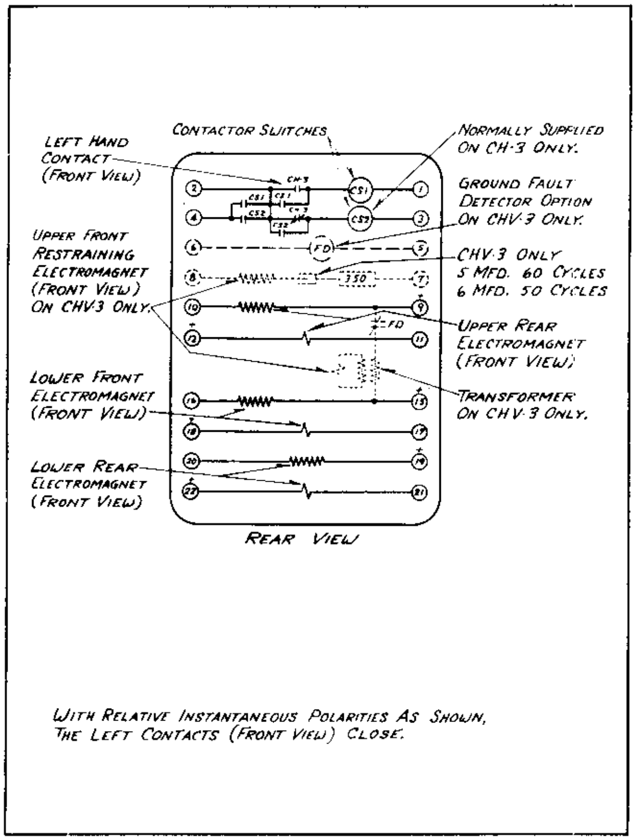

Fig. 1—Internal Schematic of the Type CH-3 and CHV-3 Relays in the Standard Case.

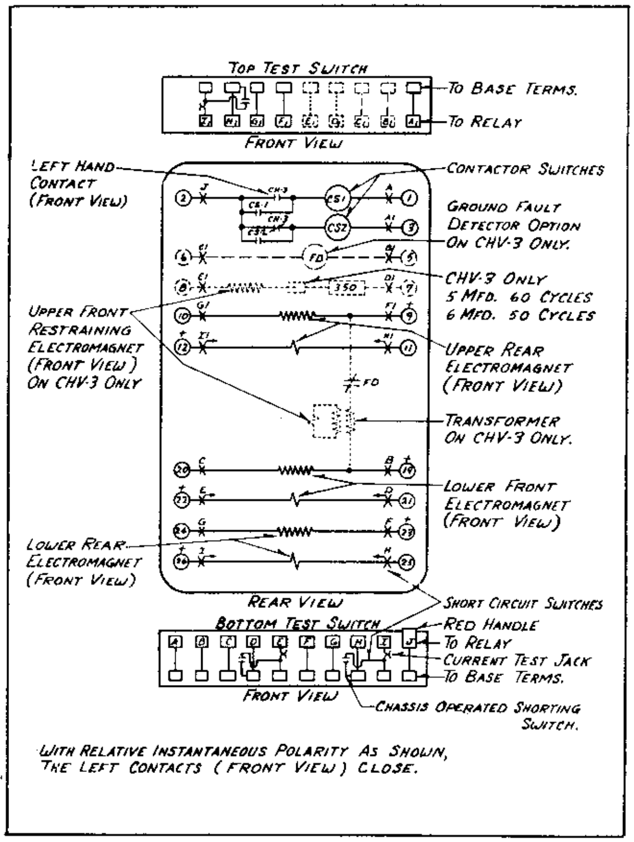

Fig. 2—Internal Schematic of the Types CH-3 and CHV-3 Relays in the Type FT Case.

sides of the lower rotating disc. The third element and a permanent magnet are mounted on opposite sides of the upper disc. The two discs are mounted on a common vertical shaft which is supported on the lower end by a steel ball-bearing riding between the concave sapphire jewel surfaces, and on the upper end by a stainless steel pin. The lower disc of the type CH-3 relay has projecting stops or either side which hits against a screw in the element frame to limit the disc travel. Three separate holes are provided for the stop screws. The stops for the type CHV-3 relay are on the moving arm

The two lower poles of each element are energized by current and the upper poles by potential. The fluxes are produced by connecting two electrical quantities which cause rotation of the disc in a direction depending upon the phase angle between the current and voltage. As power reverses the current in the elements reverse while the voltage remains fixed. Thus a directional torque is obtained.

The moving contact consists of a rigid counter-weighted arm fastened to an insulated section of the shaft between the two discs. A leaf spring is fastened to the shaft end of the arm with a silver contact attached to the free end of the leaf spring. When the moving contacts strike the stationary contacts, the spring deflects to provide the required contact follow. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other end to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact consists of two right angle brackets fastened to the element thru a Micarta insulated block. Contact screws project thru the outer end of the bracket. Stops on either side of the lower discs provide a limited travel of the contacts.

In the type CHV-3 relay, the permanent magnet is replaced by a voltage restraint element. The upper pole potential coil is energized by the voltage thru a resistor and condenser phase shifter. The two lower pole coils are energized by voltage thru a small auxiliary transformer mounted below the elements.

Contactor Switch

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker. The contactor switch is equipped with a third point which is connected to a terminal on the relay to operate a bell alarm.

Ground Fault Detector

This unit has its back contacts connected in one of the voltage circuits of the voltage restraint elements to remove voltage restraint on the occurrence of a ground fault of sufficient magnitude to operate the fault detector. It is similar to the contactor switch except that the disc normally rests on two conical-shaped contacts to provide the back contacts.

CHARACTERISTICS

The types CH-3 and CHV-3 relays are rated at 5 amperes, 115 volts, 60 cycles. The current coils have a continuous rating of 5 amperes and a one second rating of 140 amperes. The continuous rating of the voltage coil is 110% of the rated voltage.

The three phase minimum pick-up of the type CH-3 relay is 15-25 milliamperes at 115 volts or 1.5 amperes at one volt. With 115 volts applied across the relay and the external 350 ohm resistor as used in the 90° connection, the three phase pick-up is 15-25 milliamperes. With one volt similarly applied, the three phase pick-up is 1.5 amperes. These values are at 0.707 of maximum torque with current and total circuit voltage in phase and with 7/32 inch contact spacing. The single phase pick-up currents are three times the three phase currents. The relays should not bounce with 50 volts and 50 amperes applied.

The three phase minimum pick-up of the type CHV-3 relay with no voltage restraint is 4 amperes at 1 volt. These values are at maximum torque with 1 volt impressed across the potential coil and 4 amperes in phase with this voltage.

With the type CHV-3 connected per figure 3 or 4 and the external phasing resistors omitted or shorted, the three phase minimum pick-up is 4.5 to 5.5 amperes at 115 volts.

The relays have approximately wattmeter characteristics and have their maximum torque when the current in the relay current coil leads the voltage across the relay potential coil by 4 or 5 degrees. Three 350 ohm resistors are supplied with the relay. When one of the resistors is connected in series with each potential coil, the voltage across the relay coil leads the applied voltage by 45° and the maximum torque line of the relays is shifted 45° leading. By applying voltage 90° lagging the current to the resistor and voltage coil, the relay will have maximum torque when the current lags 45° from its unity power factor position. This is the 90° connection shown in the external diagrams.

The relay may be used without the external resistors and connected as a watt relay with maximum torque at unity power factor, or as a var relay with maximum torque at current lagging 90°.

* INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of

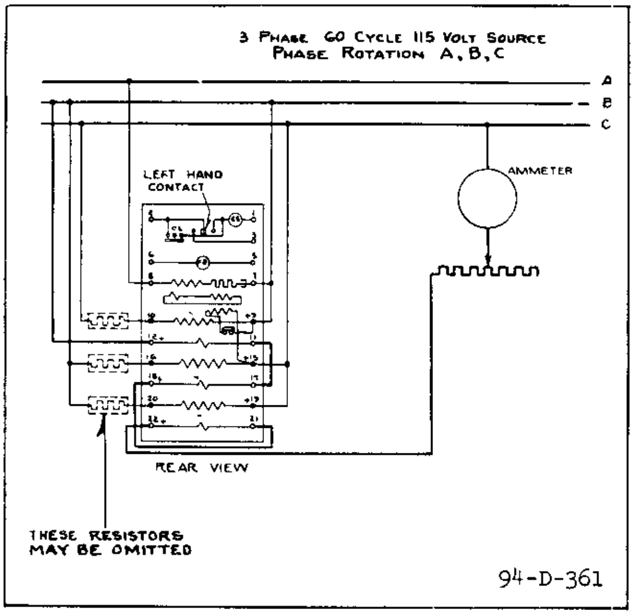

Fig. 3—Diagram of Test Connections for the Types CH-3 and CHV-3 Relays in the Standard Case.

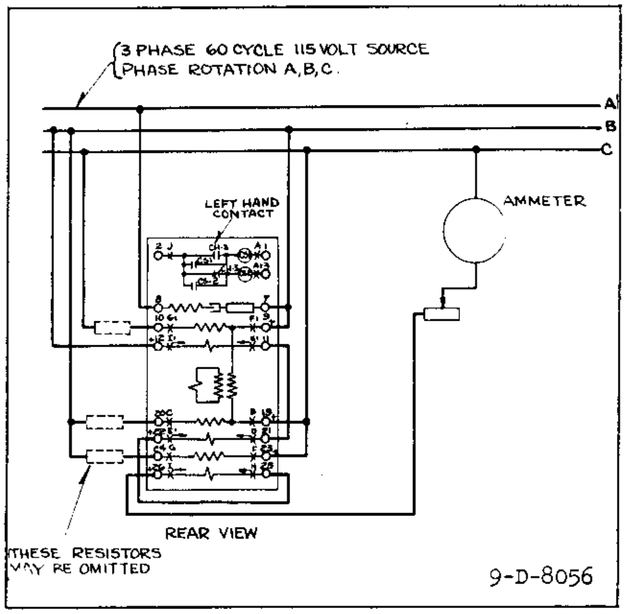

Fig. 4—Diagram of Test Connections for the Types CH-3 and CHV-3 Relays in the Type FT Case.

the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

* All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Adjust the top bearing screw so that very little play (.001 to .003 inch) can be detected by pressing up and down on the disc. This adjustment can best be made by turning down the top bearing screw until the discs fail to turn freely and then backing up a fraction of a turn. GREAT CARE MUST BE TAKEN IN MAKING THIS ADJUSTMENT SO AS NOT TO DAMAGE THE BEARINGS. Make sure the lock nut on the top bearing screw is tight.

Adjust the control spring so that the contact floats in the middle position. Pass 80 amperes thru the series coil of one of the operating elements with zero voltage on the potential coils and note whether the disc creeps in either direction. If the disc creeps, the current torque adjuster screw should be turned until the creepage ceases. This screw is located on the bottom edge of the electro-magnet iron and is available from the right hand side of the relay (front view). Repeat this check on all other elements except the voltage restraint element on the type CHV-3 relay, top front electro-magnet.

<u>Type CH-3 Relay</u>

Adjust the control spring so that the left hand relay contacts will just close with 1 volt and 1.5 amperes applied to all three elements. This can be done by connecting the three potential coils and resistors in parallel, and all three current coils in series and applying unit power factor current and voltage in the direction indicated by the polarity marks. Actually if desired, the relay may be set for lower values of pick-up by reducing the spring bias. By inserting a screw driver in the slotted disc on the spring adjuster and turning the disc, the amount of initial tension of the spiral spring can be varied such that the contact will either open or close as desired when the relay is de-energized.

With the relay connected as in the preceding paragraph, energize the potential coils at 50 volts and pass 50 amperes thru the current coils to open the left hand contact. Suddenly interrupt the current and see that the contacts do not close. The travel of the disc may be limited to reduce rebound of the contacts by moving two stop screws, one on either side of the lower disc, to one of three possible combinations of positions. These stop screws engage in a slotted section of the lower disc and limits the travel of the disc after the contacts are made. The relay is shipped with a contact separation of 7/32 of an inch, however, a much larger separation may be used. With wider separation, the time of operation will be increased and this increase is not directly proportional to the distance. After the travel is fixed, the left hand stationary contact should be adjusted to give a contact spring follow of about 1/64 inch. Then move the right hand stationary contact screw up until a small contact deflection (about .005 inches) occurs when the disc is against the stop on the right hand side of the electro-magnet.

Type CHV-3 Relay

Adjust the right hand contact core 0.005 inch follow and a contact travel of 3/64 inch exclusive of the follow. Adjust the left hand contacts for a follow of 1/64 inch in the manner described.

Apply 115 volts to the voltage restraint potential coil as shown and determine the phase angle for zero torque with 115 volts impressed across the restraint element transformer. At zero torque the voltage across this transformer should lead the restraint coil voltage by 5 ± 5 degrees.

Pass 4 amperes unity power factor current thru the current coils in series and apply 1 volt to all operating potential coils in parallel without the external resistors with the polarity as shown. Adjust the spring tension until the left hand contacts (front view) just close. With the relay totally deenergized, the right hand contact should close on spring tension.

Connect relay as shown in the test diagrams and measure the amount of current in the current coils (in series) to balance the voltage restraint torque. This current should be between 4.3 to 5.8 amperes for 110 to 120 volts, 60 cycle restraint voltage.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be most conveniently done by turning the relay up-side-down. Screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the point where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed thru the coil. The coil resistance is approximately 0.25 ohm.

Ground Fault Detector

Adjust the stationary core screw until the fault detector picks up at 5 amperes, 60 cycles for the full winding. The switch should pick-up between 7.75 and 8.25 on the 8 ampere tap.

RENEWAL PARTS

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

The burden per phase of the type CH-3 relay is as follows:

ENERGY REQUIREMENTS

Potential circuit at 115 volts
Without series resistor

Cycles	Voltamperes	Watts	P.F. Angle
25	15.3	4.0	75°
50	33.7	5.0	81.4°
60	28.0	3.4	83.1°

With series resistor

Cycles	Voltamperes	Watts	P.F. Angle
25	10.8	8.0	42.3°
50	25.9	20.5	37.8°
60	21.4	13.9	49.4°

Current Circuit at 5 Amperes

Cycles	Voltamperes	Watts	P.F. Angle
25	1.3	1.1	32°
50	1.9	1.1	55°
60	2.2	1.1	60°

The burden per phase of the type CHV-3 relay is as follows:

Potential circuit at 115 volts
Without series resistor

Cycles	Voltamperes	Watts	P.F. Angle
	Operating Elements	3 Phases each	
25	7.1	2.2	72°
50	15.6	2.7	80°
60	13.0	1.9	81.4°

With series resistor

Cycles	Voltamperes	Watts	P.F. Angle
25	5.2	3.5	47°
50	12.1	7.8	49°
60	10.2	6.5	47°

Cycles	Voltamperes	Watts	P.F. Angle
	Restraining Elements	2 phases each	
25	7.1	2.2	72°
50	15.6	2.7	80°
60	13.0	1.9	81.4°

Current Circuit at 5 Amperes

Cycles	Voltamperes	Watts	P.F. Angle
25	.5	.4	36°
50	.7	.4	55°
60	.8	.4	60°

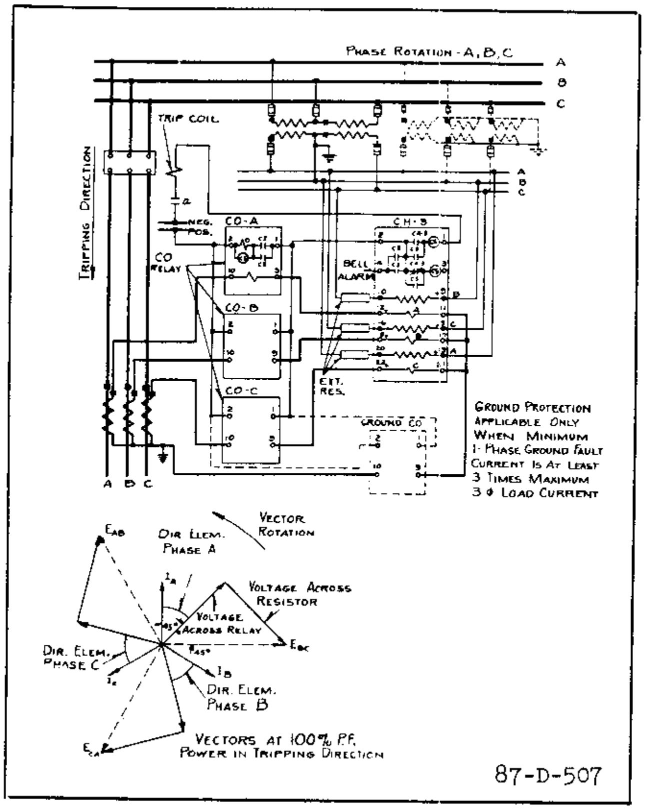

Fig. 5—External Connections for Directional Overcurrent Phase and Ground Protection of a Three Phase Line Using One Type CH-3 Relay (90° Connection) and Four Type CO Relays All in the Standard Case.

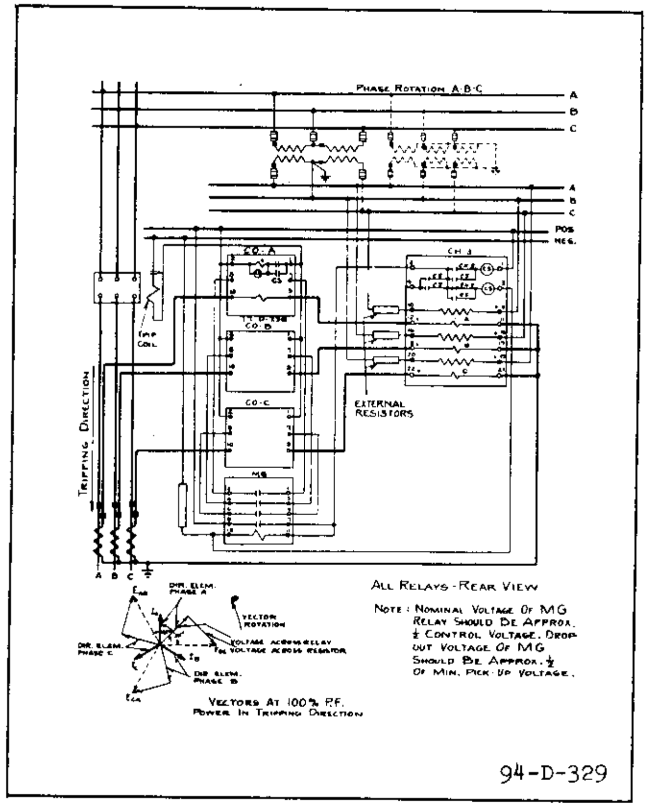

Fig. 6—External Connections for Directional Overcurrent Phase Protection of a Three Phase Line Using Three Torque Controlled Type CO Relays Directionally Controlled by One Type CH-3 Relay (90° Connection) All in the Standard Case.

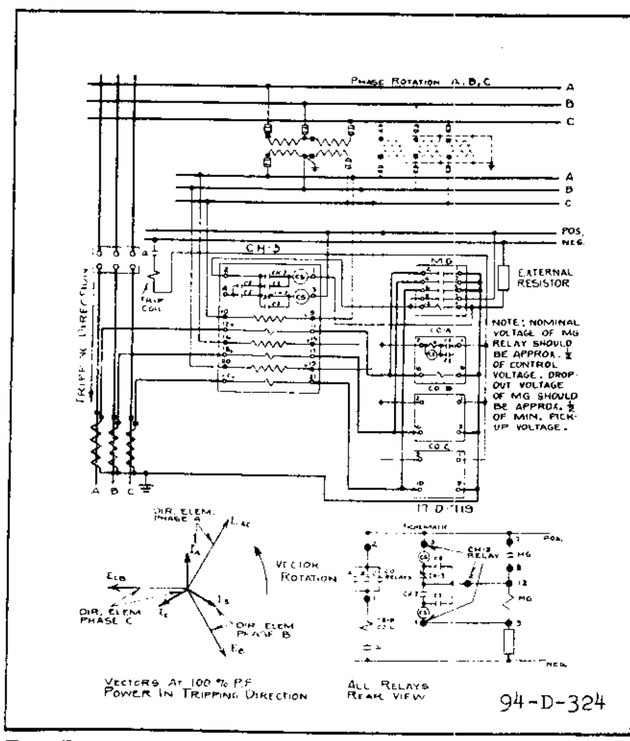

Fig. 7- External Connections for Directional Overcurrent Phase Protection of a Three Phase Line Using Three Type CO Relays Directionally Controlled by a Type CH-3 Relay (30° Connection) All in the Standard Case.

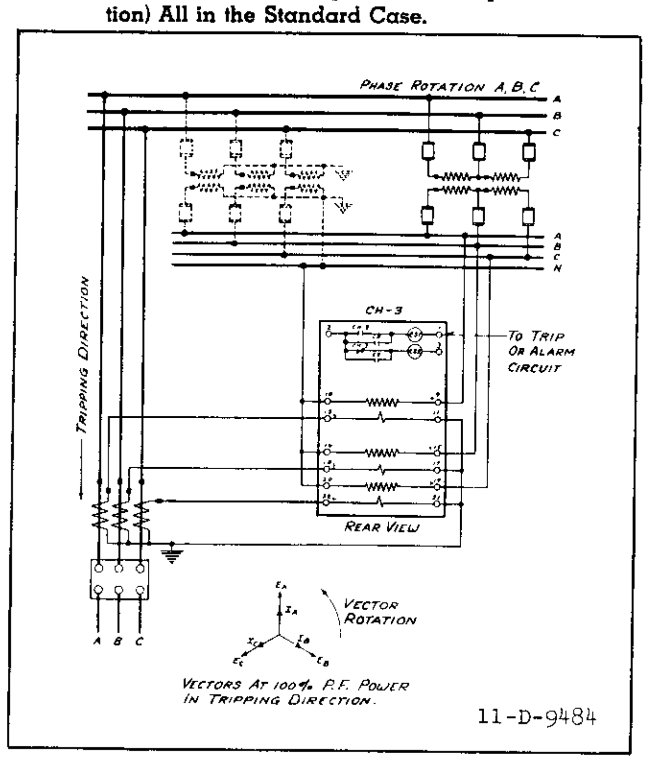

Fig. 8—External Connections for Reverse Power Protection Using the Type CH-3 Relay (Watt Connection) in the Standard Case.

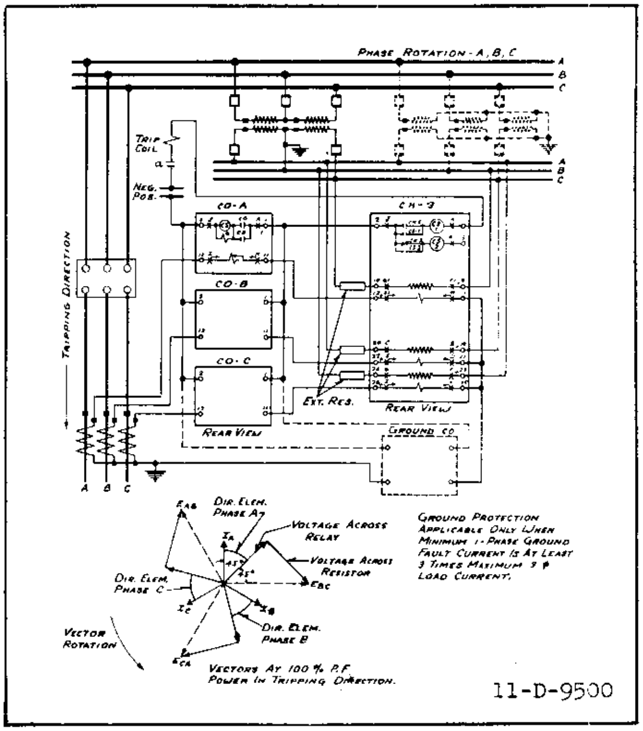

Fig. 9—External Connections for Directional Overcurrent Phase and Ground Protection of a Three Phase Line Using One Type CH-3 Relay (90° Connection) and Four Type CO Relays all in Type FT Case.

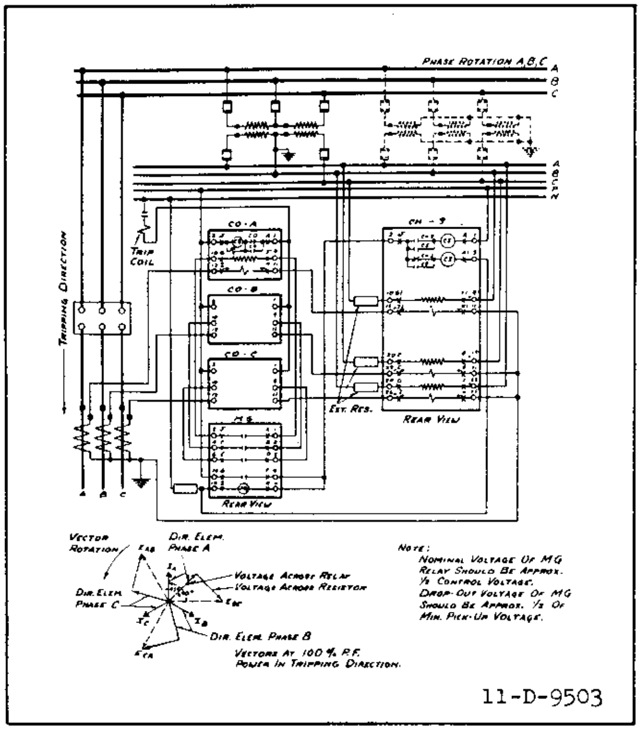

Fig. 10—External Connections for Directional Overcurrent Phase Protection of a Three Phase Line Using Three Torque Controlled Type CO Relays Directionally Controlled by One Type CH-3 Relay (90° Connection) All in the Type FT Case.

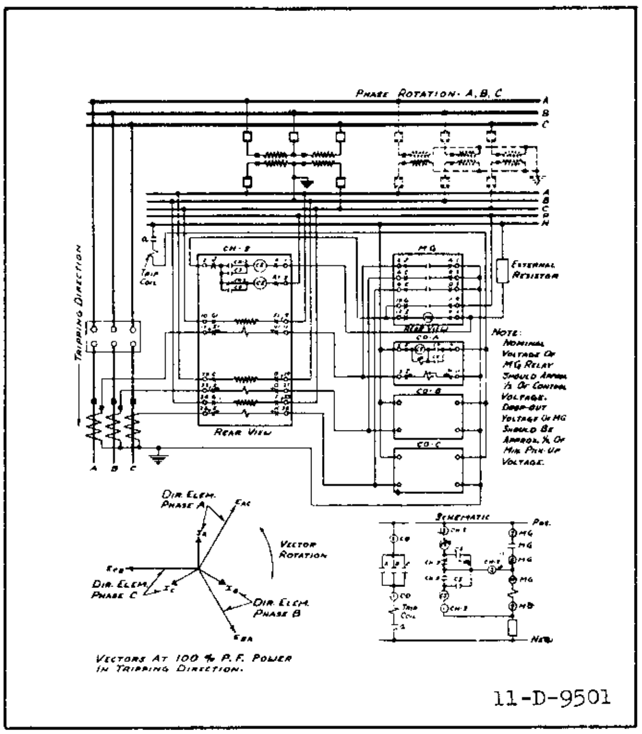

Fig. 11—External Connections for Directional Overcurrent Phase Protection of a Three Phase Line Using Three Type CO Relays Directionally Controlled by a Type CH-3 Relay (30° Connection) All in the Type FT Case.

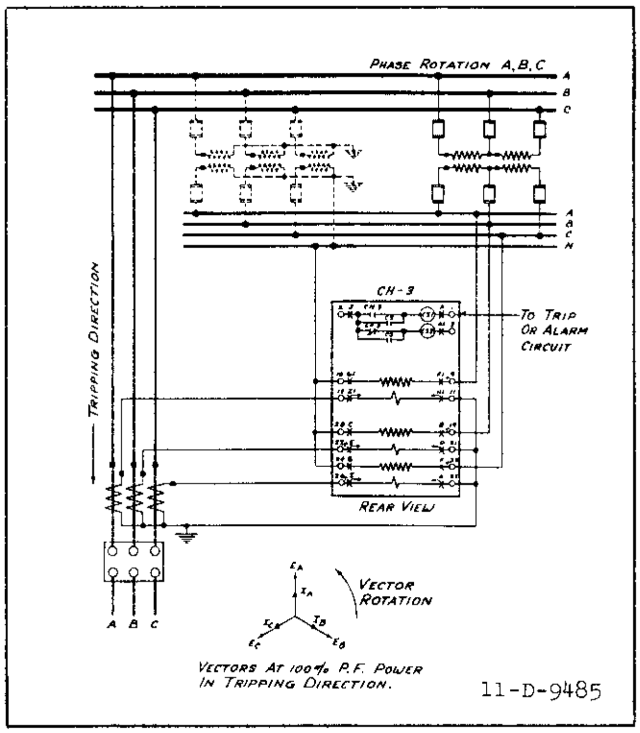

Fig. 12—External Connections for Reverse Power Protection Using the Type CH-3 Relay (Watt Connection) in the Type FT Case.

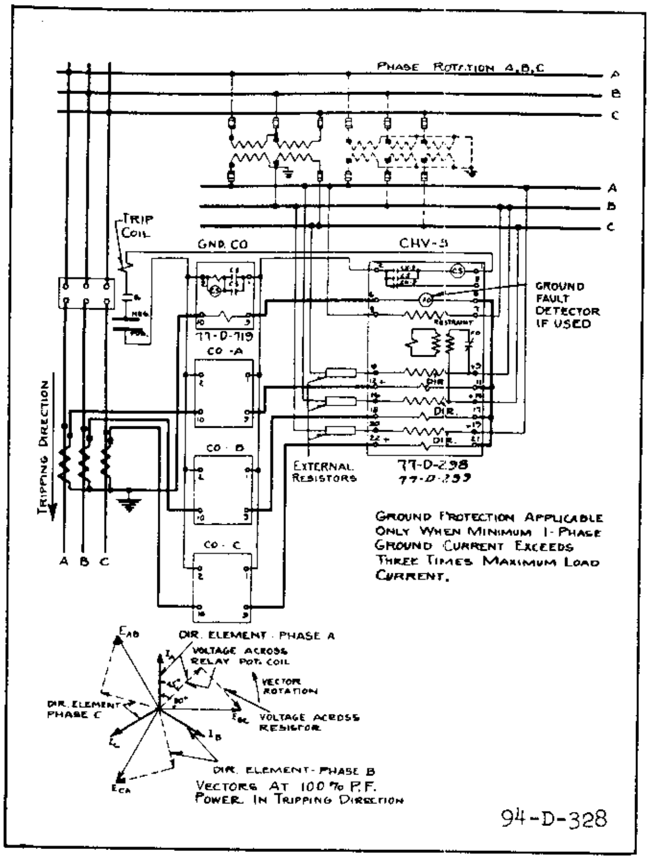

Fig. 13—External Connections for Directional Overcurrent Phase and Ground Protections of a Three Phase Line Using One Type CHV-3 Relay (90° Connection) and Four Type CO Relays all in the Standard Case.

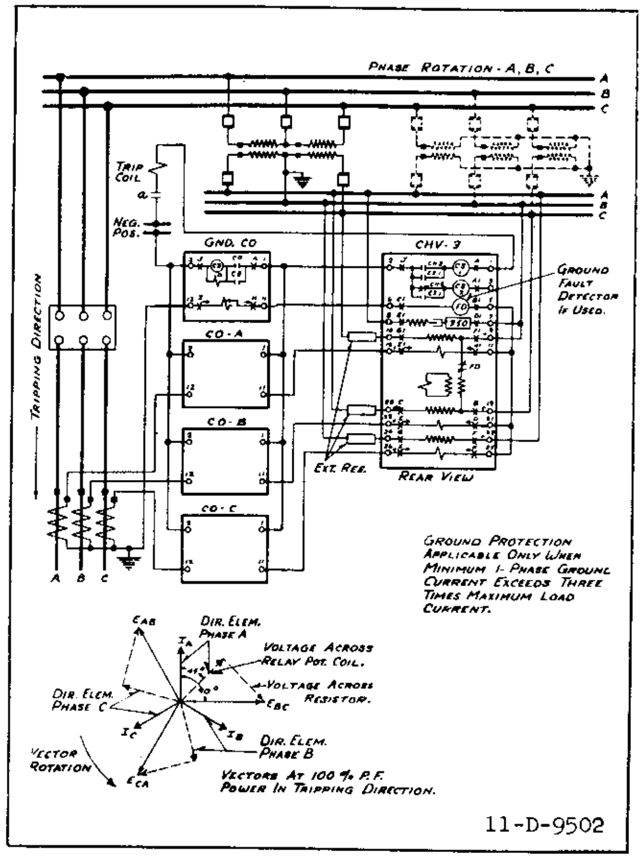

Fig. 14—External Connections for Directional Overcurrent Phase and Ground Protection of a Three Phase Line Using One Type CHV-3 Relay (90° Connection) and Four Type CO Relays all in the Type FT Case.

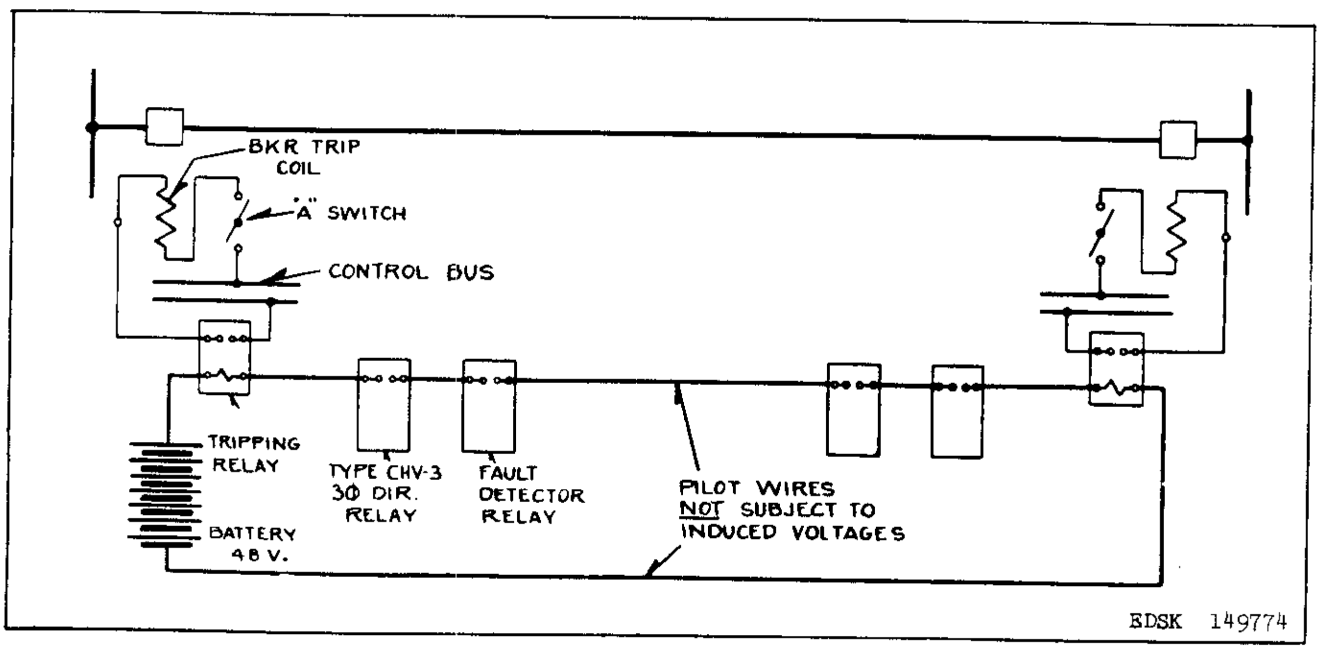

Fig. 15—Typical Schematic External Connections for Phase and Ground Protection of a Three Phase Line Using Type CHV-3, Fault Detector Relays, and Two d-c Pilot Wires. Ground Protection Applicable Only Where Minimum Ground Fault Current is at least Three Times Maximum Load Current.