INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PSA, PSD, PS-4, PS-5, PS-13 AND PS-23 PILOT WIRE SUPERVISORY RELAYS

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

APPLICATION

Type PS Supervisory Relays provide continuous supervision of a pilot wire circuit to detect open circuits, short circuits, grounds, and wire reversal. In addition, remote tripping can be effected where the PS-13 or PS-23 relays are used. Table I illustrates the functions available with each relay.

Each circuit requires the following:

At one end to introduce supervisory current

One PSA or PSD or PS-13

At the other end to receive supervisory current (Two Terminal Line)

One PS-23 or PS-4

At the other ends to receive supervisory current (Three Terminal Line)

Two PS-23 or Two PS-4 or
One PS-23 and One PS-4

CONSTRUCTION

PS relays consist of the following:

PSA

1 — Polar Unit
1 — Tapped transformer
1 — Full wave rectifier
1 — External 4 mfd. capacitor

PSD

1 — Polar Unit
1 — Set of potential divider resistors

PS-4

1 — Blocking rectifier
1 — Set of adjustable & fixed resistors

PS-5

1 — Polar Unit
1 — External 4 mfd Capacitor

PS-13

1 — Polar Alarm Unit (1)
1 — Polar Trip Unit (3)
1 — Indicating Contactor Switch (ICS)
1 — Set of Potential Divider Resistors
1 — Tapped Transformer (AC Relay Only)
1 — Full Wave Rectifier (AC Relay Only)
2 — Varistors
2 — Remote Trip Resistors (125 & 250) volts d-c trip voltage only)
1 — 4 mfd Capacitor (AC Relay Only)

PS-23

1 — Polar Unit
1 — Indicating Contactor Switch (ICS)
1 — Milliammeter, 5.0 ma
1 — Set of adjustable resistors
1 — Blocking rectifier
1 — Varistor

Polar Unit

The polar unit consists of a rectangular shaped magnetic frame, an electromagnet, a permanent magnet, and an armature. The poles of the crescent shaped permanent magnet bridge the magnet frame. The magnetic frame consists of three pieces joined in the rear with two brass rods and silver solder. These non-magnetic joints represent air gaps, which are bridged by two adjustable magnetic shunts. The winding or windings are wound around a magnetic core. The armature is fastened to this core and is free to move in the front air gap. The moving contact is connected to the free end of a leaf spring, which, in turn, is fastened to the armature.

Indicating Contactor Switch

The d-c indicating contactor switch is a small

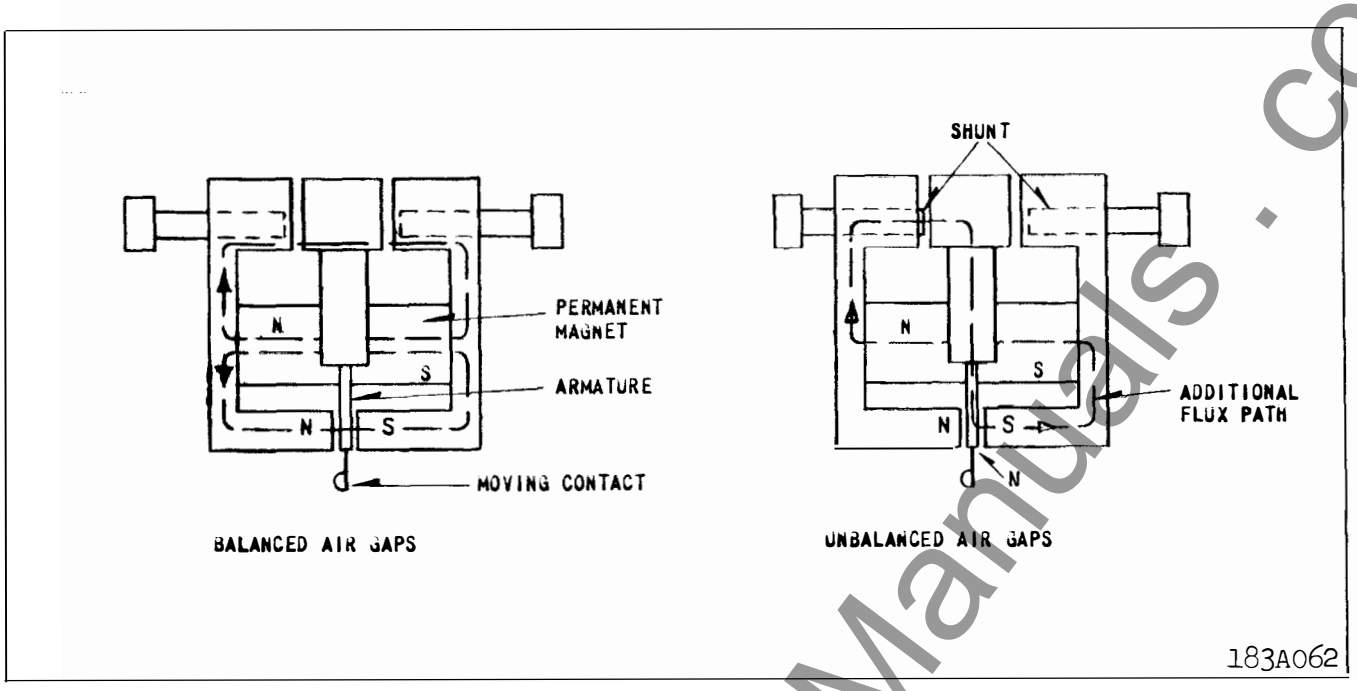


Fig. 1. Polar Unit Permanent Magnet Flux Paths.

tact. When tripping the PS-13, current above 6 ma is circulated in the reverse direction through the PS-13 to operate the trip unit (3).

See Tables II and III for tripping resistor values. Nominal trip current is 5.2 ma at all voltages rated.

Polar Unit

Polar unit flux paths are shown in figure 1. With balanced air gaps, permanent magnet flux flows in two paths, one through the front, and one through the rear gaps. This flux produces north and south poles, as shown. By turning the left shunt in, some of the flux is forced through the armature, making it a north pole. Thus, reducing the left hand rear gap will produce a force tending to pull the armature to the right. Similarly, reducing the right hand gap will make the armature a south pole and produce a force tending to pull the armature to the left.

The alarm unit contacts of the PSA, PSD, PS-13, and PS-23 are biased to move to the left when the relay is deenergized. The PS-13 trip unit contact is biased to move to the right when the relay is deenergized. The PS-5 is adjusted so that the moving contact floats when the relay is deenergized.

CHARACTERISTICS

Nominal Calibration Values

Nominal current values to close contacts are listed in Tables IV and V.

Voltage Ratings

Supply voltage ratings of the PSA, PSD, and PS-13 to obtain continuous supervision current are as follows:

DC — 48, 125, and 250 volts
AC — 120 volts, 60 cycles (Primary taps 100, 110, 120 & 130)

Voltage impressed on the pilot wire is a nominal 17 volts for supervision.

Supply voltage ratings to obtain remote tripping are: 48, 125 and 250 volts d-c.

Coil Resistance

Relay	DC Resistance
PSA, PSD & PS-13 Alarm Coils (2)	1050-1250 Ω
PS-23	2200-2600 Ω
PS-13 Trip Coil	790-970 Ω

PS-4 and PS-23 Resistance

Nominal PS-4 and PS-23 total resistance when adjusted for service is 17,000 ohms less pilot wire loop resistance at 1 ma.

TABLE IV

NOMINAL CALIBRATION VALUES – TWO TERMINAL LINES

RELAY	LOW CURRENT ALARM	HIGH CURRENT ALARM	TRIP
PSA	0.7 ma	1.3 ma	–
PSD	0.7	1.3	–
PS5†	–	±0.1	–
PS13	0.7††	1.3††	25 V
PS23†	0.6	–	3.5

† Same relay as for three terminal lines
†† These are pilot wire current values

TABLE V

NOMINAL CALIBRATION VALUES – THREE TERMINAL LINES

RELAY	LOW CURRENT ALARM	HIGH CURRENT ALARM	TRIP
PSA	1.7 ma	2.3 ma	–
PSD	1.7	2.3	–
PS5†	–	±0.1	–
PS13	1.7††	2.3††	25 V
PS23†	0.6	–	3.5

† Same relay as for two terminal lines
†† These are pilot wire current values

PSA and AC PS-13 Burden

0.5 VA at tap voltage – 2 terminal line relay
1.0 VA at tap voltage – 3 terminal line relay

Varistor

Varistor resistance decreases with an increase in applied voltage. With 1 ma d-c through a varistor, the voltage drop is 9 to 12 volts. With 5 ma d-c, the voltage drop is 15 to 18.5 volts. One varistor is used in the PS-23; two are used in the PS-13. The above voltage drops are doubled when measuring the PS-13 total varistor drop.

Rectifiers (1N91)

Approximate forward resistance - 120 ohms at 1 ma
80 ohms at 2 ma

Rating

Continuous forward current - MA	150
Continuous back voltage - rms volts	30

Remote Tripping

Remote trip resistors are listed in Table II and III for 48, 125 and 250 volts d-c.

The relays have sufficient thermal capacity to withstand 20 MA d-c continuously when remote tripping. Nominal trip currents in the tripping relays are 5.2 MA d-c with 48 volts, and 7.3 MA d-c, with 125 or 250 volts.

Trip Circuit

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

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constant

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING THE RELAY

Operating units of all relays are adjusted in the

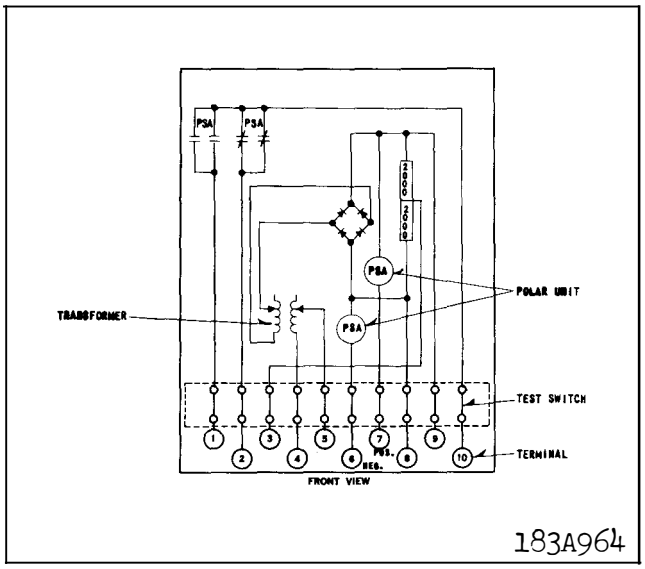


Fig. 2. Internal Schematic of the Type PSA Relay in the FT21 Case – 120 Volt, 60 cycle supply – For Two and Three Terminal Lines.

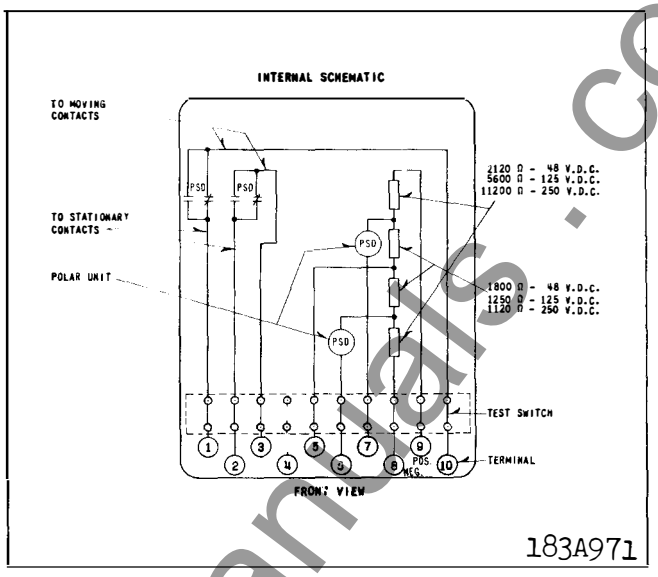


Fig. 3. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Two Terminal Lines.

factory to the values listed in Tables IV and V to a tolerance of ±5%. No settings are required on these units.

PS-4 and PS-23 Relays

Adjust the resistors in the PS-4 or PS-23 relay or relays to a value of 1 MA d-c with the supervision circuits connected for service. Use the milliammeter in the PS-23 for this purpose or use a portable milliammeter with a resistance of less than 200 ohms. Where it is not practical on three terminal lines to adjust both receiving relays simultaneously, set one receiving relay for 16,000 ohms total resistance by measurement prior to final adjustment of the other receiving relay. This procedure will minimize the the change in supervision current in the first relay to be adjusted when making the final adjustment of the second relay.

PSA and AC PS-13 Relay

Select the transformer tap nearest to expected normal a-c supply voltage. The full wave rectifier is connected to a secondary transformer tap. Where desired, the output voltage can be raised about 5% by reconnecting across the full secondary winding.

Indicating Contactor Switch

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a type WL relay switch, or equivalent, use the 0.2 ampere tap.

INSTALLATION

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

For detailed FT case information, refer to I.L. 41-076.

If the potential to ground impressed on the relays will exceed 200 volts, protection is recommended. If the potential will not exceed 500 volts, connect a 5 mfd capacitor to ground on each side of the 10 mfd capacitor (or to the each pilot wire if HCB relays are not connected) at the PSA, PSD, or PS-13 station. If the potential to ground can exceed 500 volts, gap or neutralizing reactor protection is recommended.

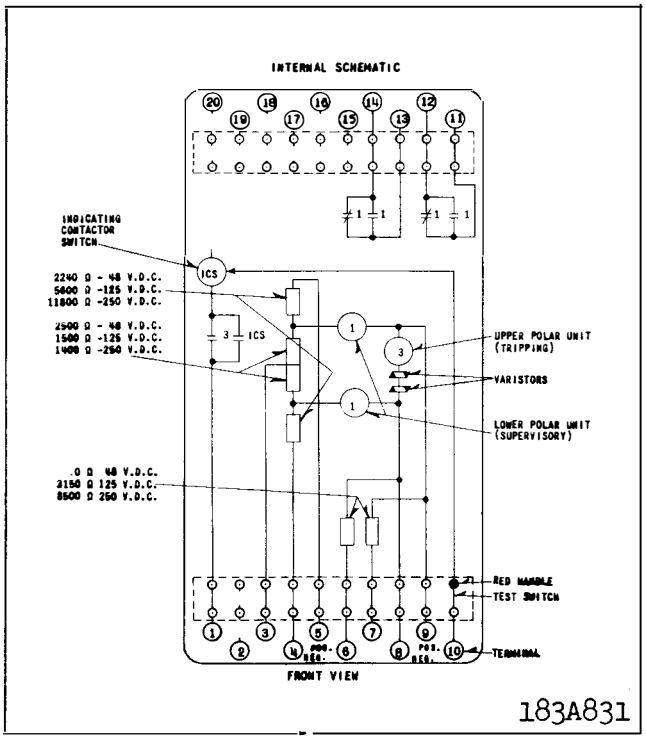


Fig. 4. Internal Schematic of the Type PS-13 Relay in the FT32 Case. DC Supply – For Two Terminal Lines.

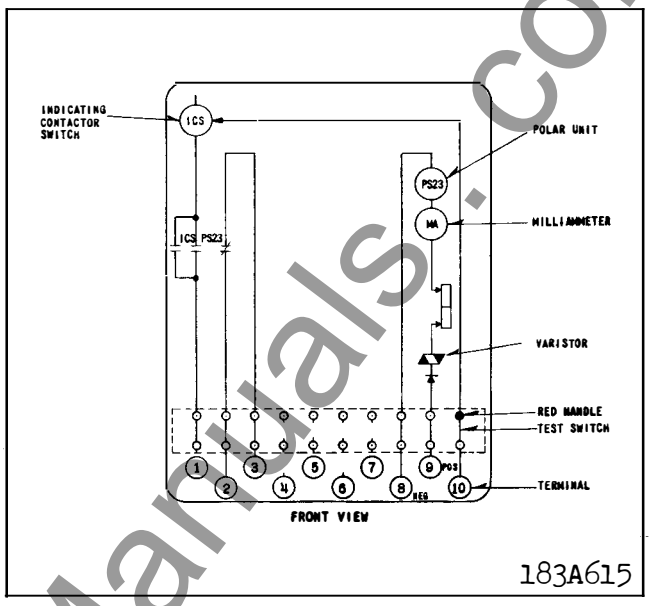


Fig. 5. Internal Schematic of the Type PS-23 Relay in the Type FT21 Case.

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.

Contacts

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.

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

Rectifier Check

If there is suspicion of a rectifier failure, apply 30 volts d-c back voltage (positive on arrowhead), through a 300-ohm resistance. Measure the voltage across the rectifier. If this voltage is not essentially 30 volts, the rectifier is shorted. Now apply 30 volts d-c in the forward direction through a 300-ohm resistor and measure the voltage across the resistor. If this voltage is not essentially 30 volts, the rectifier is open. Also see "Acceptance Tests", below, for tests when the rectifiers are connected in the relay.

Varistor Check

If there is suspicion of a varistor failure, apply 1 ma d-c through the varistor and check the voltage across the varistor. It should fall between 9 to 12 volts. Now apply 5 ma d-c through the varistor and check the voltage across the varistor. It should be at a maximum of 18.5 volts.

Acceptance Tests

The following tests are recommended when the relay is received from the factory. If the relay does not perform as specified below, the relay either is not properly calibrated or it contains a defect.

PSA Relay

Connect per figure 11, except load terminals 6 and 7 with 17,000 ohms resistance for two terminal line

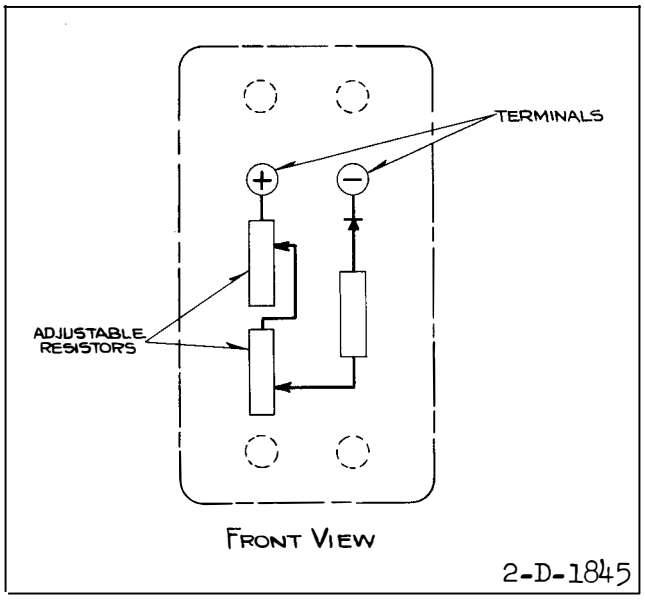


Fig. 6. Internal Schematic of the Type PS-4 Auxiliary Unit in the Small Molded Case.

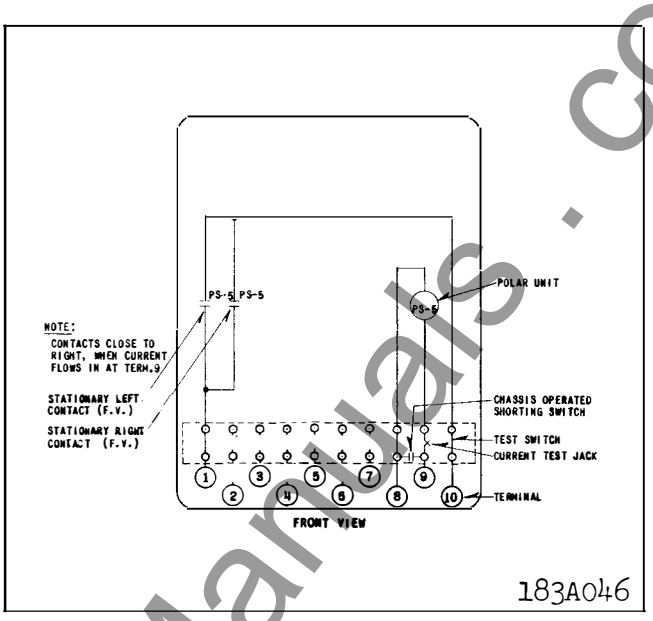


Fig. 7. Internal Schematic of the Type PS-5 Ground Detector Relay in the FT11 Case.

relays and 8500 ohms for three terminal line relay. Set in 100 volt tap and apply 100 volts, 60 cycles to terminals 4 and 5. The contact should float. Then successively short-circuit and open-circuit terminals 6 and 7. The right contact should close with a short circuit. The left hand contact should close with an open circuit. Now successively short circuit terminals 6 and 3, 7 and 3. In both cases the right-hand contact should close.

PSD Relay

Connect per figure 10 except load terminals 6 and 7 with 17,000 ohms resistance for two terminal line relays and 8500 ohms. For three terminal line relays. Apply rated d-c voltage to terminals 8 and 9. The contact should float. Then successively short circuit and open circuit terminals 6 and 7. The right-hand contact should close with a short circuit. The left-hand contact should close with an open circuit. Now successively short circuit terminals 6 and 5, 7 and 5. In both cases the right-hand contact should close.

PS-4 Auxiliary Unit

Measure forward resistance with an ohmmeter. Resistance should be about 7,000 to 23,000 ohms, depending on resistor settings. Apply 30 volts d-c back voltage (positive on "minus" terminal). The voltage across the resistors should be substantially zero.

PS-5

Apply 5 volts d-c to terminals 8 and 9. Reverse polarity of voltage. Both left and right hand contacts should close.

PS-13 (DC)

Connect per figure 12, except load terminals 8 and 9 with 17,000 ohms resistance for 2 terminal line relays and 8,500 ohms for three terminal line relays. Apply rated d-c voltage to terminals 4 and 5. The lower polar unit contact should float. Then successively short circuit and open circuit terminals 8 and 9. The right-hand contact of the lower polar unit should close with a short circuit. The left-hand contact should close with an open circuit. Now successively short circuit terminals 8 and 3, 9 and 3. In both cases the right-hand contact should close. During all of these operations the upper polar unit should remain reset to the right.

Apply 48 volts dc to terminals 8 and 9. The upper polar unit should close.

PS-13 (AC)

Load terminals 8 and 9 with 17,000 ohms for two terminal line relays and 3,500 ohms for 3 terminal line relays. Apply 100 volts, 60 cycles across terminals 4 and 5, with transformer tap at 100 volts. The lower polar unit contact should float. Then successively short circuit and open circuit terminals 8 and 9. The right-hand contact of the lower polar unit should close with a short circuit; left-hand contact should close with an open circuit. Now successively short circuit terminals 8 and 3, 9 and 3. In

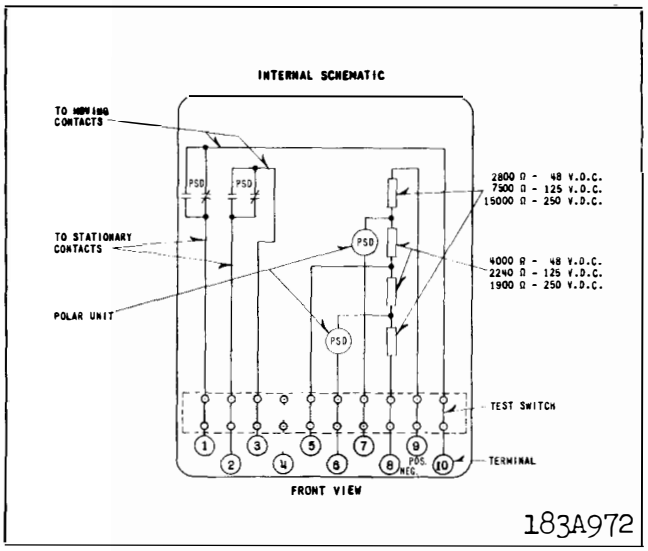


Fig. 8. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Three Terminal Lines.

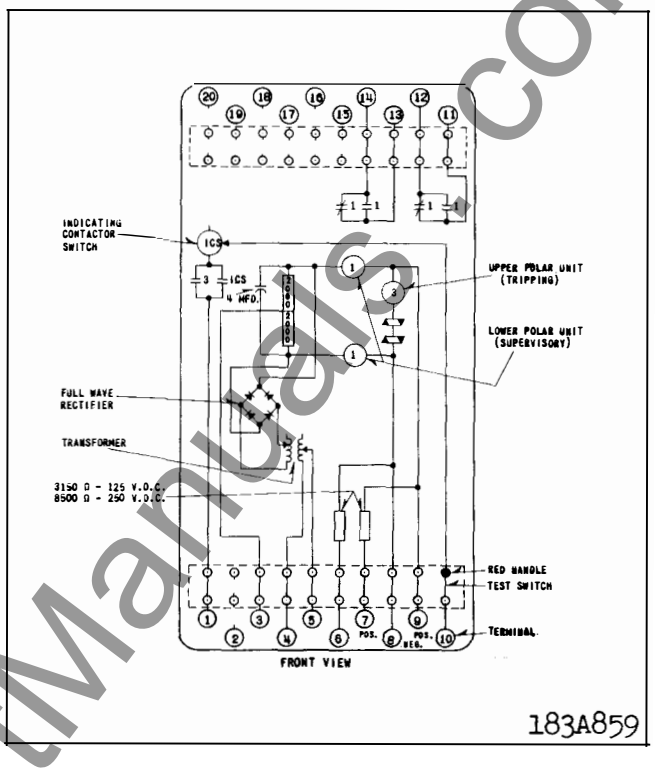


Fig. 9. Internal Schematic of the Type PS-13 Relay in the FT32 Case – 120 volt, 60 cycle supply – For Two Terminal Lines.

both cases the right-hand contact should close. During all of these operations the upper polar unit should remain reset to the right.

Apply 48 volts dc to terminals 8 and 9. The upper polar unit should close.

Calibration Check

CAUTION While the PS relays are connected to the pilot wire it should be assumed that they are energized. Adjustments should be made with the pilot wire disconnected.

The PS relays may be removed from service for testing, without jeopardizing HCB relay protection, provided that the connections between the 10 mfd capacitor and HCB insulating transformer are not distrubed. However, it is recommended that the HCB relaytrip circuits be opened prior to the circulation of remote trip current, even though the HCB relays should not operate on nominal remote trip currents.

Currents for contact closing are shown in Tables IV and V. The following procedure can be used to check these values.

PSA and PSD Relay

Open switches 6 and 7 and connect a load and milliammeter across switch jaws 6 and 7. (The load should be adjustable between 13,000 and 25,000 ohms for two terminal lines and between 7,000 and 10,000 ohms for three terminal lines.) With contact initially floating, check current values to close contacts.

PS-5 Relays

Open switches 8 and 9. Apply approximately 5 volts dc across switch jaws 8 and 9. Check pick up current with relay initially floating.

PS-13 Relays

Open switches 8, 9 and 10 and connect a load and milliammeter across switch jaws 8 and 9. (The load should be adjustable between 13,000 and 25,000 ohms for two terminal lines and between 7,000 and 10,000 ohms for three terminal lines). With lower polar unit contact initially floating check current values to close contacts.

Then apply approximately 48 volts d-c across switch jaws 8 and 9, with positive on 9. Check pickup of upper polar unit contact with contact initially reset.

PS-23 Relay

Open switches 8, 9 and 10 and apply approximately 48 volts d-c across switch jaws 8 and 9, with positive on 9. Check pickup with contact initially reset or floating.

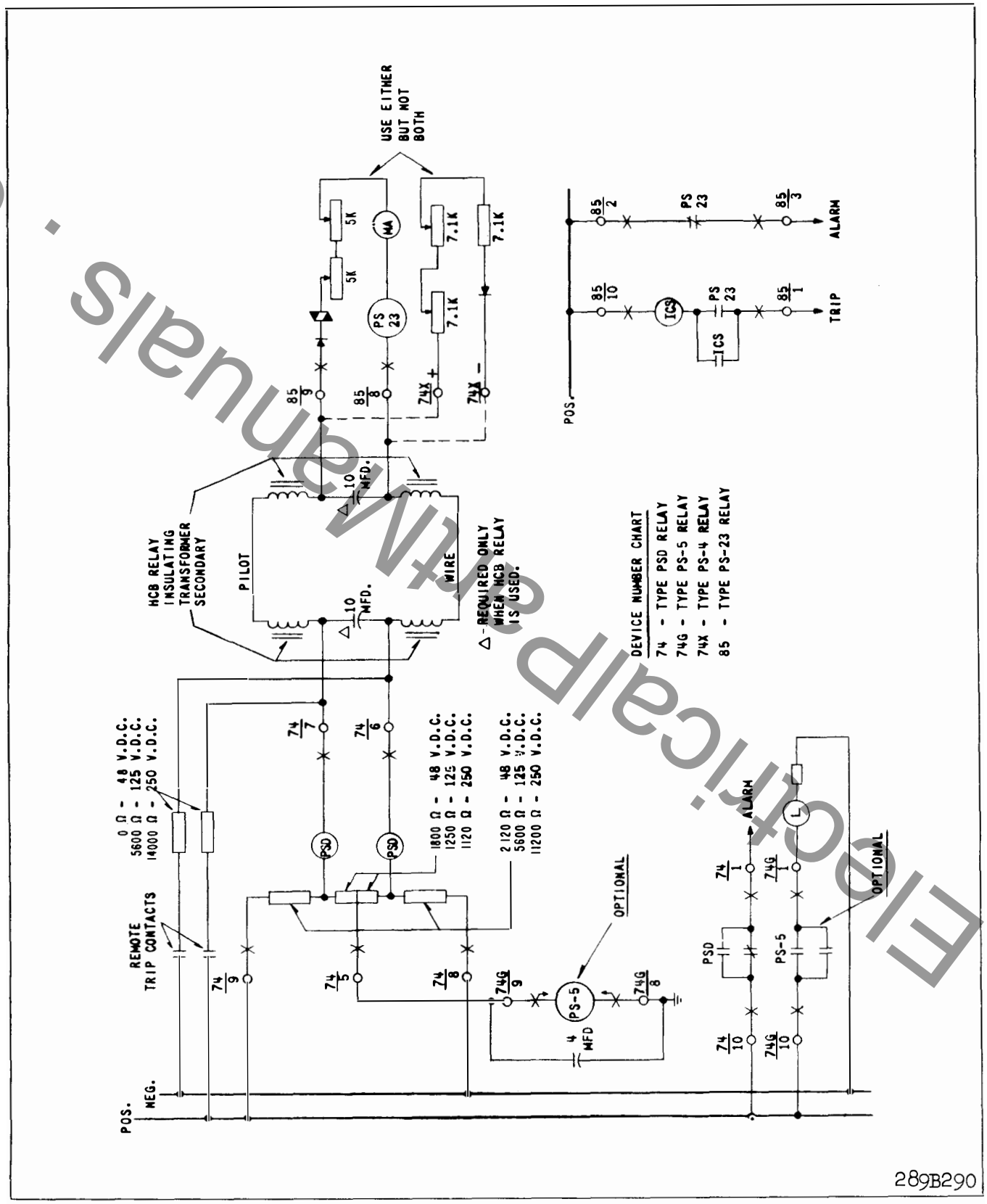


Fig. 10. External Schematic of the Type PSD and PS-5 Relays with Type PS-23 or PS-4 Relay – Two Terminal Line.

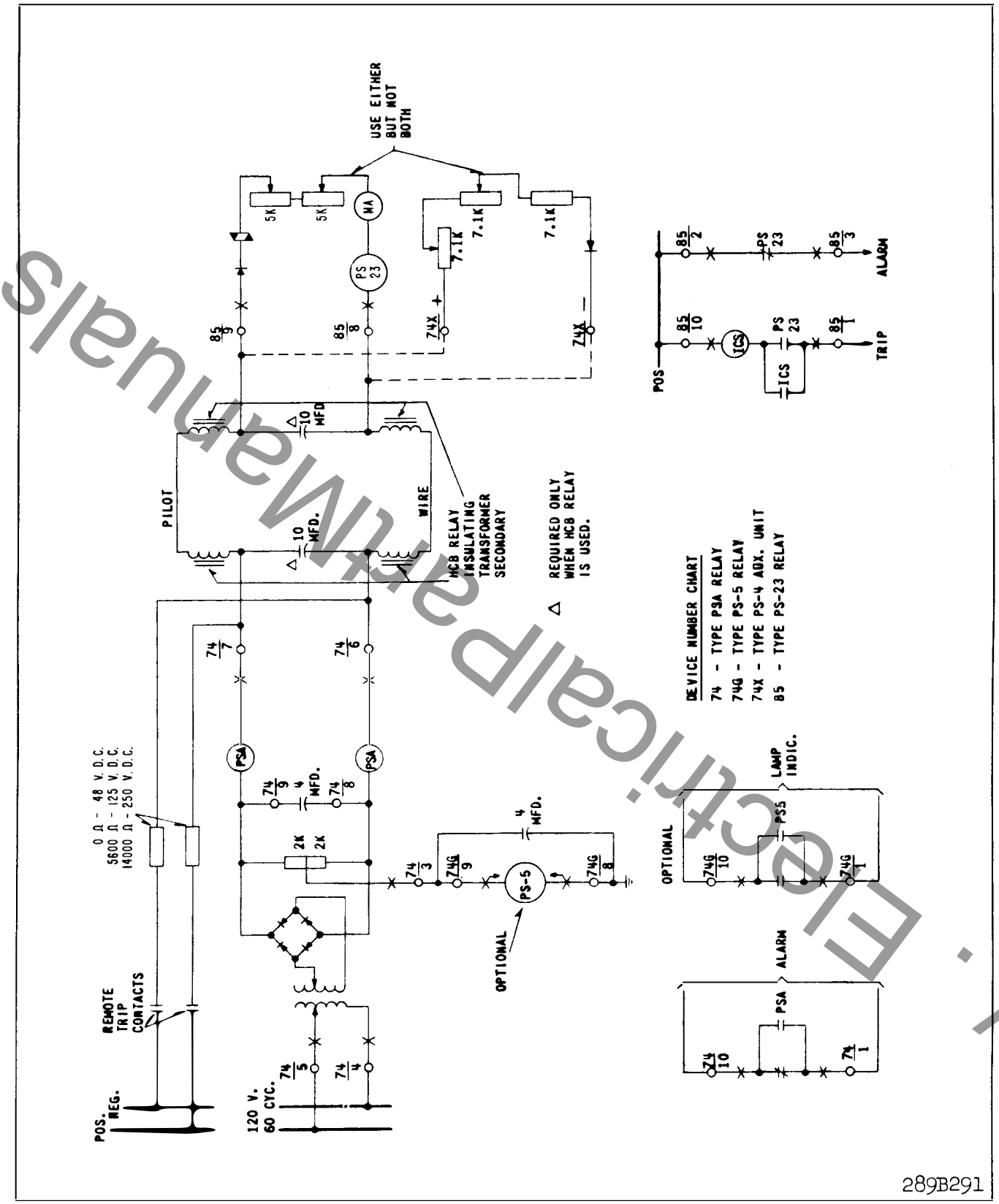


Fig. 11. External Schematic of the Type PSA and PS-5 Relay with Type PS-23 or PS-4 Relay — Two Terminal Line.

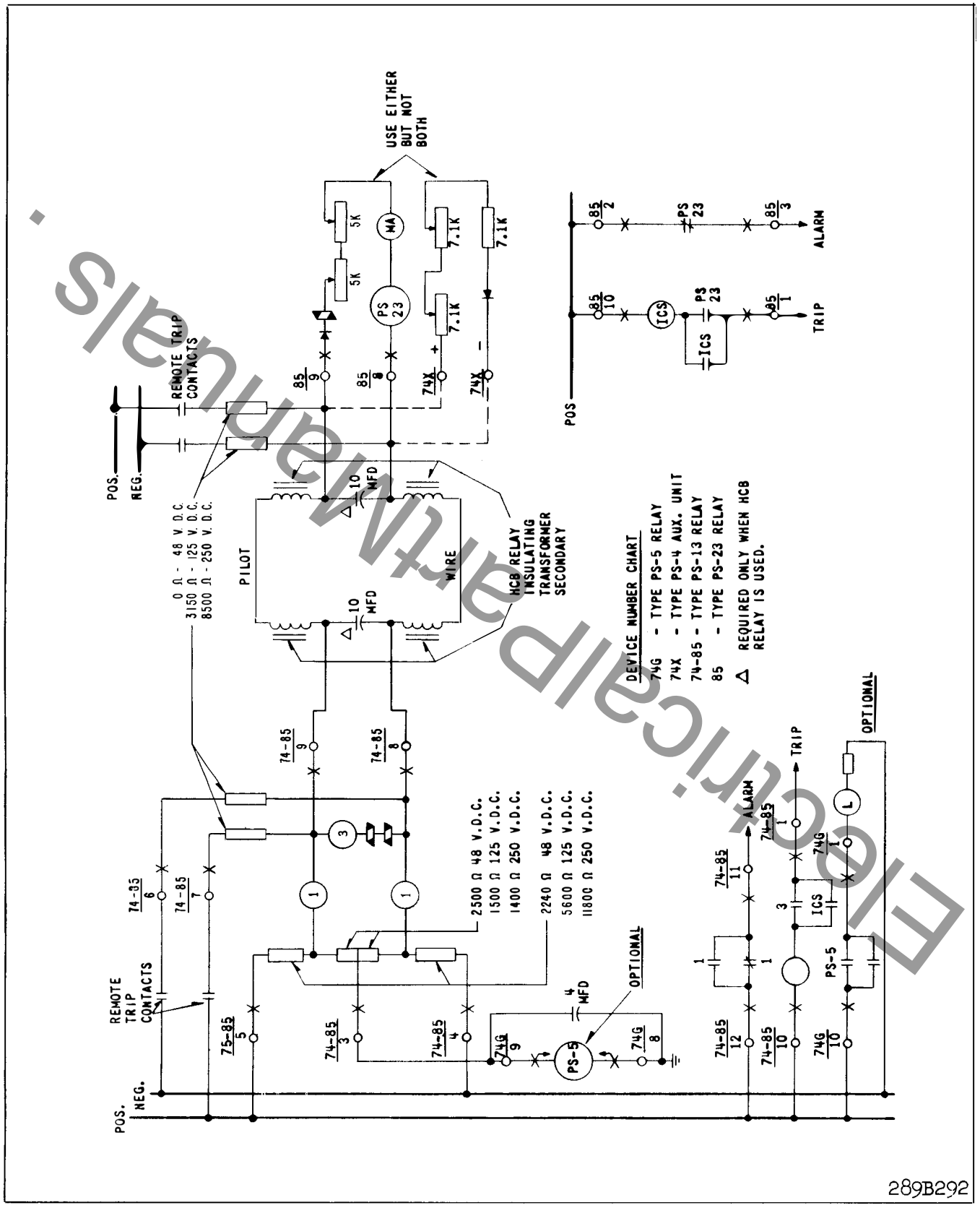


Fig. 12. External Schematic of the DC Type PS-13 and PS-5 Relay with Type PS-23 or PS-4 Relay — Two Terminal Line.

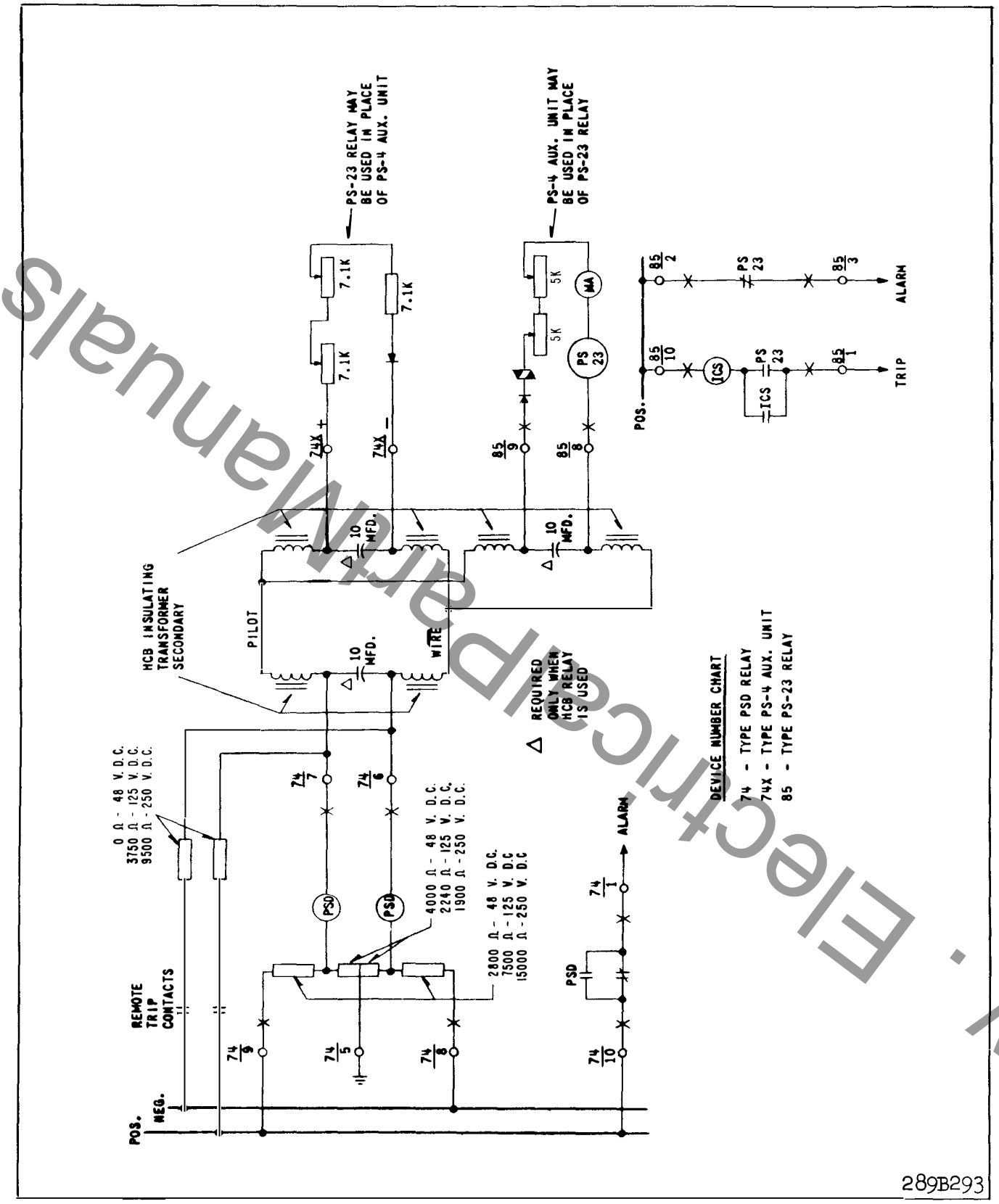


Fig. 13. External Schematic of the Type PSD Relay with Types PS-23 and PS-4 Relays – for Three Terminal Lines.

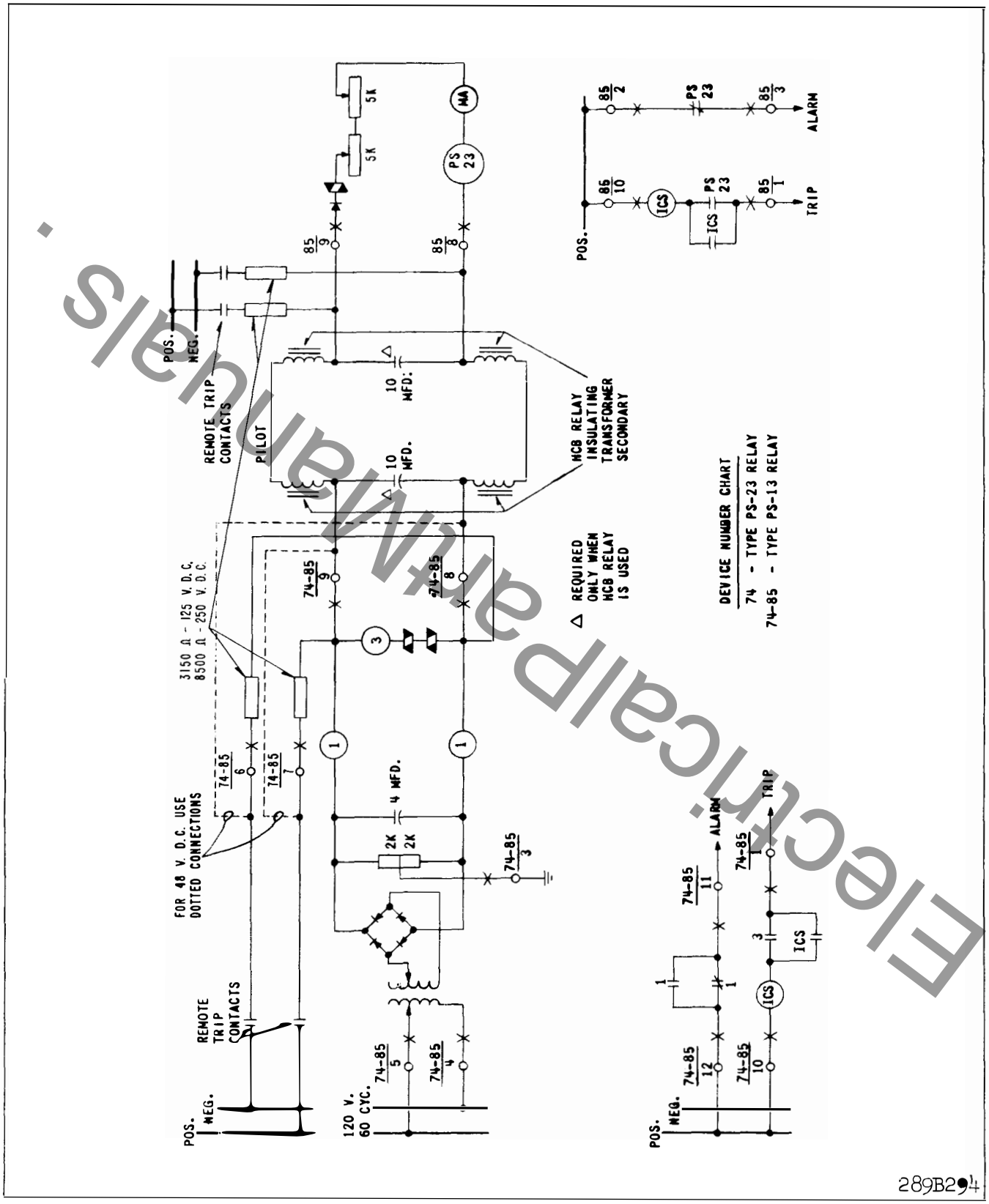


Fig. 14. External Schematic of the AC Type PS-13 With PS-23 Relay – Two Terminal Line.

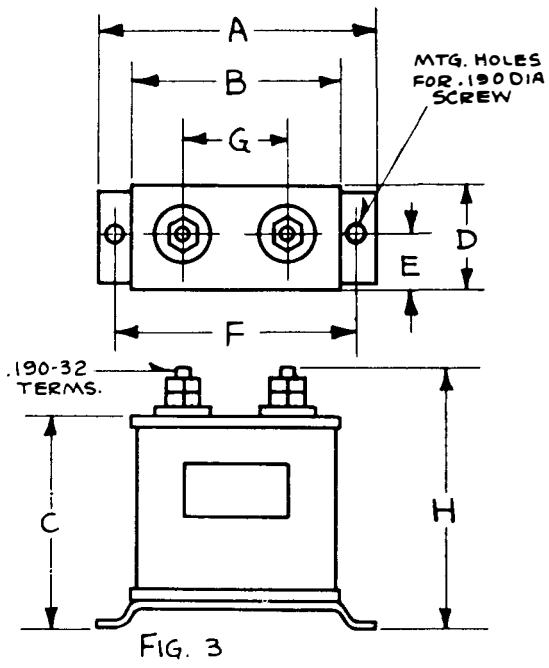


FIG. 3

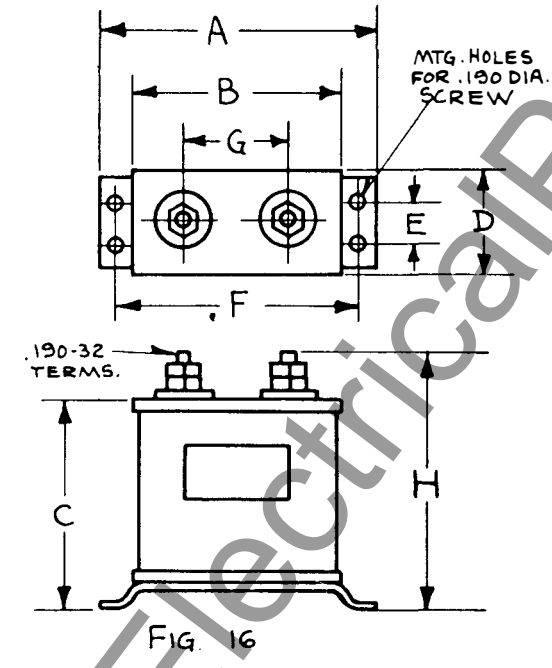


FIG. 16

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
3	±1/32 4	3	3 1/8	1 +1/16 -1/32	±1/32 1 1/2	±1/32 3 1/2	±1/32 1 1/4	+1/16 -1/16 4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	+1/16 -1/16 5 1/16

11-D-9524

Fig. 15. Outline & Drilling Plan for 4 and 10 mfd. capacitors. For Reference Only.

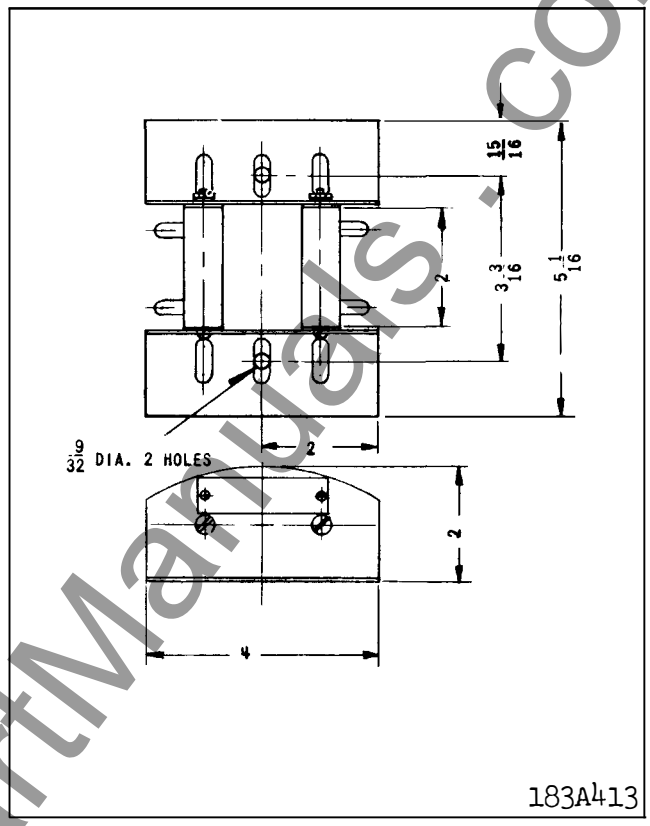


Fig. 16. Outline & Drilling Plan for External Remote Trip Resistor Assembly.

Routine Maintenance

CAUTION While the PS relays are connected to the pilot wire, it should be assumed that they are energized. Adjustments should be made with the pilot wire disconnected.

In addition to cleaning contacts it is recommended that a functional check be performed by open and short circuiting, and grounding the supervision circuits at the pilot wire terminals (7 and 6 of PSA and PSD; 9 and 8 of PS-13 and PS-23). These pilot wire faults should not be applied directly to the pilot wire when the HCB relays are in service. If the HCB relays are not in service, simulate a remote trip operation with switch 10 of the PS-23 and PS-13 relays open by closing the remote trip contacts. If the HCB relays are in service, open switches 8, 9 and 10 of the PS-13 and PS-23 relays and apply about 48 volts d-c to switch jaws 8 and 9, with positive on jaw 9. The tripping contact of these relays should close.

If the relays do not perform as expected and rectifier failure is suspected, the rectifier tests described

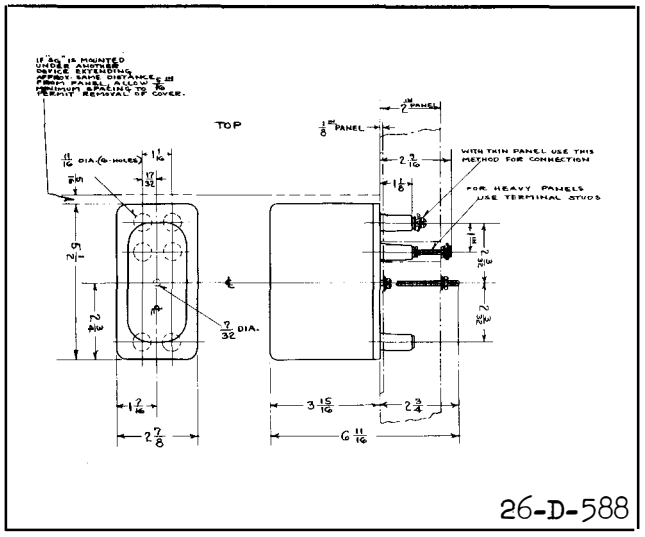


Fig. 17. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Projection Molded Case.

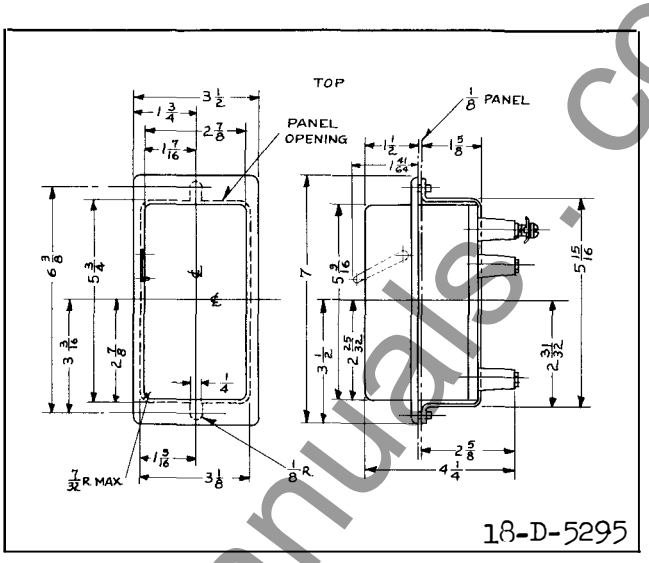


Fig. 18. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Semi-Flush Molded Case.

under "Acceptance Tests" may be performed.

Calibration

If the relay has been dismantled or the calibration has been disturbed, use the following procedure for calibration.

With the permanent magnet removed see that the moving armature floats between the poles or lightly touches the left-hand pole piece. If necessary, loosen the core screw in the center rear of the unit and shift the core and contact assembly until the armature floats. Then retighten the core screw. Continue as follows:

PSA and PSD Relay

Adjust the stationary contacts so that they just make when the armature touches the pole faces. Then turn each contact screw four turns to obtain approximately 5/32" between the stationary contacts. Reassemble the permanent magnet with the north pole to the right (front view). Turn both shunts all the way in. With 1.3 or 2.3 ma flowing in 1 ma or 2 ma rating relays, respectively, draw out the right hand shunt until the right hand contacts close. Then, with 0.7 or 1.7 ma flowing in 1 ma or 2 ma rating relays, respectively, draw out left-hand shunt until left-hand contacts close. Recheck and readjust right-hand contact pickup. Then recheck and readjust left-hand contact pickup. Continue as required.

PS-5 Relays

Adjust the stationary contacts so that they just make with the moving contact when the armature is floating midway between the pole pieces. Then turn the contact screws two full turns in the opening direction to obtain approximately 0.050" contact opening. Reassemble permanent magnet with the north pole to the right. Turn both shunts all the way in. Energize with 0.1 ma, positive on terminal 9. Draw out the right-hand shunt until the right-hand contact closes. Reverse current of 0.1 ma. Draw out left hand shunt until left hand contact closes. Recheck and readjust right-hand contact pickup. Then recheck and readjust left hand contact pickup. Continue as required.

PS-13 Relay

Adjust the stationary contacts so that they just make when the armature touches the pole faces. Then turn each contact screw four turns to obtain approximately 5/32" between stationary contacts. Reassemble the permanent magnet with the north pole on the left. Turn both shunts all the way in. Continue as follows.

For the lowerpolar unit (alarm), draw out the right-hand shunt until the right-hand contact closes at 1.3 or 2.3 ma, for the 1 ma and 2 ma relay ratings, respectively. Then draw out the left hand shunt until the left-hand contacts close at 0.7 or 1.7 ma, for the 1 and 2 ma relay ratings respectively. Recheck and readjust right hand contact pickup. Then recheck and readjust left hand contact pickup. Continue as required.

For the upper polar unit (trip), draw out both shunts about 5 turns. Continue to draw out the left-

hand shunt until contact closes to the left at 25 volts d-c across pilot wire terminals. The contact should reset to right at 20 volts.

PS-23 Relay

Adjust the stationary contacts so that they just make when the armature touches the pole faces. Then turn each contact screw four turns to obtain approximately 5/32" gap between stationary contacts. Reassemble the permanent magnet with the north pole on the left. Turn both shunts in all the way and then draw both out about seven turns. Adjust the left-hand shunt until the left-hand contacts close at 0.6 ma d-c. Then adjust the right-hand shunt until the right-hand contacts close at 1.4 ma d-c. Recheck and readjust left-hand contact pickup. Then recheck and readjust the right-hand pickup. Continue as required. Now position the adjustment screw located below the right hand stationary contact, such that 3.5 ma d-c are required to close the right-hand contact. If the pickup is too low, move the screw to the left. This change will increase the amount of deflection of the moving contact assembly spring, which is required in order to close the right-hand contact. Pass 10 ma d-c thru the relay, recheck and readjust the right hand pickup by moving the adjustment screw only. Continue as required.

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 complate nameplate data.

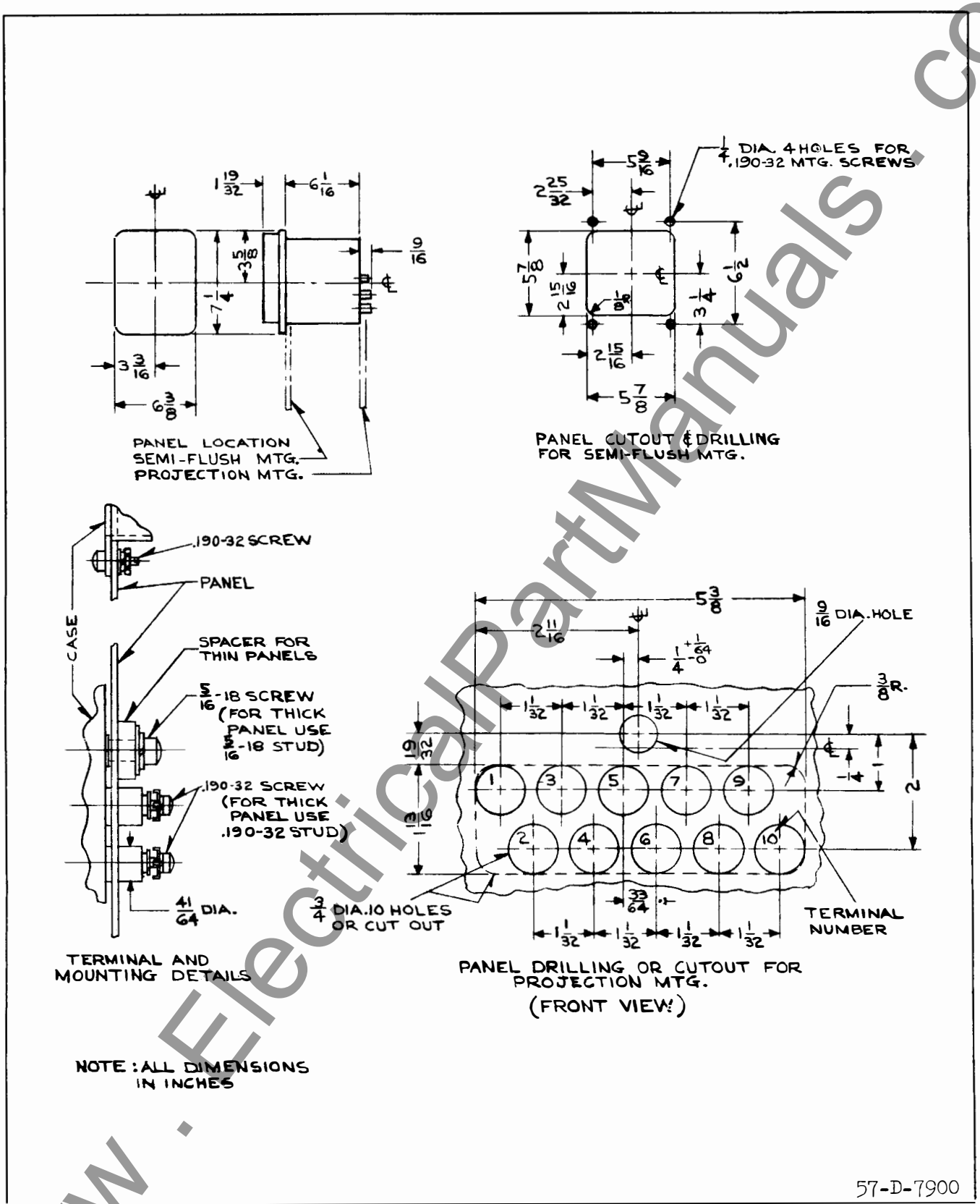


Fig. 19. Outline & Drilling Plan for the Type PSD and PS-5 Relays in the Type FT11 Case.

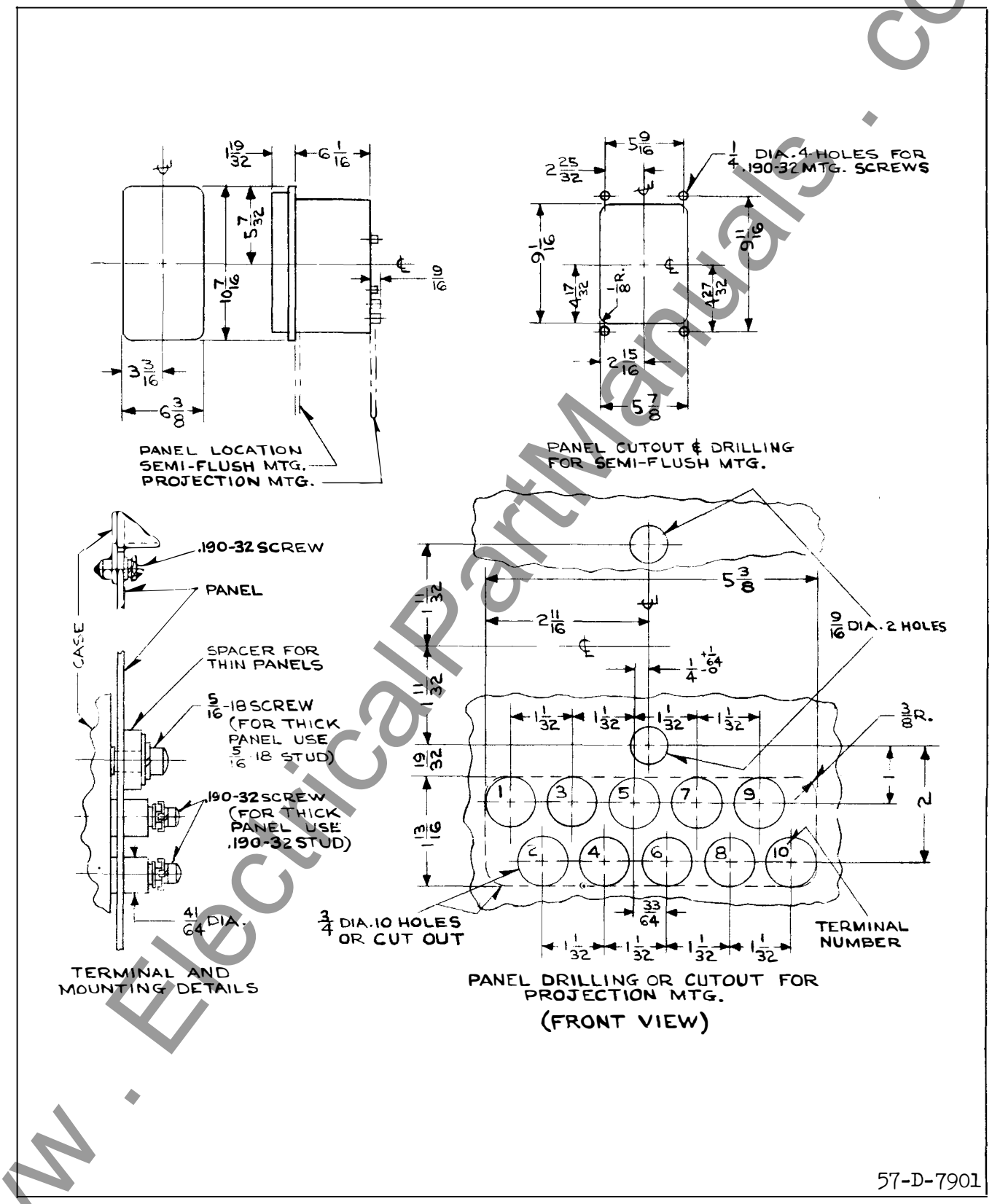


Fig. 20. Outline & Drilling Plan for the Type PSA and PS-23 Relays in the Type FT21 Case.

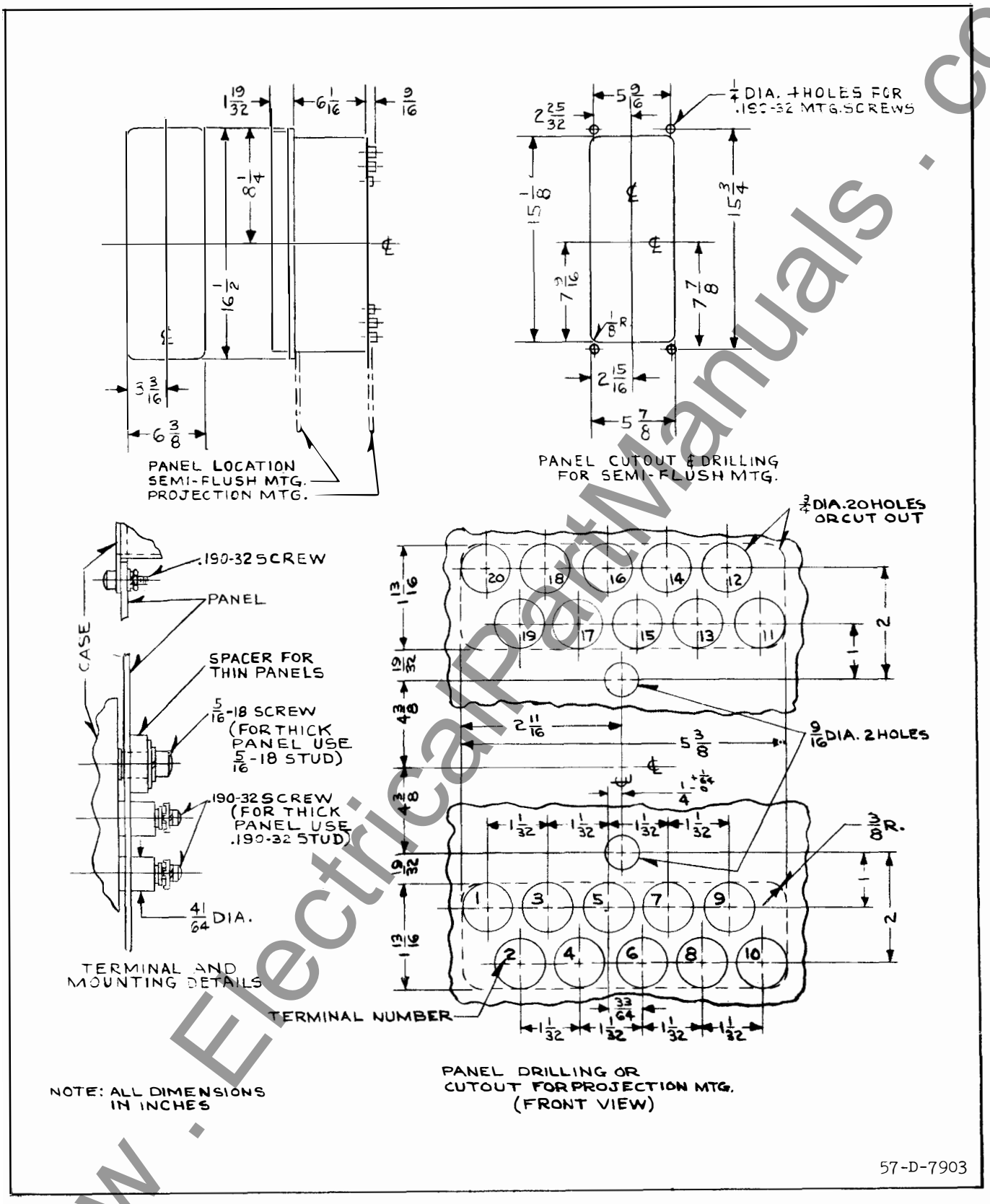


Fig. 21. Outline & Drilling Plan for The Type PS-13 Relay in the Type FT32 Case.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PS-1 AND PS-23 PILOT WIRE SUPERVISORY RELAYS

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

APPLICATION

The type PS-1 supervisory relay is used with the type PS-23 relay on HCB pilot wire systems to detect short circuits, open circuits, grounds and reversed pilot wires.

The type PS-1 relay is located at one terminal to introduce the supervisory current to the pilot wires and to initiate an alarm when the pilot wire is opened or shorted. The type PS-23 relay is located at the other end of the pilot wire circuit and operates to initiate an alarm at that terminal when the pilot wire is opened or shorted. If remote tripping is required, the type PS-23 relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal. When used for this function, the type PS-23 relay does not act as a fault detector to initiate an alarm at its station. The type PS-23 relay provides a continuous visual indication and means of adjusting the supervisory current.

Note: Unless otherwise specified, the reference to the type PS-1 relay pertains to both the d-c operated and the a-c operated relays.

CONSTRUCTION AND OPERATION

The d-c operated type PS-1 relay consists of a polarized relay element adapted to operate on .001 ampere or .002 ampere d-c pilot wire supervisory current. It is equipped with internal resistor tubes to obtain this current from a battery source. The 22 volt d-c relays utilize series resistors, whereas relays for operation from 48, 125, or 250 volt batteries utilize the resistors in a potentiometer arrangement. See Figs. 1 to 4 for three terminal lines, where the output of the type PS-1 relay is .002 ampere, the potentiometer models are equipped with different resistance values in the potentiometer than for two terminal lines,

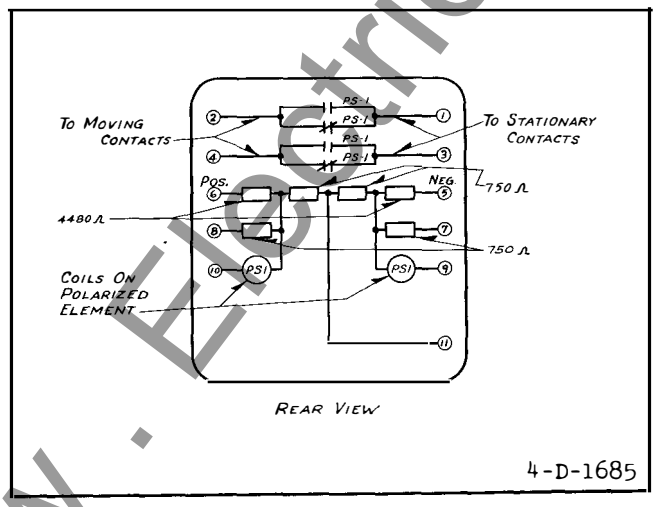


Fig. 1. Internal schematic of the 48, or 125 volt d-c type PS-1 relay in the standard case. When remote tripping is not required, or for 48 volts d-c with or without remote tripping, terminals 7 and 8 and associated resistors are ommitted.

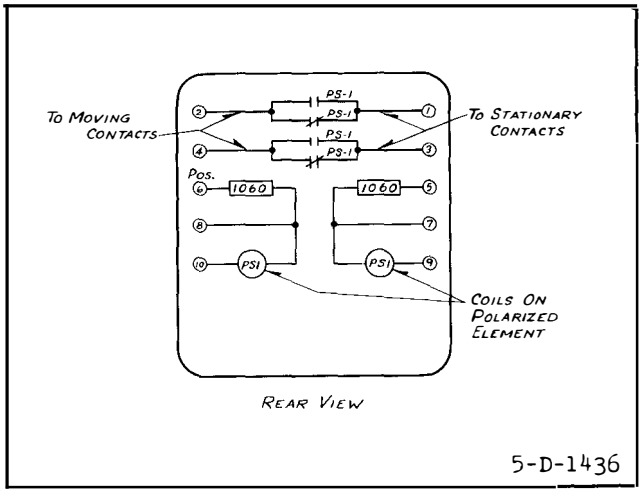


Fig. 2. Internal schematic of the 22 volt d-c type PS-1 relay in the standard case.

SUPERSEDES I. L. 41-973

*Denotes change from superseded issue.

EFFECTIVE APRIL 1955

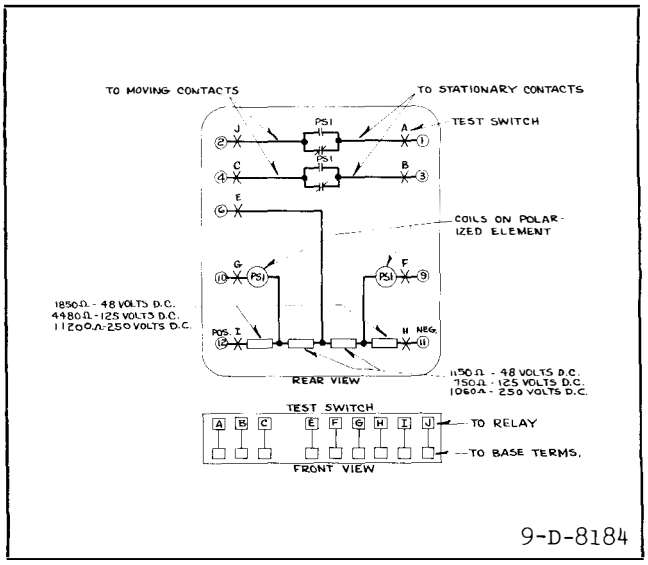


Fig. 3. Internal schematic of the 48, 125 or 250 volt d-c type PS-1 relay in the type FT case.

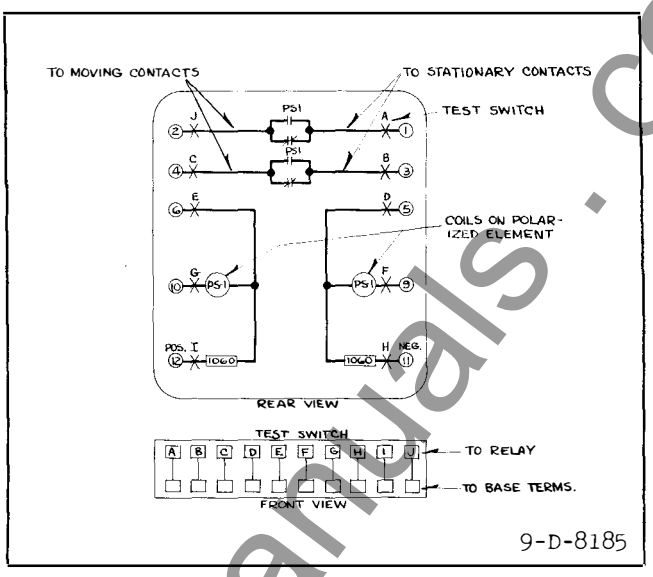


Fig. 4. Internal schematic of the 22 volt d-c type PS-1 relay in the type FT case.

where the output of the type PS-1 is .001 ampere.

The a-c operated type PS-1 relay consists of a small transformer with taps on the primary, and secondary windings, a full wave Rectox unit, a polarized relay, and a potentiometer for grounding the d-c circuit. See Figs. 5 and 6. The relay is also supplied with a 4 mfd. and a 10 mfd. capacitor to be used with it as shown in Figs. 13 and 14. The two capacitors serve as a filter to smooth out the pulsation of the rectified current to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The type PS-23 relay consists of a polarized relay element, a 0-5 milliammeter, an operation indicator, an adjustable resistor and a Rectox unit. These component parts are connected as shown in Figs. 7 and 8.

POLAR TYPE RELAY ELEMENT

The polarized relay element consists of an armature and contact assembly mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable screw type shunts are located in the rear air gaps. They change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias causing it to move toward one or the other of the poles, depending upon the adjustment of the magnetic shunts. For the type PS-1 relay, two operating coils are placed around the armature within the magnetic frame. The windings are connected in series with each of the pilot wires. The type PS-23 relay utilizes only one operating coil and it is placed around the armature in a similar manner as the two operating coils of the type PS-1 relay. The type PS-23 relay coil is connected across the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the left side of the front air gap with the coils de-energized. This holds the left-hand contact closed. When either of the operating coils is energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move towards the right-hand contact. Normally, the current through the relay coils is of such a magnitude that the armature floats approximately midway between the right and left stationary contacts.

TRANSFORMER

The a-c type PS-1 relay transformer has 100, 110, 120 and 130 volt taps on the transformer primary. With tap voltage applied to the transformer primary, the relay will supply .001 ampere d-c to the pilot wire with approximately 17 volts d-c at the output terminals. If necessary as much as 130 volts may be used continuously on any of the taps marked from 100 to 130.

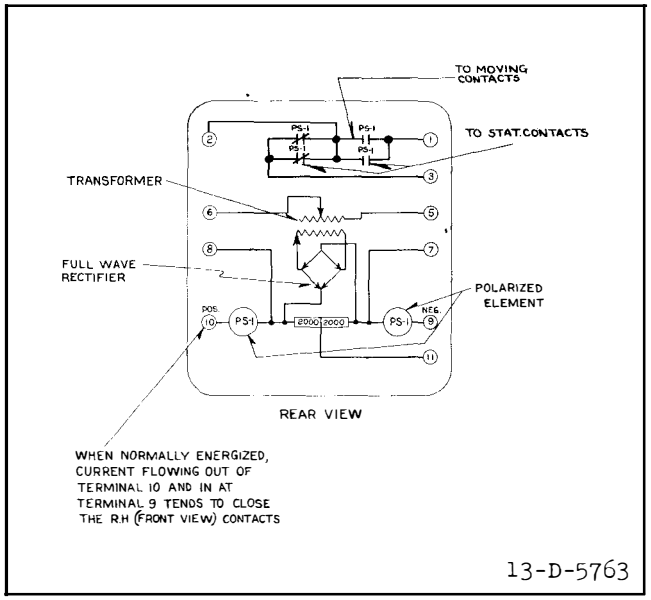


Fig. 5. Internal schematic of the a-c type PS-1 relay in the standard case.

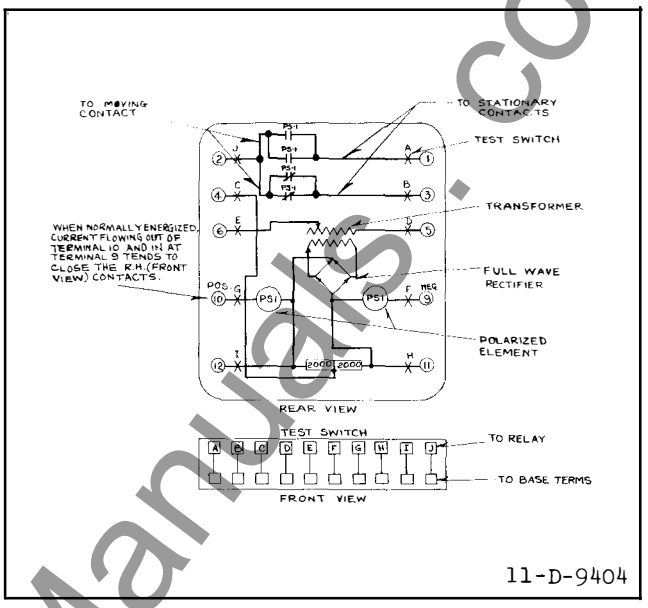


Fig. 6. Internal schematic of the a-c type PS-1 relay in the type FT case.

The secondary winding also has a tap, the use of which is described under "Settings".

OPERATION INDICATOR

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

The operation of the type PS-1 and PS-23 relays for pilot wire supervision is as follows:

(1a). Normal Pilot Wire-Two Terminal Lines

The relays are continuously energized with .001 ampere d-c, which is introduced from a battery source (for d-c operated relay) or an external a-c source (for a-c operated relay) through the type PS-1 relay and circulated over the pilot wire circuit. This current holds the contact of the type PS-1 relay and the left-hand contact (front view) of the type PS-23 relay open, and tends to close the right-hand (front view) contact of the type PS-23 relay.

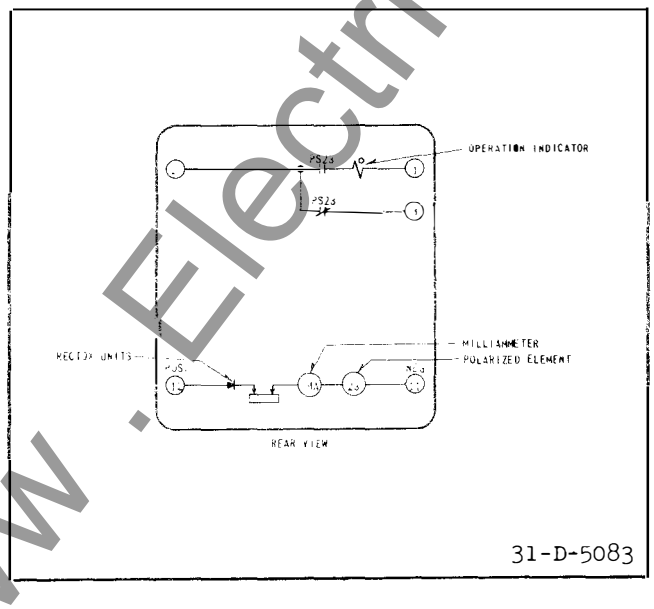


Fig. 7. Internal schematic of the type PS-23 relay in the standard case.

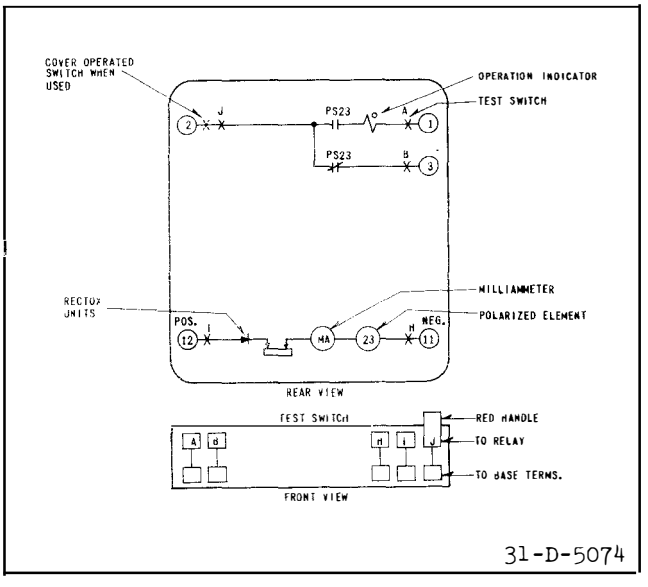


Fig. 8. Internal schematic of the type PS-23 relay in the type FT case.

(1b). Normal Pilot Wire-Three Terminal Lines

The action here is the same in principle as for two terminal lines, except that the type PS-1 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-23 relays involved.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts, left-hand (front view) of the type PS-23 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the types PS-1 and PS-23 relay terminals.

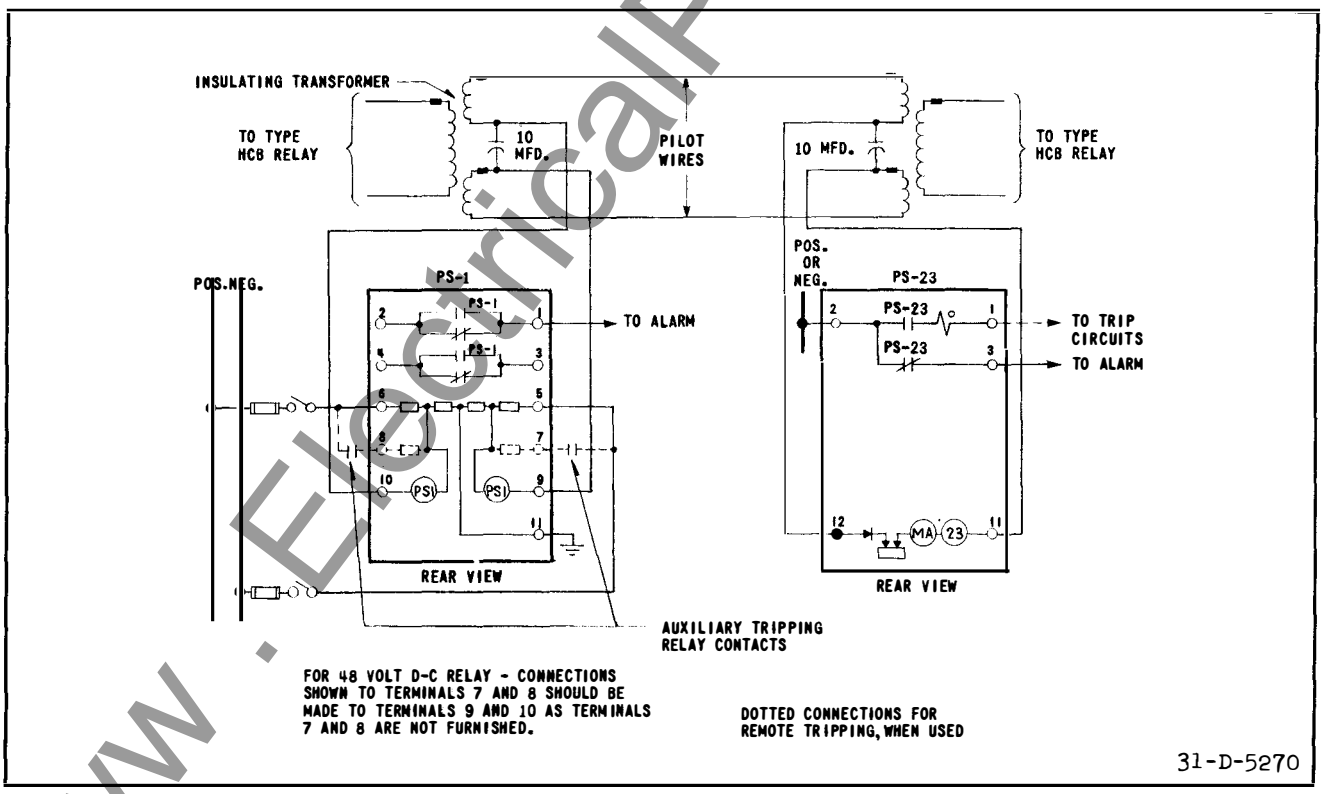
(4). Pilot Wire Grounded

The connection of the separate windings of the type PS-1 relay in each of the pilot wire circuits provides two circuits of equal impedance from the grounded mid-tap of the potentiometer in the type PS-1 relay to the remote terminal on the pilot wire. The type PS-23 relay contains a relatively high resistance, such that when either pilot wire becomes grounded at any point along its length, unequal currents flow to operate the type PS-1 relay. This provides supervision for ground fault resistance values of 500 ohms or less. In the 22 volt d-c relays the mid-point of the battery is grounded.

Station batteries are frequently grounded at the midpoint of a circuit consisting of two lamps connected in series across the battery terminals. An accidental ground on the station battery circuits will not affect the ability of the pilot wire short circuits or open circuits, although the relative sensitivity of the type PS-1 relay to grounds on one of the two wires of a pilot pair will be changed. Ground faults on the pilot wire will not affect the grounding lamps on the station battery because of the high internal resistance of the type PS-1 relay.

(5). Reversed Pilot Wires

A reversal of the pilot wires will tend to pass current thru the type PS-23 relay in the reversed direction. The back resistance of



** Fig. 9. External connections of the 48, 125 or 250 volt d-c type PS-1 and the type PS-23 relay in the standard case for pilot wire supervisory and remote tripping.*

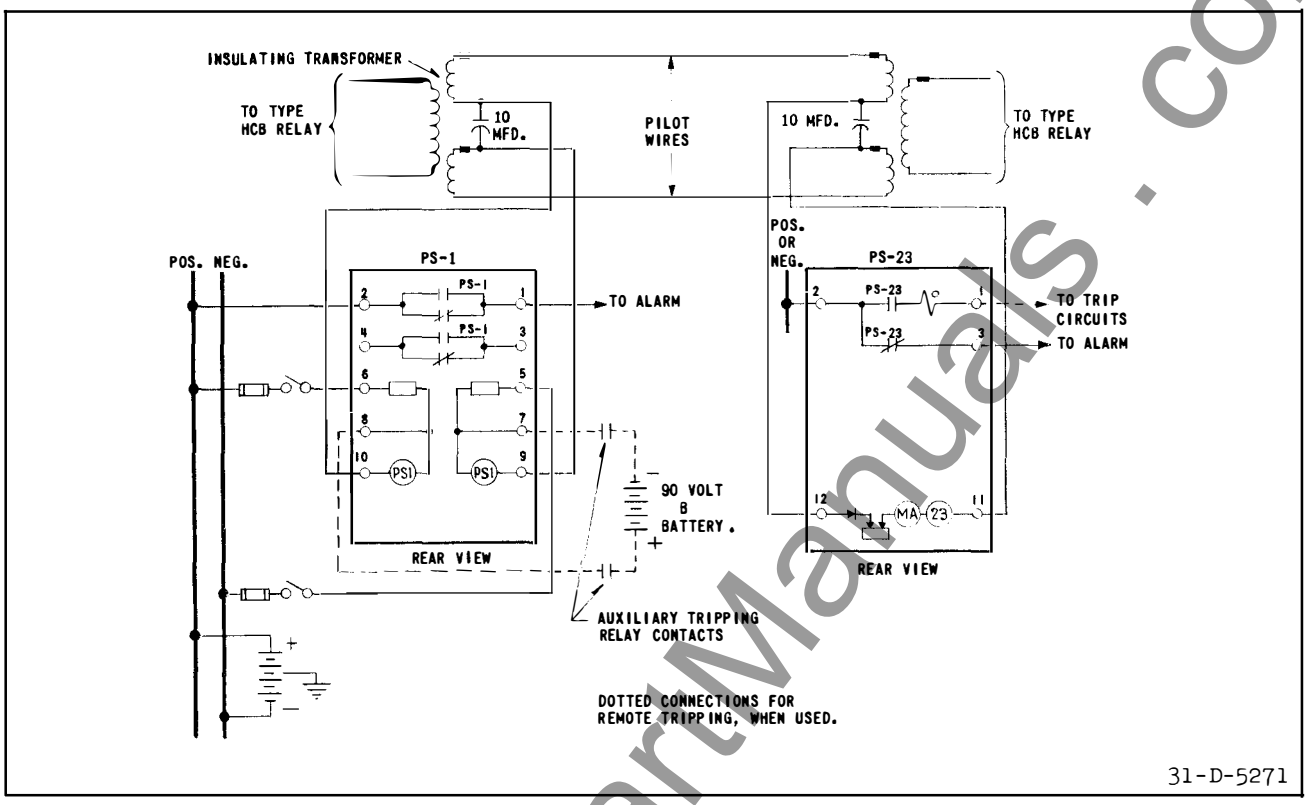


Fig. 10. External connections of the 22 volt d-c type PS-1 and the type PS-23 relays in the standard case for pilot wire supervisory and remote tripping.

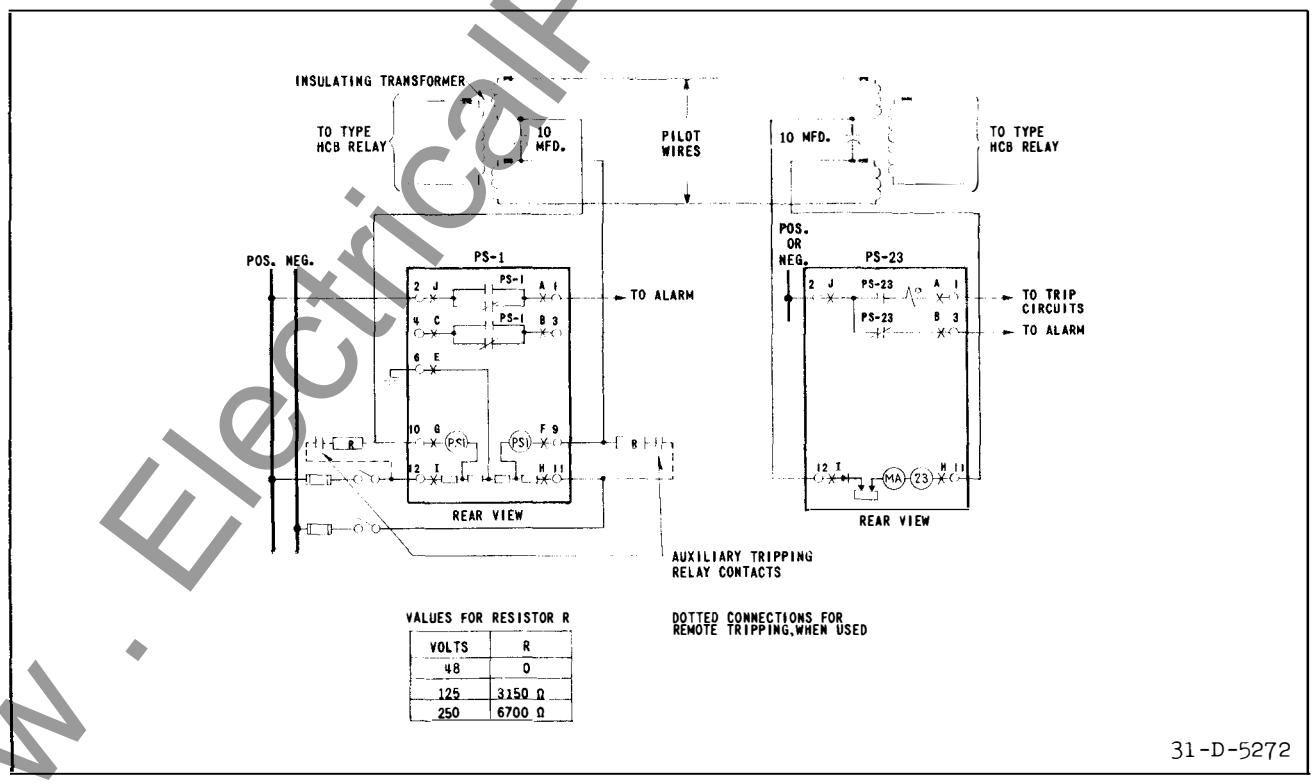


Fig. 11. External connections of the 48, 125 or 250 volt d-c type PS-1 and the type PS-23 relays in the type FT case for pilot wire supervisory and remote tripping.

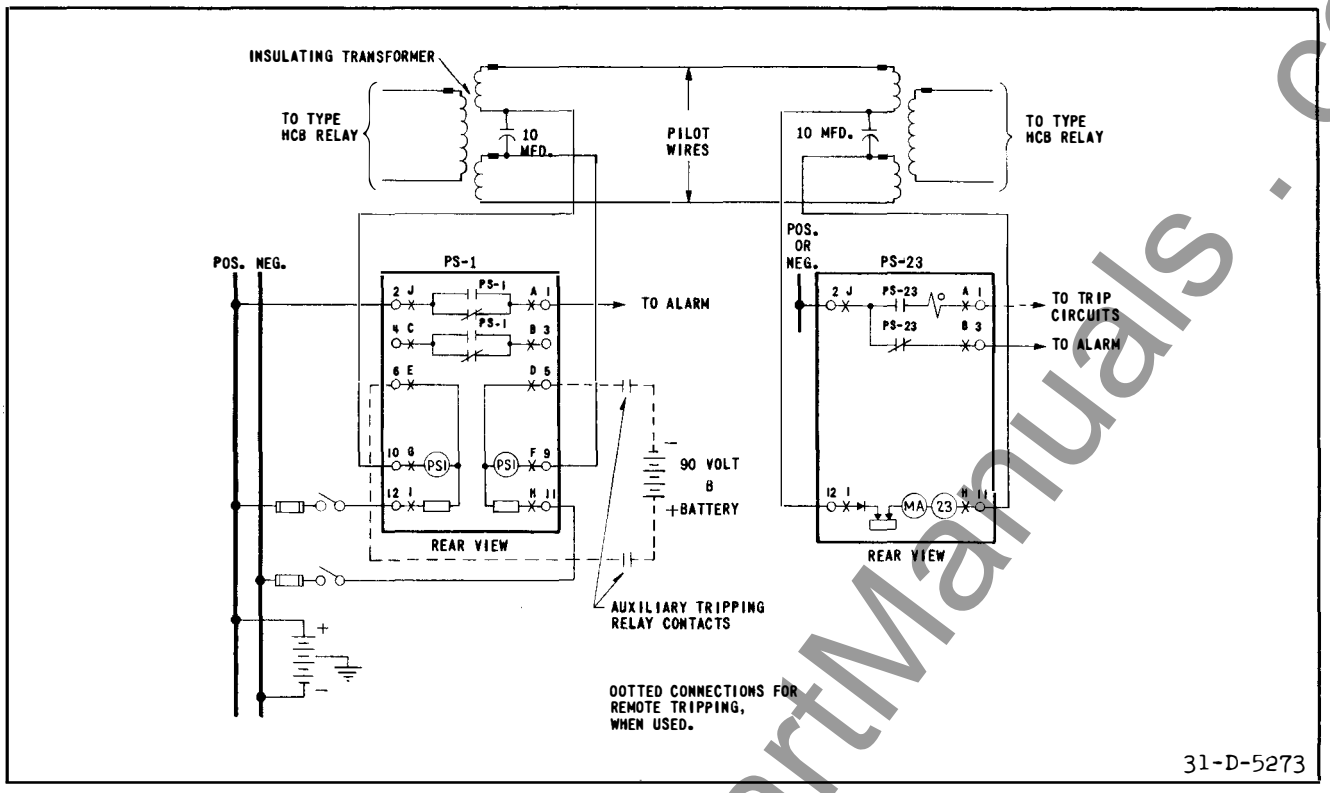


*Fig. 12. External connections of the 22 volt d-c type PS-1 and the type PS-23 relays in the type FT case for pilot wire supervisory and remote tripping.

the Rectox units in this relay is sufficiently high and, therefore, limits the magnitude of supervisory current so that both the type PS-1 and PS-23 relays operate on undercurrent.

(6). Remote Tripping

Remote tripping is accomplished by applying a higher d-c voltage to the pilot wires at the sending end, where the type PS-1 relay is located.

For the d-c operated type PS-1 see Figs. 11 and 12. The polarity of this voltage is the same as the normal voltage. For 125 and 250 volt d-c sources, resistors are used to limit the pilot wire current. For the 22 volt models, an extra battery source of higher voltage must be used.

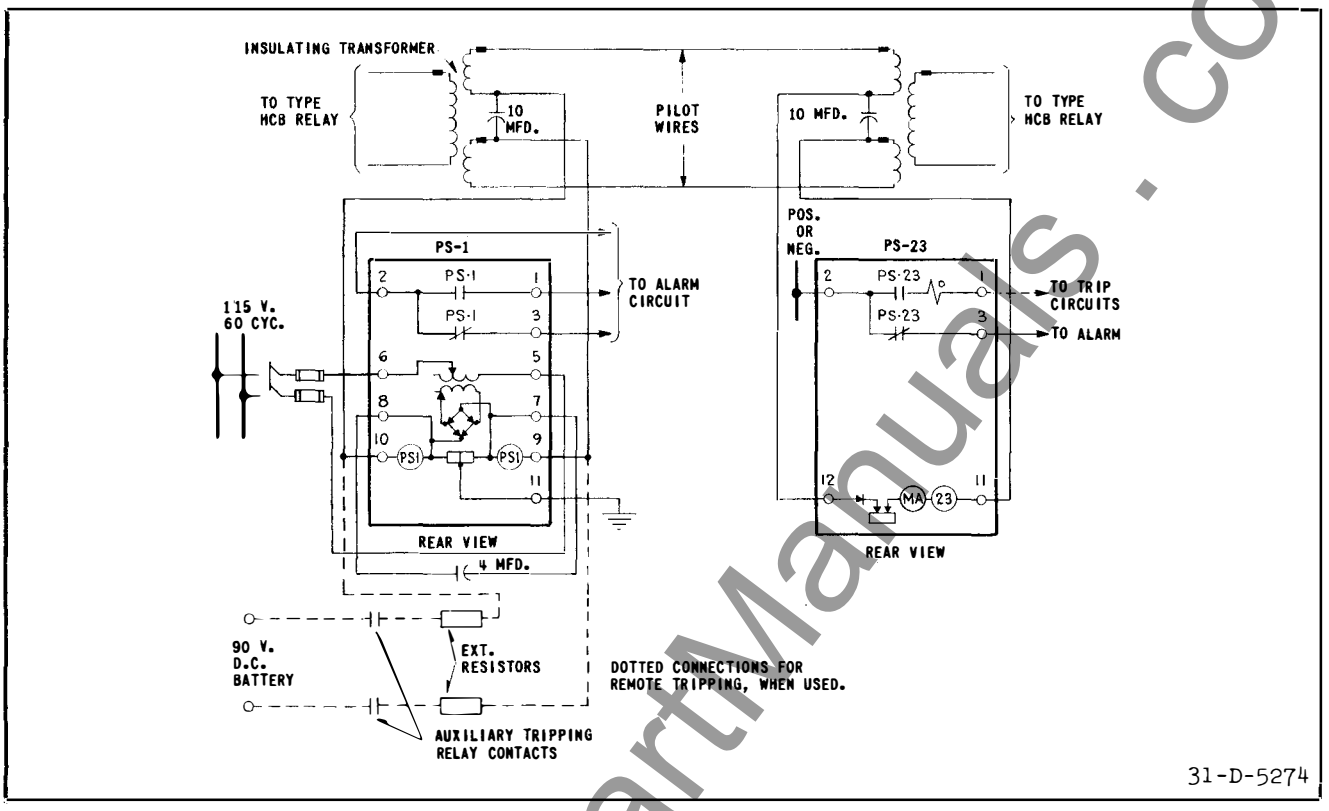
Remote tripping for a-c operated type PS-1 relays is accomplished as indicated in Figs. 13 and 14. When a 90 volt source is used, such as a "B" battery, the two resistors shown in the diagram should be 1100 ohms each to limit the pilot wire tripping current to .005 ampere, which is sufficient to operate the PS-23 relay adjusted for .002 ampere pickup. On the other hand, a 45 volt battery source may be used and the resistors omitted, in which case the pilot wire current will increase to approximately .004 ampere for the remote tripping operation.

(7). Difference in Ground Potential

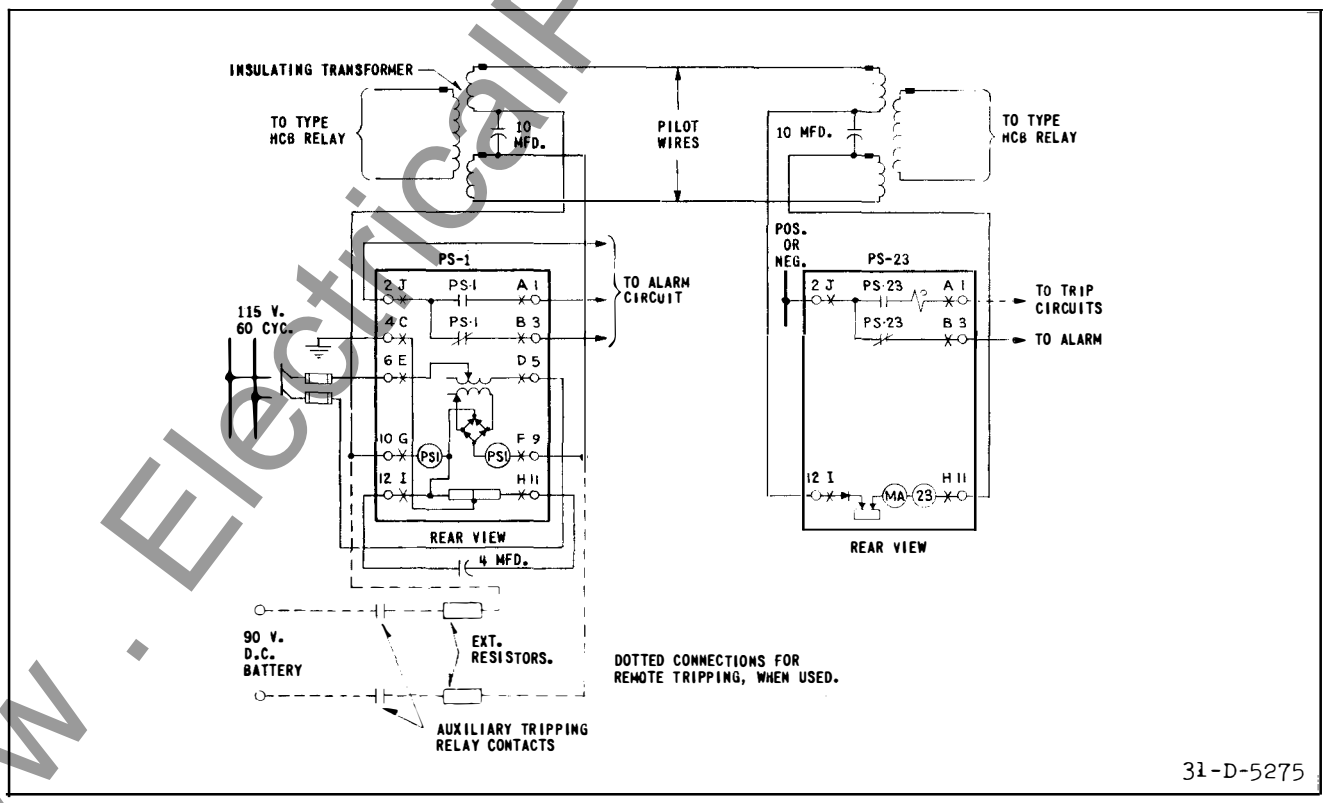
These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals. If the magnitude of this potential is between 200 and 500 volts, it is recommended that 5 mfd. capacitors be connected -- one each between the relay pilot wire terminals and ground at the type PS-1 relay. If the magnitude of this potential exceeds 500 volts, special means of protecting the relays are available.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means



** Fig. 13. External connections of the a-c type PS-1 and PS-23 relays in the standard case for pilot wire supervision and remote trip of a two terminal line.*



** Fig. 14. External connections of the a-c type PS-1 and PS-23 relays in the type FT case for pilot wire supervision and remote trip of a two terminal line.*

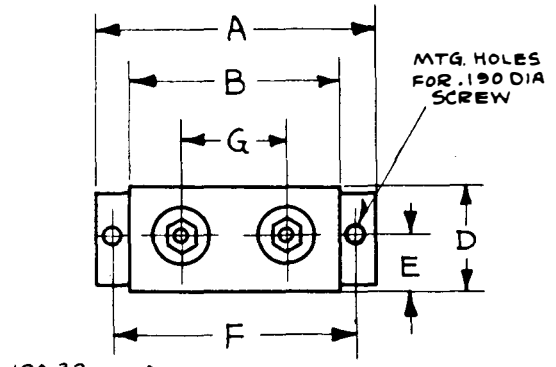


FIG. 3

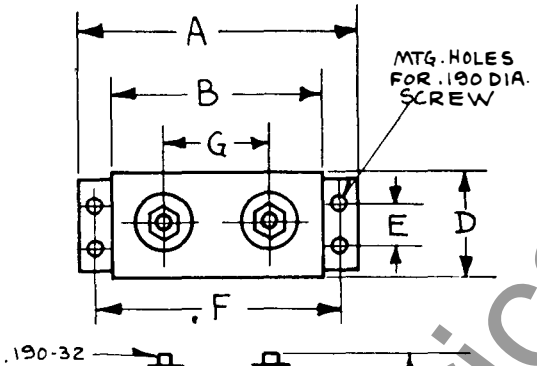


FIG. 16

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
3	±1/32 4	3	3 1/8	+1/16 -1/32	±1/32 1 1/2	±1/32 3 1/2	±1/32 1 1/4	+1/16 -1/16 4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	+1/16 -1/16 5 1/16

94-D-596

Fig. 15. Outline and Drilling plan for the auxiliary 4 and 10 mfd. capacitors. For reference only.

of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external connections for the types PS-1 and PS-23 relays are shown in Figs. 9 to 14. For information concerning the type HCB relay see I.L. 41-658.

CAUTION These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals.

SETTINGS

The relays are calibrated in the factory to be energized continuously with one milliampere d-c. After the relays are checked and installed, the only setting required on the d-c operated types PS-1, PS-23 combination is to adjust the slide wire resistance in the type PS-23 so that the milliammeter in the relay indicates that one milliammeter d-c is circulating over the pilot wires.

If an a-c operated type PS-1 is used with a type PS-23 relay, the only setting required is to select the proper voltage tap in the type PS-1 relay and to adjust the slide wire resistance in the type PS-23 relay, so that the milliammeter in the relay indicates that one milliampere d-c is circulating over the pilot wires. If difficulty is experienced in getting .001 ampere d-c supervisory current in the pilot wire, select the next lower or higher voltage tap in the type PS-1 relay, as may be required.

Due to a relatively wide variation in Rectox forward resistance characteristics, it is necessary to provide an extra terminal on the transformer secondary coil in the a-c type PS-1 relay for purposes of adjustment. In the event that .001 ampere d-c supervisory current cannot be obtained by the combined adjustments of the slide wire resistance in the type PS-23 relay and the use of the primary voltage taps in the a-c type PS-1 relay, then the connection to the transformer secondary coil in the a-c type PS-1 relay must be changed. In such cases, remove the lead from the center terminal on the secondary coil and connect it to the extra terminal, which is the top terminal on the coil. This connection will raise the voltage output of the a-c type PS-1 relay so that the current may be adjusted to .001 ampere by means of the slide wire resistance in the type PS-23 relay.

CAUTION If the pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relay be set in the laboratory rather than while they are directly connected to the pilot wires. This precaution is to prevent injury to the personnel from high induced voltages. Neutralizing reactors are available for use to keep high voltage from the relay.

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 periodically cleaned with a fine file. Style #1002110 file 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.

TYPE PS-1 RELAY, POLARIZED ELEMENT

With the relay de-energized, remove the permanent magnet and adjust the moving armature so that it floats between the poles or lightly touches the left-hand pole piece. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn each contact screw four turns to obtain approximately 5/32" between the stationary contacts. Re-assemble the permanent magnet with the north pole to the right (front view) and pass .001 ampere thru the operating coils.

This should be done by connecting the relays per one of the figures or using an equivalent resistance in place of the pilot wires and insulating transformer. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the moving contacts float midway between the stationary contacts. With this adjustment, the right-hand contacts should operate at approximately .0013 ampere, and the left-hand contacts should close at .0007 ampere. For three terminal lines, the type PS-1 relay contacts should float at .002 ampere, close to the right at .0023 ampere, and close to the left at .0017 ampere.

A good way to adjust the element is to start with both magnetic shunts at the extreme "in"

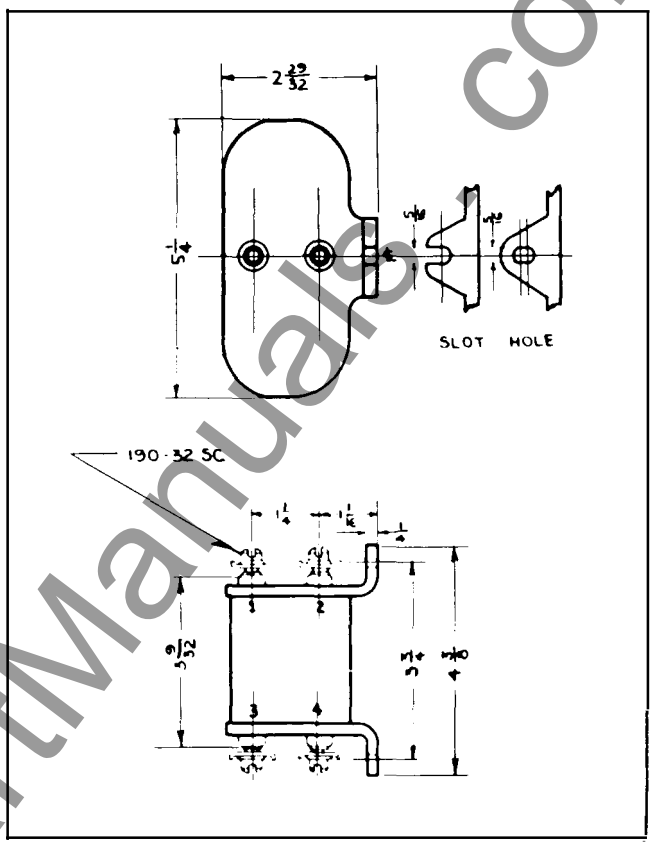


Fig. 16. Outline and drilling plan for the external resistor used with the d-c type PS-1 relay in the type FT case for remote tripping. For reference only.

position, then draw out the right-hand shunt until the right-hand contacts make at the desired current. Then lower the current and draw out the left-hand shunt until the left-hand contacts make at the right value. This will upset the adjustment for the right-hand contacts, which should then be rechecked. The process is easily carried back and forth until both values will check properly. The shunts are held securely in place by means of a spring type clamp.

TYPE PS-23 POLARIZED ELEMENT

With the relay de-energized and with the permanent magnet removed, the moving armature may be adjusted so that it floats between the poles. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn each contact screw four turns to obtain approximately 5/32" gap between the stationary contacts.

Re-assemble the permanent magnet with the north pole to the left (front view). Connect the relay per one of the Figures and pass .001

ampere through the relay. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the moving contacts float midway between the stationary contacts. With this adjustment, the right-hand contacts (F.V.) should operate at approximately .002 ampere, and the left-hand contacts (F.V.) should close at .0006 ampere.

Starting with both magnetic shunts out approximately seven turns, adjust left hand shunt until the left-hand contacts make at the desired value. The right-hand calibration is achieved after the left-hand calibration has been completed by the use of the adjustment screw, located below the right-hand stationary contact, striking the moving contact assembly spring. This allows for the necessary adjustment to obtain the correct values for the calibration of the right hand contact. The current required to make the right-hand contacts will have to be increased as the adjustment screw is screwed farther against the contact assembly spring.

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.

ENERGY REQUIREMENTS

The 60 cycle burden of the a-c type PS-1 is approximately 0.5 volt-ampere at tap voltage with .001 ampere d-c flowing over the pilot wire.

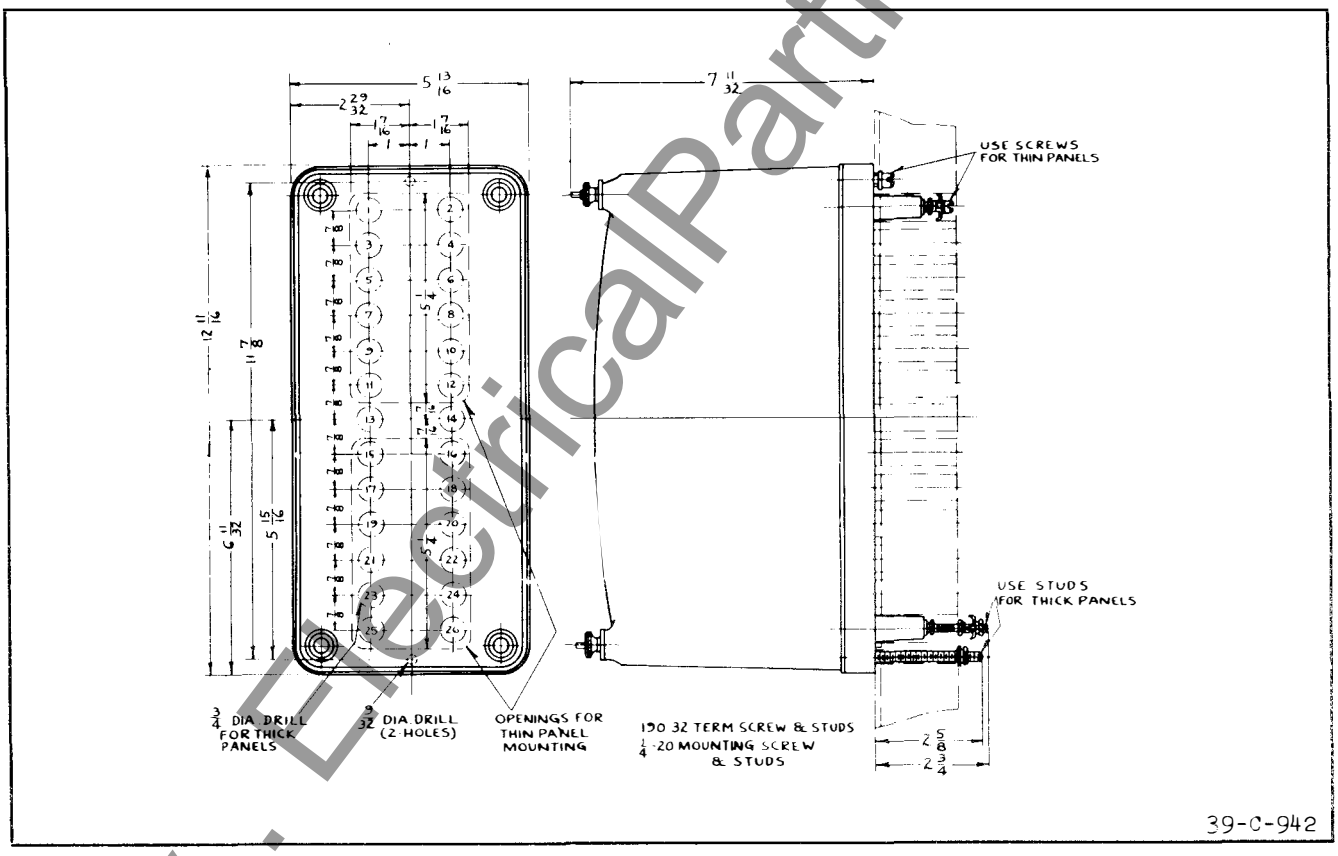


Fig. 17. Outline and drilling plan for the standard case. See the internal schematics for the terminals supplied. For reference only.

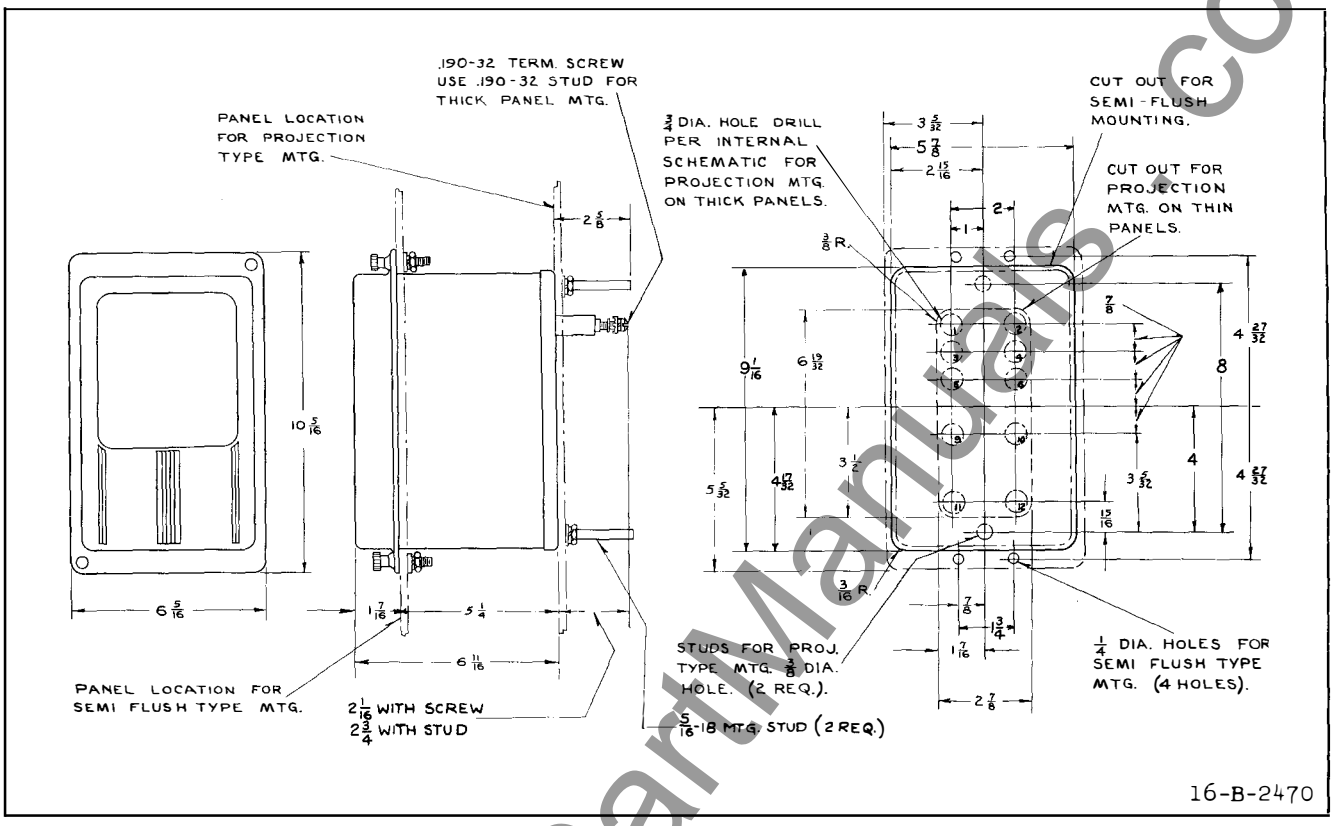


Fig. 18. Outline and drilling plan for the S10 semi-flush or projection type FT case. See the internal schematics for the terminals supplied. For reference only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

Printed in U. S. A.