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

TABLE I

APPLICATION CHART

FUNCTION	PSA & PSD	PS-13	PS-23	PS-4	PS-5
Introduces Supervision Current	X	X			
Receives Supervision Current			X	X	
Trouble Alarm	X	X	X		X
Transmits Trip Signal	X	X	X	X	
Receives Trip Signal		X	X		
Sensitive Ground Detection					X
Measures Supervision Current			X		

clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Pilot Wire Supervision

Supervision current is introduced into the pilot wire as shown in the external schematics, figures 10 to 14, by the PSA, PSD, or PS-13 relays. A nominal 17 volts is impressed across the 10 mfd. capacitors. This voltage produces a current circulating through one winding of the HCB insulating transformer, one pilot wire, the PS-4 or PS-23, and back through the * other pilot wire. Note that in the PS-13 of figures 12 and 14, supervision current flows in the "1" coil, and a negligible current of about 0.5 milliamperes flows in the "3" coil, because of the high resistance of the varistors when a nominal 17 volts is impressed across the 10 mfd. capacitors.

Adjustment of the resistors of the PS-4 or PS-23 relay at the other end of the pilot wire provides a normal one milliampere d-c circulating current. In the case of three terminal lines, the PSA, PSD, or PS-13, output current is 2 ma in order to provide each receiving end relay with 1 ma. The alarm unit of the PSA, PSD, or PS-13 is adjusted to float between the high and low current contacts with normal supervision current. The PS-23, receiving end relay, is adjusted to float between the low current contact (trip) with 1 ma flowing.

Short Circuits

Current increases in the PSA, PSD, or PS-13 to close the high current alarm contact, current decreases in the PS-23 to close the alarm contact. * Short circuits of 3000 ohms or less will be detected.

Open Circuits

Current decreases to zero in all relays. Low current alarm contact of PSA, PSD, or PS-13 closes. Alarm contact of PS-23 closes.

Reversed Wires

Current decreases in both sending and receiving end relays because of the rectifier unit in the PS-23

TABLE II

PSA & PSD APPLICATIONS

EXTERNAL RESISTORS FOR D.C. REMOTE TRIPPING

(2 Required per Station)

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PSA OR PSD	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0	—	—	PS-23
	125	5600	—	—	PS-23
	250	14000	—	—	PS-23
3	48	0	—	—	PS-23
	125	3750	—	—	PS-23
	250	9500	—	—	PS-23

TABLE III

PS-13 APPLICATIONS

(2 Required per Station)

RESISTORS FOR D.C. REMOTE TRIPPING

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PS-13	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0†	0	—	PS-13 & PS-23
	125	3150†	3150	—	PS-13 & PS-23
	250	8500†	8500	—	PS-13 & PS-23
3	48	0†	0	0	PS-13 & PS-23
	125	2500†	2500	2500	PS-13 & PS-23
	250	6000†	6000	6000	PS-13 & PS-23

† Mounted in Relay

or PS-4. Low current alarm contacts close.

Grounds

The sending end relays (PSA, PSD, or PS-13) are mid-point grounded, so that a pilot wire ground will cause an increase in current in one of the two alarm unit coils of the PSA, PSD, or PS-13, closing the high current alarm contact. Grounds of 500 ohms or less will be detected. The high internal resistance of the PSD and d-c PS-13 relays will prevent a pilot wire ground from affecting the station battery ground lamps. An accidental ground on the battery circuits will affect the sensitivity of the relays in detecting pilot wire grounds.

For sensitive ground detection a PS-5 relay can be inserted in the PSA, PSD, or PS-13 ground connection. This relay will detect grounds of 50,000 ohms or less. The PSA, PSD, or PS-13 will not detect grounds when the PS-5 is used because of the additional resistance that the PS-5 inserts into the circuit. Because of its very high sensitivity, it is recommended that the PS-5 contact be connected to an indicating lamp rather than to an alarm.

Remote Tripping

Breakers located at the PS-13 and PS-23 stations can be tripped by the application of a d-c voltage to the pilot wires at remote locations, as shown in figures 10 to 14. Remote tripping can be effected from any location by applying 48 volts d-c or more to the pilot wire. When tripping the PS-23, the current is increased above 3.5 ma to close the high current con-

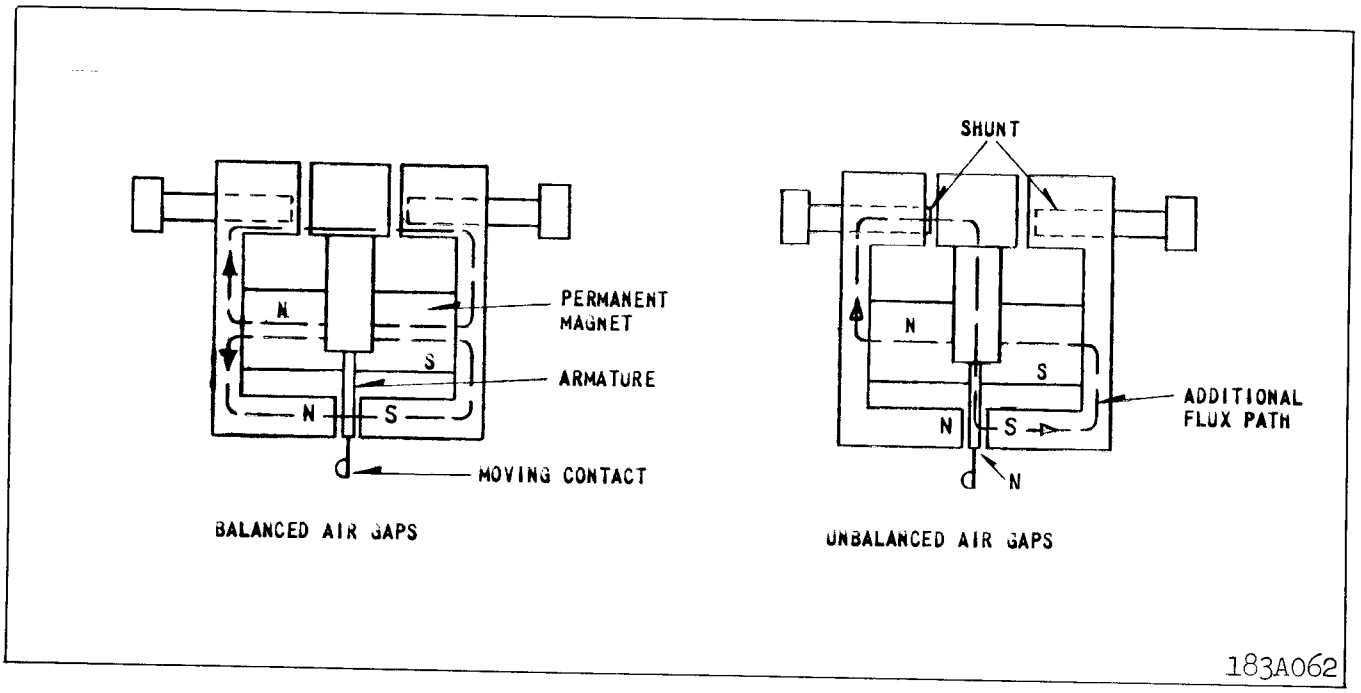


Fig. 1. Polar Unit Permanent Magnet Flux Paths.

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

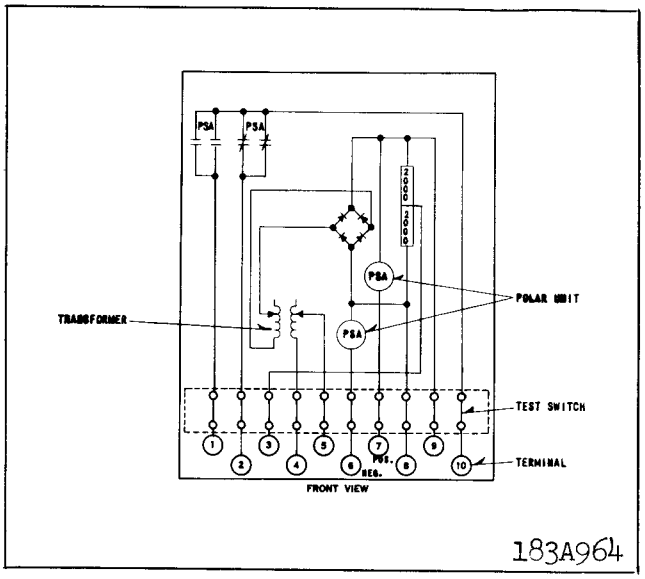


Fig. 2. Internal Schematic of the Type PSA Relay in the FT21 Case – 120 Volt, 60 cycle supply – For Two and Three Terminal Lines.

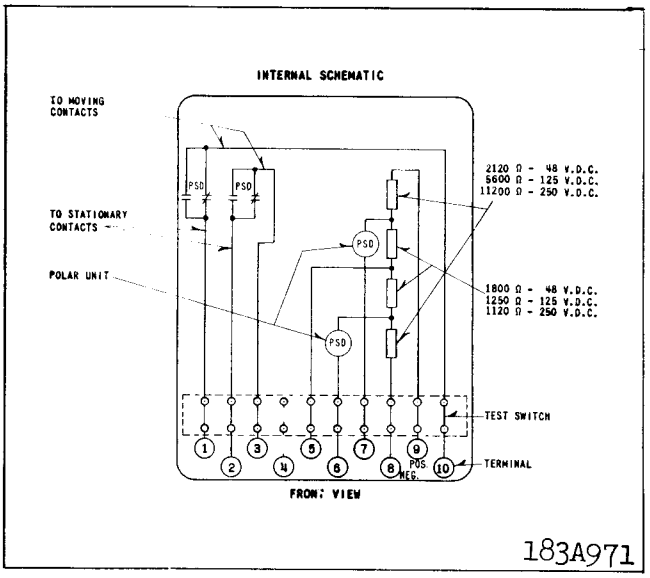


Fig. 3. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Two Terminal Lines.

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.

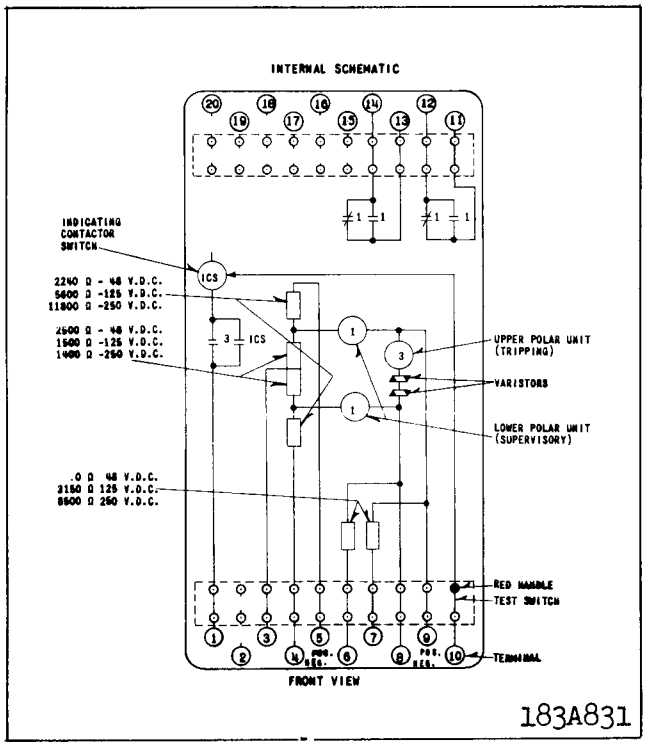


Fig. 4. Internal Schematic of the Type PS-13 Relay in the FT32 Case. DC Supply – For Two Terminal Lines.

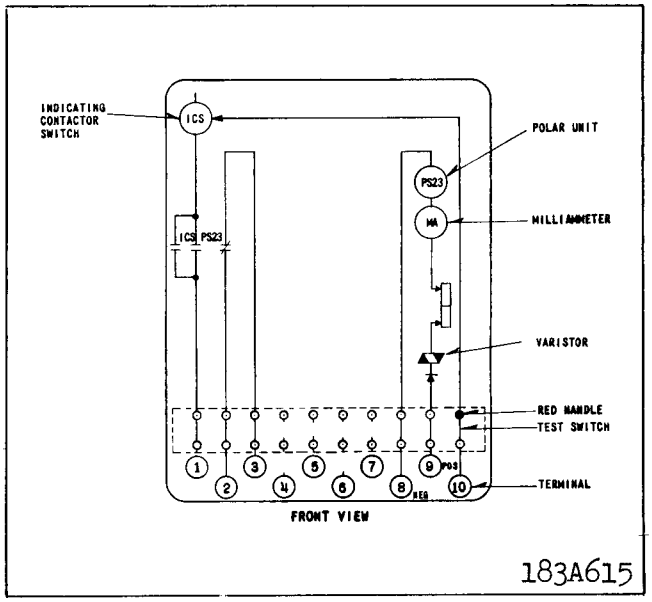


Fig. 5. Internal Schematic of the Type PS-23 Relay in the Type FT21 Case.

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

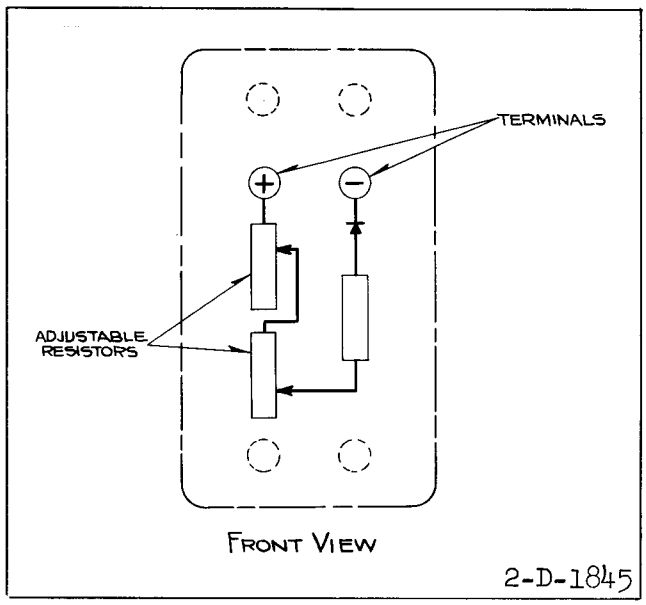


Fig. 6. Internal Schematic of the Type PS-4 Auxiliary Unit in the Small Molded Case.

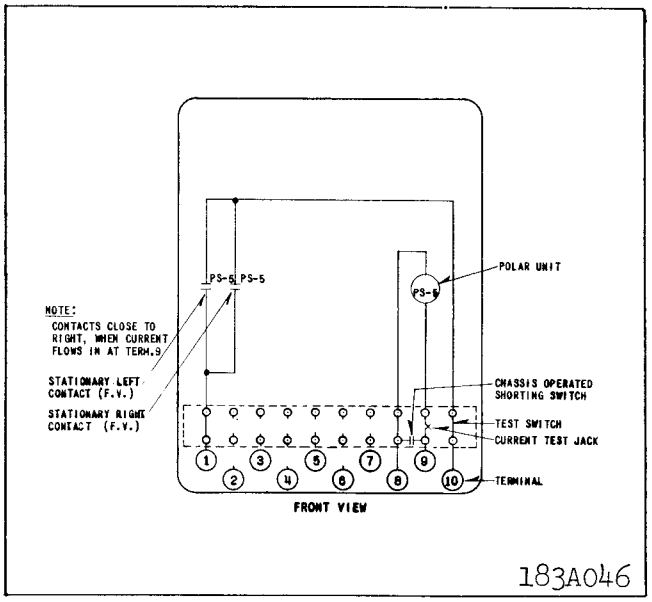


Fig. 7. Internal Schematic of the Type PS-5 Ground Detector Relay in the FT11 Case.

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 8,500 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

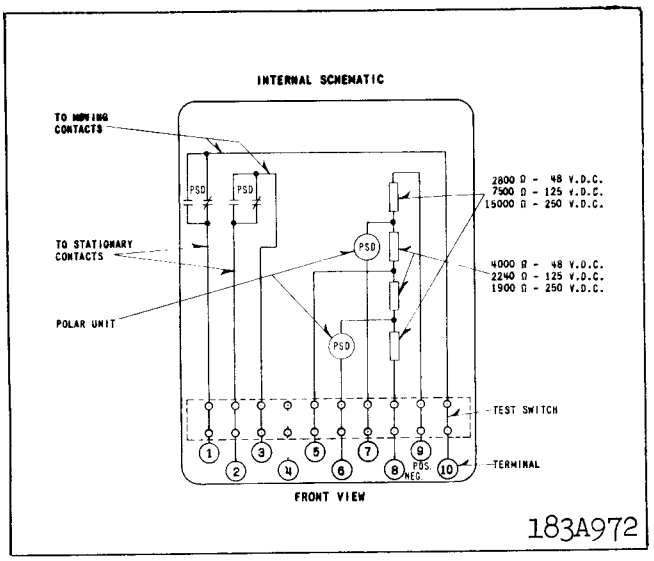


Fig. 8. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Three Terminal Lines.

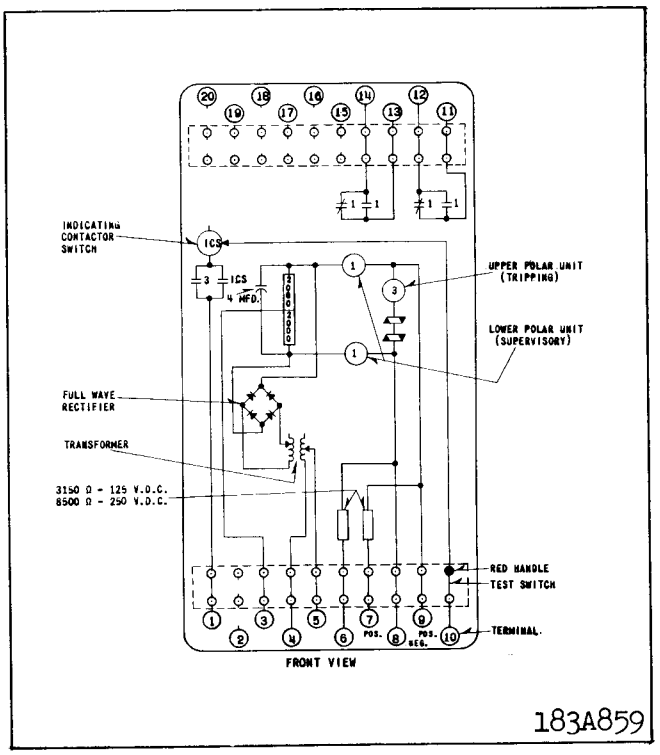


Fig. 9. Internal Schematic of the Type PS-13 Relay in the FT32 Case – 120 volt, 60 cycle supply – For Two Terminal Lines.

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.

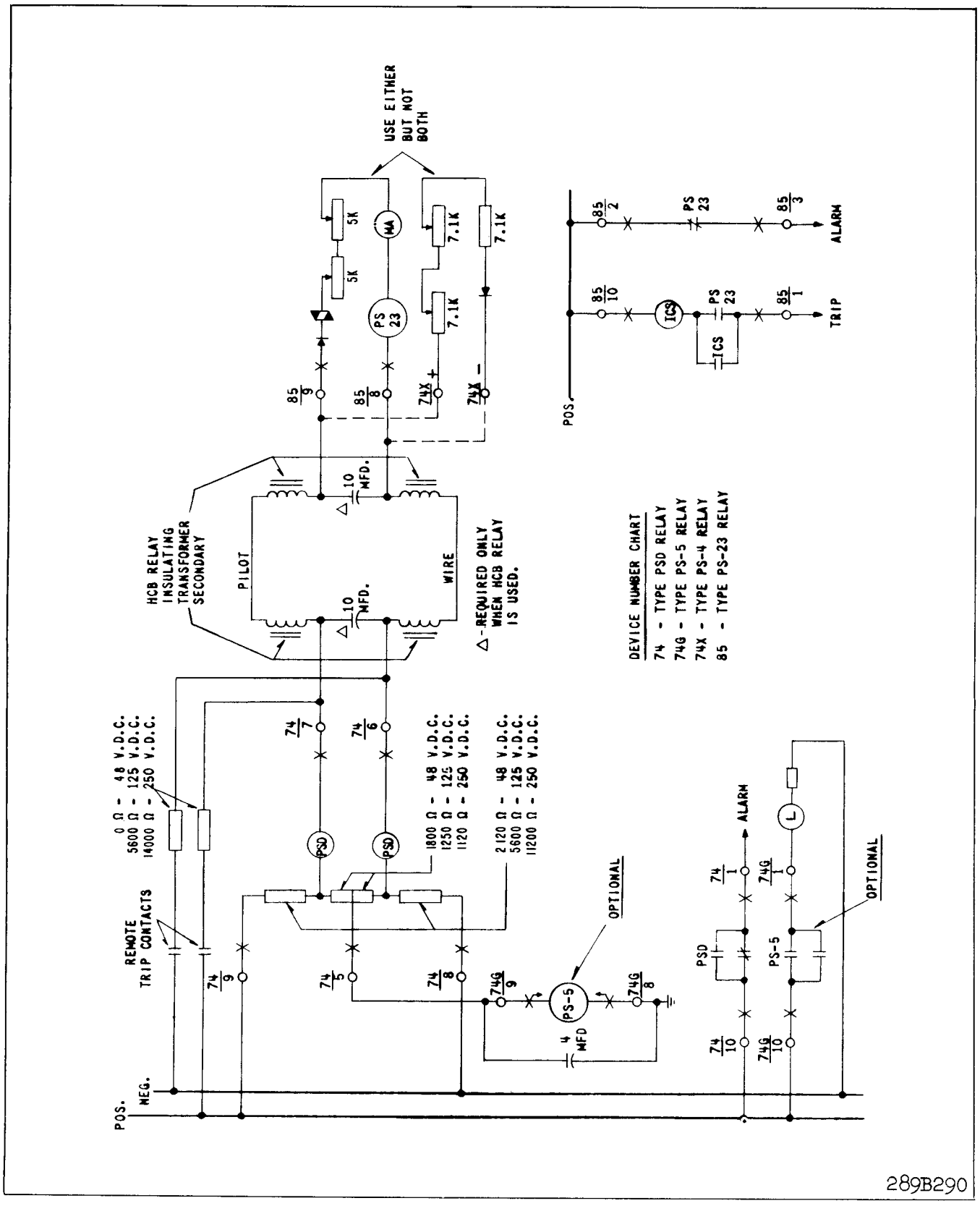


Fig. 10. External Schematic of the Type PSD and PS-5 Relays with Type PS-23 or PS-4 Relay – Two Terminal Line.

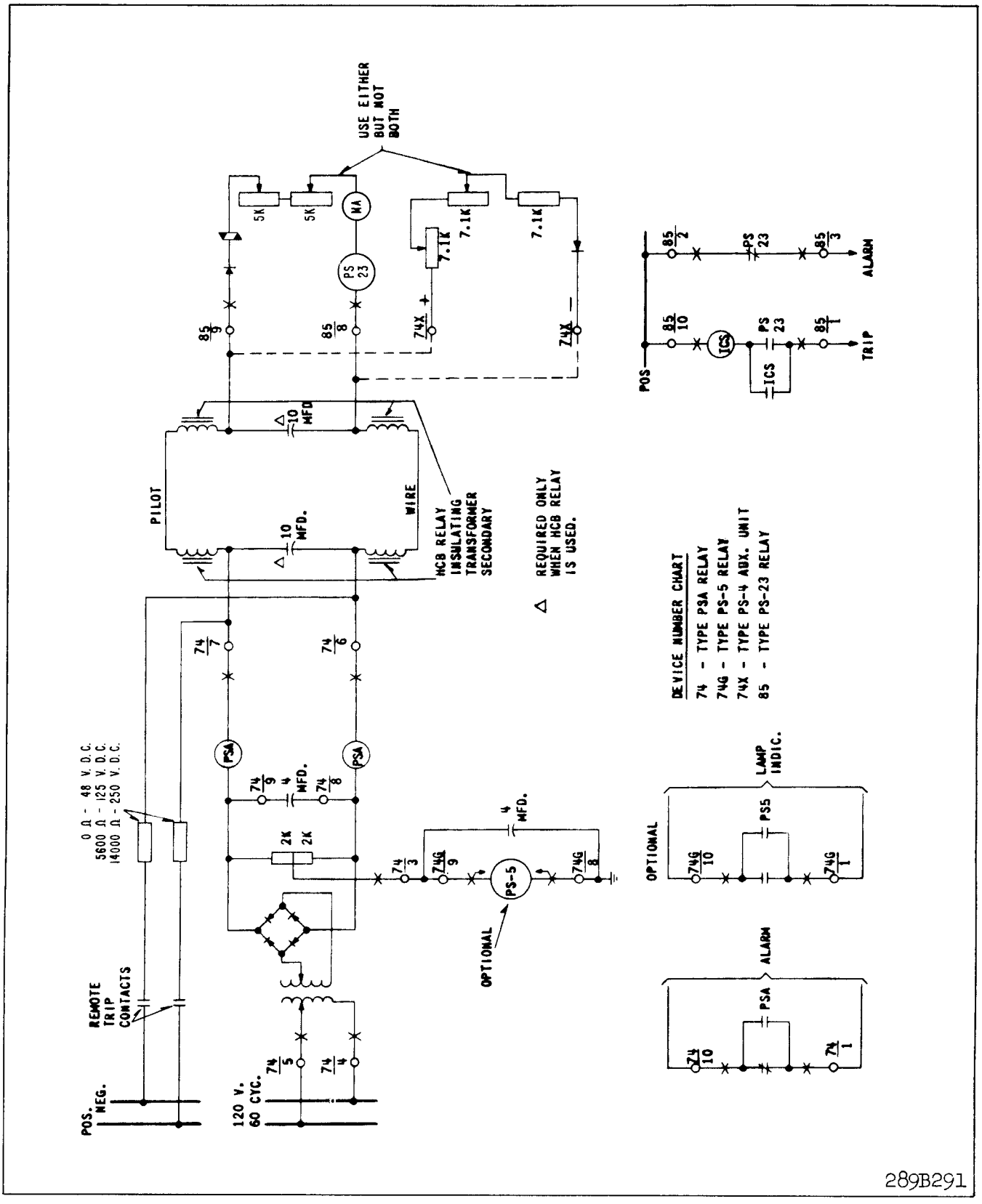


Fig. 11. External Schematic of the Type PSA and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

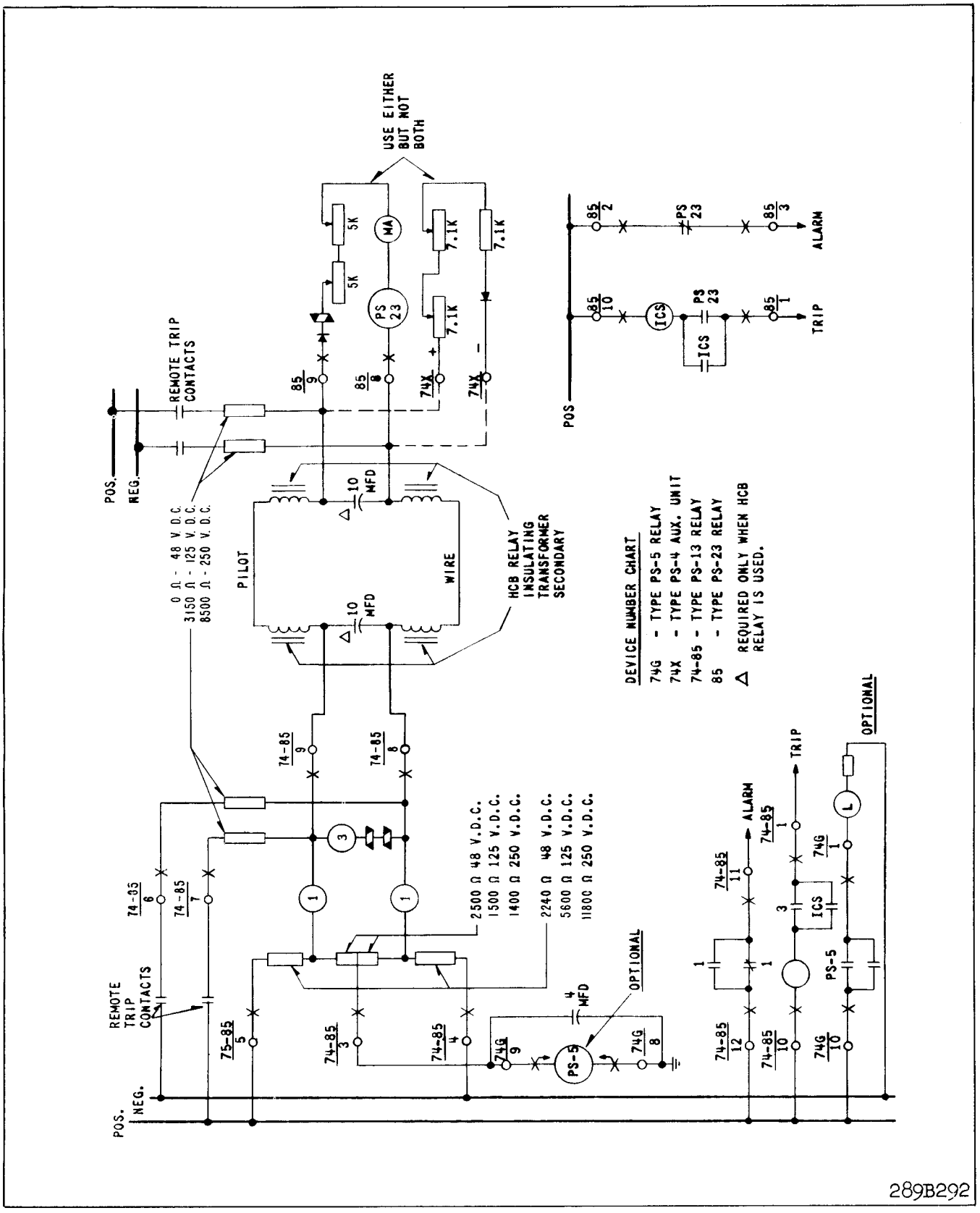


Fig. 12. External Schematic of the DC Type PS-13 and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

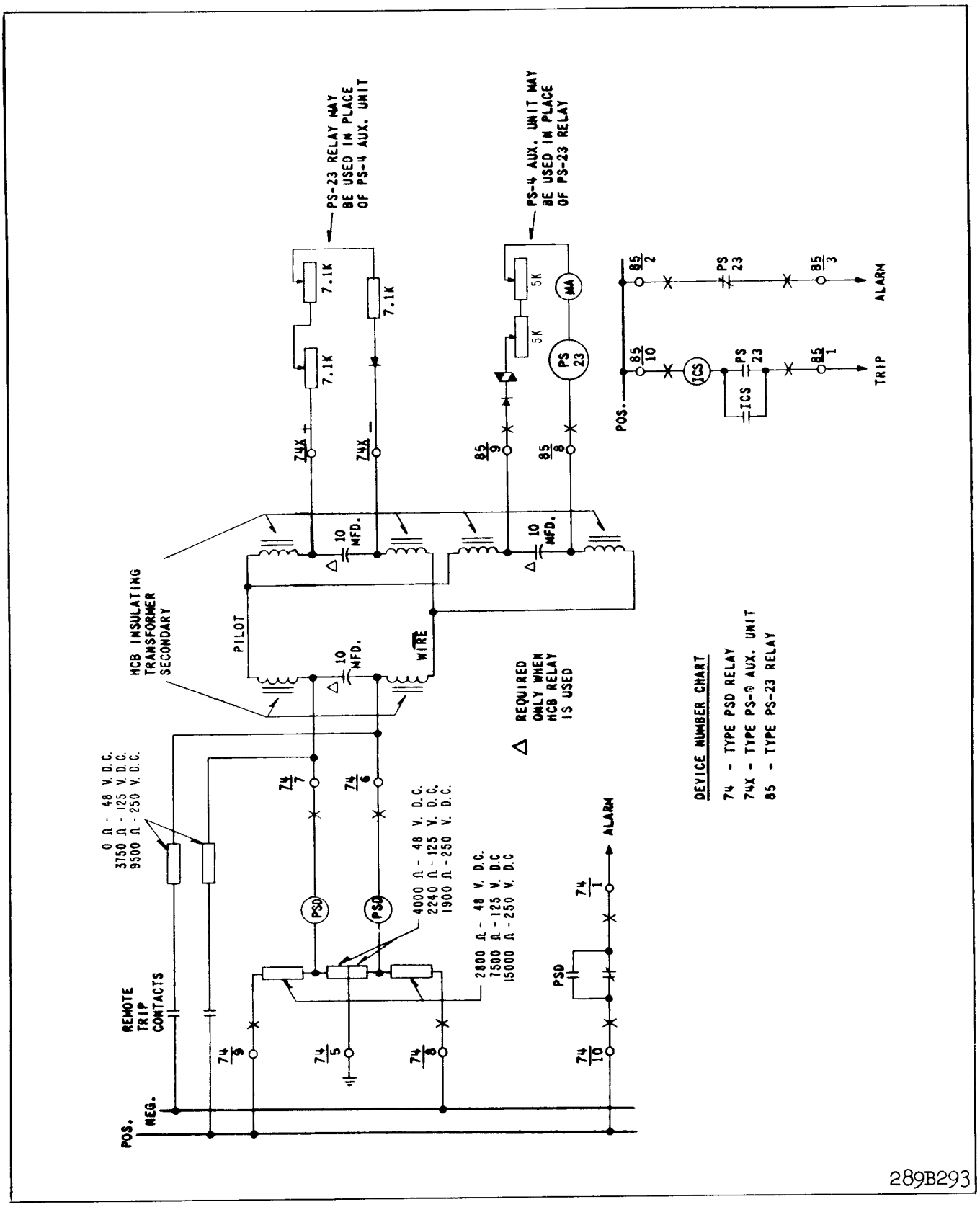


Fig. 13. External Schematic of the Type PSD Relay with Types PS-23 and PS-4 Relays – for Three Terminal Lines.

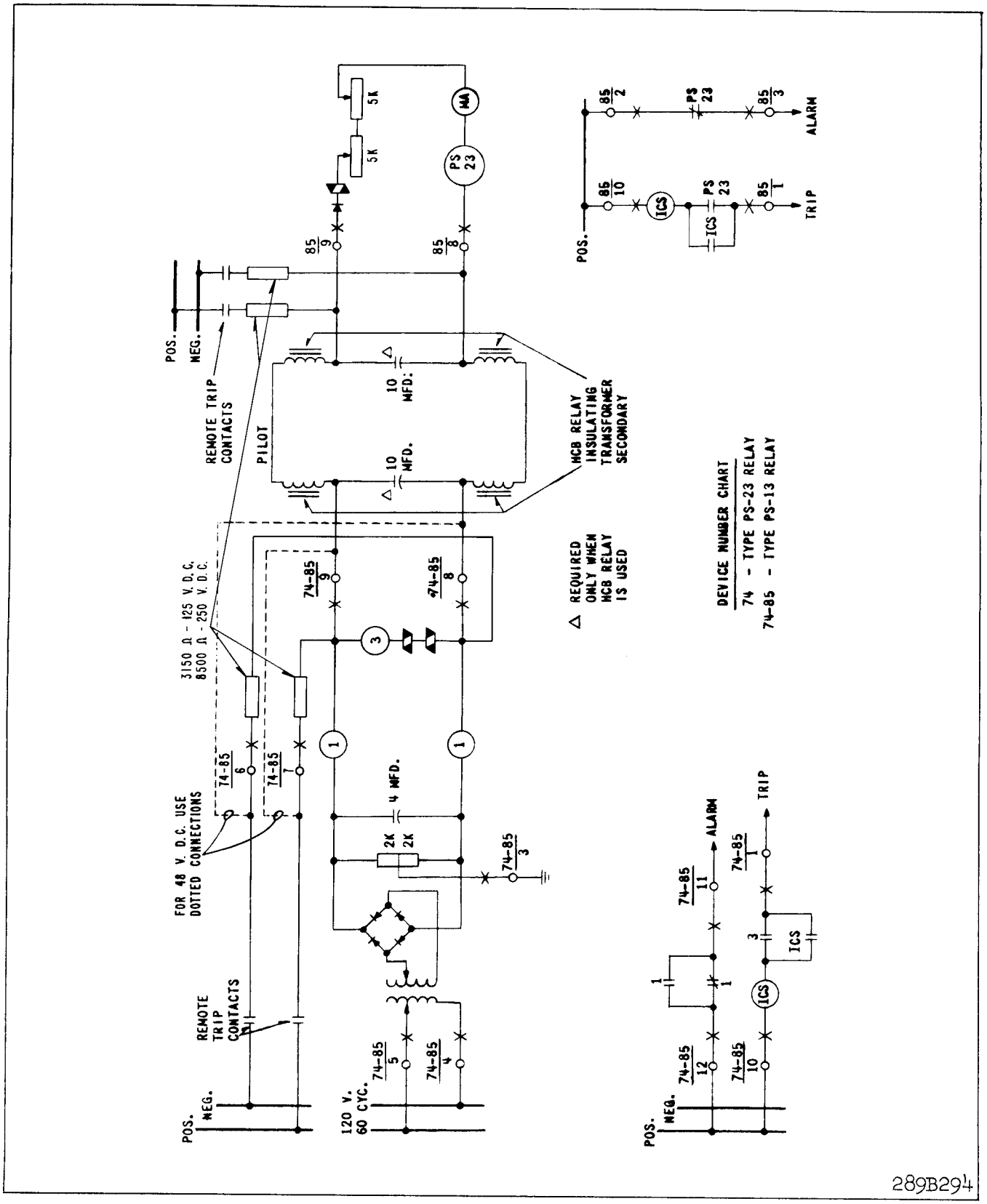


Fig. 14. External Schematic of the AC Type PS-13 With PS-23 Relay – Two Terminal Line.

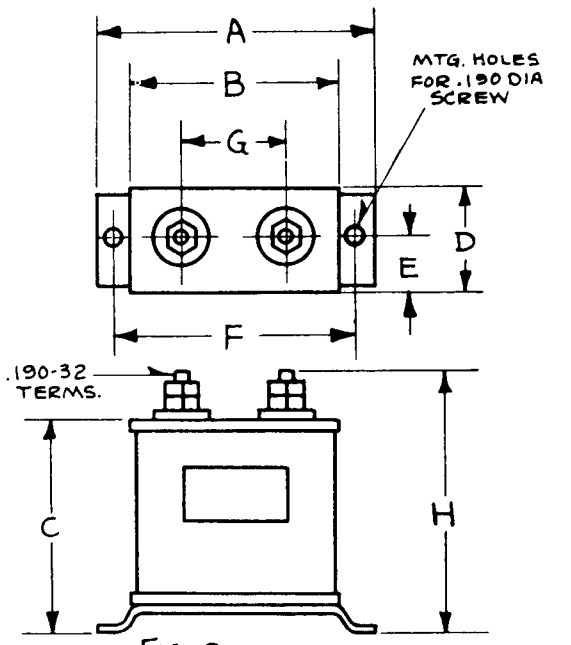


FIG. 3

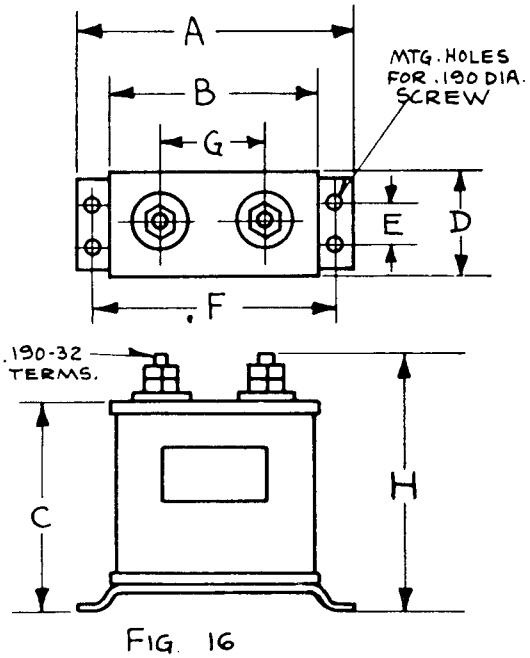


FIG. 16

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

11-D-9524

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

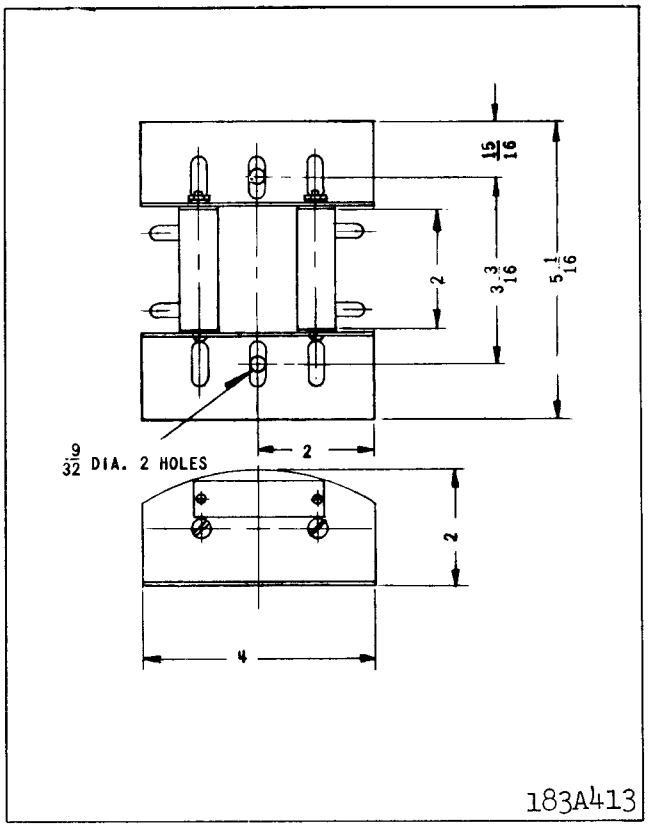


Fig. 16. Outline & Drilling Plan for External Remote Trip Resistor Assembly.

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

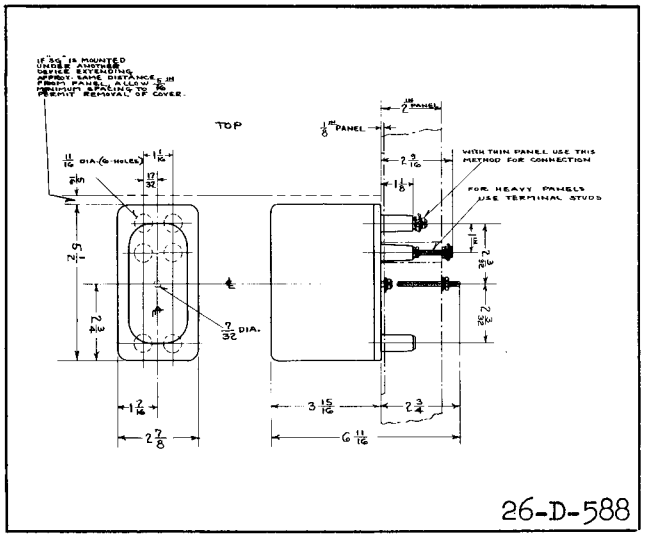


Fig. 17. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Projection Molded Case.

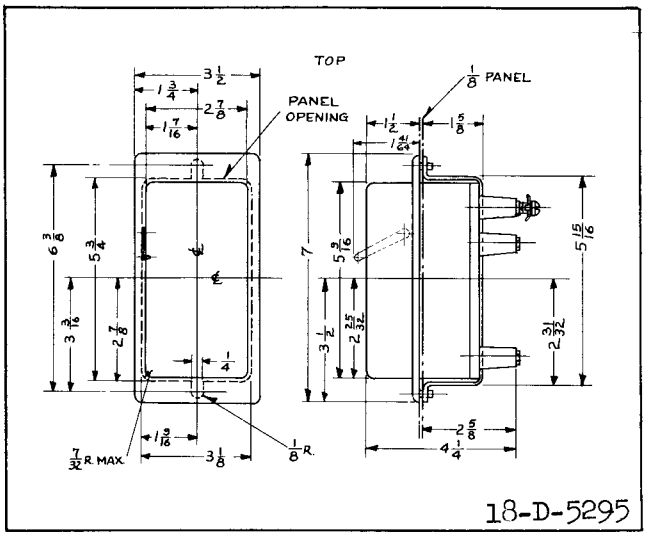


Fig. 18. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Semi-Flush Molded Case.

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 lower polar 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.

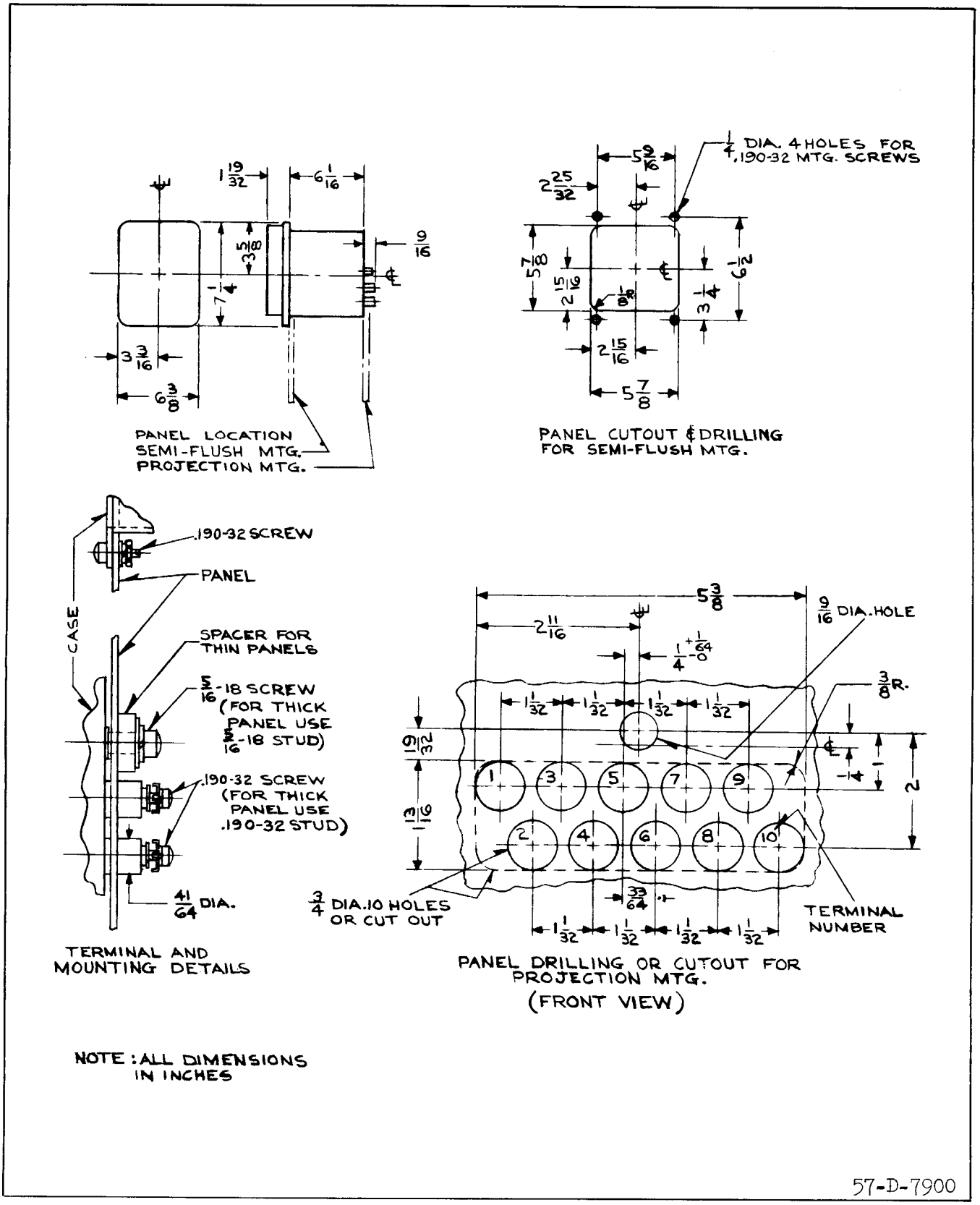


Fig. 19. Outline & Drilling Plan for the Type PSD and PS-5 Relays in the Type FT11 Case.

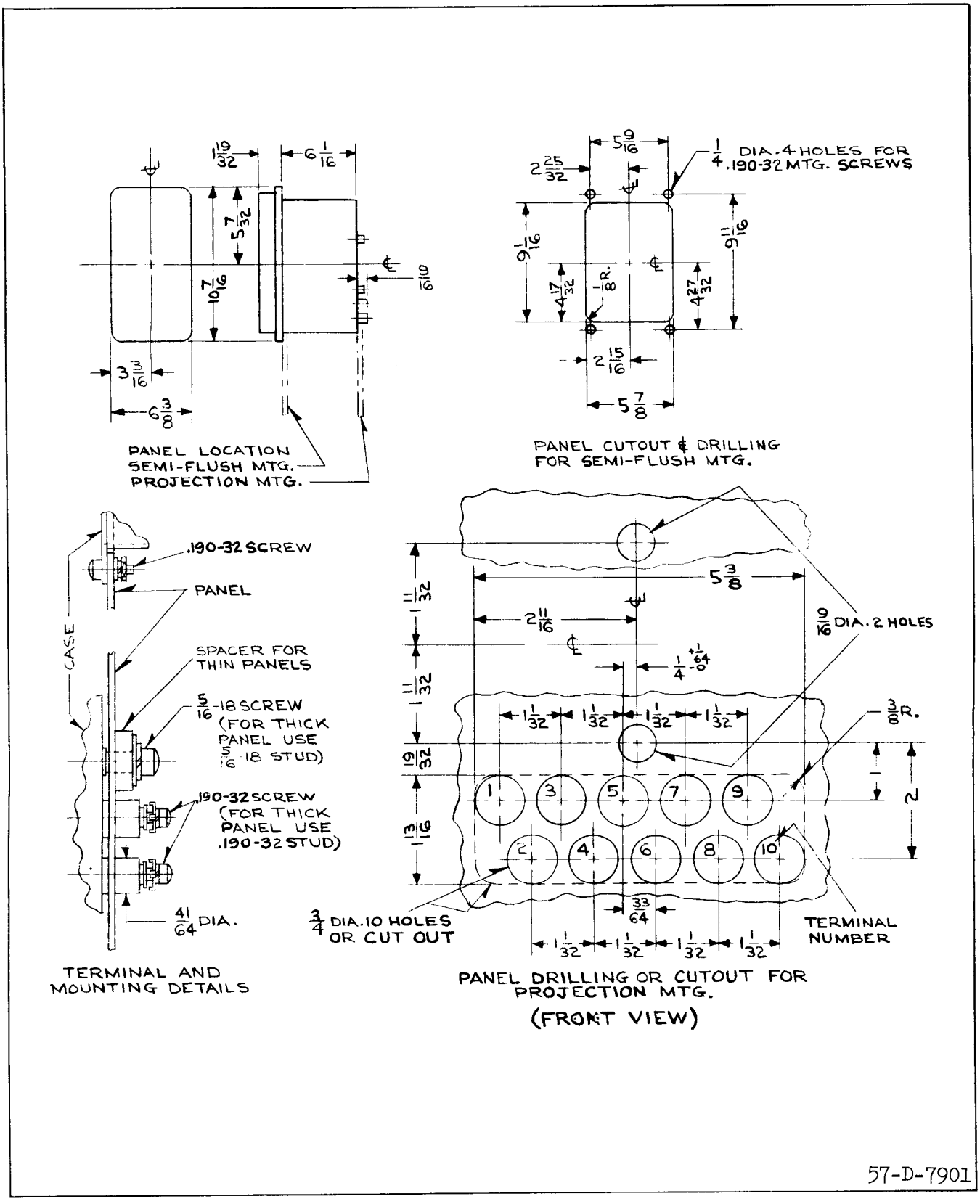
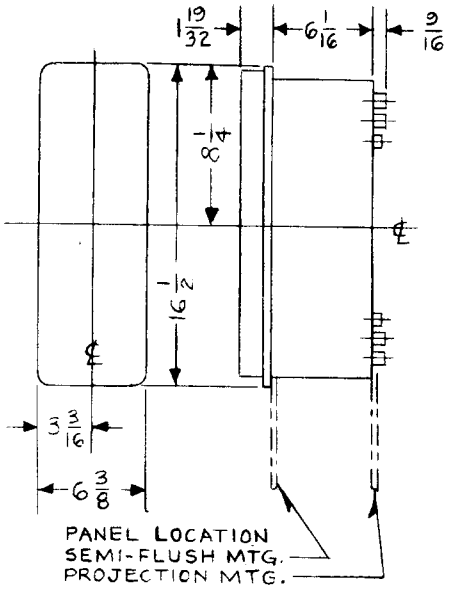
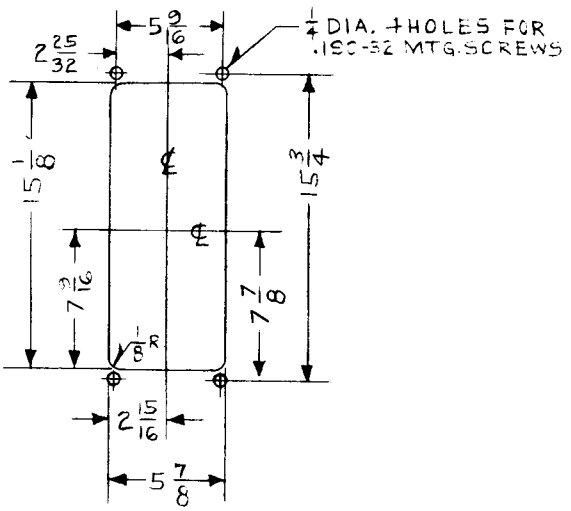
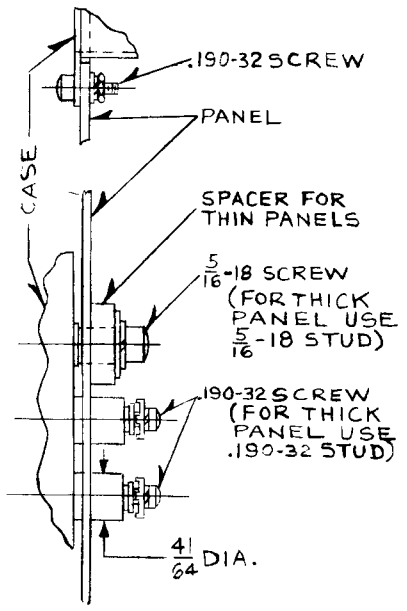
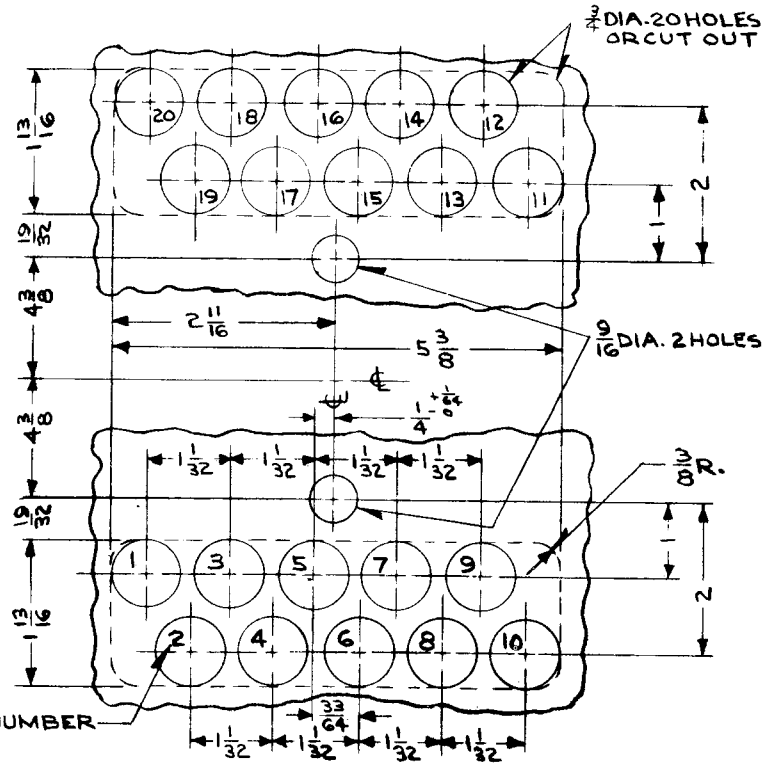


Fig. 20. Outline & Drilling Plan for the Type PSA and PS-23 Relays in the Type FT21 Case.









NOTE: ALL DIMENSIONS IN INCHES

57-D-7903

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

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 – External 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

TABLE I

APPLICATION CHART

FUNCTION	PSA & PSD	PS-13	PS-23	PS-4	PS-5
Introduces Supervision Current	X	X			
Receives Supervision Current			X	X	
Trouble Alarm	X	X	X		X
Transmits Trip Signal	X	X	X	X	
Receives Trip Signal		X	X		
Sensitive Ground Detection					X
Measures Supervision Current			X		

clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Pilot Wire Supervision

Supervision current is introduced into the pilot wire as shown in the external schematics, figures 10 to 14, by the PSA, PSD, or PS-13 relays. A nominal 17 volts is impressed across the 10 mfd. capacitors. This voltage produces a current circulating through one winding of the HCB insulating transformer, one pilot wire, the PS-4 or PS-23, and back through the other pilot wire. Note that in the PS-13 of figures 12 and 14, supervision current flows only in the "1" coil, and not in the "3" coil, because of the blocking rectifier connections.

Adjustment of the resistors of the PS-4 or PS-23 relay at the other end of the pilot wire provides a normal one milliampere d-c circulating current. In the case of three terminal lines, the PSA, PSD, or PS-13, output current is 2 ma in order to provide each receiving end relay with 1 ma. The alarm unit of the PSA, PSD, or PS-13 is adjusted to float between the high and low current contacts with normal supervision current. The PS-23, receiving end relay, is adjusted to float between the low current contact (trip) with 1 ma flowing.

Short Circuits

Current increases in the PSA, PSD, or PS-13 to close the high current alarm contact, current decreases in the PS-23 to close the alarm contact. Short circuits of 2000 ohms or less will be detected.

Open Circuits

Current decreases to zero in all relays. Low current alarm contact of PSA, PSD, or PS-13 closes. Alarm contact of PS-23 closes.

Reversed Wires

Current decreases in both sending and receiving end relays because of the rectifier unit in the PS-23

TABLE II

PSA & PSD APPLICATIONS

EXTERNAL RESISTORS FOR D.C. REMOTE TRIPPING

(2 Required per Station)

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PSA OR PSD	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0	—	—	PS-23
	125	5600	—	—	PS-23
	250	14000	—	—	PS-23
	48	0	—	—	PS-23
	125	3750	—	—	PS-23
	250	9500	—	—	PS-23

TABLE III

PS-13 APPLICATIONS

(2 Required per Station)

RESISTORS FOR D.C. REMOTE TRIPPING

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PS-13	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0†	0	—	PS-13 & PS-23
	125	3150†	3150	—	PS-13 & PS-23
	250	8500†	8500	—	PS-13 & PS-23

† Mounted in Relay

or PS-4. Low current alarm contacts close.

Grounds

The sending end relays (PSA, PSD, or PS-13) are mid-point grounded, so that a pilot wire ground will cause an increase in current in one of the two alarm unit coils of the PSA, PSD, or PS-13, closing the high current alarm contact. Grounds of 500 ohms or less will be detected. The high internal resistance of the PSD and d-c PS-13 relays will prevent a pilot wire ground from affecting the station battery ground lamps. An accidental ground on the battery circuits will affect the sensitivity of the relays in detecting pilot wire grounds.

For sensitive ground detection a PS-5 relay can be inserted in the PSA, PSD, or PS-13 ground connection. This relay will detect grounds of 50,000 ohms or less. The PSA, PSD, or PS-13 will not detect grounds when the PS-5 is used because of the additional resistance that the PS-5 inserts into the circuit. Because of its very high sensitivity, it is recommended that the PS-5 contact be connected to an indicating lamp rather than to an alarm.

Remote Tripping

Breakers located at the PS-13 and PS-23 stations can be tripped by the application of a d-c voltage to the pilot wires at remote locations, as shown in figures 10 to 14. Remote tripping can be effected from any location by applying 48 volts d-c or more to the pilot wire. When tripping the PS-23, the current is increased above 3.5 ma to close the high current con-

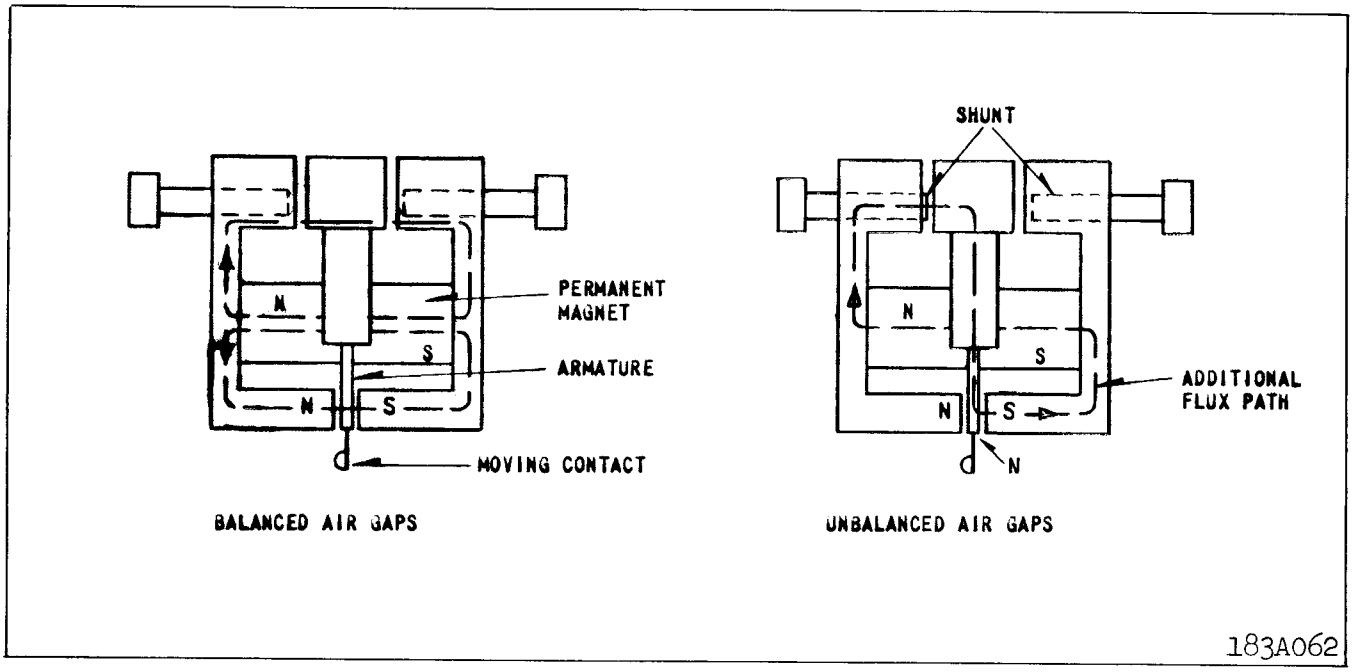


Fig. 1. Polar Unit Permanent Magnet Flux Paths.

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 Coils (2)	1050-1250 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

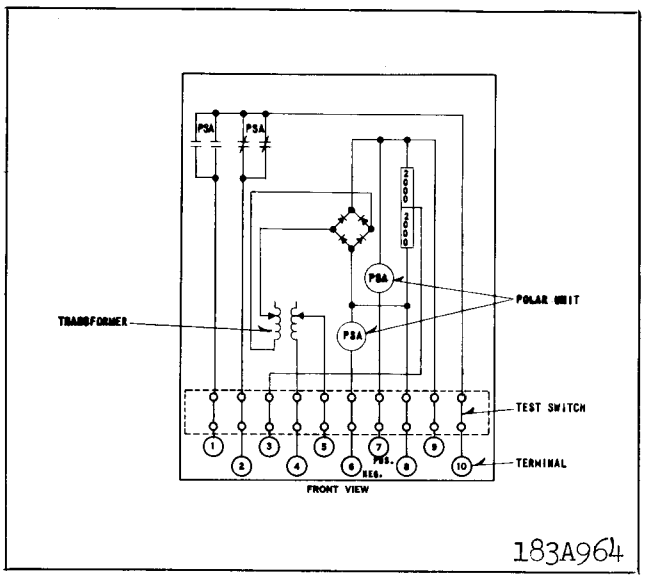


Fig. 2. Internal Schematic of the Type PSA Relay in the FT21 Case – 120 Volt, 60 cycle supply – For Two and Three Terminal Lines.

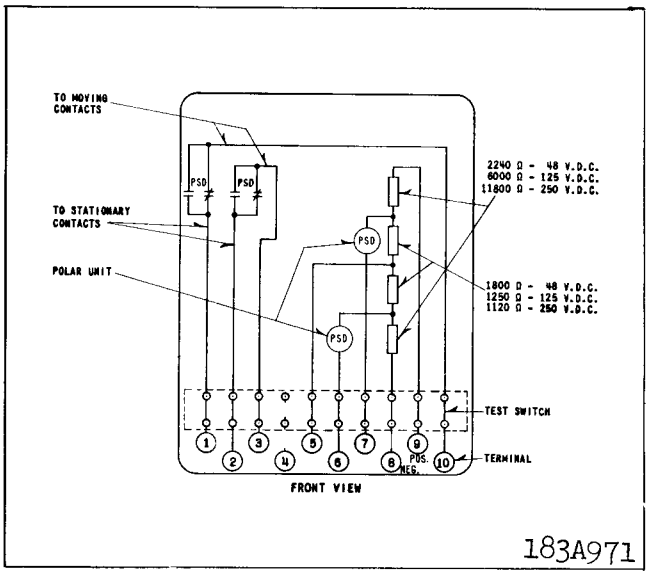


Fig. 3. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Two Terminal Lines.

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.

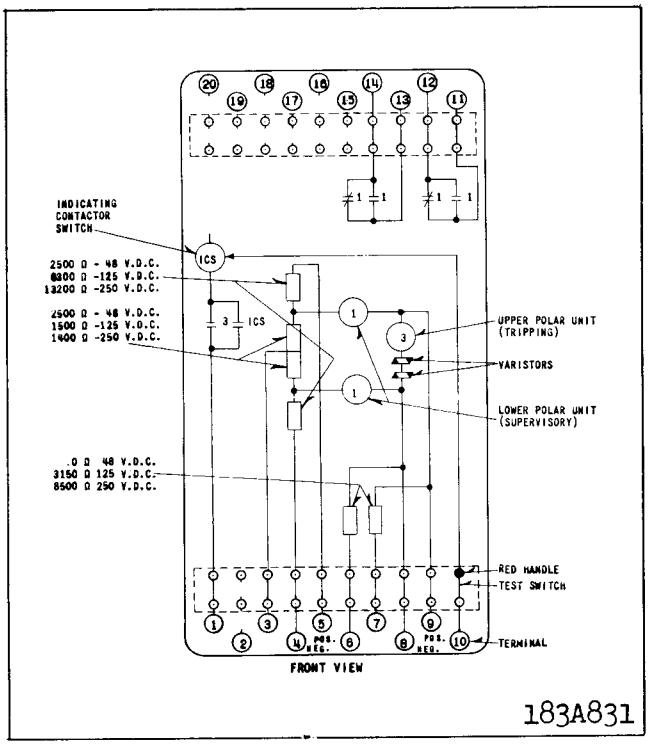


Fig. 4. Internal Schematic of the Type PS-13 Relay in the FT32 Case. DC Supply – For Two Terminal Lines.

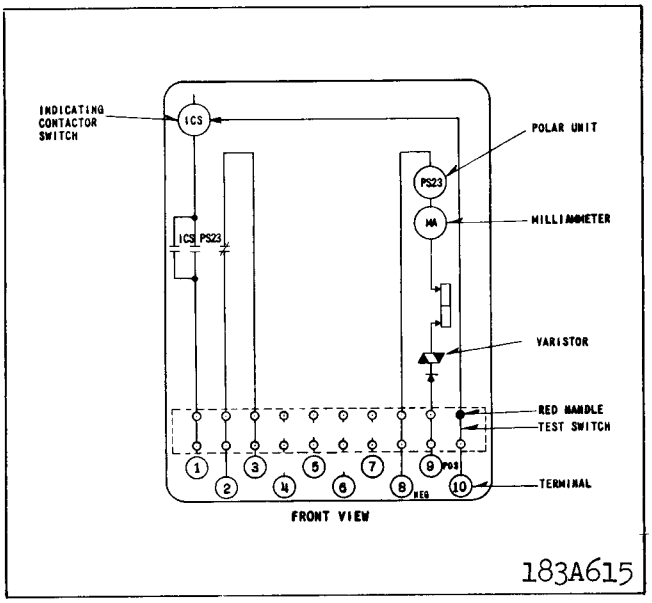


Fig. 5. Internal Schematic of the Type PS-23 Relay in the Type FT21 Case.

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

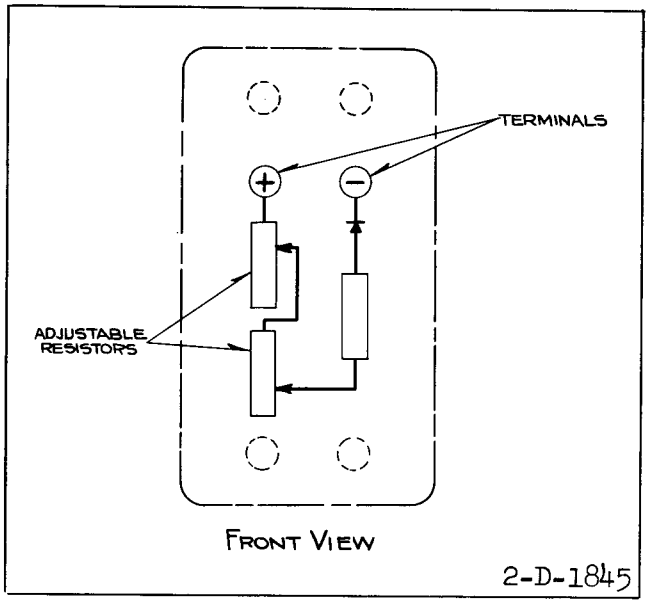


Fig. 6. Internal Schematic of the Type PS-4 Auxiliary Unit in the Small Molded Case.

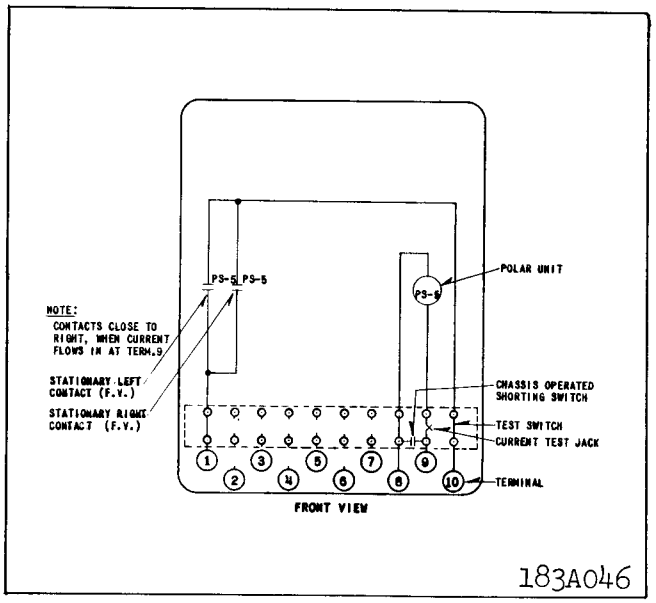


Fig. 7. Internal Schematic of the Type PS-5 Ground Detector Relay in the FT11 Case.

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 8,500 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

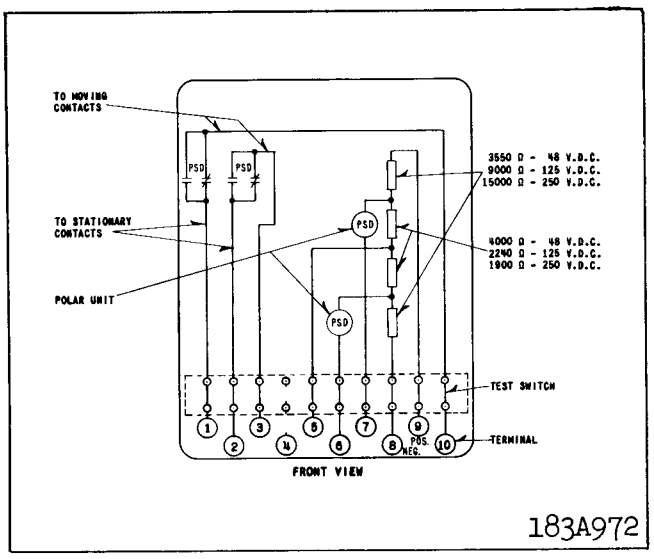


Fig. 8. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Three Terminal Lines.

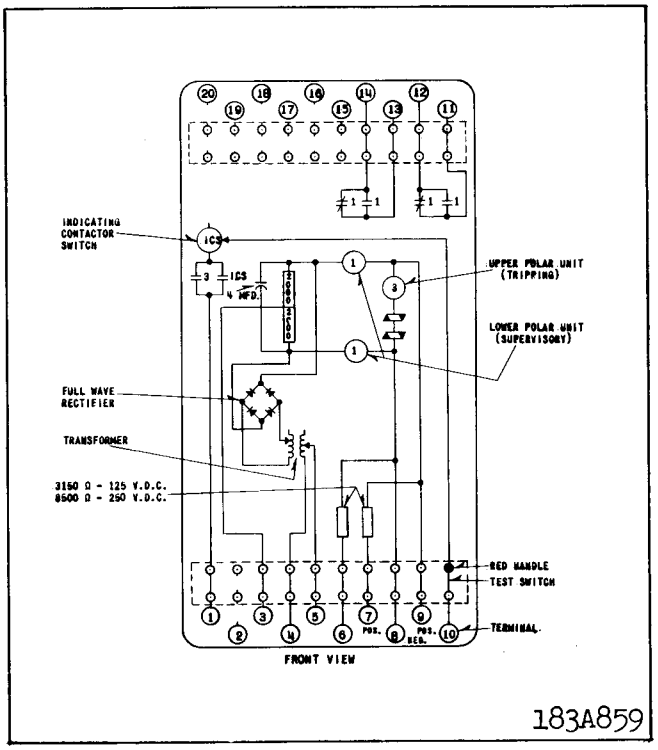


Fig. 9. Internal Schematic of the Type PS-13 Relay in the FT32 Case – 120 volt, 60 cycle supply – For Two Terminal Lines.

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 relay trip 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.

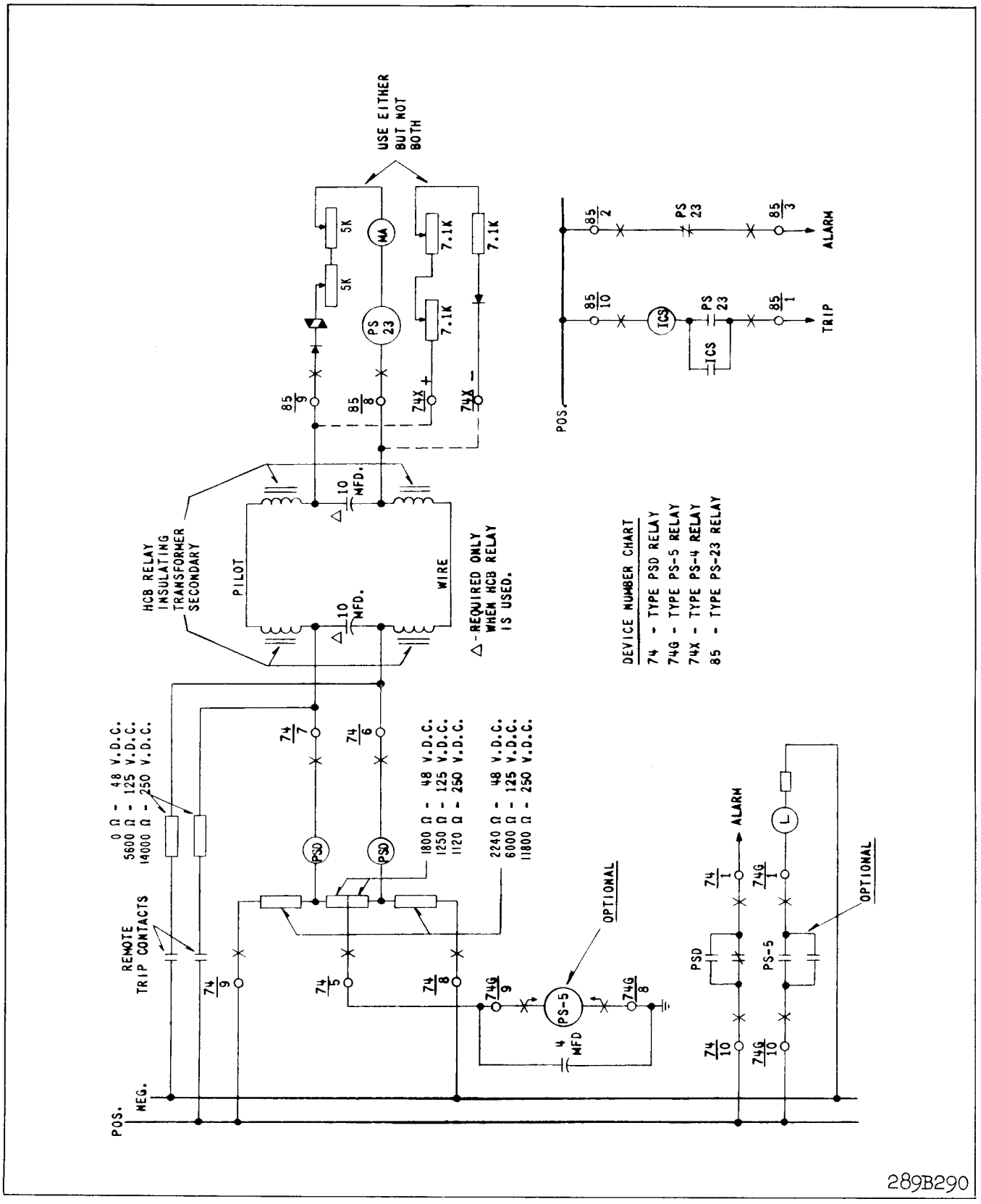


Fig. 10. External Schematic of the Type PSD and PS-5 Relays with Type PS-23 or PS-4 Relay – Two Terminal Line.

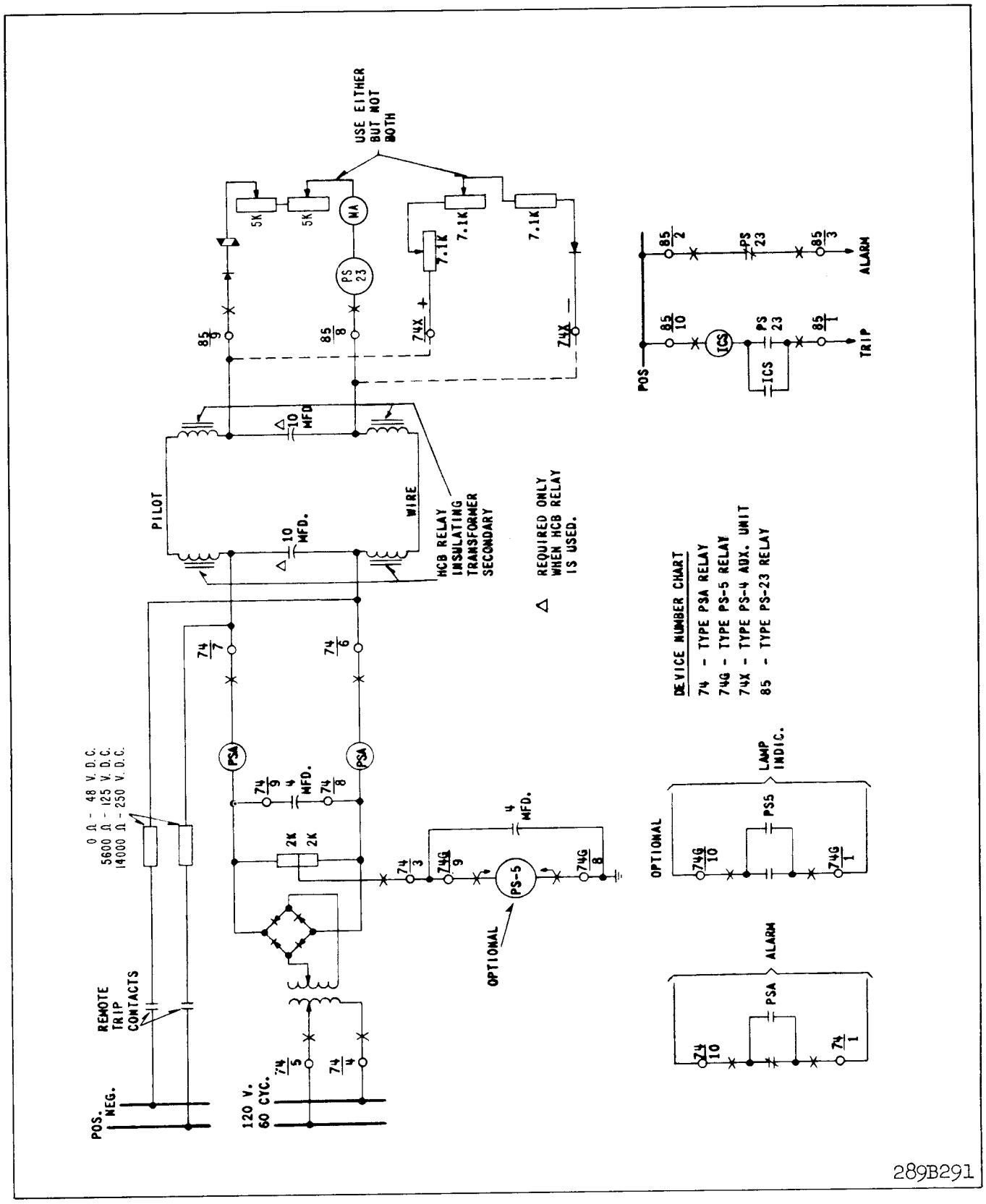


Fig. 11. External Schematic of the Type PSA and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

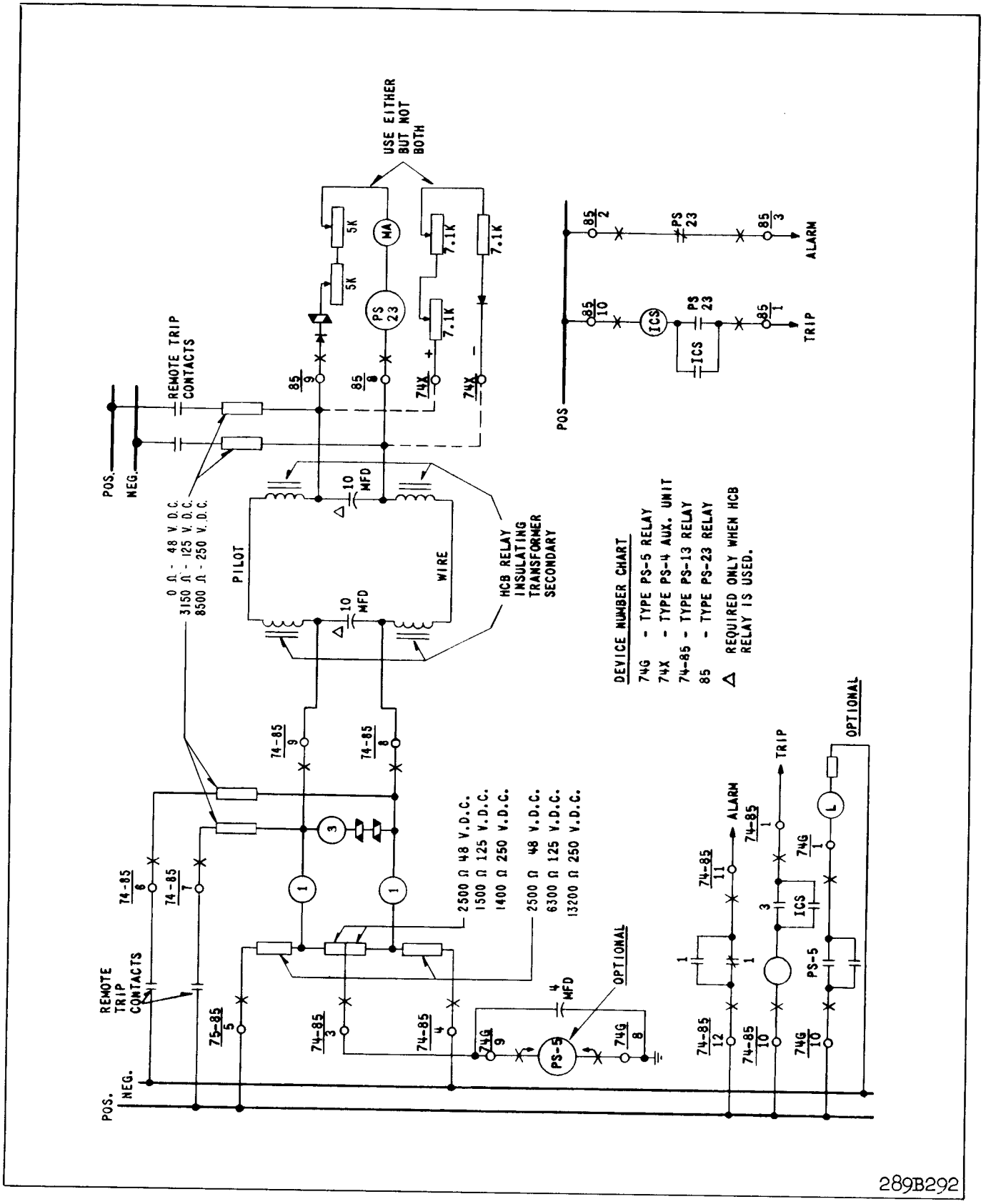


Fig. 12. External Schematic of the DC Type PS-13 and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

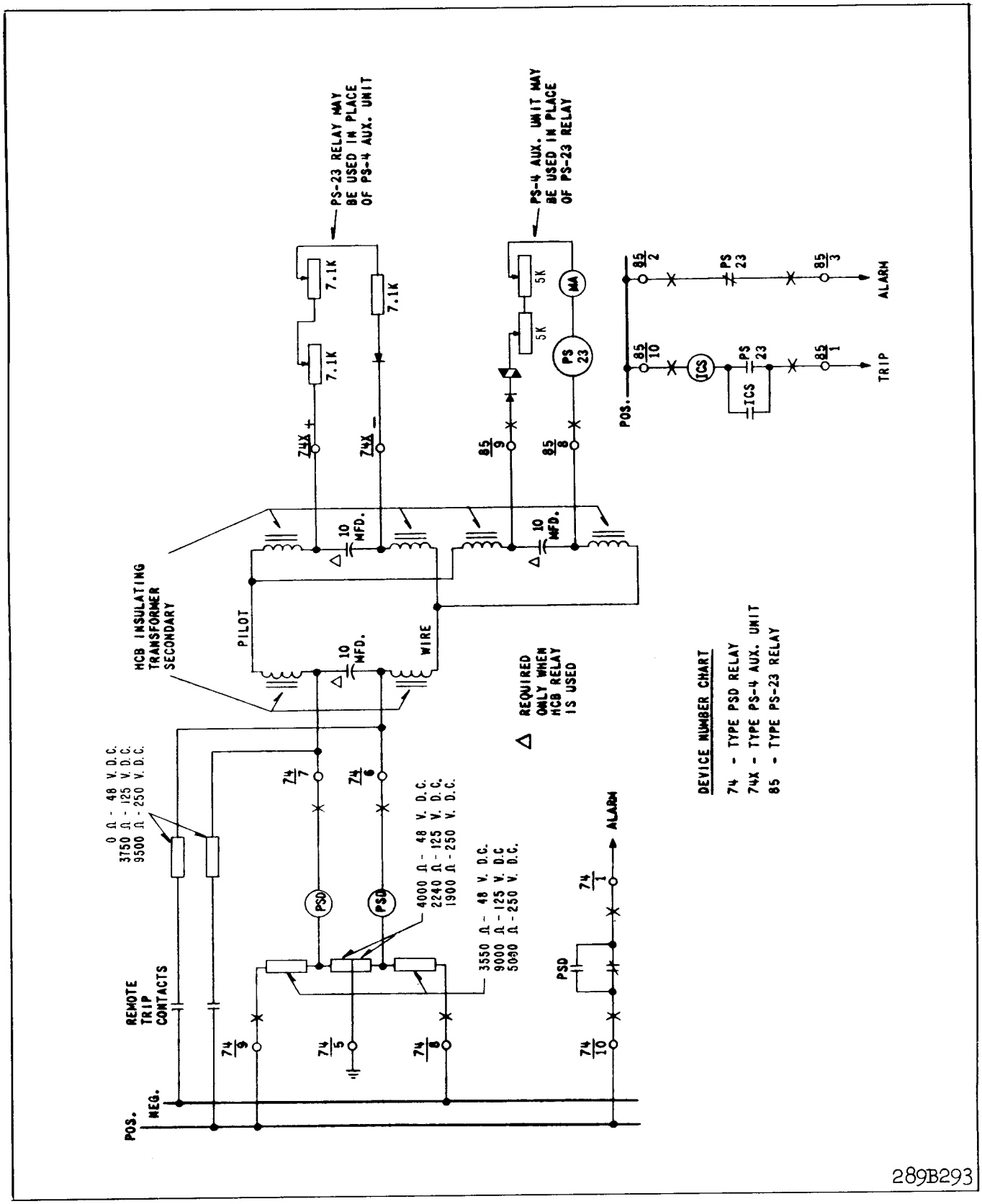


Fig. 13. External Schematic of the Type PSD Relay with Types PS-23 and PS-4 Relays – for Three Terminal Lines.

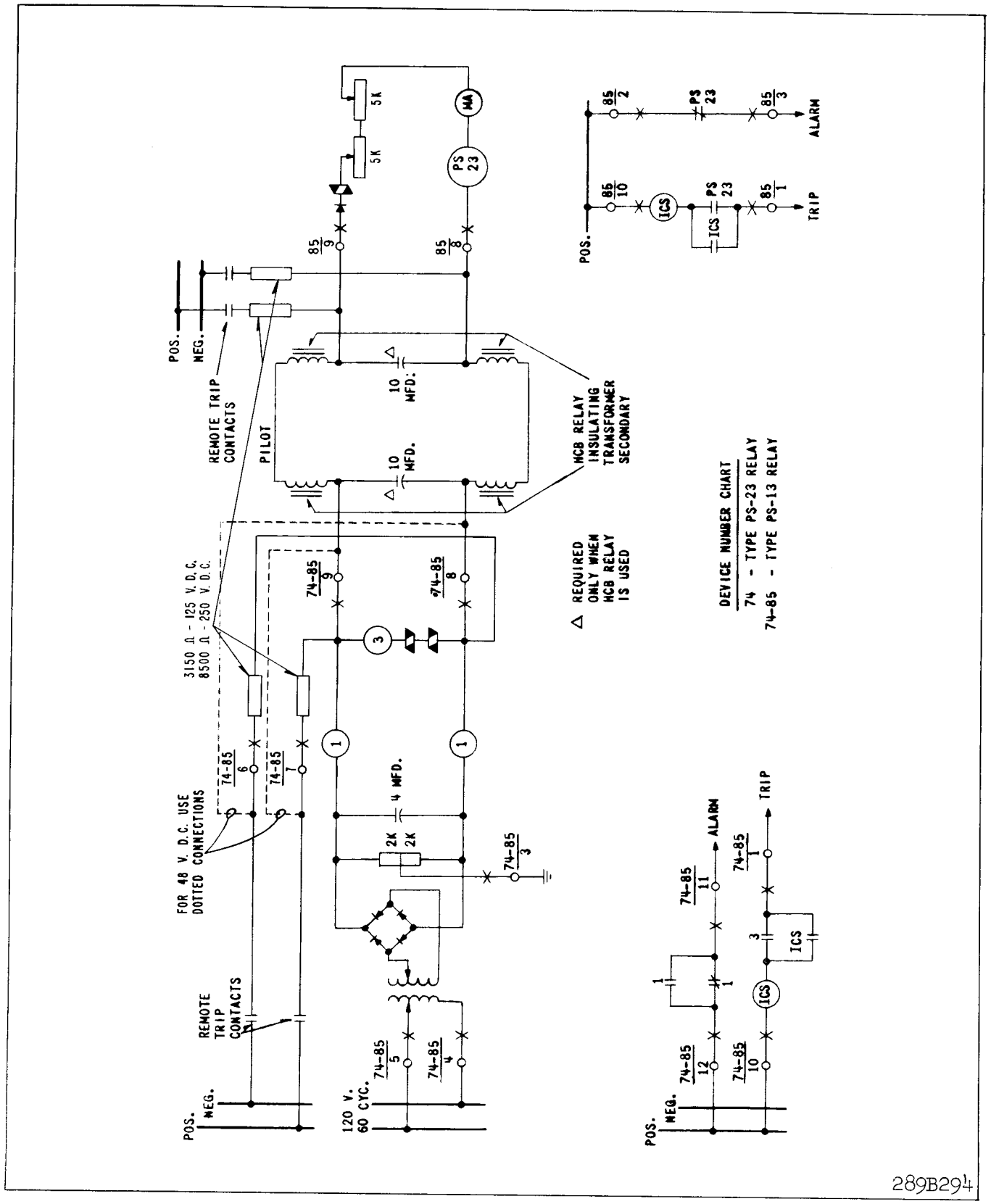


Fig. 14. External Schematic of the AC Type PS-13 With PS-23 Relay – Two Terminal Line.

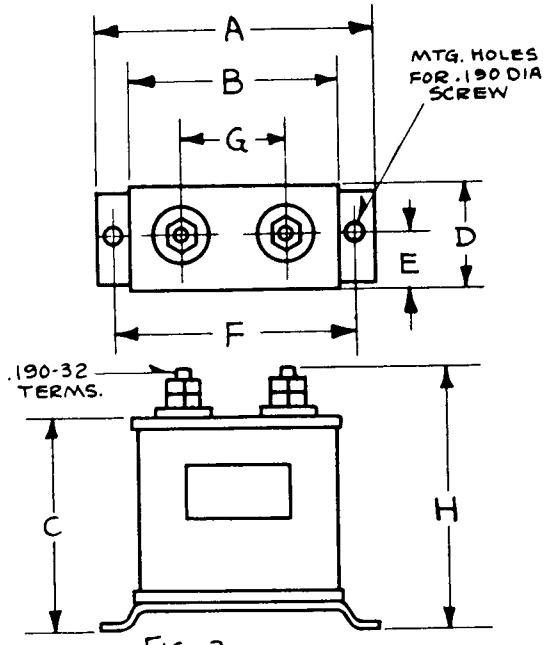


FIG. 3

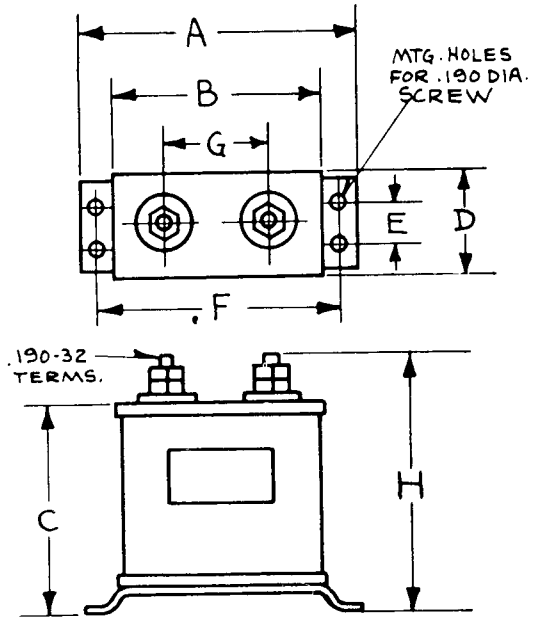


FIG. 16

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	4 3/16 +1/16 -3/16
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	6 1/16 +1/16 -3/16

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

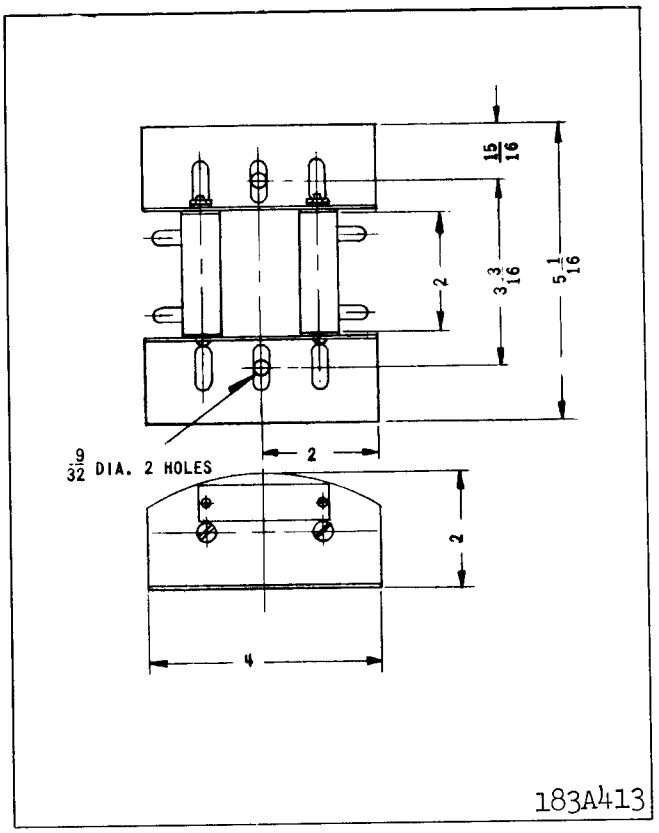

Fig. 16. Outline & Drilling Plan for External Remote Trip Resistor Assembly.

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

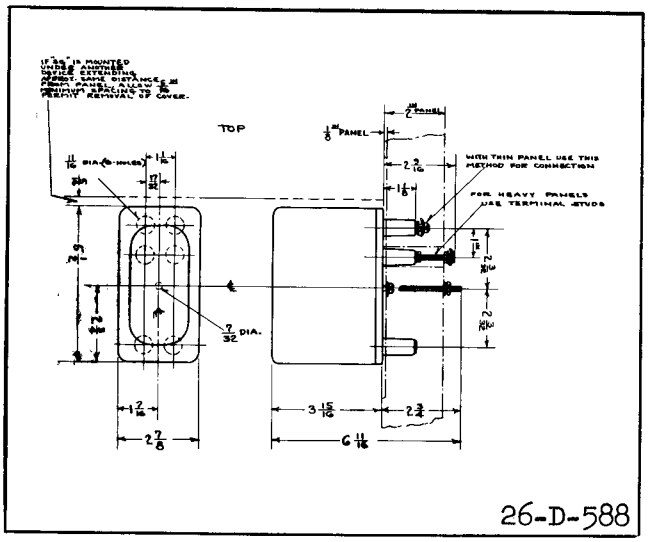

Fig. 17. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Projection Molded Case.

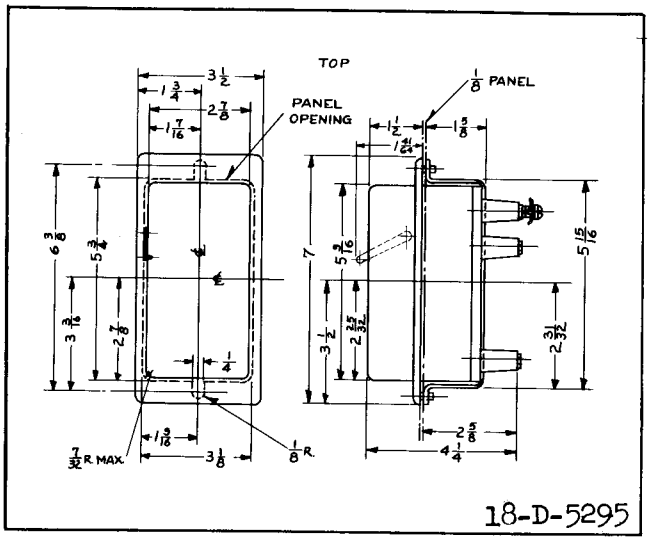

Fig. 18. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Semi-Flush Molded Case.

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 lower polar 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.

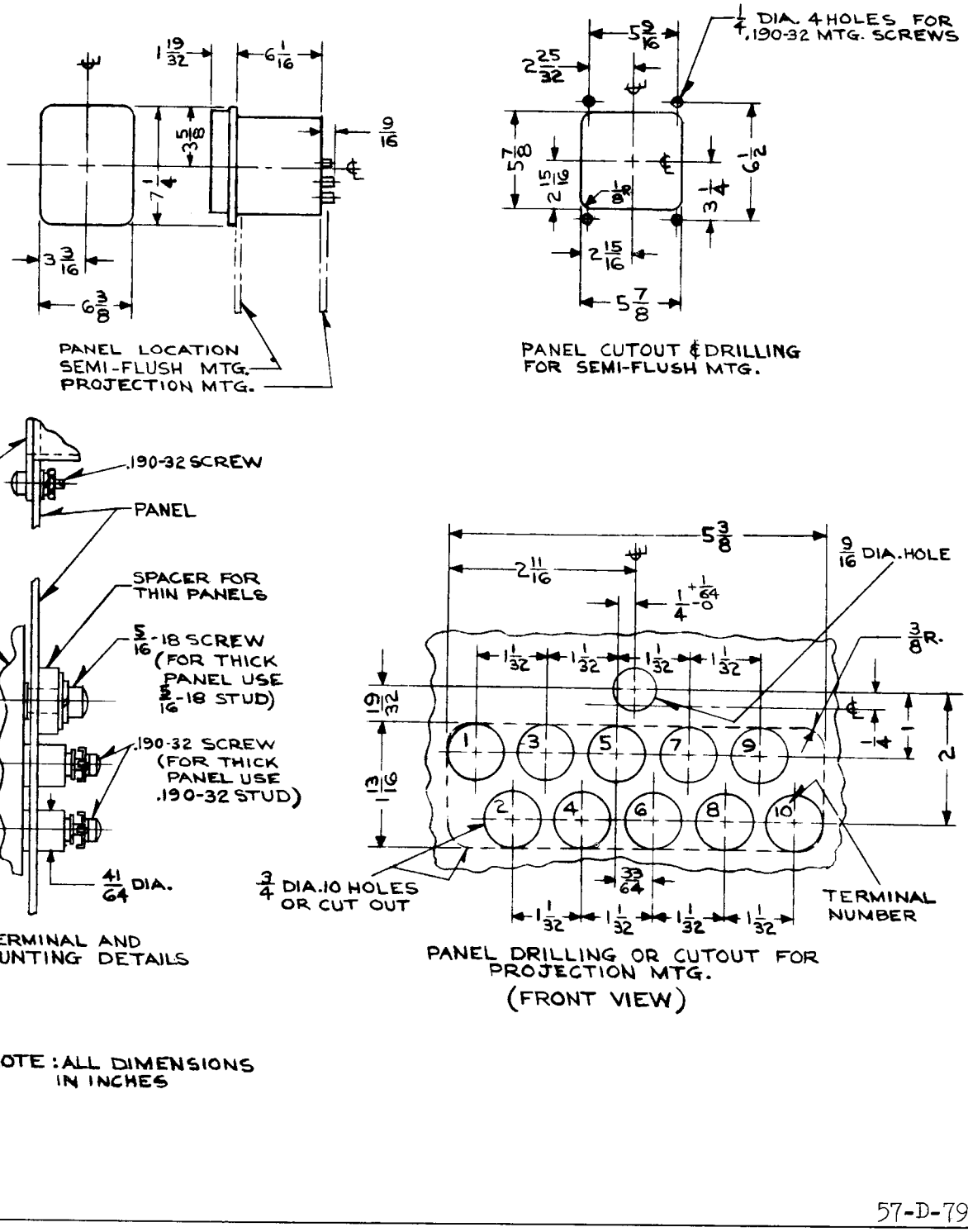

Fig. 19. Outline & Drilling Plan for the Type PSD and PS-5 Relays in the Type FT11 Case.

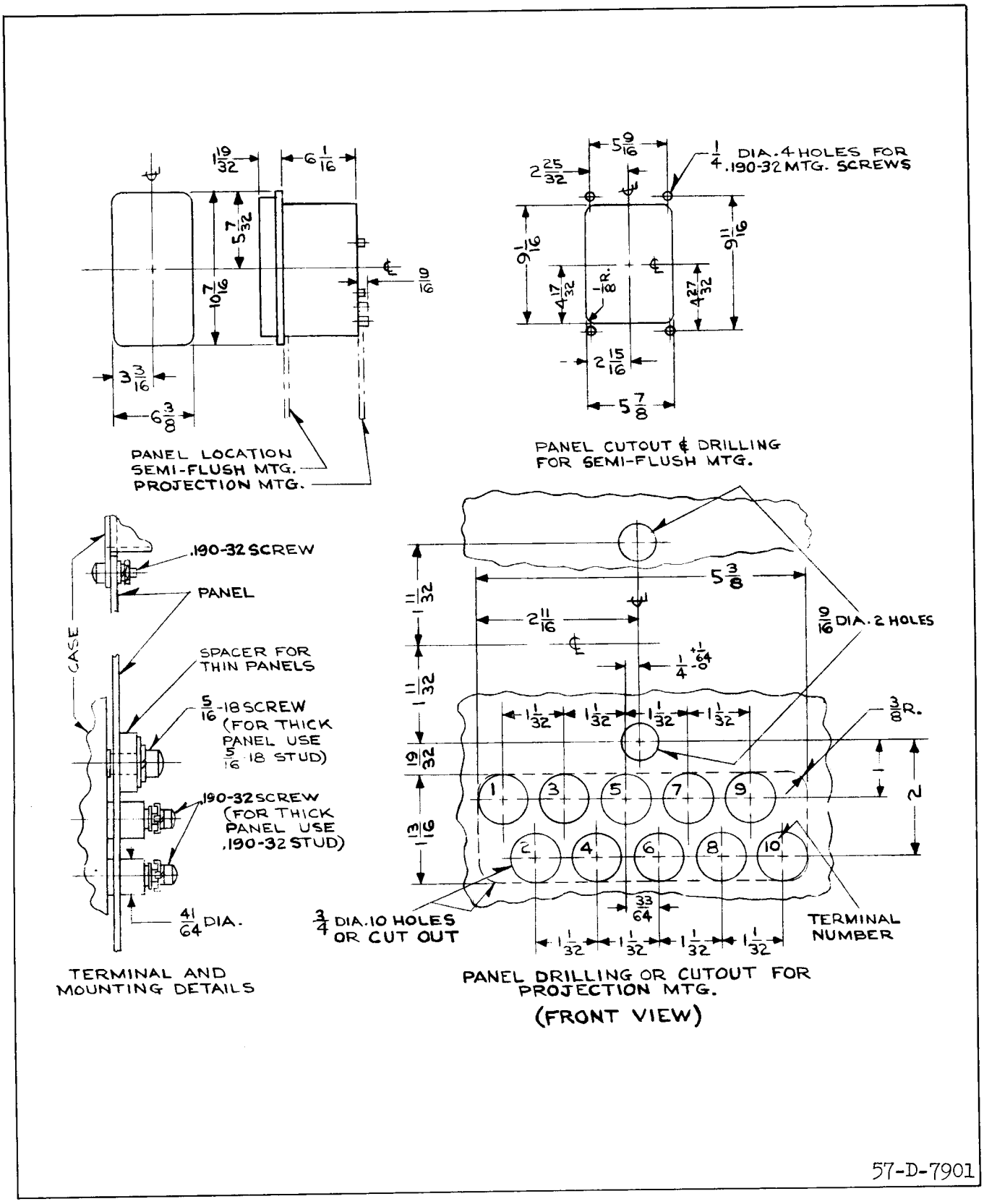

Fig. 20. Outline & Drilling Plan for the Type PSA and PS-23 Relays in the Type FT21 Case.

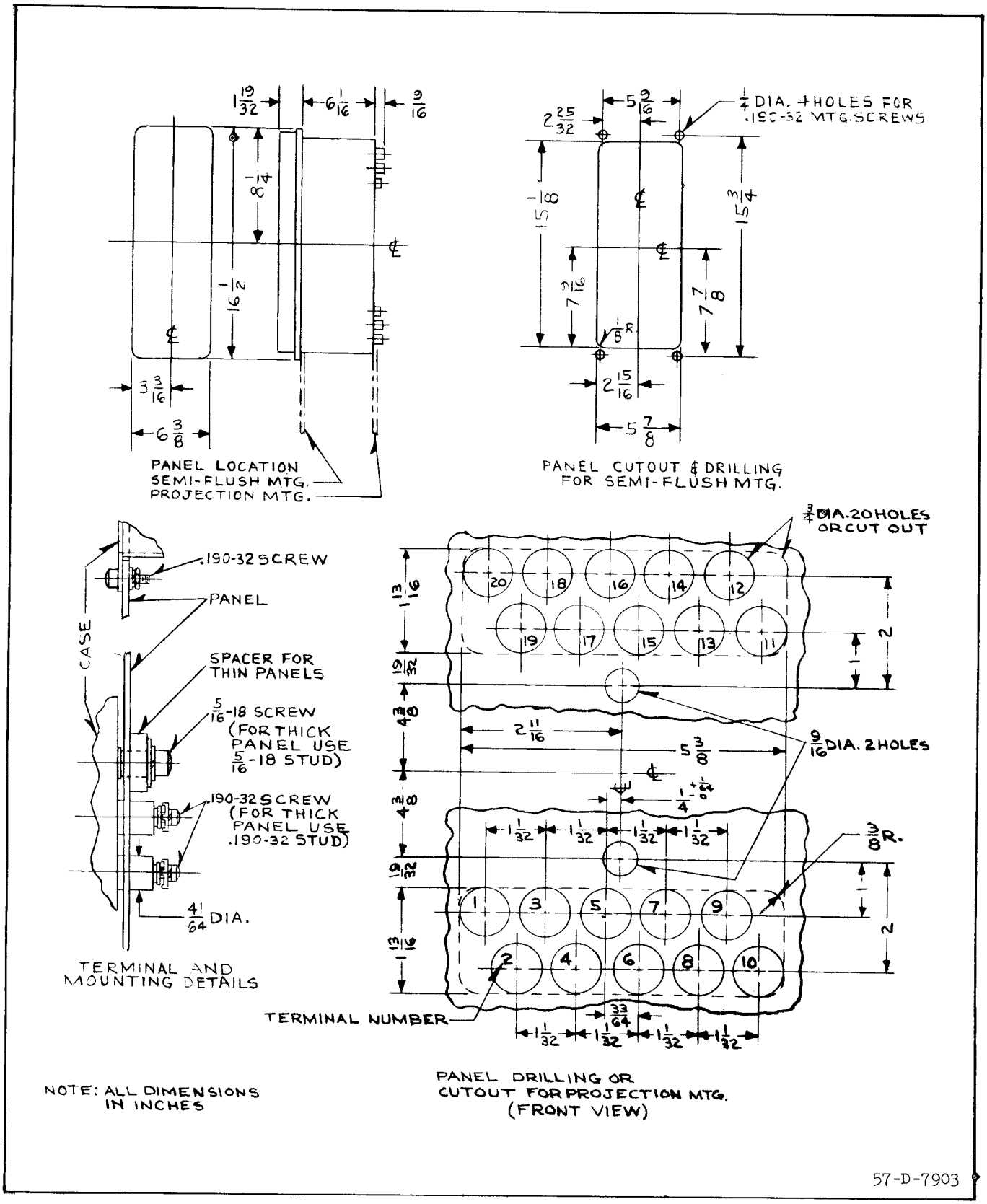

Fig. 21. Outline & Drilling Plan for The Type PS-13 Relay in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION • **NEWARK, N.J.**

Printed in U.S.A.

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

TABLE I

APPLICATION CHART

FUNCTION	PSA & PSD	PS-13	PS-23	PS-4	PS-5
Introduces Supervision Current	X	X			
Receives Supervision Current			X	X	
Trouble Alarm	X	X	X		X
Transmits Trip Signal	X	X	X	X	
Receives Trip Signal		X	X		
Sensitive Ground Detection					X
Measures Supervision Current			X		

clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Pilot Wire Supervision

Supervision current is introduced into the pilot wire as shown in the external schematics, figures 10 to 14, by the PSA, PSD, or PS-13 relays. A nominal 17 volts is impressed across the 10 mfd. capacitors. This voltage produces a current circulating through one winding of the HCB insulating transformer, one pilot wire, the PS-4 or PS-23, and back through the * other pilot wire. Note that in the PS-13 of figures 12 and 14, supervision current flows in the "1" coil, and a negligible current of about 0.5 milliamperes flows in the "3" coil, because of the high resistance of the varistors when a nominal 17 volts is impressed across the 10 mfd. capacitors.

Adjustment of the resistors of the PS-4 or PS-23 relay at the other end of the pilot wire provides a normal one milliampere d-c circulating current. In the case of three terminal lines, the PSA, PSD, or PS-13, output current is 2 ma in order to provide each receiving end relay with 1 ma. The alarm unit of the PSA, PSD, or PS-13 is adjusted to float between the high and low current contacts with normal supervision current. The PS-23, receiving end relay, is adjusted to float between the low current contact (trip) with 1 ma flowing.

Short Circuits

Current increases in the PSA, PSD, or PS-13 to close the high current alarm contact, current decreases in the PS-23 to close the alarm contact. * Short circuits of 3000 ohms or less will be detected.

Open Circuits

Current decreases to zero in all relays. Low current alarm contact of PSA, PSD, or PS-13 closes. Alarm contact of PS-23 closes.

Reversed Wires

Current decreases in both sending and receiving end relays because of the rectifier unit in the PS-23

TABLE II

PSA & PSD APPLICATIONS

EXTERNAL RESISTORS FOR D.C. REMOTE TRIPPING

(2 Required per Station)

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PSA OR PSD	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0	—	—	PS-23
	125	5600	—	—	PS-23
	250	14000	—	—	PS-23
3	48	0	—	—	PS-23
	125	3750	—	—	PS-23
	250	9500	—	—	PS-23

TABLE III

PS-13 APPLICATIONS

(2 Required per Station)

RESISTORS FOR D.C. REMOTE TRIPPING

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PS-13	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0†	0	—	PS-13 & PS-23
	125	3150†	3150	—	PS-13 & PS-23
	250	8500†	8500	—	PS-13 & PS-23
3	48	0†	0	0	PS-13 & PS-23
	125	2500†	2500	2500	PS-13 & PS-23
	250	6000†	6000	6000	PS-13 & PS-23

† Mounted in Relay

or PS-4. Low current alarm contacts close.

Grounds

The sending end relays (PSA, PSD, or PS-13) are mid-point grounded, so that a pilot wire ground will cause an increase in current in one of the two alarm unit coils of the PSA, PSD, or PS-13, closing the high current alarm contact. Grounds of 500 ohms or less will be detected. The high internal resistance of the PSD and d-c PS-13 relays will prevent a pilot wire ground from affecting the station battery ground lamps. An accidental ground on the battery circuits will affect the sensitivity of the relays in detecting pilot wire grounds.

For sensitive ground detection a PS-5 relay can be inserted in the PSA, PSD, or PS-13 ground connection. This relay will detect grounds of 50,000 ohms or less. The PSA, PSD, or PS-13 will not detect grounds when the PS-5 is used because of the additional resistance that the PS-5 inserts into the circuit. Because of its very high sensitivity, it is recommended that the PS-5 contact be connected to an indicating lamp rather than to an alarm.

Remote Tripping

Breakers located at the PS-13 and PS-23 stations can be tripped by the application of a d-c voltage to the pilot wires at remote locations, as shown in figures 10 to 14. Remote tripping can be effected from any location by applying 48 volts d-c or more to the pilot wire. When tripping the PS-23, the current is increased above 3.5 ma to close the high current con-

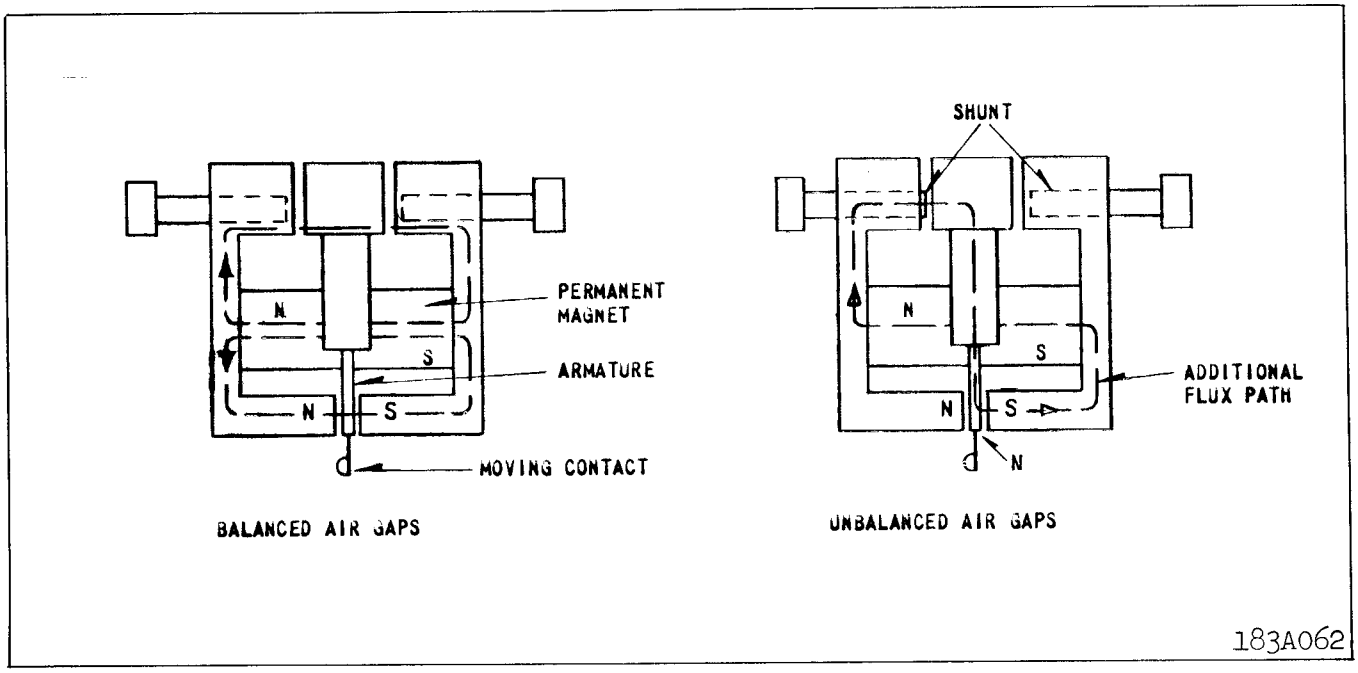

Fig. 1. Polar Unit Permanent Magnet Flux Paths.

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

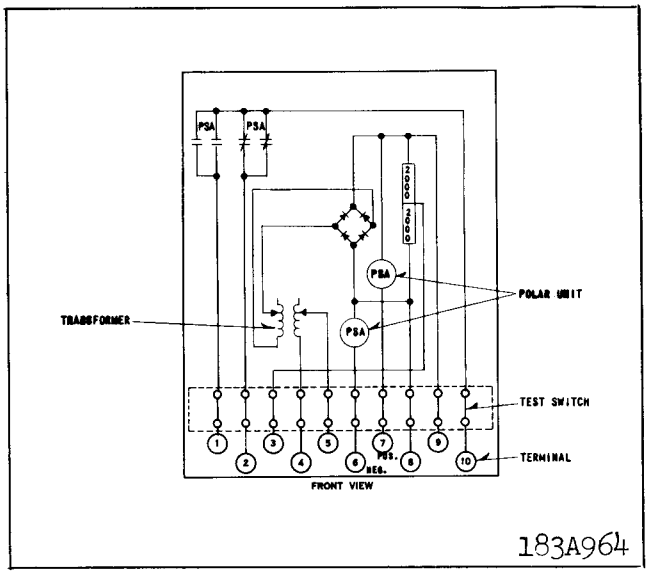

Fig. 2. Internal Schematic of the Type PSA Relay in the FT21 Case – 120 Volt, 60 cycle supply – For Two and Three Terminal Lines.

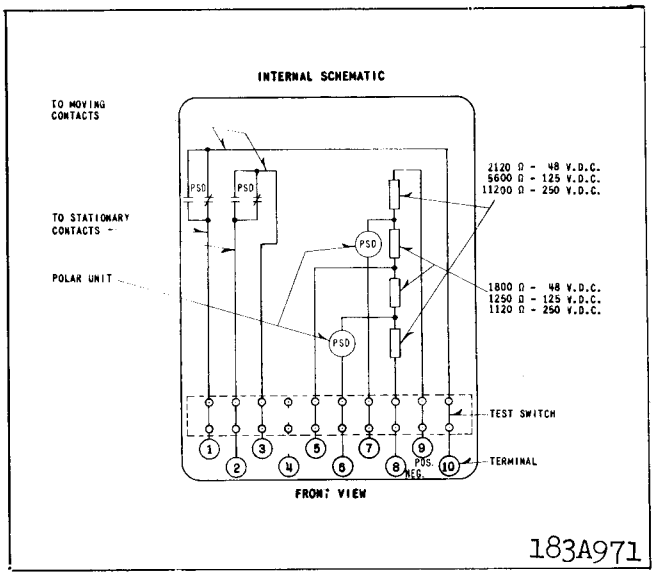

Fig. 3. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Two Terminal Lines.

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.

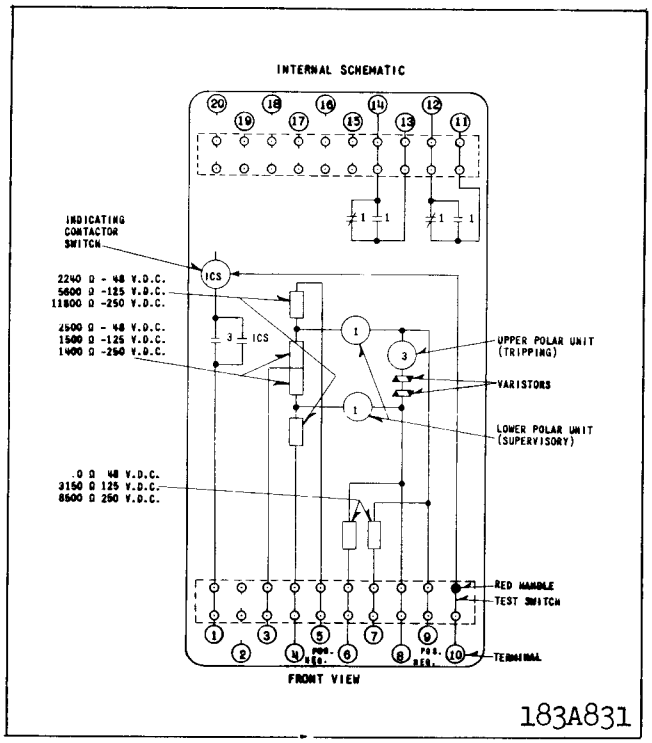

Fig. 4. Internal Schematic of the Type PS-13 Relay in the FT32 Case. DC Supply – For Two Terminal Lines.

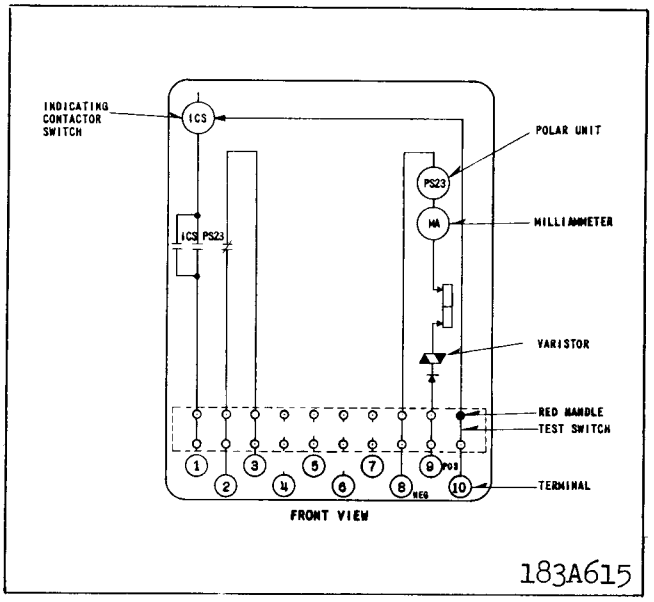

Fig. 5. Internal Schematic of the Type PS-23 Relay in the Type FT21 Case.

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

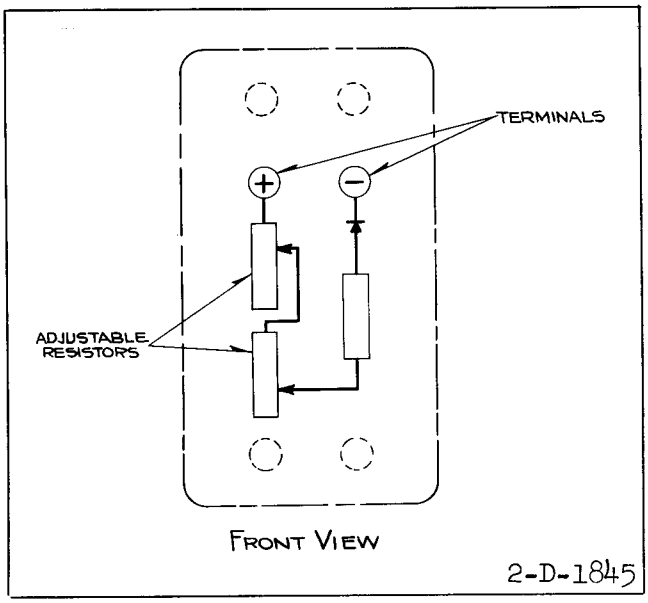

Fig. 6. Internal Schematic of the Type PS-4 Auxiliary Unit in the Small Molded Case.

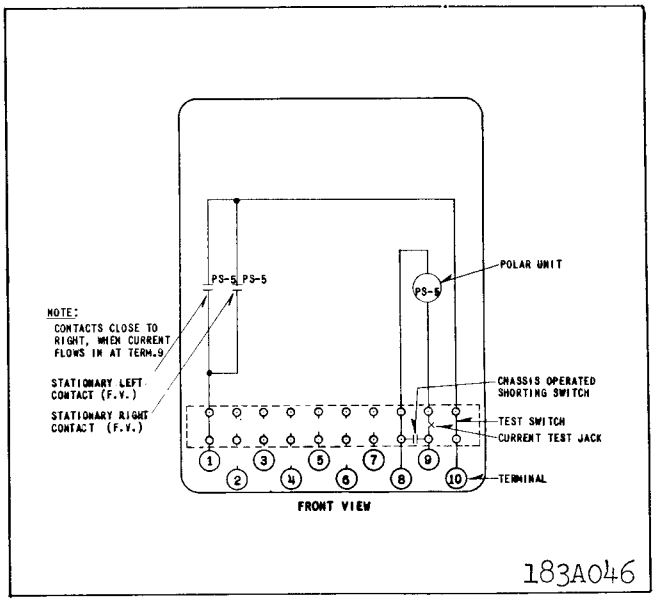

Fig. 7. Internal Schematic of the Type PS-5 Ground Detector Relay in the FT11 Case.

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 8,500 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

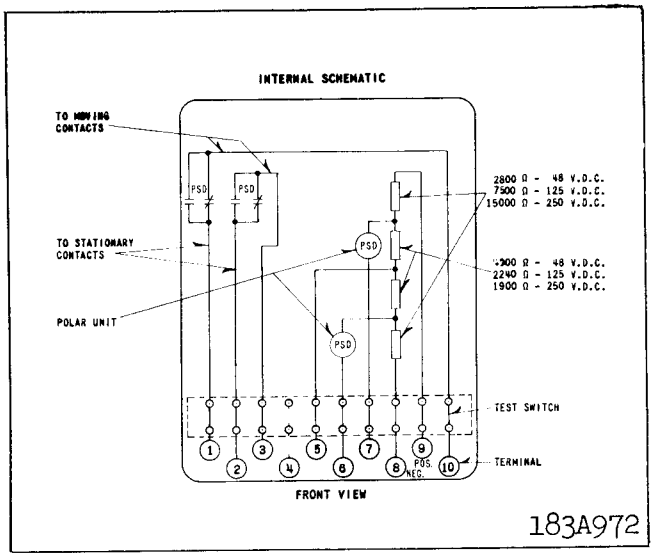

Fig. 8. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Three Terminal Lines.

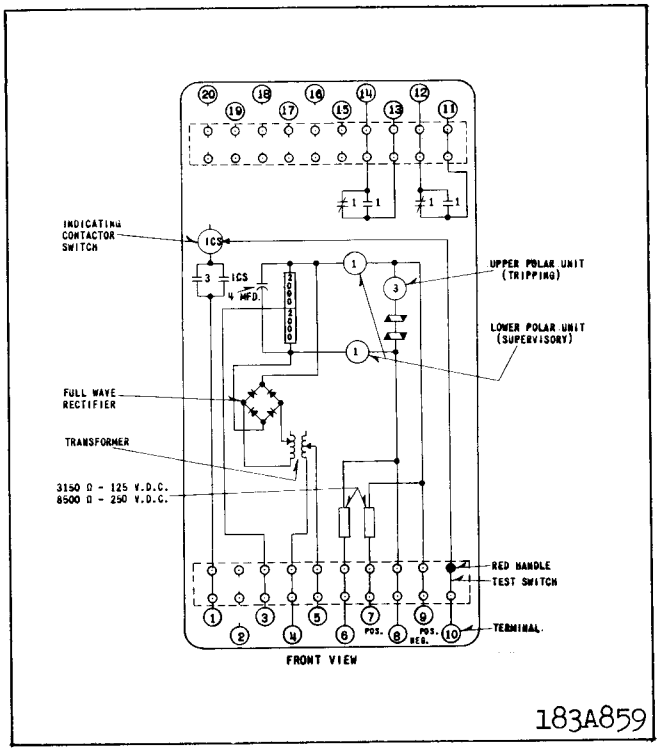

Fig. 9. Internal Schematic of the Type PS-13 Relay in the FT32 Case – 120 volt, 60 cycle supply – For Two Terminal Lines.

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 relay trip 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.

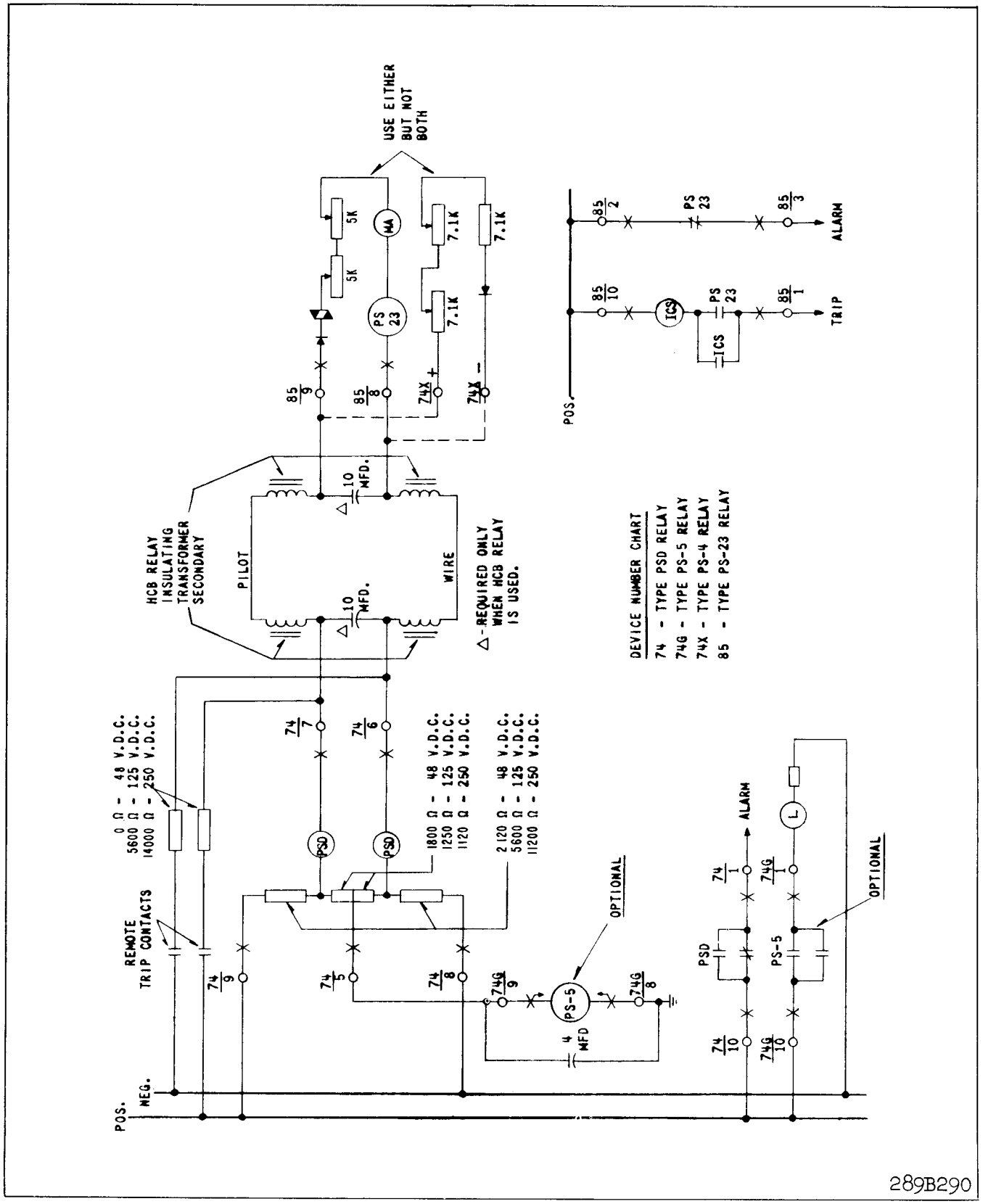

Fig. 10. External Schematic of the Type PSD and PS-5 Relays with Type PS-23 or PS-4 Relay – Two Terminal Line.

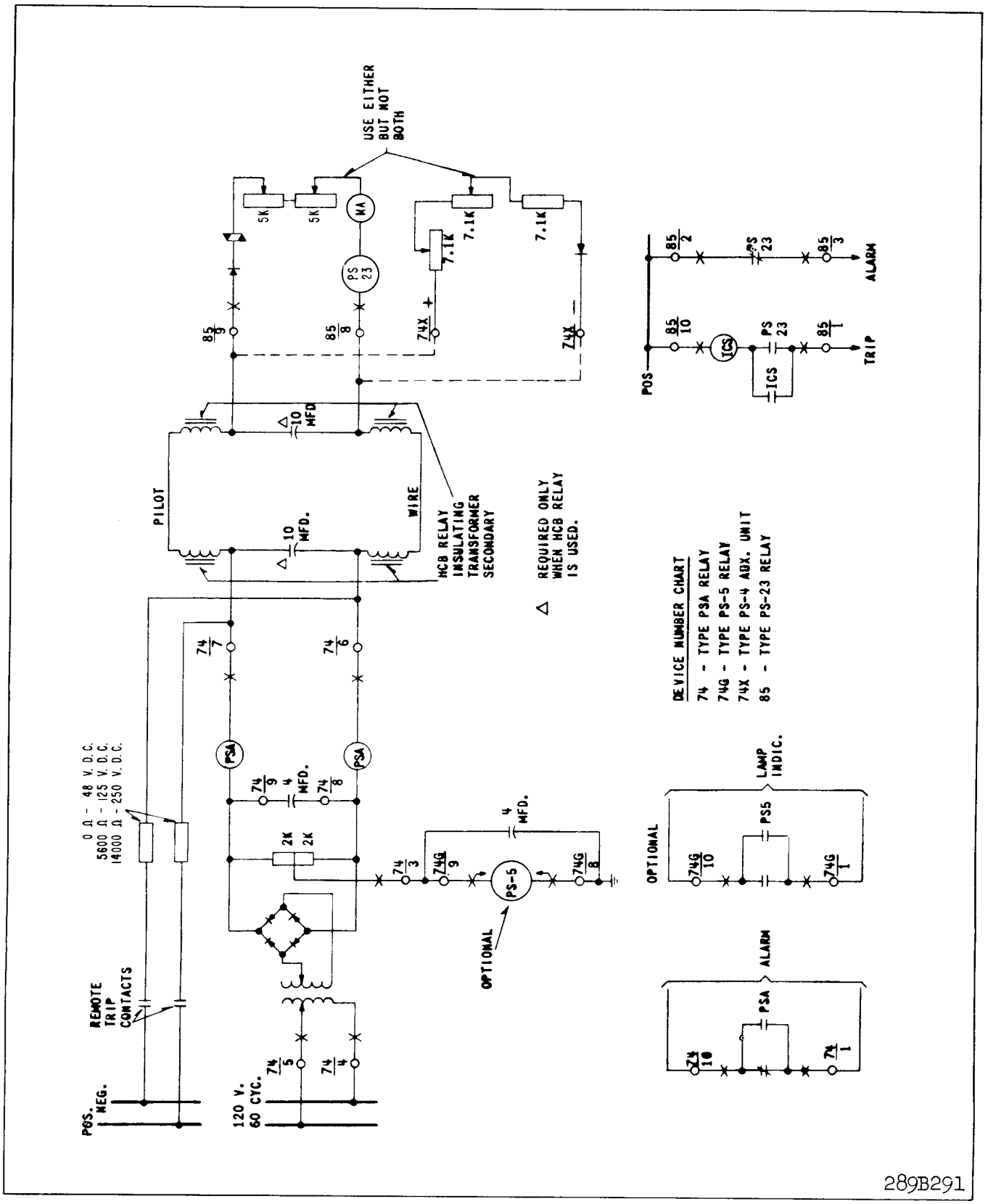

Fig. 11. External Schematic of the Type PSA and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

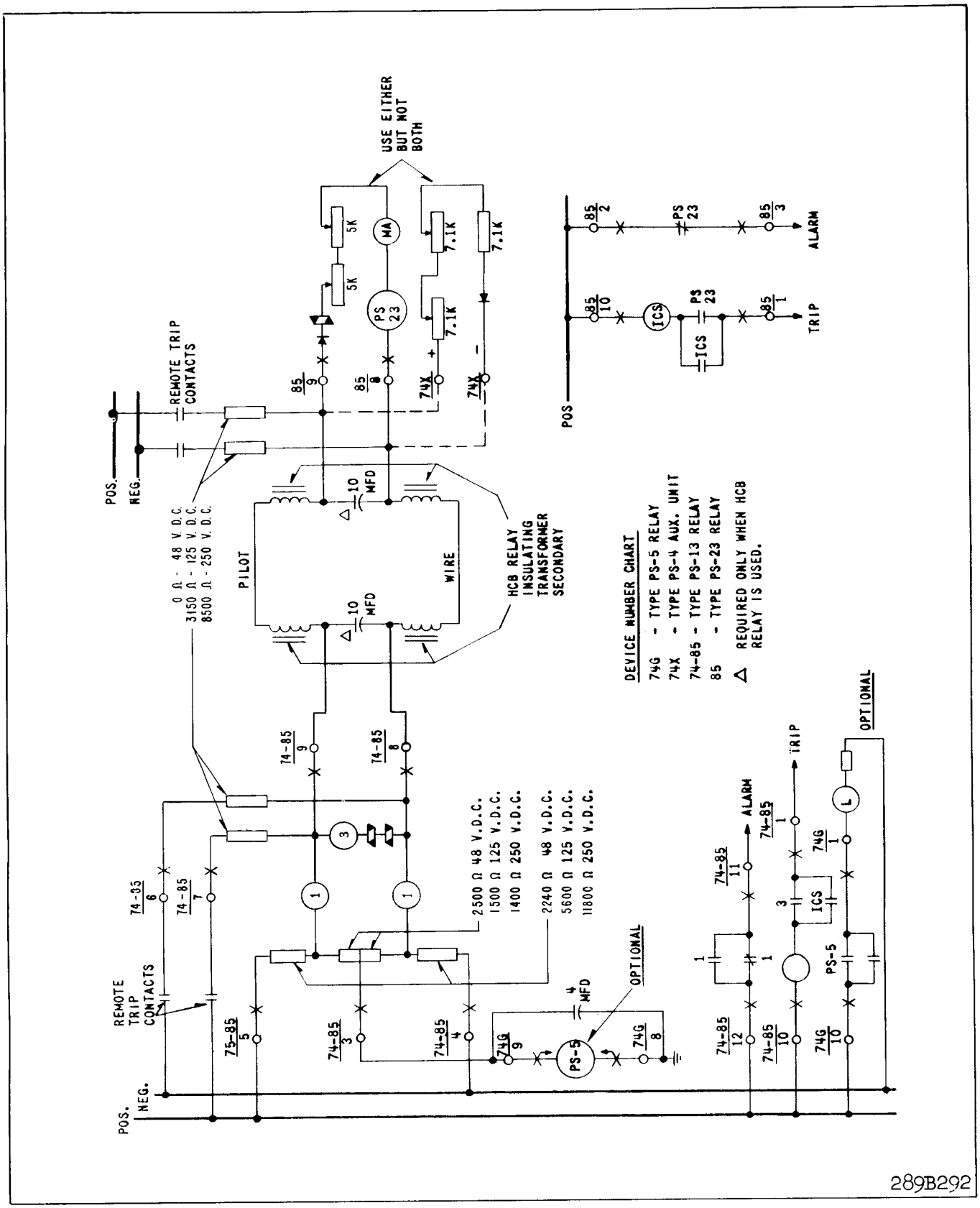

Fig. 12. External Schematic of the DC Type PS-13 and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

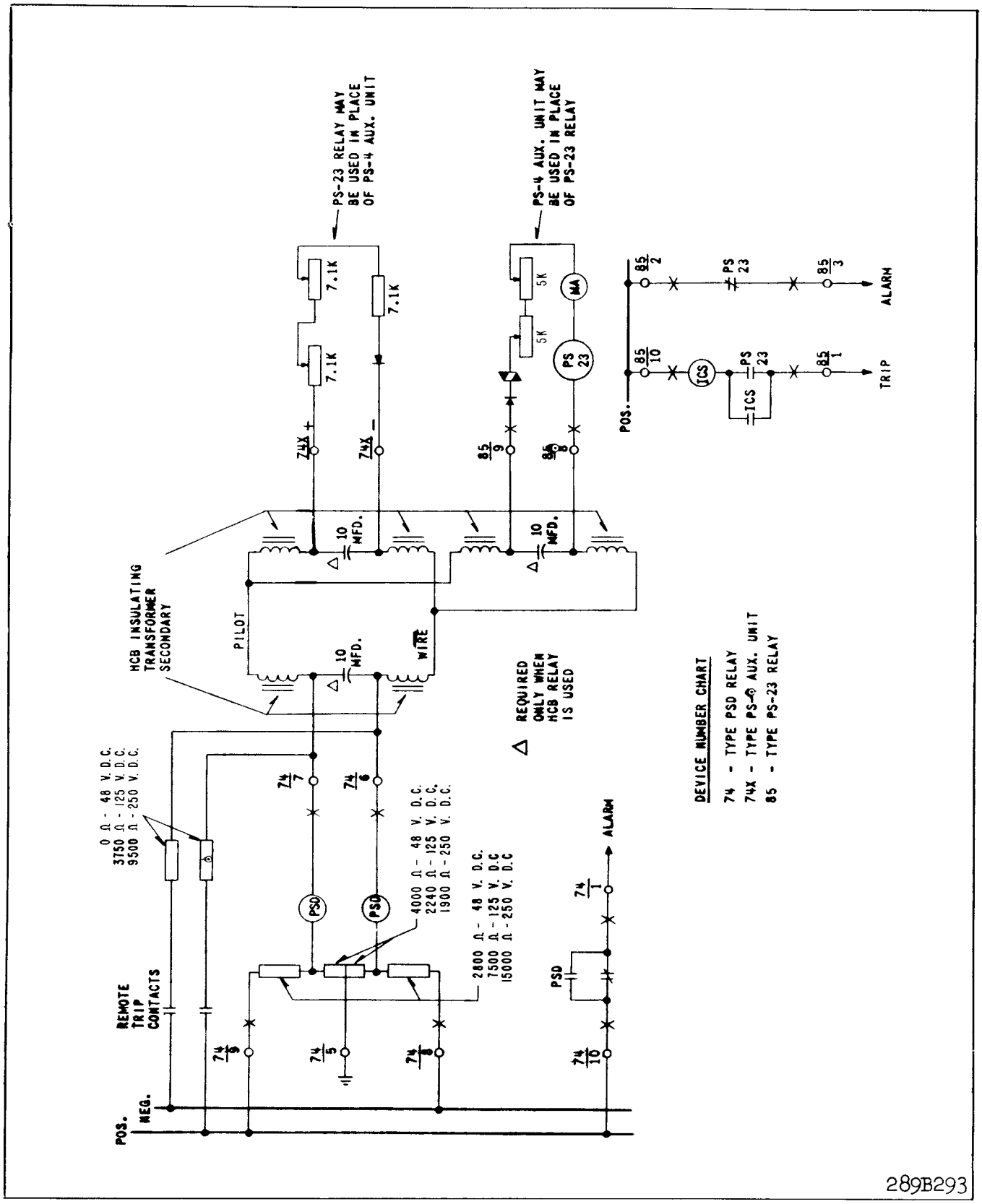

Fig. 13. External Schematic of the Type PSD Relay with Types PS-23 and PS-4 Relays – for Three Terminal Lines.

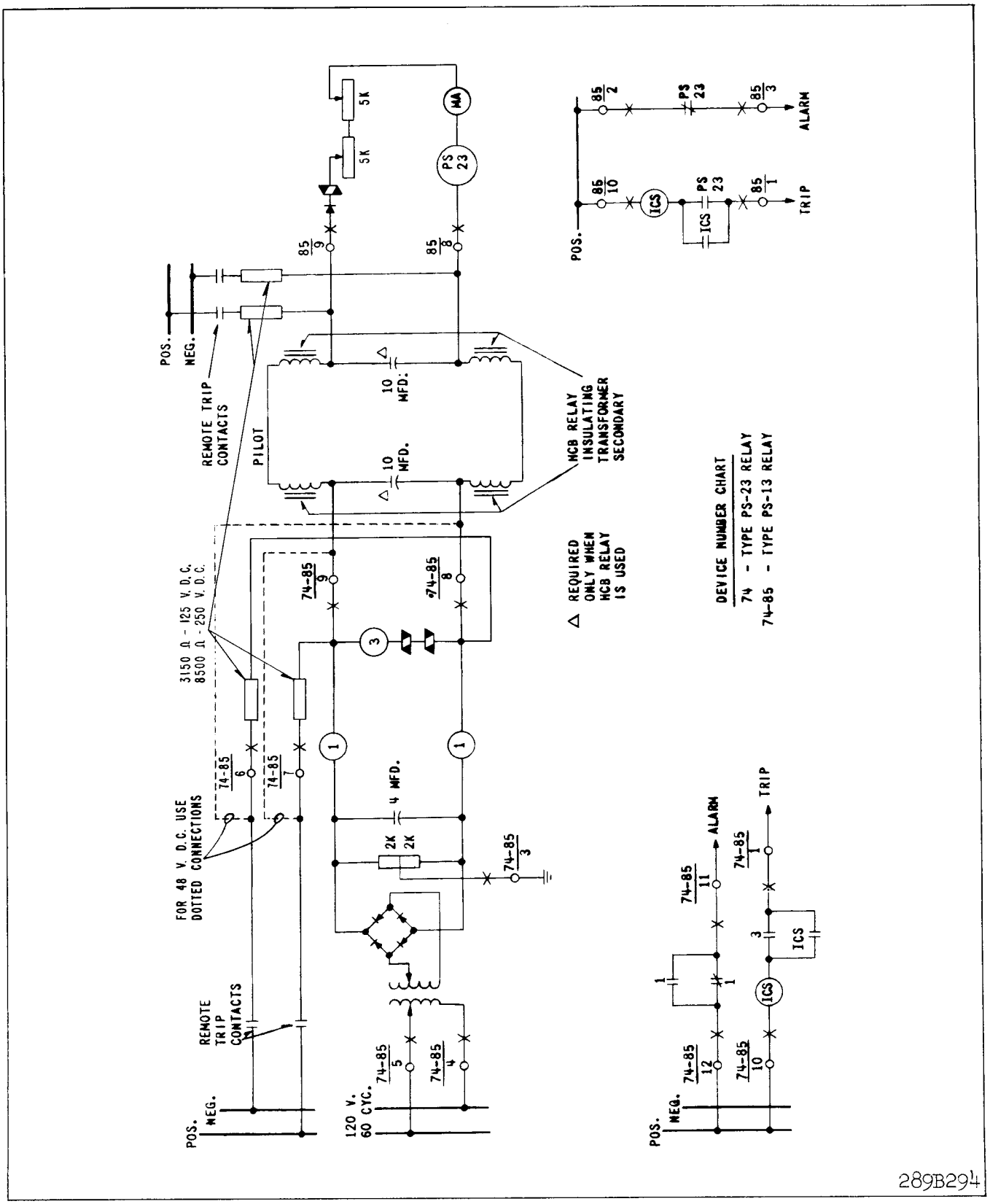

Fig. 14. External Schematic of the AC Type PS-13 With PS-23 Relay – Two Terminal Line.

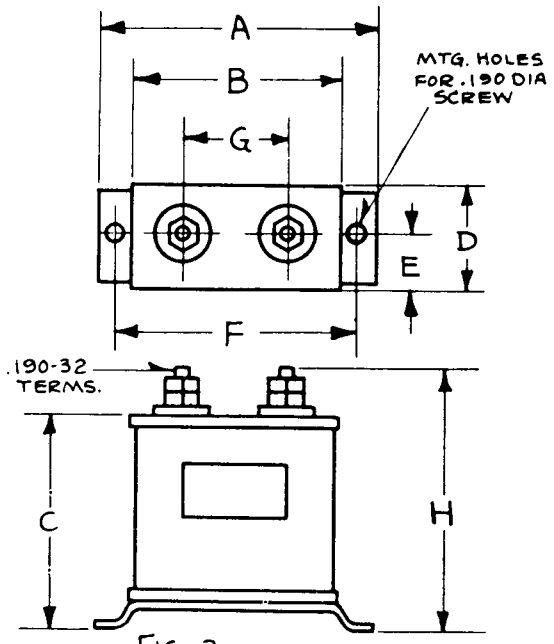

FIG. 3

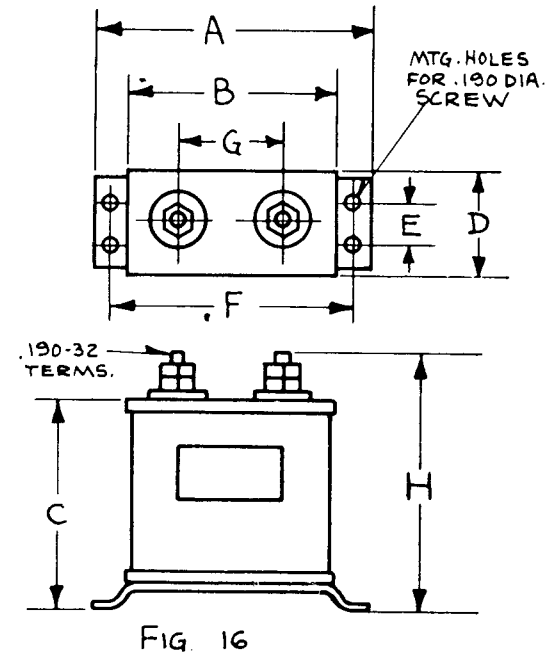

FIG. 16

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 1/2	±1/32 3 1/2	±1/32 1 1/4	4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1/2	±1/32 3 1/2	1 1/4	5 1/16

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

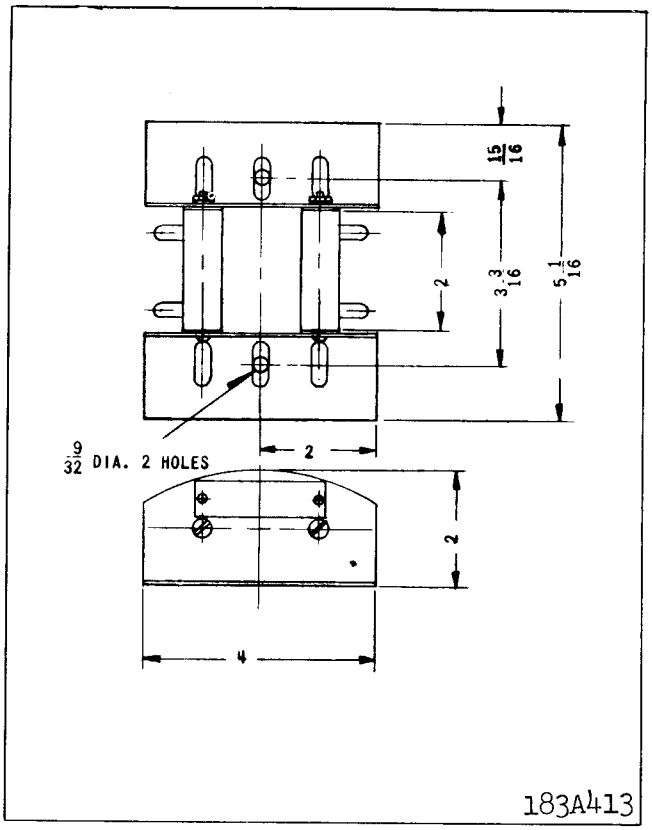

Fig. 16. Outline & Drilling Plan for External Remote Trip Resistor Assembly.

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

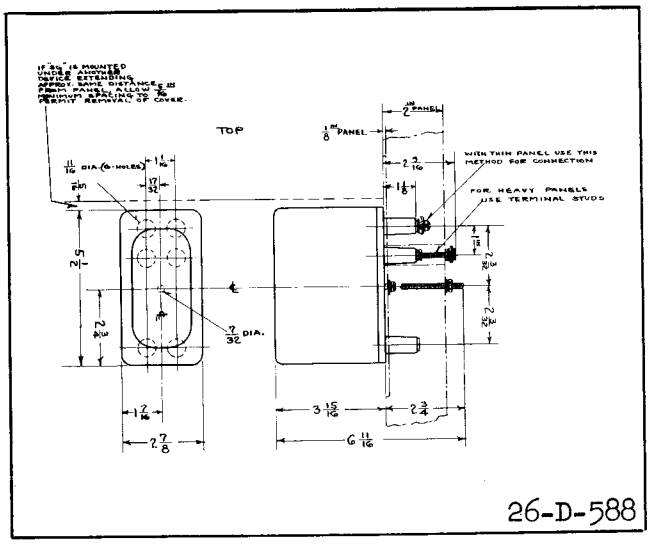

Fig. 17. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Projection Molded Case.

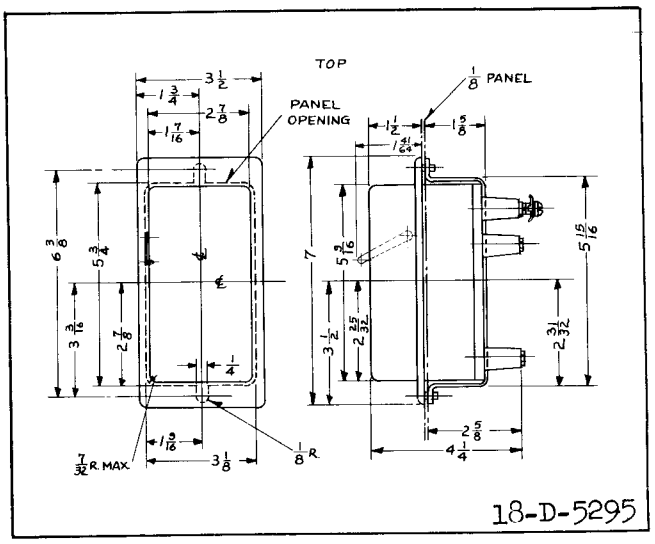

Fig. 18. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Semi-Flush Molded Case.

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 lower polar 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.

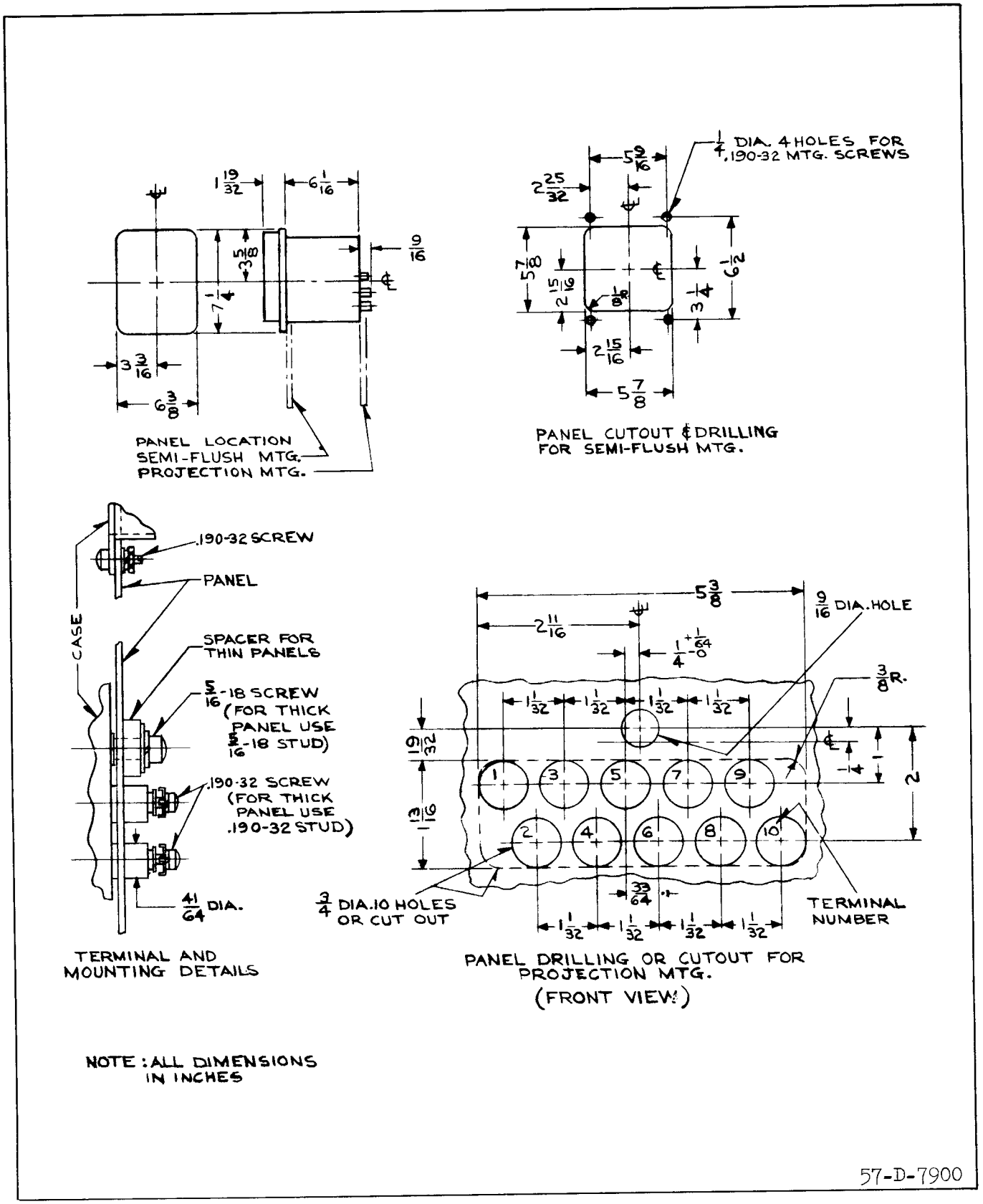

Fig. 19. Outline & Drilling Plan for the Type PSD and PS-5 Relays in the Type FT11 Case.

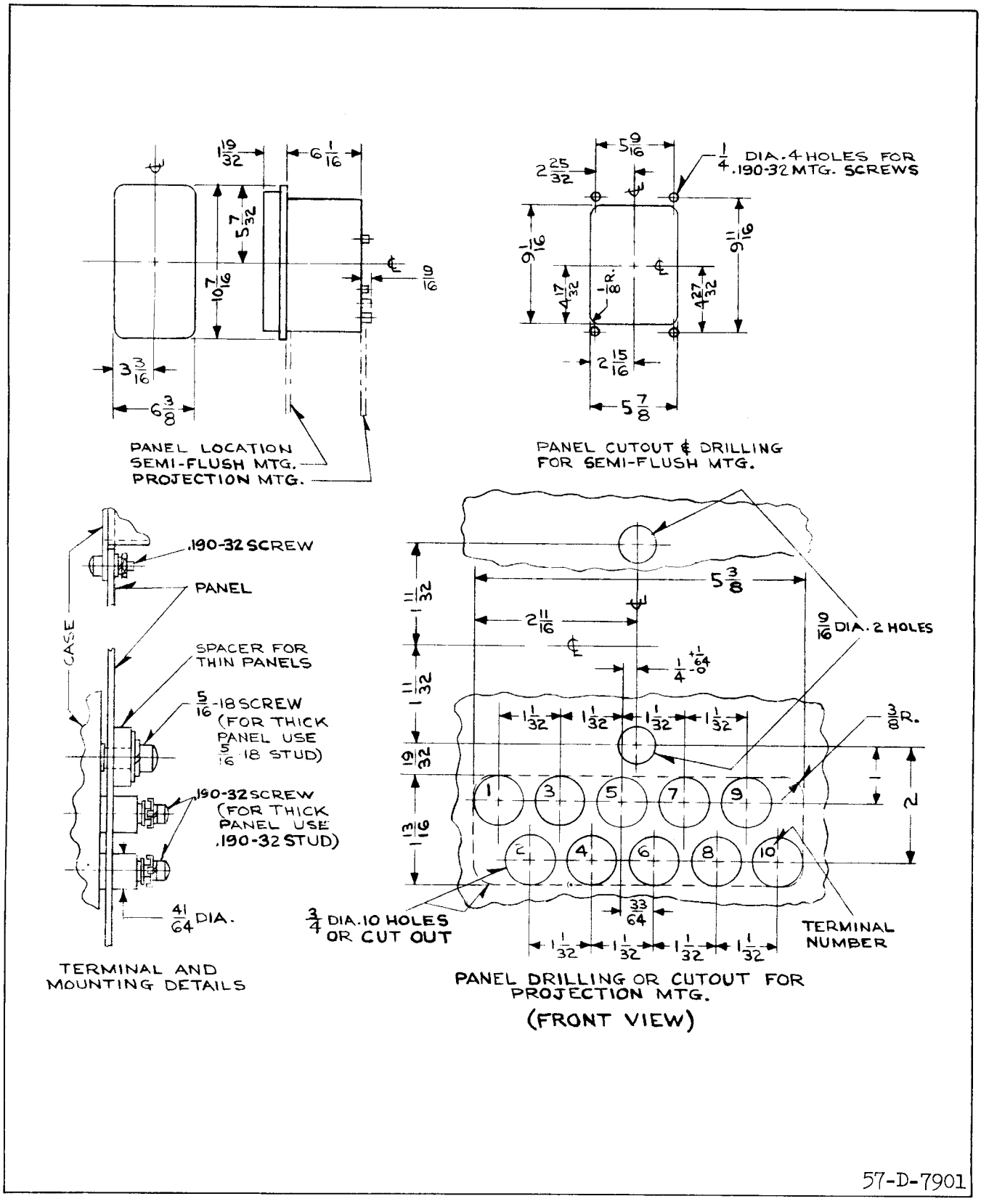

Fig. 20. Outline & Drilling Plan for the Type PSA and PS-23 Relays in the Type FT21 Case.

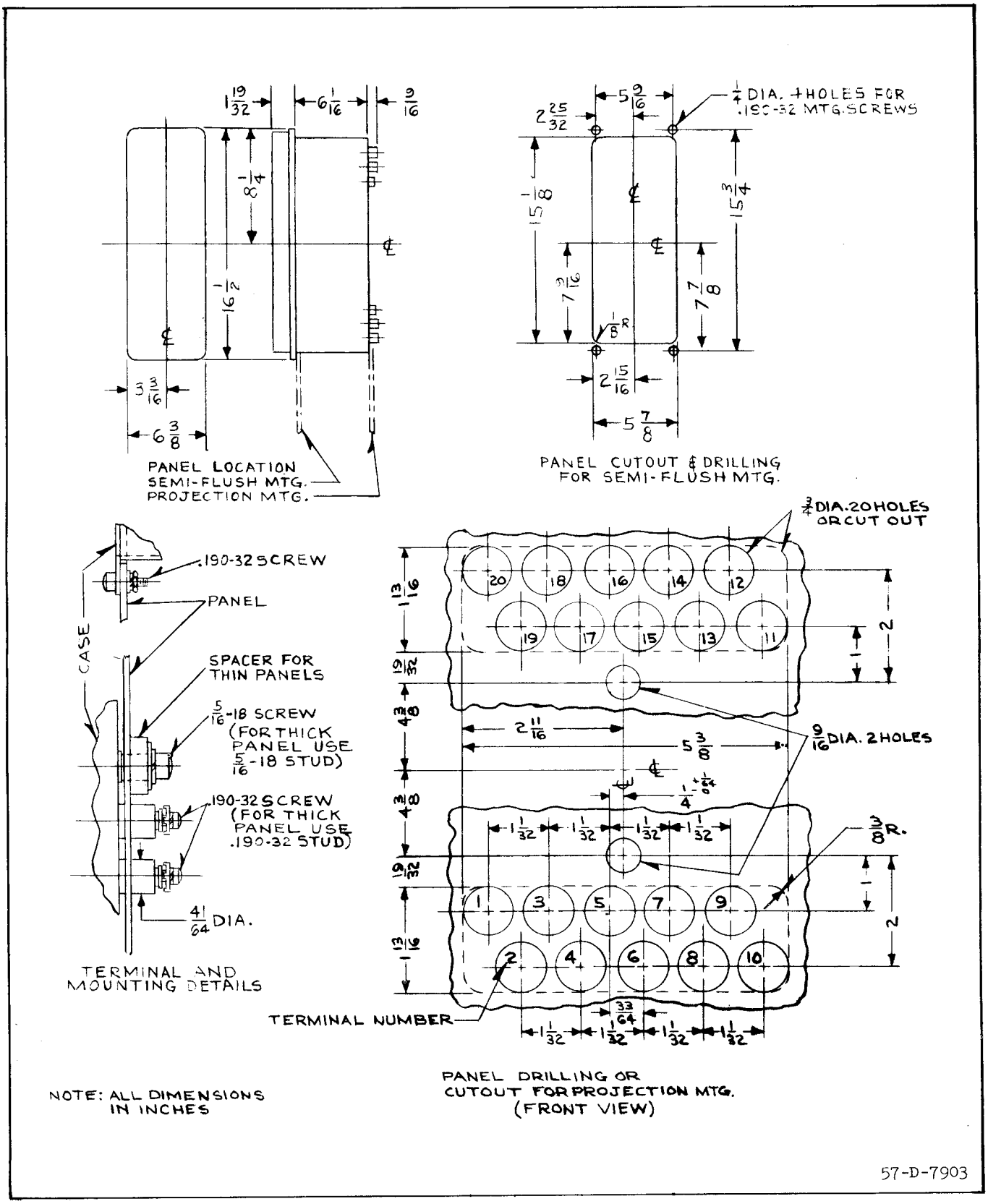

Fig. 21. Outline & Drilling Plan for The Type PS-13 Relay in the Type FT32 Case.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES 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 – External 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

TABLE I

APPLICATION CHART

FUNCTION	PSA & PSD	PS-13	PS-23	PS-4	PS-5
Introduces Supervision Current	X	X			
Receives Supervision Current			X	X	
Trouble Alarm	X	X	X		X
Transmits Trip Signal	X	X	X	X	
Receives Trip Signal		X	X		
Sensitive Ground Detection					X
Measures Supervision Current			X		

clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Pilot Wire Supervision

Supervision current is introduced into the pilot wire as shown in the external schematics, figures 10 to 14, by the PSA, PSD, or PS-13 relays. A nominal 17 volts is impressed across the 10 mfd. capacitors. This voltage produces a current circulating through one winding of the HCB insulating transformer, one pilot wire, the PS-4 or PS-23, and back through the other pilot wire. Note that in the PS-13 of figures 12 and 14, supervision current flows only in the "1" coil, and not in the "3" coil, because of the blocking rectifier connections.

Adjustment of the resistors of the PS-4 or PS-23 relay at the other end of the pilot wire provides a normal one milliampere d-c circulating current. In the case of three terminal lines, the PSA, PSD, or PS-13, output current is 2 ma in order to provide each receiving end relay with 1 ma. The alarm unit of the PSA, PSD, or PS-13 is adjusted to float between the high and low current contacts with normal supervision current. The PS-23, receiving end relay, is adjusted to float between the low current contact (trip) with 1 ma flowing.

Short Circuits

Current increases in the PSA, PSD, or PS-13 to close the high current alarm contact, current decreases in the PS-23 to close the alarm contact. Short circuits of 2000 ohms or less will be detected.

Open Circuits

Current decreases to zero in all relays. Low current alarm contact of PSA, PSD, or PS-13 closes. Alarm contact of PS-23 closes.

Reversed Wires

Current decreases in both sending and receiving end relays because of the rectifier unit in the PS-23

TABLE II

PSA & PSD APPLICATIONS

EXTERNAL RESISTORS FOR D.C. REMOTE TRIPPING

(2 Required per Station)

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PSA OR PSD	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0	–	–	PS-23
	125	5600	–	–	PS-23
	250	14000	–	–	PS-23
	48	0	–	–	PS-23
	125	3750	–	–	PS-23
	250	9500	–	–	PS-23

TABLE III

PS-13 APPLICATIONS

(2 Required per Station)

RESISTORS FOR D.C. REMOTE TRIPPING

NO. OF LINE TERMINALS	D.C. VOLTAGE	STATION A PS-13	STATION B PS-23 OR PS-4	STATION C PS-23 OR PS-4	TO OPERATE
2	48	0†	0	–	PS-13 & PS-23
	125	3150†	3150	–	PS-13 & PS-23
	250	8500†	8500	–	PS-13 & PS-23

† Mounted in Relay

or PS-4. Low current alarm contacts close.

Grounds

The sending end relays (PSA, PSD, or PS-13) are mid-point grounded, so that a pilot wire ground will cause an increase in current in one of the two alarm unit coils of the PSA, PSD, or PS-13, closing the high current alarm contact. Grounds of 500 ohms or less will be detected. The high internal resistance of the PSD and d-c PS-13 relays will prevent a pilot wire ground from affecting the station battery ground lamps. An accidental ground on the battery circuits will affect the sensitivity of the relays in detecting pilot wire grounds.

For sensitive ground detection a PS-5 relay can be inserted in the PSA, PSD, or PS-13 ground connection. This relay will detect grounds of 50,000 ohms or less. The PSA, PSD, or PS-13 will not detect grounds when the PS-5 is used because of the additional resistance that the PS-5 inserts into the circuit. Because of its very high sensitivity, it is recommended that the PS-5 contact be connected to an indicating lamp rather than to an alarm.

Remote Tripping

Breakers located at the PS-13 and PS-23 stations can be tripped by the application of a d-c voltage to the pilot wires at remote locations, as shown in figures 10 to 14. Remote tripping can be effected from any location by applying 48 volts d-c or more to the pilot wire. When tripping the PS-23, the current is increased above 3.5 ma to close the high current con-

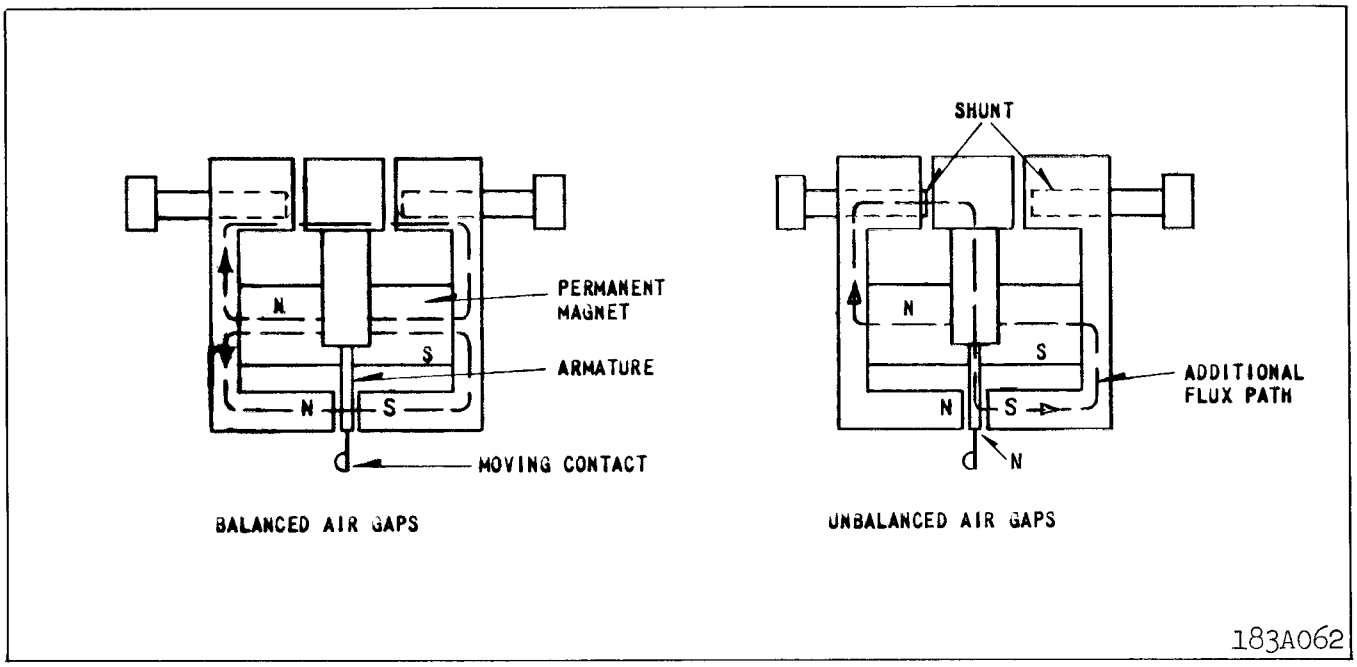

Fig. 1. Polar Unit Permanent Magnet Flux Paths.

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 Coils (2)	1050-1250 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

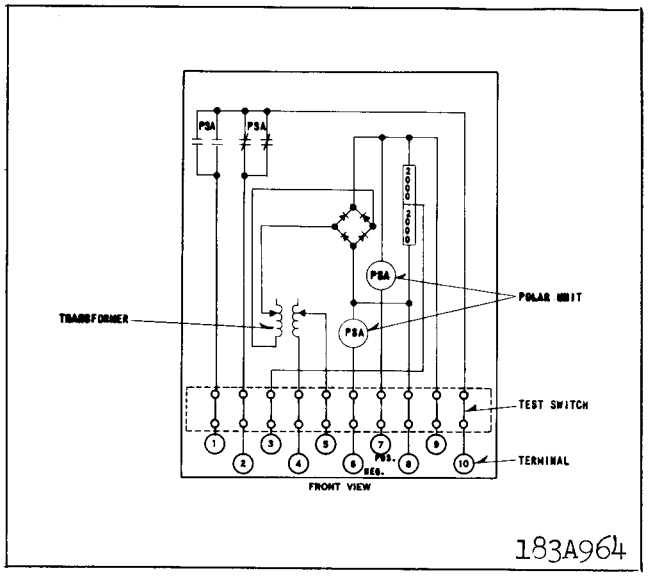

Fig. 2. Internal Schematic of the Type PSA Relay in the FT21 Case – 120 Volt, 60 cycle supply – For Two and Three Terminal Lines.

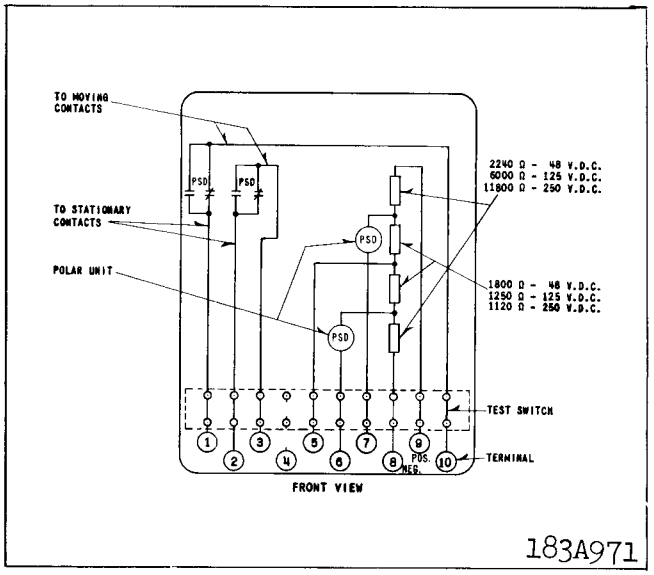

Fig. 3. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Two Terminal Lines.

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.

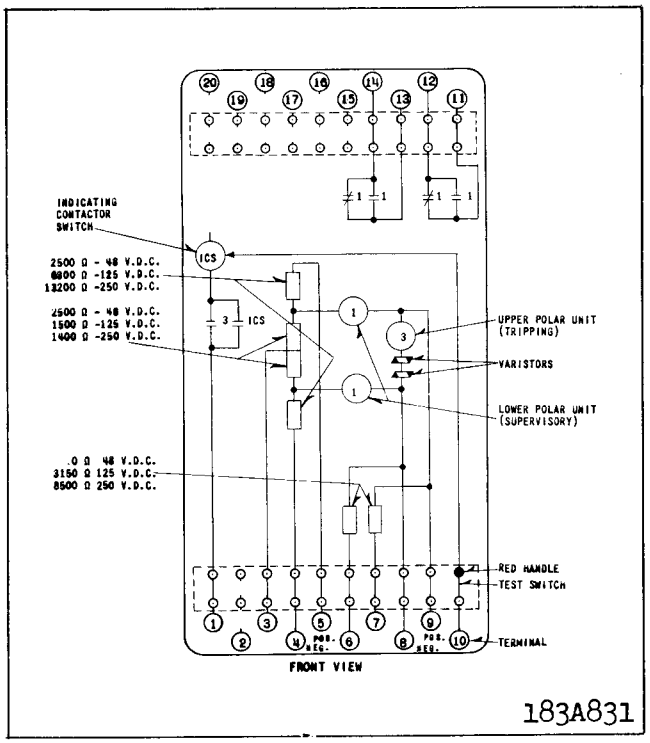

Fig. 4. Internal Schematic of the Type PS-13 Relay in the FT32 Case. DC Supply – For Two Terminal Lines.

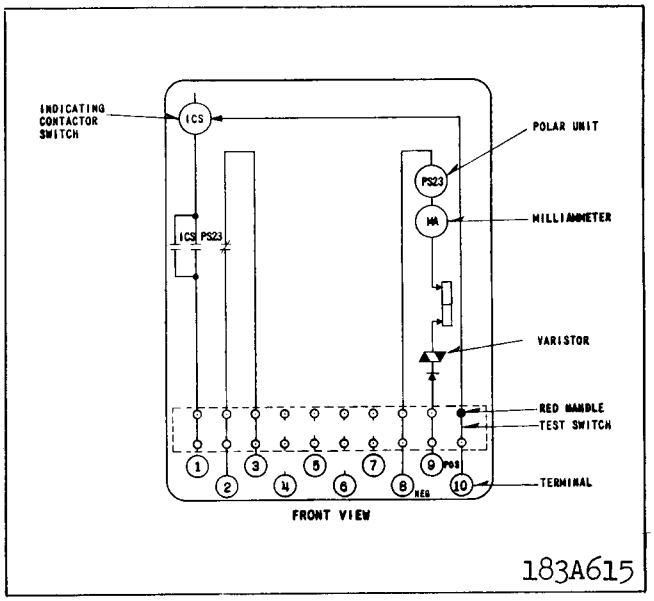

Fig. 5. Internal Schematic of the Type PS-23 Relay in the Type FT21 Case.

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

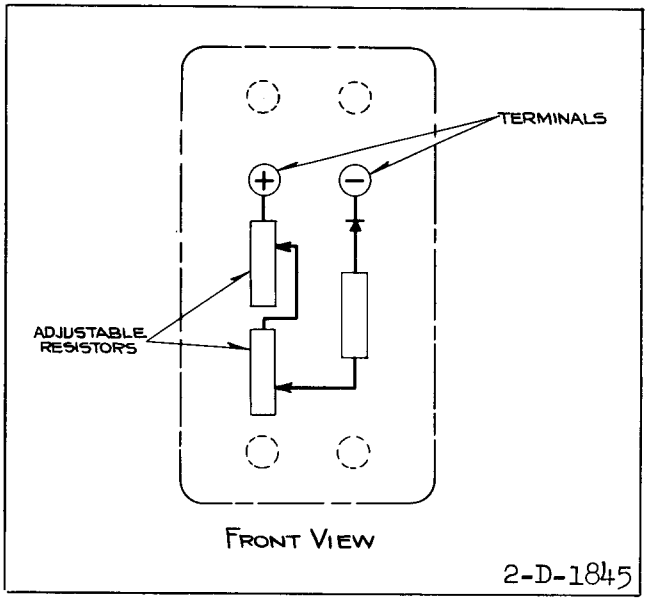

Fig. 6. Internal Schematic of the Type PS-4 Auxiliary Unit in the Small Molded Case.

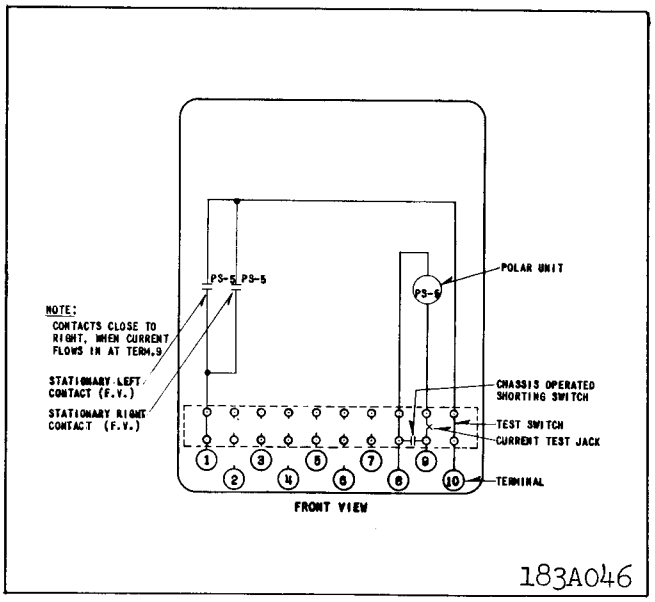

Fig. 7. Internal Schematic of the Type PS-5 Ground Detector Relay in the FT11 Case.

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 8,500 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

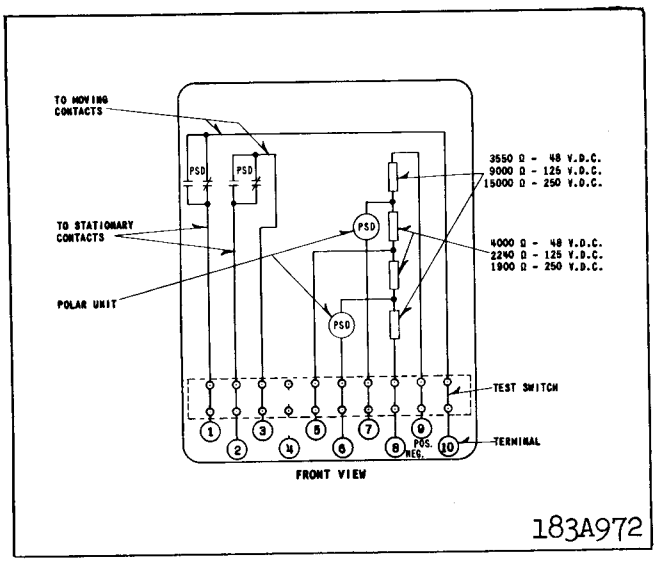

Fig. 8. Internal Schematic of the Type PSD Relay in the FT11 Case – DC Supply – For Three Terminal Lines.

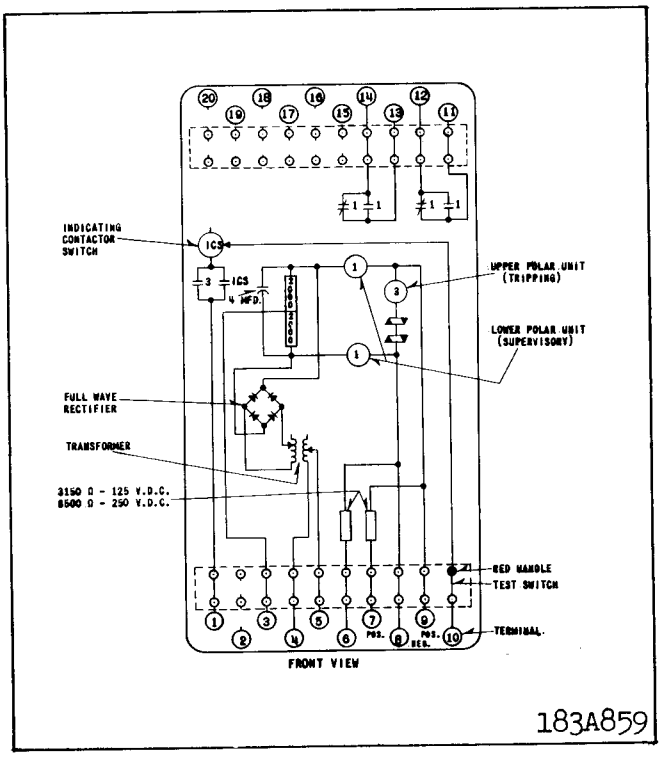

Fig. 9. Internal Schematic of the Type PS-13 Relay in the FT32 Case – 120 volt, 60 cycle supply – For Two Terminal Lines.

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 relay trip 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.

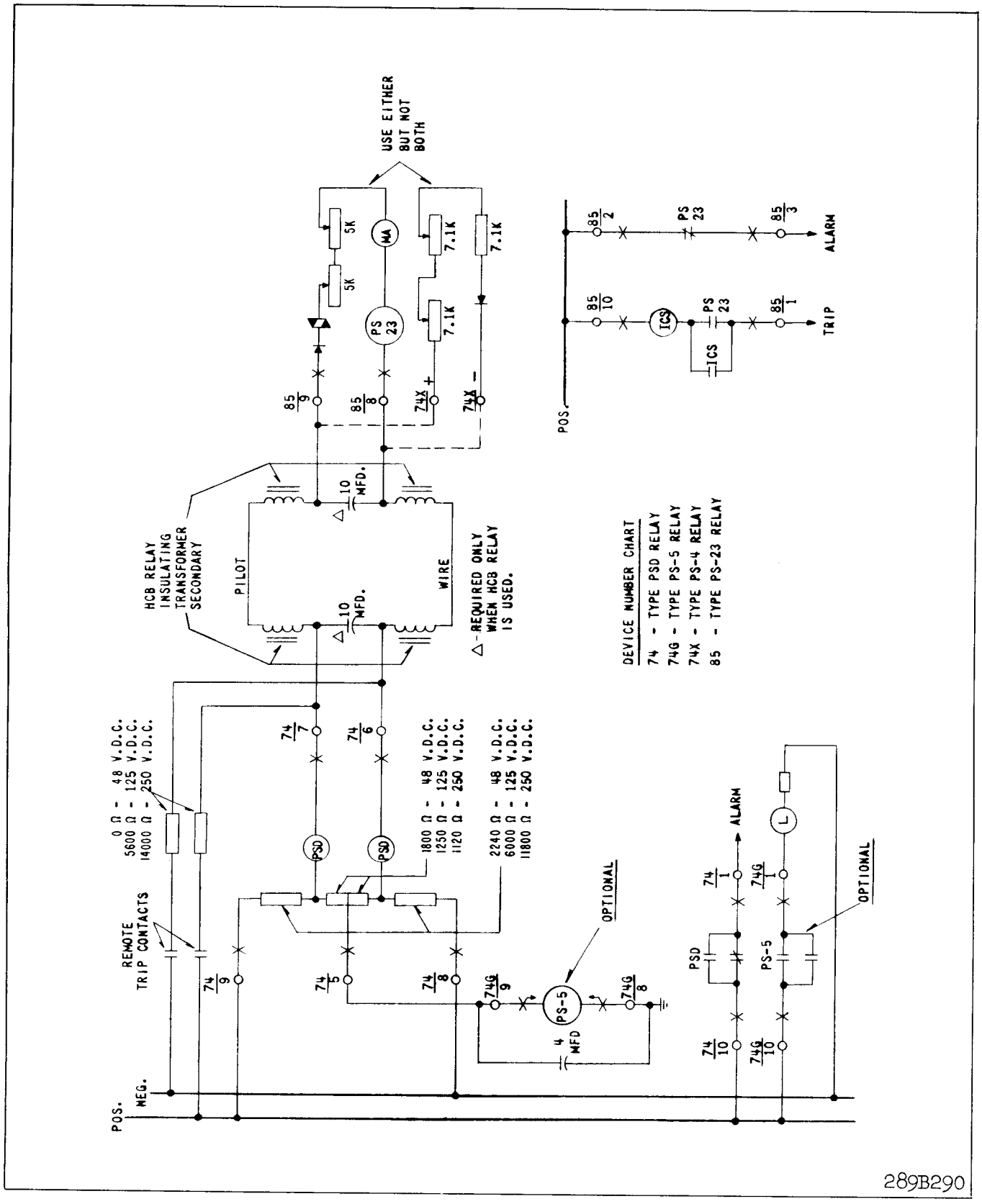

Fig. 10. External Schematic of the Type PSD and PS-5 Relays with Type PS-23 or PS-4 Relay – Two Terminal Line.

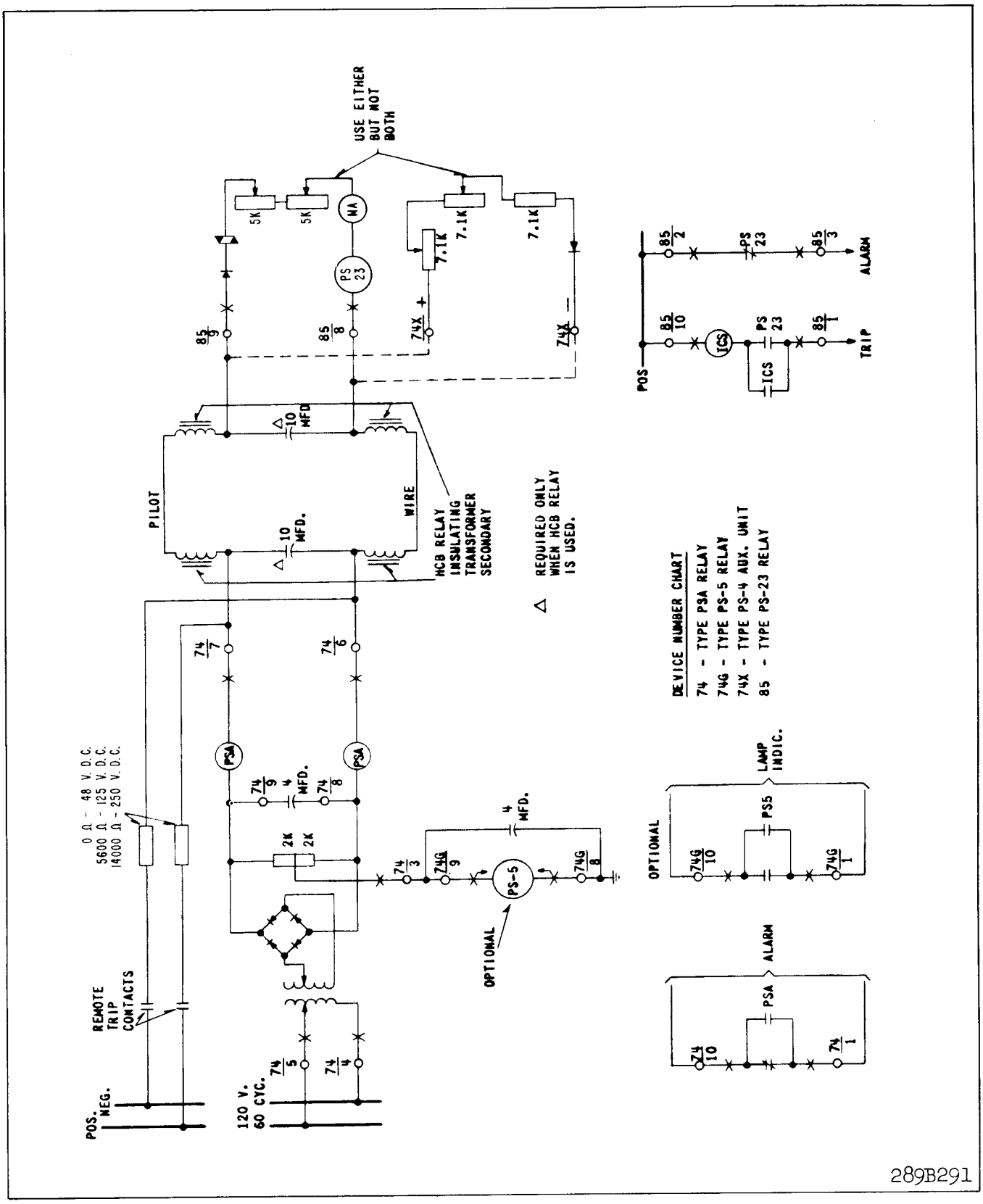

Fig. 11. External Schematic of the Type PSA and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

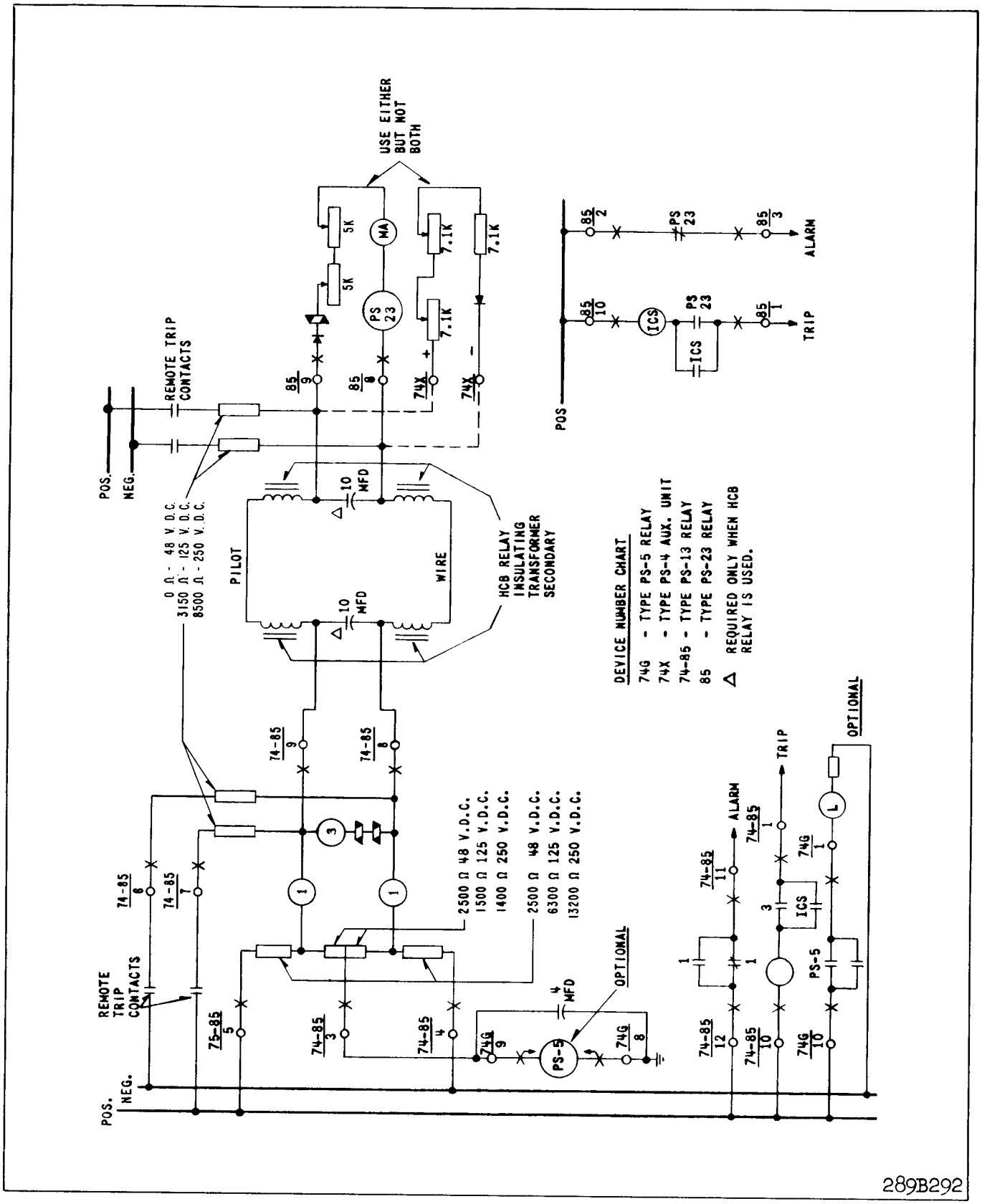

Fig. 12. External Schematic of the DC Type PS-13 and PS-5 Relay with Type PS-23 or PS-4 Relay – Two Terminal Line.

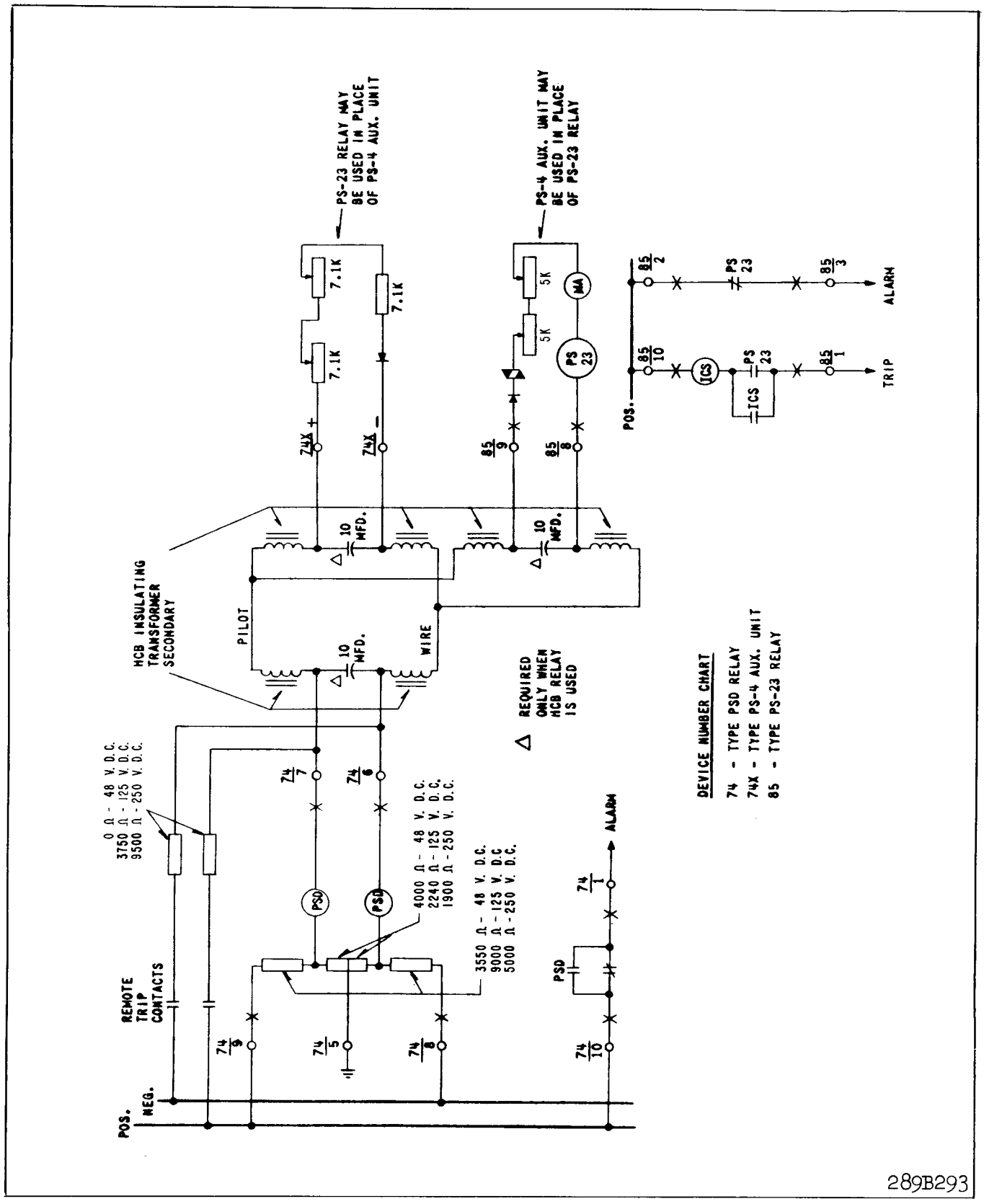

Fig. 13. External Schematic of the Type PSD Relay with Types PS-23 and PS-4 Relays – for Three Terminal Lines.

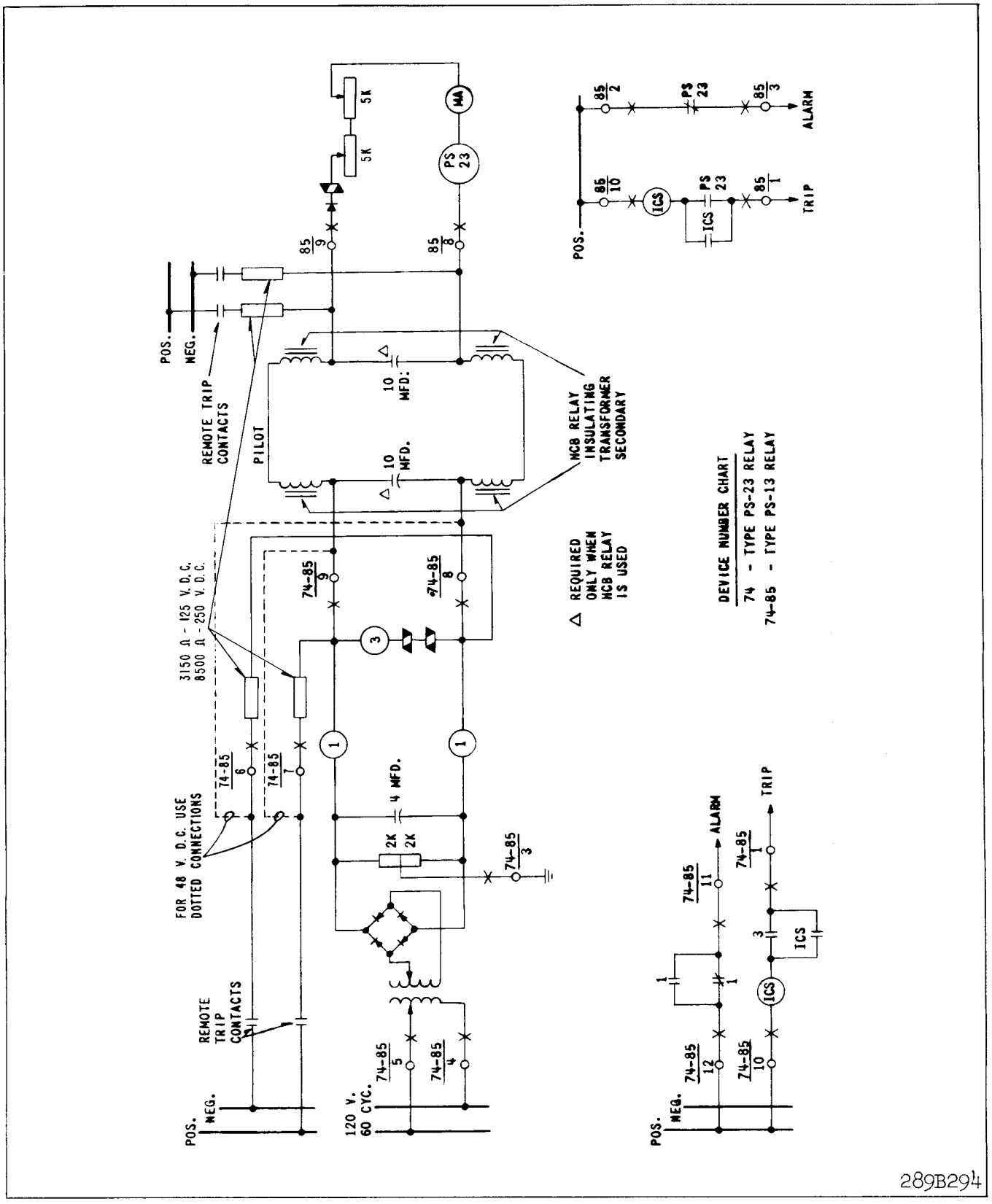

Fig. 14. External Schematic of the AC Type PS-13 With PS-23 Relay – Two Terminal Line.

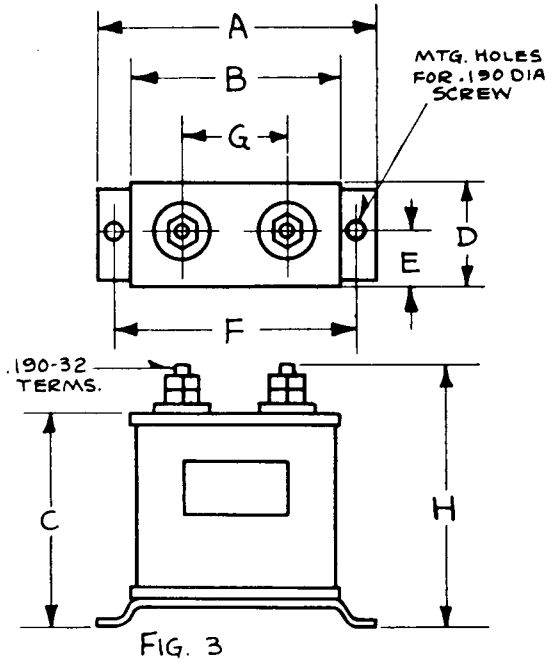

FIG. 3

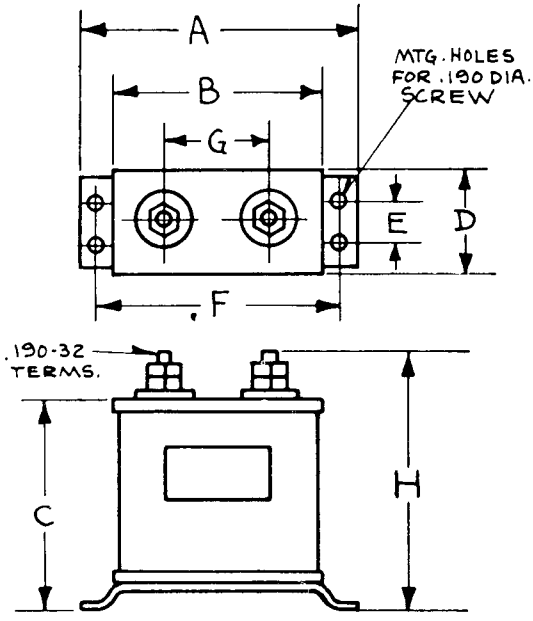

FIG. 16

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

11-D-9524

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

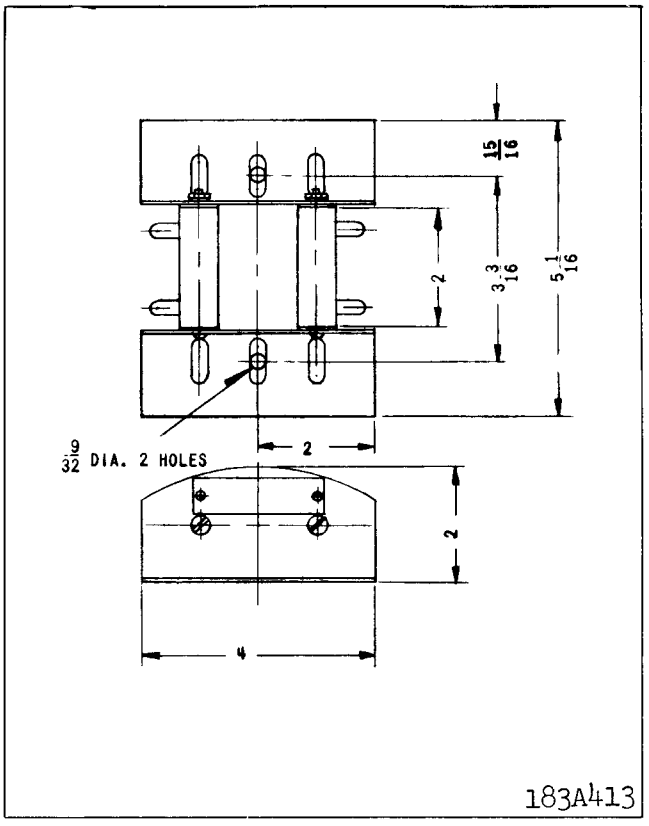

Fig. 16. Outline & Drilling Plan for External Remote Trip Resistor Assembly.

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

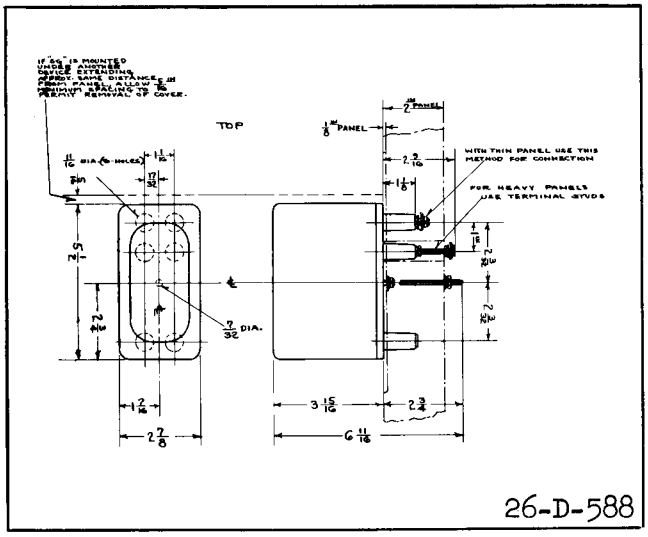

Fig. 17. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Projection Molded Case.

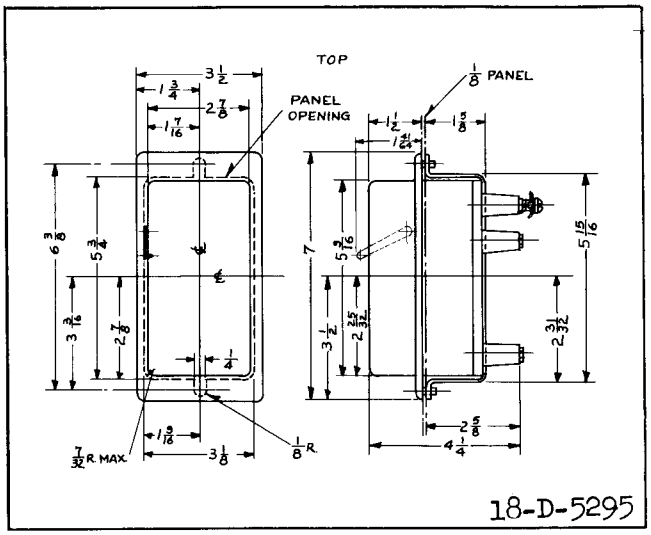

Fig. 18. Outline & Drilling Plan for the Type PS-4 Auxiliary Unit in the Semi-Flush Molded Case.

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 lower polar 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.

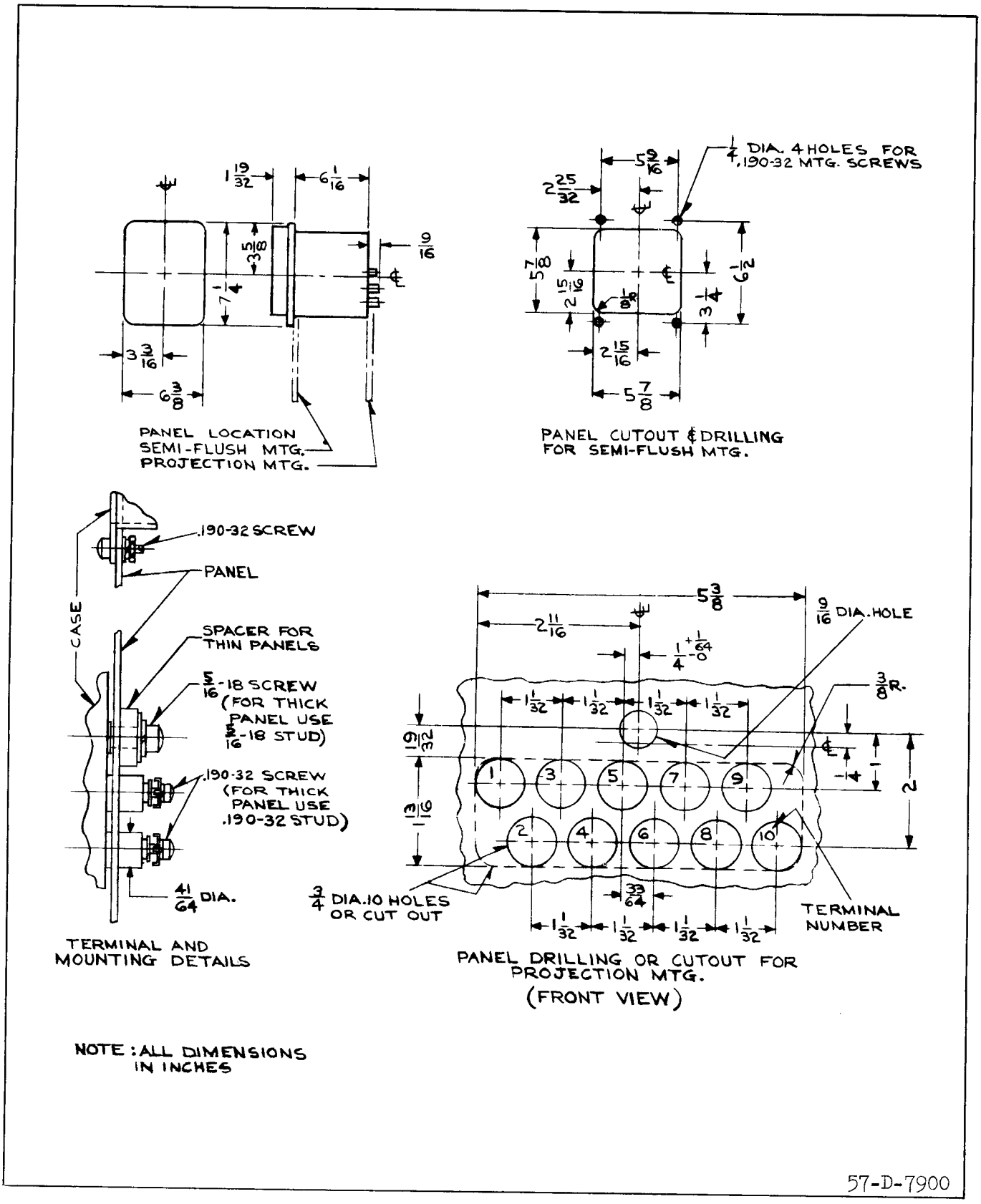

Fig. 19. Outline & Drilling Plan for the Type PSD and PS-5 Relays in the Type FT11 Case.

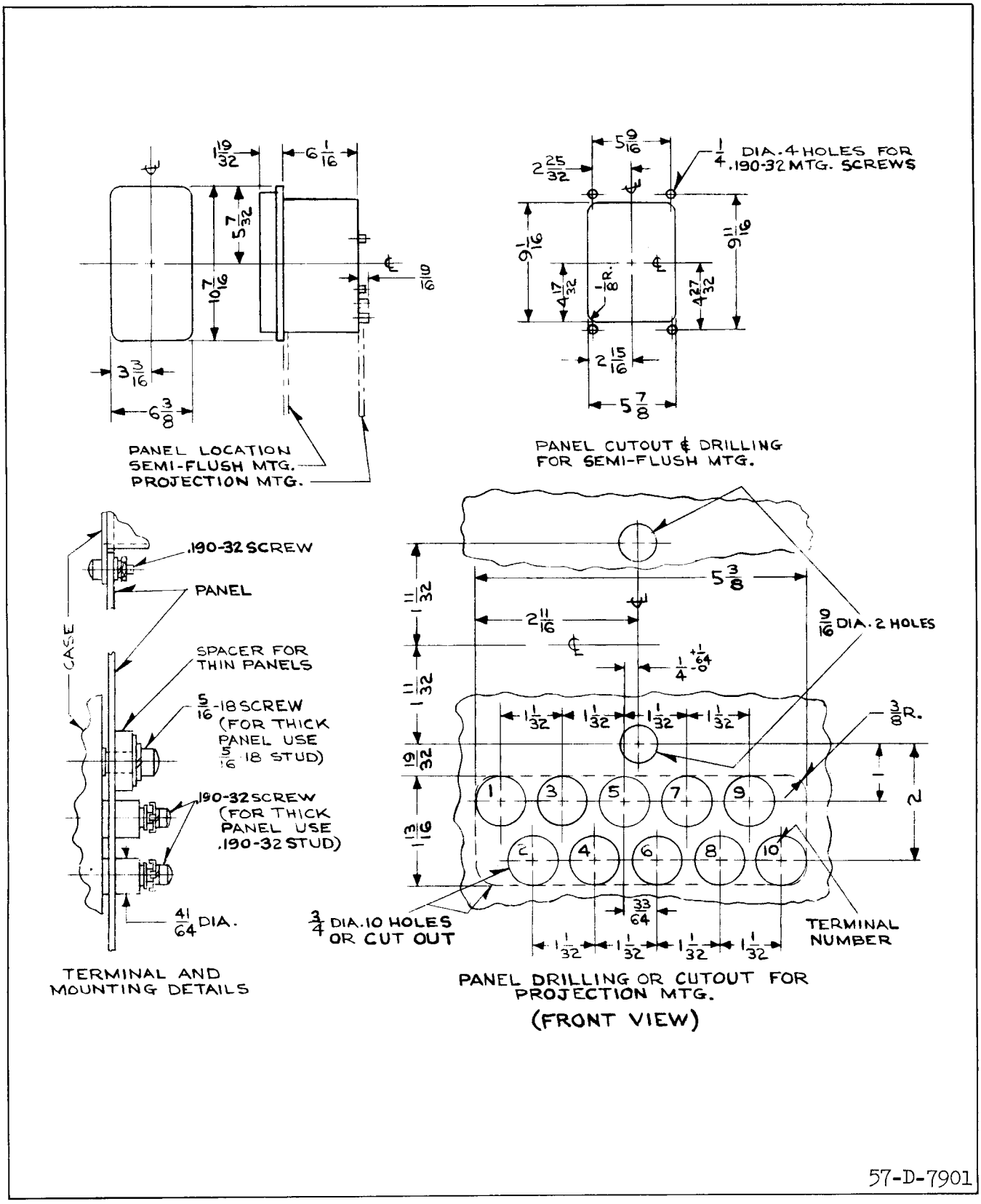

Fig. 20. Outline & Drilling Plan for the Type PSA and PS-23 Relays in the Type FT21 Case.

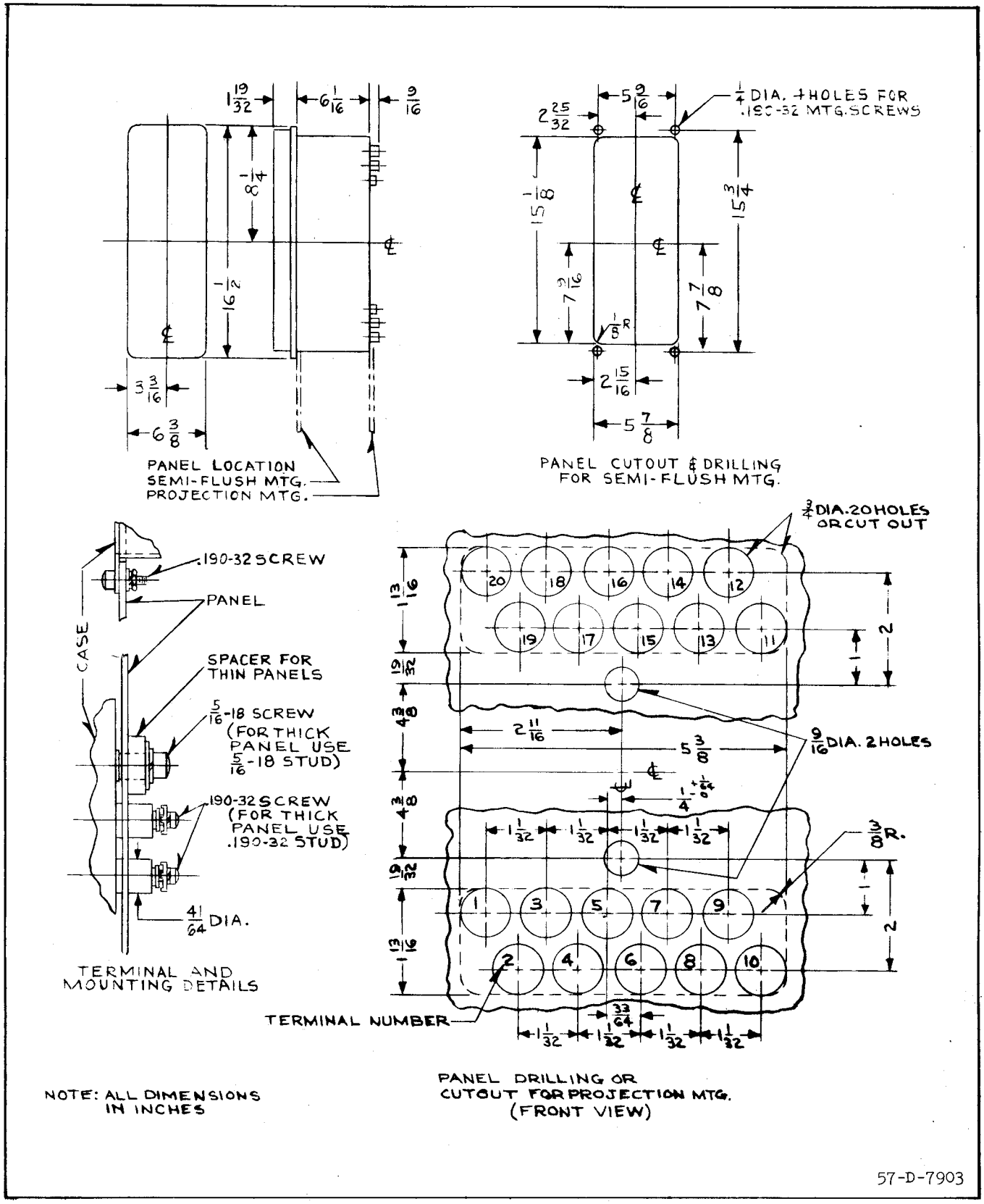

Fig. 21. Outline & Drilling Plan for The Type PS-13 Relay in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

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