INSTRUCTIONS

GEI-33891E
SUPERSEDES GEI-33891D

POWER DIRECTIONAL RELAY

TYPE GGP53B

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS

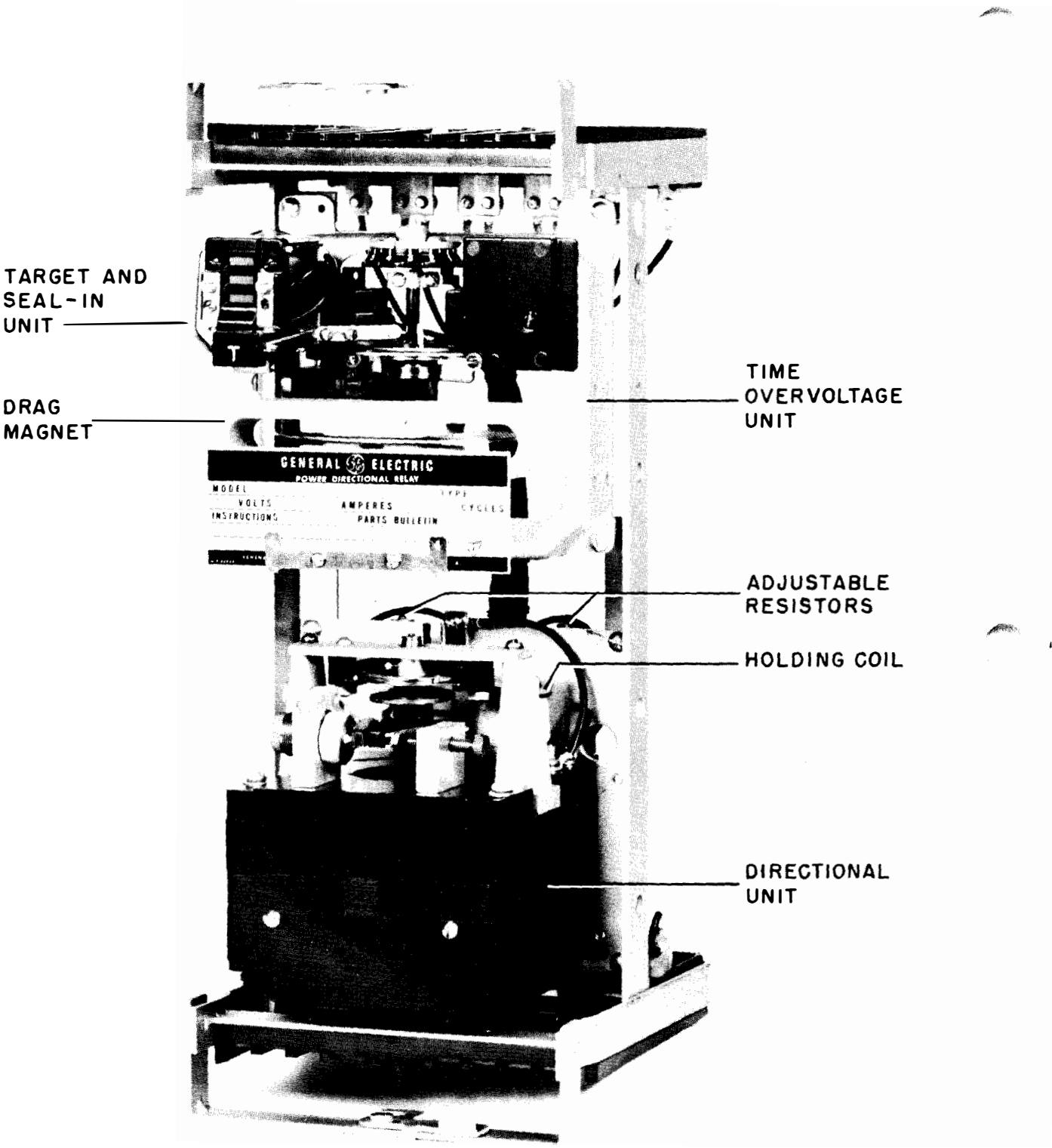


FIG. 1 (8024961) TYPE GGP53B RELAY REMOVED FROM CASE (FRONT VIEW)

POWER DIRECTIONAL RELAY

TYPE GGP53B

INTRODUCTION

The Type GGP53B is a three phase power directional relay. It consists of one eight pole induction cup power directional unit and an induction disk a-c operated timing unit. This relay is designed specifically for use in protecting against motoring of a generator upon the loss of its prime mover power. The relay is furnished in a size M2 case and it has a target-seal-in device. One relay per generator is required.

APPLICATION

While the GGP53B relay may be employed whenever reverse power, time delay operation is required, its major field of application is the protection of generators against motoring. Because of its extreme sensitivity, the GGP53B is almost universally applicable for this function. However, in many instances, the motoring power taken by the generator is so large that the sensitivity of the GGP53B is not required and a less sensitive relay may be applied.

The following table lists the appropriate motoring power taken by the various types of generators.

TYPE OF PRIME POWER	MOTORING POWER IN PERCENT OF UNIT RATING
Gas Turbine - Single Shaft	100
Gas Turbine - Double Shaft	10 - 15
4 Cycle Diesel	15
2 Cycle Diesel	25
Hydraulic Turbine	2 - 100*
Stean Turbine (conventional)	1 - 4
Steam Turbine (Cond. Cooled)	0.5 - 1.0

* The larger powers are taken by turbines having submerged impellers.

When the generator starts to motor, the directional unit closes its contacts and energizes the coil of the time delay unit. The time delay unit then starts to time out. If the generator continues to motor long enough for the time delay unit to time out, the generator breaker is tripped. If the prime mover starts to drive the generator before the time delay unit has timed out, the directional unit will open its contacts and the time delay unit will reset. The time delay setting is adjustable over the range of 1.5 to 30 seconds at rated voltage. The time delay is determined by the time dial setting.

The directional unit has maximum torque when the current is at unity power factor. The directional unit therefore operates on the watt component of the current flowing into the generator. The directional unit will close if the primary KW into the generator is more than the following:

Primary KW = 0.0052 x CT Ratio x PT Ratio

With the CT ratio such that generator full load current is between 5 and 2.5 secondary amperes, the Type GGP53B relay will operate when the power flows into the generator is between 0.5 to 1.0 percent of the generator nameplate rating in KW.

The power directional unit in the GGP53B relay operates instantaneously to energize a separate AC operated time delay unit in the relay. This time delay unit is adjustable in the range of from about 1 t 30 seconds. See time curves in Figure 6. A suitable setting should be made so that,

1) The relay will not time out on power swings during synchronizing.

2) The relay will not time out if the directional unit operates on a transient basis during nearby external faults.

It is suggested that a minimum setting of about 5 seconds be considered unless there is good reason for shorter settings.

Figure 3 illustrates the external connections to the relay. It is important to note that the associated circuit breaker's auxiliary switch should be used in the timer circuit to prevent operation when the main circuit breaker is open. This will eliminate any possibility of nuisance operations due to vibration while the generator unit is being brought up to speed.

It is important to recognize that the GGP53B is a true power directional relay only under balanced voltage and current conditions. Its sensitivity is based on balanced conditions with rated voltages applied. At applied balanced voltages different from the rated value, the current required to operate the relay is given by the following equation.

$$I = I_R \times \frac{\text{Rated Voltage}}{\text{Applied Voltage}}$$

where: I_R is the current required to operate the relay with voltage applied.

When selecting a GGP53B relay it is important to select a voltage rating that matches the voltage supply. For example, if the generator PT's will be connected to supply a nominal 120 volts phase-to-phase then a relay with a 120 volt rating should be used. If the PT's will supply a nominal 208 volts phase-to-phase then a 208 volt relay should be specified.

CALCULATIONS OF SETTINGS

Following is a sample calculation of the relay setting check.

Consider a steam turbine driven generator with the following rating

18.0 KV
192,000 KVA

Assume that it is desired to provide motoring protection for this unit. On the basis of the above rating, the full load current of this unit would be

$$I_{FL} = \frac{192,000}{18\sqrt{3}} = 6,150 \text{ primary amperes.}$$

Assume a CT ratio of 8,000/5 and a PT ratio of 18,600/120. Assume further that the manufacturer of the unit advises that the motoring power taken by the machine at rated speed will be 4,000 KW. At rated voltage this represents an in-phase component of current

$$I_M = \frac{4,000}{18\sqrt{3}} = 128 \text{ primary amperes.}$$

or

$$I_M = \frac{128}{8,000} \times 5 = 0.08 \text{ secondary amperes.}$$

The GGP53B relay has a minimum pickup of 0.025 in-phase amperes at rated volts adjustable to 0.3 amperes maximum. Since the rated voltage of the machine (18,000 volts) is somewhat lower than that of the associated PT's (18,600 volts), the PT secondary voltage at rated machine voltage will be

$$\frac{18,000}{18,600} \times 120 = 116 \text{ volts.}$$

At 116 volts the GGP53B relay will require

$$\frac{120}{116} (0.025) = 0.026 \text{ secondary amperes.}$$

to pick up.

Since the in-phase component of the motoring current of the machine exceeds the relay pick-up current, this is a good application.

It is important to note that the time delay setting employed should be long enough to override momentary power reversals during synchronizing and system swings.

RATINGS

Type GGP53B relays are available with potential coils rated at 120 volts or 208 volts and current coils rated at 5 amperes.

The current closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying ratings are affected by the selection of the tap on the seal-in coil as indicated in the following table:

	Amperes, AC or DC	
	Target and Seal-in Coil Tap	
	2-Amp (0.13 ohms)	0.2-Amp (7 ohms)
Tripping Duty	30	5
Carry Continuously	3	0.3

The tap setting used on the seal-in unit is determined by the current drawn by the trip coil. The 0.2 ampere tap is for use with trip coils that operate on currents ranging from 0.2 up to 2 amperes at the minimum control voltage. If this tap is used with trip coils requiring more than two amperes, there is a possibility that the seven ohms resistance will reduce the current to so low a value that the breaker will not be tripped.

The 2.0 ampere tap should be used with trip coils that take 2.0 amperes or more at minimum control voltage, provided the tripping current does not exceed 30 amperes at the maximum voltage. If the tripping current exceeds 30 amperes, an auxiliary relay should be used, the connections being such that the tripping current does not pass through the contacts or the target seal-in coil of the protective relay.

BURDENS

The burdens of the current circuits at 5 amperes are as follows:

TERMINAL	FREQ	VA	WATT	P.F.
3-4 or 5-6	60	3.6	1.8	0.50
7-8	60	7.2	3.6	0.50
3-4 or 5-6	50	2.9	1.5	0.52
7-8	50	5.8	3.0	0.52
3-4 or 5-6	25	1.6	1.0	0.62
7-8	25	3.2	2.0	0.62

The burden of the potential circuit across studs 2-12 at rated voltage and frequency is as follows:

RATED				
Voltage	Frequency	VA	WATTS	P.F.
100	60	14.1	5.5	0.39
120	60	20.0	6.8	0.34
208	60	21.7	7.2	0.33
100	50	14.7	5.3	0.36
120	50	21.2	7.6	0.36
208	50	16.0	5.9	0.37
120	25	15.5	8.3	0.54

The burden of the potential circuits across studs 13-14, 15-16, 17-18, or 19-20 at rated voltage and frequency are each as follows:

RATED				
Voltage	Frequency	VA	Watts	P.F.
100	60	3.6	1.8	0.50
120	60	5.2	2.6	0.50
208	60	4.6	2.3	0.50
100	50	4.3	2.2	0.51
120	50	6.2	3.2	0.51
208	50	5.5	2.8	0.51
120	25	3.6	1.9	0.53

RECEIVING, HANDLING AND STORAGE

These relays, when not included as a part of a control panel will be shipped in cartons desinged to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust, and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

DESCRIPTION

Type GGP53B relay consists of an time-delay overvoltage unit (upper) a three phase directional unit (lower) and a target and seal-in unit.

DIRECTIONAL UNIT

The three-phase directional unit is of the induction-cylinder construction. The principle by which torque is developed is the same as that employed in an induction-disk relay with a watt-hour meter element, though in arrangement of parts the relay is more like a split-phase induction motor.

The holding coil is connected in series with contacts of the lower unit.

Included in the construction of the lower assembly is the stator which has eight laminated magnetic poles projecting inward and arranged symmetrically around a central magnetic core. The poles are fitted with current and potential coils. In the annular air gap between the poles and central core is the cylindrical part of the cup-like aluminum rotor, which turns freely in the air gap. The central core is fixed to the stator frame; the aluminum cup alone turns.

This construction provides higher torque and lower rotor inertia than the induction-disk construction, making this relay faster and more sensitive.

TIME OVERVOLTAGE UNIT

The time delay overvoltage unit is of the induction-disk construction: A potential operating coil on a laminated U-magnet actuates the disk. The disk shaft carries the moving contact which completes the trip or alarm circuit when it touches the stationary contact or contacts. To give the proper contact closing voltage, the disk shaft is restrained by a spiral spring, and its motion is retarded by a permanent magnet acting on the disk to give the correct time delay.

TARGET AND SEAL-IN UNIT

A seal-in unit is mounted to the left of the disk shaft. This unit has its coil in series and its contacts in parallel with the main contacts of the time overvoltage unit such that when the main contacts close, the seal-in unit picks up and seals in. When the seal-in unit picks up, it raises a target into view which latches up and remains exposed until released by pressing a button beneath the lower-left corner of the corner.

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel drilling dimensions are shown in Fig. 10.

CONNECTIONS

The internal connections diagram for this relay is shown in Fig. 2. A typical wiring diagram is shown in Fig. 3.

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B & S gauge copper wire or its equivalent.

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other imperfections. If any trouble is found, it should be corrected in the manner described under MAINTENANCE.

CAUTION:

EVERY CIRCUIT IN THE DRAWOUT CASE HAS AN AUXILIARY BRUSH. IT IS ESPECIALLY IMPORTANT ON CURRENT CIRCUITS AND OTHER CIRUCIT WITH SHORING BARS THAT THE AUXILIARY BRUSH BE BENT HIGH ENOUGH TO ENGAGE THE CONNECTING PLUG OR TEST PLUG BEFORE THE MAIN BRUSHES DO. THIS WILL PREVENT CT SECONDARY CIRCUITS FROM BEING OPENED. SEE FIG. 4 SHOWING A CUT-AWAY VIEW OF THIS ASSEMBLY.

FIELD INSTALLATION TESTS

When installing the relay, it is necessary to know (1) that the voltages and currents go to the proper relay terminals, and (2) that none of the relay coils are open-circuited.

Test (1) may be performed using a Weston phase angle meter and two relay test plugs as shown in Fig. 5. With the relay connected as shown in external wiring diagram, Fig. 3 perform the tests outlined below.

Phase angle meter readings are the angle by which the current leads the voltage.

θ = Angle by which I_1 leads V1-2.

θ = 330° at unity power factor when power flow is in non-trip direction.

θ = 150° at unity power factor when power flow is in the trip direction.

Connect P_1 to common points 13R and 13B, P_2 to common points 14R and 14B.

Connect	3R	3B	5R	5B	7R	7B	Phase Angle Meter Reading
(1	C1	C2	5B	5R	7B	7R	θ
To (2	3B	3R	C1	C2	7B	7R	θ + 240
(3	3B	3R	5B	5R	C1	C2	θ + 120

Connect P_1 to common points 15R and 15B, P_2 to common points 16R and 16B.

Connect	3R	3B	5R	5B	7R	7B	Phase Angle Meter Reading
(1	C1	C2	5B	5R	7B	7R	θ + 120
To (2	3B	3R	C1	C2	7B	7R	θ
(3	3B	3R	5B	5R	C1	C2	θ + 240

Connect P_1 to common points 17R and 17B, P_2 to common points 18R and 18B.

Connect	3R	3B	5R	5B	7R	7B	Phase Angle Meter Reading
(1	C1	C2	5B	5R	7B	7R	θ + 240
To (2	3B	3R	C1	C2	7B	7R	θ + 120
(3	3B	3R	5B	5R	C1	C2	θ

Connect P_1 to common points 19R and 19B, P_2 to common points 20R and 20B.

Connect	3R	3B	5R	5B	7R	7B	Phase Angle Meter Reading
(1	C1	C2	5B	5R	7B	7R	θ + 120
To (2	3B	3R	C1	C2	7B	7R	θ
(3	3B	3R	5B	5R	C1	C2	θ + 240

Test (2) may be performed ny noting that torque is available and in the correct direction upon removal of two of the three currents, removing each of the three current combinations in turn. When making this test, the current should be considerably removed from the angle of zero torque.

Some operators believe that test (2) is all that is necessary. However, it is possible to get the correct direction of the torque in test (2) without having current connections.

POLARITY

Complete polarity tests are made in the factory and these may be checked by connecting terminals A and C together as listed in the following table, connecting terminals B and D through a resistor (20 ohms), and applying rated voltage to terminals C and D. With these connections, the left-hand contact (front view) should close in each of the following eight checks.

Current Coil		Potentail Coil	
A	B	C	D
3	4	20	19
3	4	14	13
5	6	16	15
5	6	18	17
7	8	13	14
7	8	15	16
7	8	17	18
7	8	19	20

TARGET AND SEAL-IN ELEMENT

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap screw in the 0.2 ampere tap.

For trip coils operating on currents ranging from 2 to 30 amperes at the minimum control voltage, place the tap screw in the 2.0 ampere tap.

The tap screw in the screw holding the right-hand stationary contact of the seal-in unit. To change the tap setting, first remove the connection plug. Then, take a screw from the left-hand stationary contact and place it in the desired tap. Next remove the screw from the other tap, and place it in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Screws should not be in both taps at thesame time.

TIME SETTING

The time delay of the upper unit is determined by the setting if the time dial. The time is 30 seconds when the time dial is set on #10 T.D.S. Fig. 6 shows the time delay for any time dial setting.

PICKUP

The pickup of Type GGP53B relay may be checked by connecting it as in Fig. 7. With rated voltage, current and frequency, the relay should just close its contacts at a phase angle of 120 degrees and 300 degrees, current leading voltage. This means the maximum torque angle read on the phase angle meter is 30 degrees.

With the phase angle set at 30 degrees, current leading voltage, the relay should just close its contacts when each of the ammeters in Fig. 7 is reading 0.025 amperes.

CLUTCH

The clutch adjusting screw on the lower unit should be tightened so that the clutch will not slip when rated voltage and current at the angle of maximum torque is applied.

HOLDING COIL

The holding coil gap should be adjusted so that the holding action will not be enough to hold the directional unti contacts closed when there is only potential applied to the directional unit potential coils. This holding coil is used to assist the directional unit to hold its contacts closed when the relay is operating near pickup, in a location where there is vibration. If when installed it is found that the holding coil will hold the directional contact closed when only voltage is applied to the relay, the holding coil gap should be increased until the holding coil will no longer hold the contact closed. This gap can be increased by backing out the stop screw, set 1/2 turn, then bringing the contact barrel forward by a 1/2 turn also to maintain the same contact gap.

If the vibration at the relay location is not too severe the holding coil can be shorted out and the holding action eleminated entirely.

MAINTENANCE

PERIODIC TEST AND INSPECTION

An operation test and inspection of the relay at least once every six months is recommended. Regarding tests, it is believed that test (2) under FIELD INSTALLATION TESTS is sufficient.

SERVICING

The relay was properly adjusted at the factory to obtain the desired characteristics and it is advisable not to disturb these adjustments. If for any reason it becomes necessary to remove the rotor from the lower unit, proceed in the following manner.

a. Disconnect all the lead from this unit that go to the terminal or to the upper unit.

b. Remove the four screws that hold the relay base plate to the cradle, and remove the unit from the cradle.

c. Remove the two screws which secure the top bearing plate.

d. The contact plate is secured to the stator assembly by means of three screws. The screws are located on the right-hand and left-hand sides in the front and in the middle at the rear. Remove the three screws.

e. The shaft, rotor and top bearing plate will lift out with the contact plate.

f. The rotor amy be removed from the shaft by loosening the two set screws which fit into V-holes in the shaft when the rotor is properly placed on the shaft.

The two stator castings are permanently fastened together with the lamenations clamped between them and the faces of the poles and the cylindrical surfaces on these castings are then machined true about the same axis. To preserve this alignment the large rivets in the corners should never be removed.

Use care in handling the rotor while it is out of the relay; and see that the air gap and rotor are kept clean.

In reassembly, the rotor will go into the air gap easily without forcing if the parts are held in line properly.

BEARINGS

The lower jewel bearing should be screwed all the way in until its head engages the end of the threaded core. The upper bearing should be adjusted to allow about 1/64 inch end play to the shaft.

To check the clearance between the iron core and the inside of the rotor cup, press down on the contact arm near the shaft and thus depress the spring mounted jewel until the cup striked the iron. The shaft should move about 1/16 inch.

The lower jewel may be tested for cracks be exploring its surface with the point of a fine needle. If it is necessary to replace the jewel a new pivot should be screwed into the bottom of the shaft at the same time.

If lower unit is dissambled the relay must be recalibrated.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility if the tool insures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioation of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described above can be obtained from the factory.

The stationary contacts on the lower unit is a barrel type assembly which supports a cone type silver contact mounted on a flexible diaphram. It is important to note that this assembly does not use a solid diaphram behind the silver contact nor does it have a steel ball. These last two items are commonly used in this barrel type stationary contact. This assembly then, in conjunction with the action of the holding coil results in good contact action.

The contact barrel has 32 threads per inch, hence provides a convenient means to set or check the required contact of 0.018". 210 degree of the barrel is equal to a 0.018" displacement.

RECALIBRATION

BIAS

A voltage bias is made on the lower unit. The potential connections are made as shown in Fig. 7. The current connecitons are not made. Rated voltage and frequency is then applied to the relay after the control spring is set so that teh contact floats free from both the contact and the backstop. When voltage is applied the contacts should remain in the same position as they were before the voltage was applied. If the contacts move the unit should be adjusted for zero torque as follows:

Zero torque is obtained by loosening the nut at the bottom of the stator which locks the core in position andturning the core a small amount by means of a screw driver in the slot at the bottom of the core. Small notches in the core face parallel to the axis of the cover make this adjustment possible. Be sure to tighten the nut after this adjustment.

MAXIMUM ANGLE OF TORQUE

With the relay connected as in Fig. 7 rated voltage, current and frequency applied, the four adjustable resistors mounted on the rear of the relay may be adjusted so that the lower unit contacts will just close at phase angle readings of 120 and 200 degrees. Hence, teh maximum angle of torque will be at 30 degrees, current leading voltage.

CLUTCH

Tighten the clutch adjusting screw so that the clutch will not slip when rated voltage and current at rated frequency is applied.

PICK UP (LOWER UNIT)

The pick up amy be set by first adjusting the phase shifter of Fig. 7 for 30 degrees. Then, the current through the ammetrs should be reduced to 0.025 amperes. The spring should be adjusted so that the lower unit contacts just close at this current.

HOLDING COIL

The information under INSTALLATION for the holding coil should be applied.

PICK UP (UPPER UNIT)

With the relay connected as in Fig. 8, the pick up of the upper unit should be set using the control spring. The contacts should just close at 57.5 volts for 120 volt relays and 100 volts for 208 volt relays.

TIME TEST (UPPER UNIT)

The time of the upper unit may be checked by connecting relay as in Fig. 8. If the time does not check that given in Fig. 6, adjust alnico drag magnet along its shelf a short distance, until a time of 30 seconds from the number 10 time dial setting is obtained. Moving the drag magnet toward the disk shaft shortens the time shile moving it toward the disk edge lengthens the time.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken, or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted, and give complete nameplate data. If possible, give the General Electric Company requisition number on which the relay was furnished. For a parts list refer to GEF-3956.

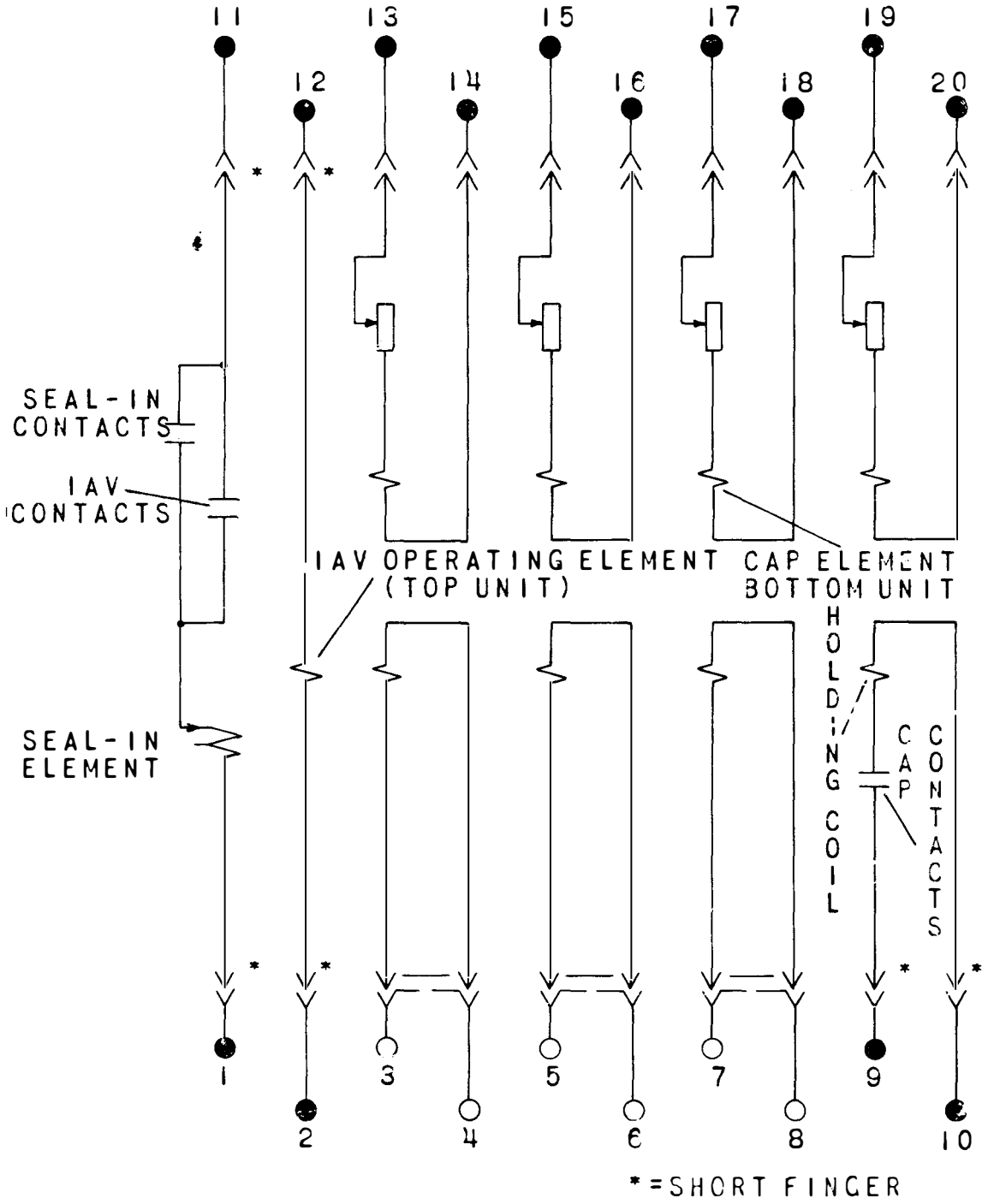


FIG. 2 (6507969-0) Internal Connections Diagram For The GGP53B Relay (Front View)

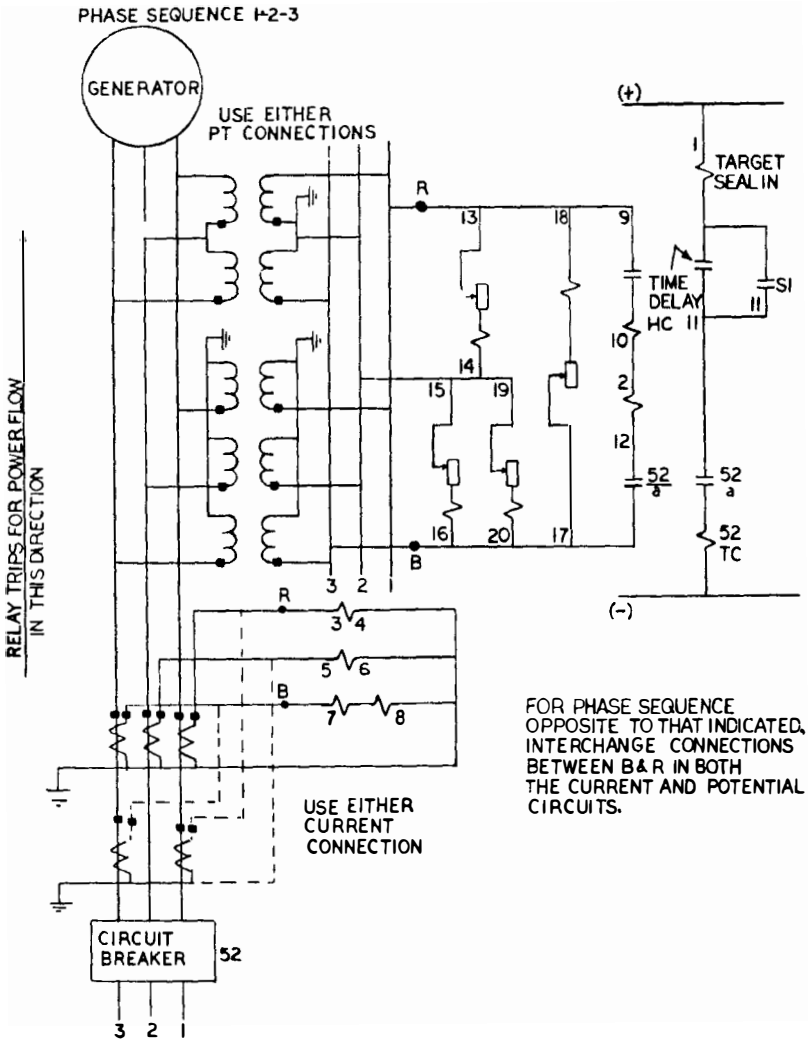
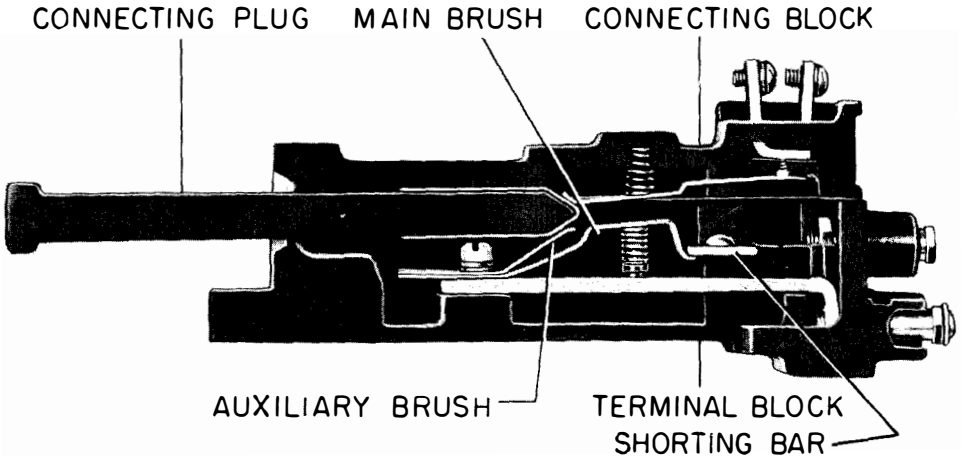
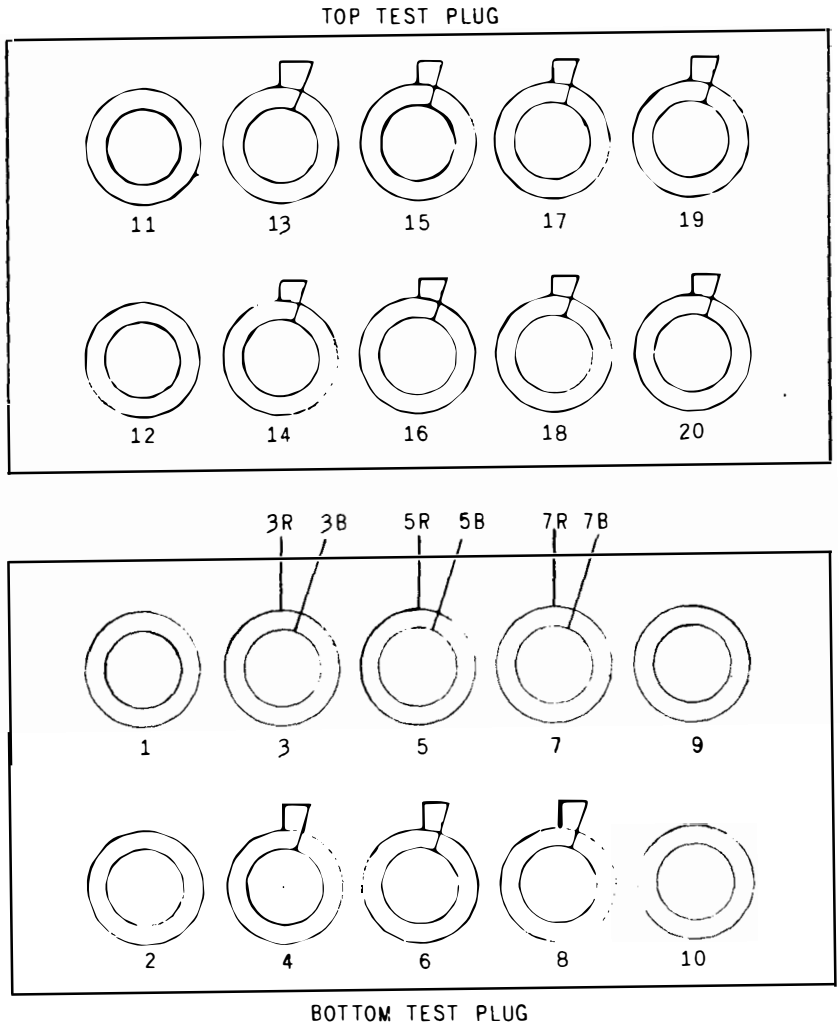


FIG. 3 (0226A7012-1) External Connections Diagram For The GGP53B Relay



NOTE: AFTER ENGAGING AUXILIARY BRUSH, CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK

FIG. 4 (8025039) Cross Section Drawout Case Showing Position Of Auxiliary Brush



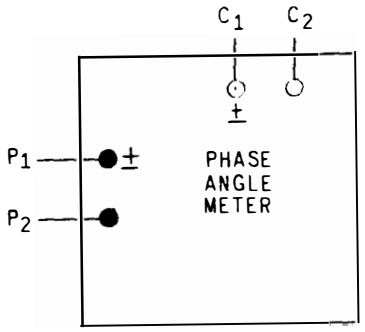


FIG. 5 (264B417-0) Sh. 1 Test Plug Diagram For The GGP53B Relay

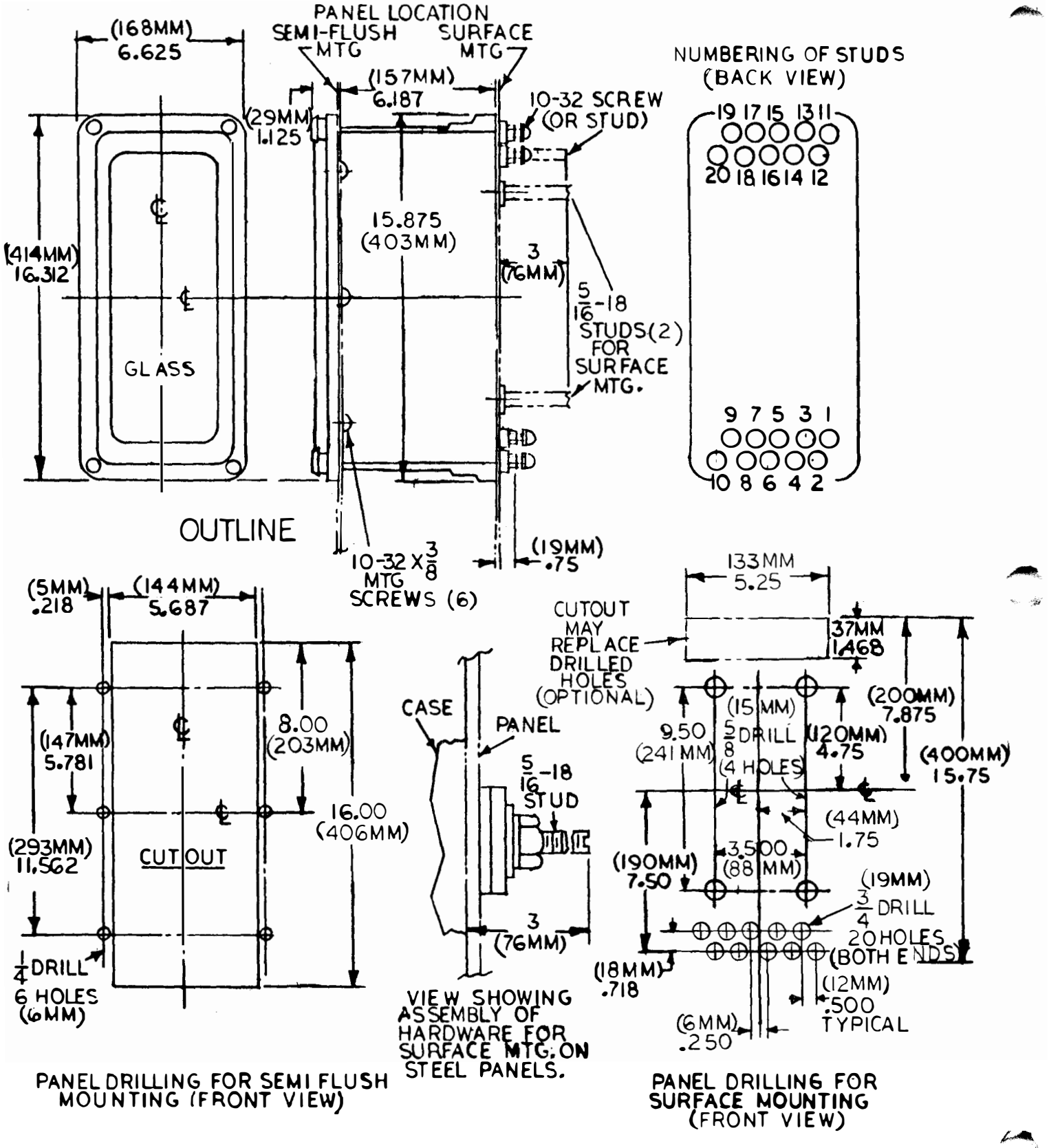


FIG. 9 (K-6209274-2) Outline And Panel Drilling Dimensions For The GGP53B Relay

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