INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-4 OVERCURRENT RELAY

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

APPLICATION

The type KC-4 is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other relays. It is well suited to breaker-failure relaying for indicating the presence or lack of current flow in the circuit breaker. The relay can be applied where the phase units are to be operated indefinitely in the picked up position well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load) the 98% or better dropout ratio of the phase units is advantageous.

Breaker-failure relaying offers advantages over remote back-up protection. It is faster and more sensitive than remote back-up methods. In addition, it is selective, whereas remote back-up protection is frequently non-selective. Fig. 2 shows some fault conditions where breaker-failure relaying could improve the quality of back-up protection. Note that the generating-station high-voltage bus uses a breaker-and-a-half arrangement. Lines interconnect the station to systems S_1, S_2, and S_3.

If there is no malfunctioning, fault L will be cleared by line relays tripping breakers 5, 6, and 9. However, assume that the breaker-6 mechanism sticks so that current flow through breaker 6 is not interrupted. Now back-up protection must function. If remote backup is relied upon, time-delay relays must trip remote breakers 7 and 8. In addition, the local generator feed through breaker 6 must be interrupted by tripping breaker 4. However, if breaker-failure protection is installed, the fault is cleared by tripping breaker 3. Note that this provided selective tripping, since as much of the system as possible was left intact. If breakers 4, 7, and 8 must trip, the local generator is lost and unnecessary separation of the generating station from power systems S_1 and S_2 results. Also, the tapped load is interrupted unnecessarily instead of being left tied to system S_2.

Remote backup, in addition to not being selective, may not be sensitive enough because of the relatively small proportion of the total fault current following in any one line. For example, in Fig. 2 there may be very little current flow in breakers 7 and 8 for fault L because of the large current contribution by the local machines at the generating station. Thus, it may be difficult or impossible at breakers 7 and 8 to detect adjacent line faults without depending upon sequential tripping. If the generator feed is interrupted for fault L, such as by tripping breaker 4, the current through breakers 7 and 8 may increase sufficiently for the relays to operate and trip breakers 7 and 8. However, the system is by now cut to pieces, and because of the long time delay in clearing the fault, the remainder of the system may be unstable.

Although breaker-failure protection offers many advantages, remote backup cannot be completely eliminated. For example, assume that breaker 3 fails for bus-fault B in Fig. 2. Breaker-failure protection will promptly trip breaker 2, but the fault is still fed by breaker 8. Likewise, if breaker 2 fails with a line fault at M, a remote breaker must trip to clear the fault. Breaker-failure protection trips breaker 3, but breaker 8 still feeds the fault. Although breaker-failure protection does not complete the job in these examples, it does expeditiously trip the local breaker, making it easier for the remote relays to detect the fault.

SUPERSEDES I.L. 41-776.1
*Denotes change from superseded issue.

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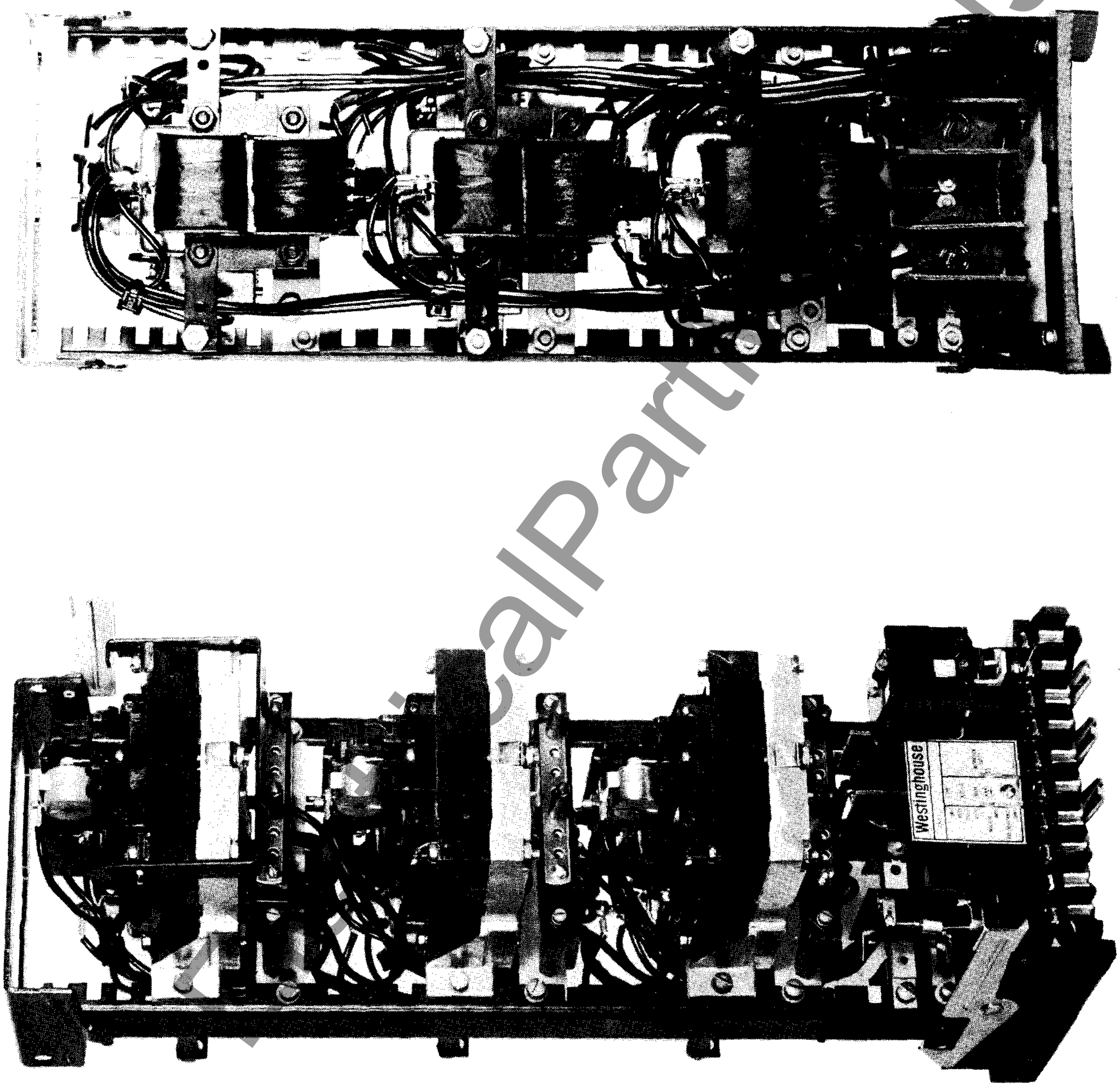


Fig. 1. Type KC-4 Relay Without Case.

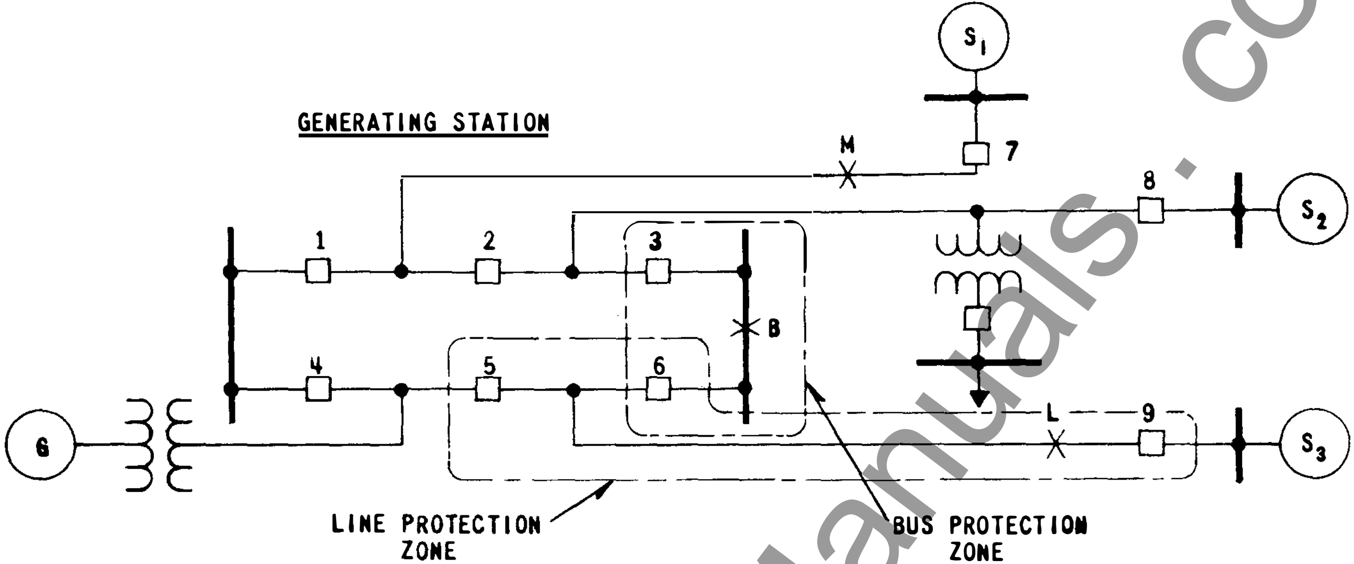


Fig. 2. Sample System to Show Advantages of Breaker-Failure Protection.

CONSTRUCTION

The type KC-4 relays consists of two phase instantaneous overcurrent units, (I_1 and I_3), one one ground instantaneous unit (I_O), and an indicating contactor switch (ICS). The principal component parts of the relay and their location are shown in Figures 1 and 3.

Phase and Ground Instantaneous Overcurrent Units (I_1, I_3, I_o)

Each instantaneous overcurrent unit consists of an induction cylinder unit, capacitor, varistor, and a transformer. The components are connected such that a contact closing torque is produced when the current exceeds a specified value.

Induction Cylinder Unit

Mechanically, the cylinder unit is composed of four basic components: a diecast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another, and a capacitor is connected in series with one pair of coils. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearings, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

Transformer

The transformer is a saturating type consisting of a tapped primary winding and a secondary winding. A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction cylinder unit and phase shifting capacitor.

Indicating Contactor Switch Unit (ICS.)

The indicating contactor switch is a small d-c operated 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 valve of the switch.

OPERATION

Instantaneous Overcurrent Unit

Operation of the instantaneous overcurrent unit occurs when the primary current of the transformer exceeds a value as marked on the tap plate. Upon application of current to the transformer, a voltage is induced in the secondary winding. This voltage is impressed upon the parallel connected pairs of cylinder unit coils. The capacitor connected in series with one pair of coils shifts the current flowing in these coils in reference to the current flowing in the other pair of coils. As a result, the air gap fluxes of the cylinder unit are out of phase and a contact closing torque is produced.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pickup current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

General Operation Of Scheme

When the proper breaker successfully interrupts the fault current the KC-4 relay quickly disables the breaker-failure timing circuit. In addition, where the line relays trip two breakers such as on a ring

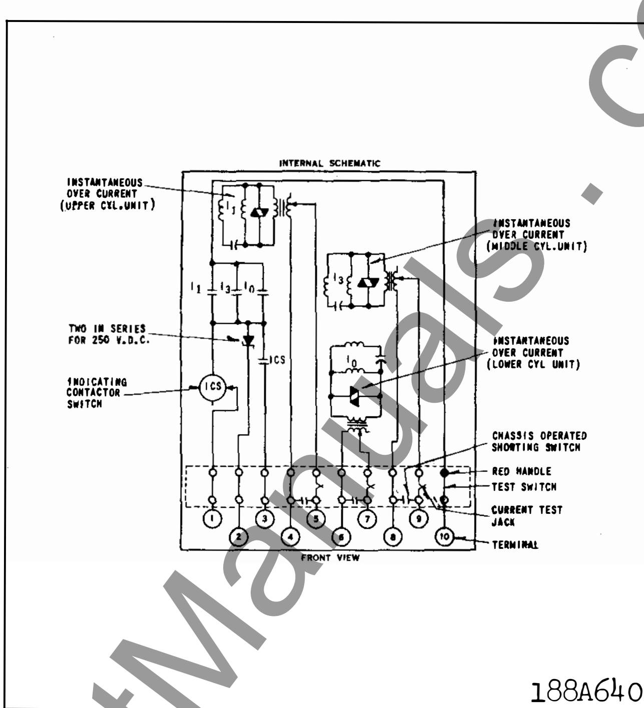


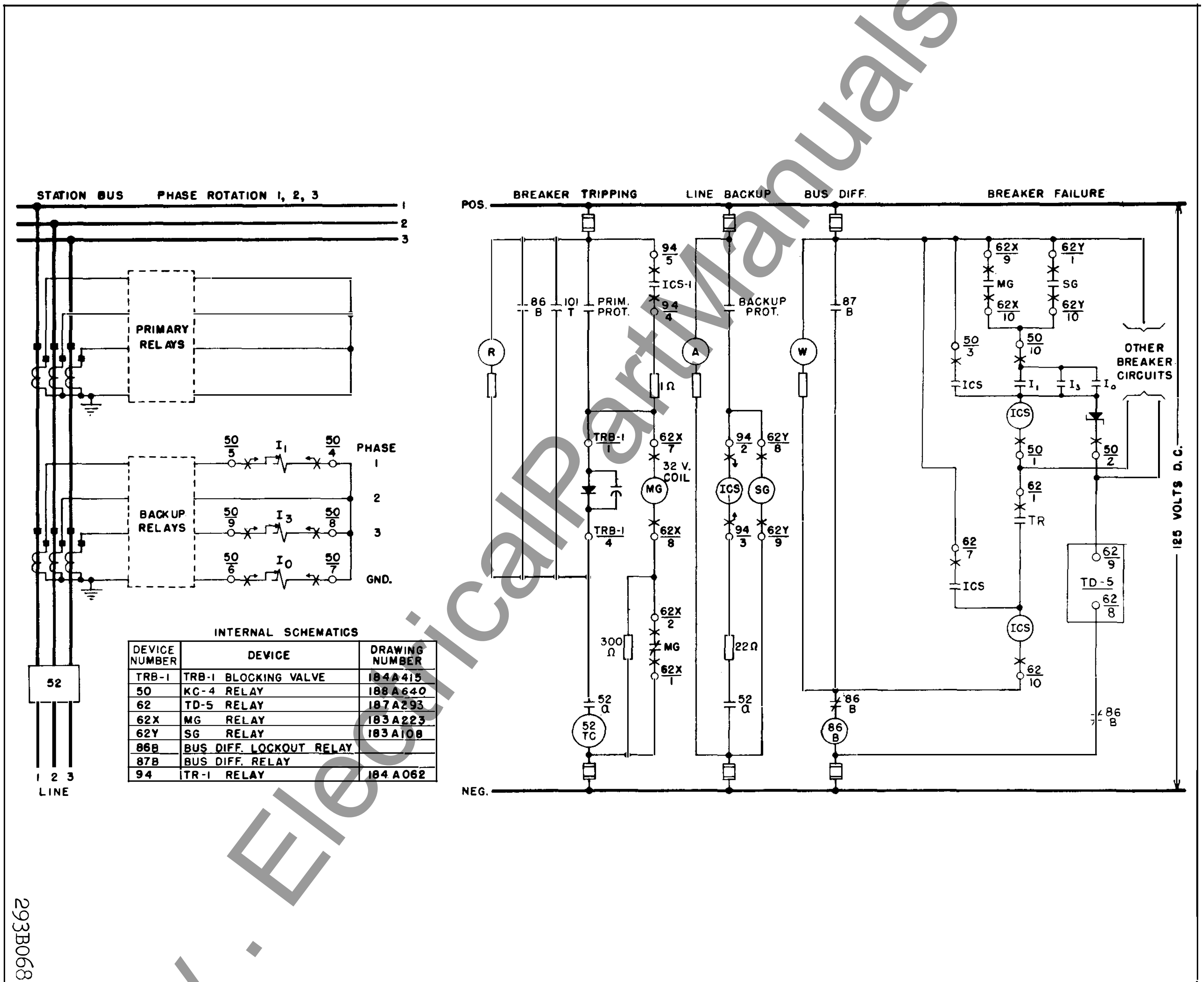
Fig. 3. Internal Schematic of the KC-4 Relay in the FT-41 Case.

bus, the KC-4 selects which of the two breakers has failed. When the phase overcurrent units I_1 and I_3 are set above load-current level, the KC-4 also functions as a fault detector to prevent undesired tripping by test personnel. The following paragraphs describe KC-4 operation in more detail for different system bus connections.

Single Bus/Single Breaker Arrangement

Unless something fails, current flow in the breaker should cease shortly after the trip circuit is energized. The time interval between these two occurrences will be the breaker-interrupting time. If this interruption does not occur, breaker-failure relaying will initiate the tripping of other breakers. Fig. 4 shows how this is accomplished. Unless something fails either the primary of back-up relays initiate tripping of the faulted line breaker. Note that the primary and back-up relays connect to separate sets of current transformers and d-c supplies. This way a failure in one or the other circuits will not disable all of the protection.

When the primary protection operates, it energizes 62X; the back-up protection energizes 62Y. Contacts of these two auxiliaries start the breaker-failure timer 62, through the KC-4 contacts. If the line breaker fails to clear the fault, KC-4 contacts remains closed. The contact of timer 62 closes, energizing the bus lock-out relay 86B through 62X or 62Y and KC-4 contacts. Relay 86B then trips all the



INTERNAL SCHEMATICS

DEVICE NUMBER	DEVICE	DRAWING NUMBER
TRB-1	TRB-1 BLOCKING VALVE	184A415
50	KC-4 RELAY	188A640
62	TD-5 RELAY	187A293
62X	MG RELAY	183A223
62Y	SG RELAY	183A108
86B	BUS DIFF. LOCKOUT RELAY	
87B	BUS DIFF. RELAY	
94	TR-1 RELAY	184A062

Fig. 4. External Schematic of the KC-4 Relay for Breaker Failure Protection of a Single Bus/Single Breaker Arrangement

breakers on the bus.

The TRB-1 rectifier in the primary – protection circuits of Fig. 4 blocks the flow of red-light supervision current through the 62X coil.

An MG-6 relay performs the 62X function in Fig. 4. Actually an SG will suffice unless a directional-comparison blocking system provides the primary protection. With this system two MG-6 contacts seal around the RRG and RRP contacts. (Refer to drawing 540D542 for the details of this arrangement.)

Breaker-and-a-Half Arrangement

Typical trip and control circuits for breaker-failure back-up protection for the breaker-and-a-half bus arrangement are shown in Fig. 5. The trip cir-circuits for line A and bus L are shown. Similar circuits would exist for breaker 3, line B and bus R. cuits would exist for breaker 3, line B and bus R. Protection against breaker 2 failure for line A faults and breaker 1 failure for line A or bus L faults is discussed below. All other breaker failure fault combinations are equivalent to one of these three combinations. For example, protection against a breaker 3 failure for bus R faults is similar to the protection against a breaker 1 failure for bus L faults.

Assuming a failure of breaker 2 for a fault on line A, the breaker-failure timer 62 associated with breaker 2 is energized by 62X or 62Y from line A. Since the KC-4 current detector 50-2 which is supplied by breaker 2 current does not drop out, 62 of breaker 2 operates 86LN of breaker 2. One 86LN contact trips breaker 3. Another 86LN contact stops the transmission of a blocking signal on line B, allowing the remote pilot relays to trip the remote line B breaker, if they detect the fault. Thus, the fault on line A is now cleared. Another 86LN contact blocks high-speed reclosing of breaker 3. Note that the timer is associated with the middle breaker, which is the breaker that has failed. The timer causes tripping of both outside breakers, which is the same approach used for ring bus protection, to be described later.

An essential function, the selection of the faulty breaker, is performed by the KC-4. Relays 62X and and 62Y indicate that the fault has not been cleared, but they are unable to define for a line A fault whether breaker 1 or breaker 2 is still feeding current to the fault. The 50-1 or 50-2 KC-4 performs this job.

If breaker 1 fails for a fault on line A, bus L is cleared. This is accomplished by the bus L breaker-failure timer which is energized by the line A relay detector 50-1 selects the faulty breaker. Note that the line A part of the bus L timer circuit in Fig. 5 is the same as that used with the single bus/single breaker arrangement in Fig. 4

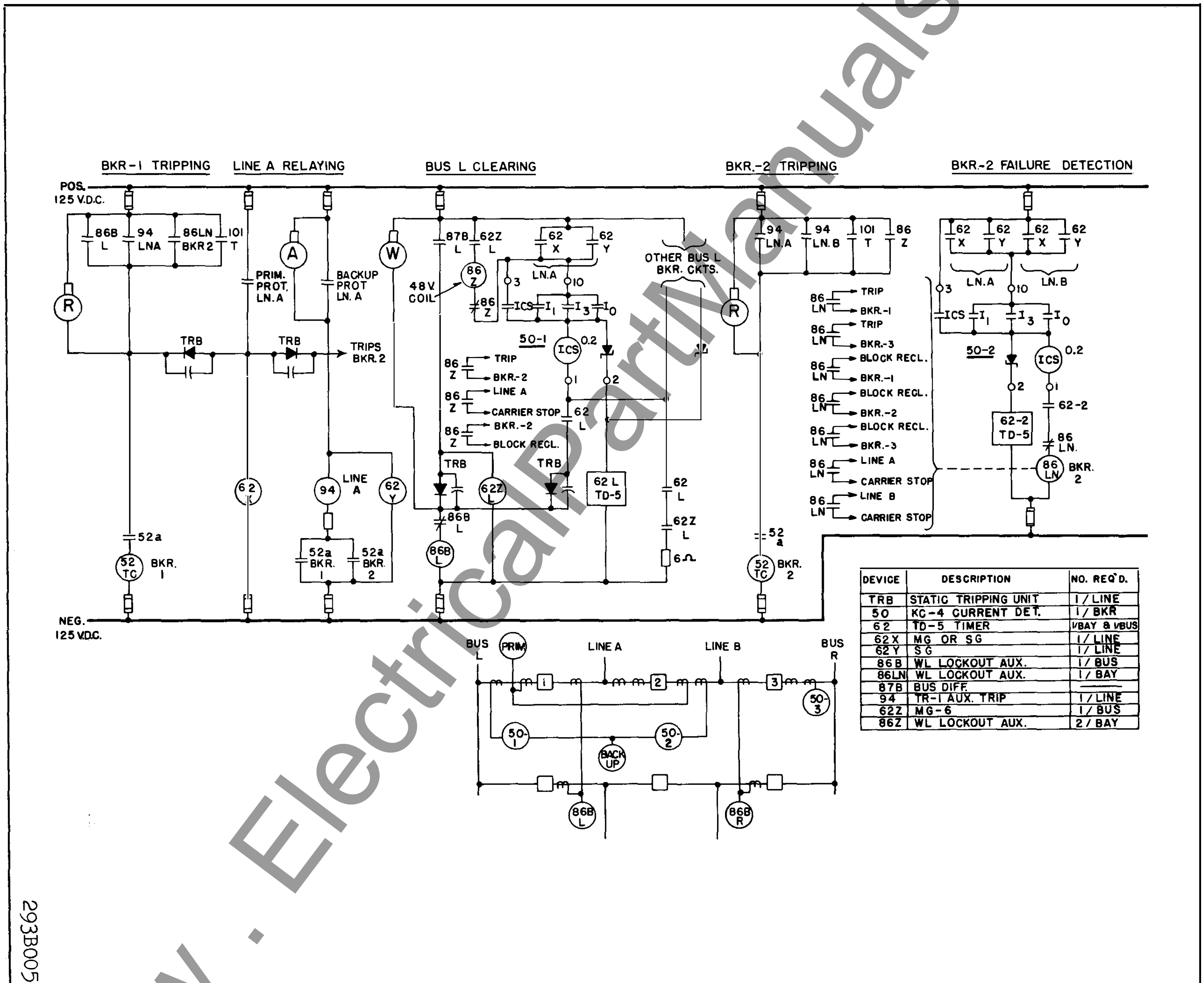
If breaker 1 fails for a fault on bus L it is desirable to trip breaker 2 and stop the transmission of blocking carrier on line A. This is accomplished by the 86Z device which is energized through 62ZL, 50-1 and 62L contacts and a six ohm resistor, as shown in Fig. 5. One 86Z contact trips breaker 2. Other 86Z contacts stop blocking carrier on line A and block reclosing of breaker 2. The six ohm resistor and the 86Z coil are both low impedance compared to the 62L circuit resistance. Therefore, the 86Z coil will not affect the 62L timing, and the 62L timing circuit current will not be enough to pick-up the 86Z device. The six ohm circuit maintains approximately half-voltage on the 62L device after the timing is completed. The purpose of this seemingly involved circuitry is to permit a single current detector, device 50-1, to supervise 62L timing, 86BL tripping and 86Z tripping.

Ring Bus Arrangement

The circuits for the ring bus are shown in Fig. 6 with trip and control circuits outlined for breaker 2, together with line-B primary and back-up protection circuits. As with the breaker-and-a-half scheme, the primary protection uses tripping rectifiers, and the backup uses an auxiliary relay to trip two breakers. As before, the 62X and 62Y relays are operated by the primary and back-up relays, respectively.

Assume a failure of breaker 2 for a fault on line B. Line-B relay 62X or 62Y is operated and energizes breaker-2 timer. Since current detector 50 for breaker 2 remains energized by the breaker-2 current, 62 operates to energize relay 86LN. Relay 86LN trips breakers 1 and 3, blocks reclosing on breakers 1,2, and 3, and stops carrier on lines A and B. The tripping of breaker 3 and the stopping of carrier of line B is unnecessary, since it is assumed that the protective relays have already accomplished these results. Although unnecessary, these functions do no harm and simplify the circuitry by permitting the 86LN relay to trip breakers and stop carrier symmetrically, without regard to whether the fault is on line A or line B.

The purpose of stopping carrier on line A is to remove carrier blocking to permit remote carrier relay relay tripping. Otherwise, line A continues to feed the fault through breaker 2 until a back-up relay operates or until the fault burns clear.



DEVICE	DESCRIPTION	NO. REQ'D.
TRB	STATIC TRIPPING UNIT	1 / LINE
50	KC-4 CURRENT DET.	1 / BKR
62	TD-5 TIMER	1/BAY & 1/BUS
62X	MG OR SG	1 / LINE
62Y	SG	1 / LINE
86B	WL LOCKOUT AUX.	1 / BUS
86LN	WL LOCKOUT AUX.	1 / BAY
87B	BUS DIFF.	——
94	TR-1 AUX. TRIP	1 / LINE
62Z	MG-6	1 / BUS
86Z	WL LOCKOUT AUX.	2 / BAY

Fig. 5. Simplified External Schematic of the Type KC-4 for Breaker Failure Protection of a Breaker-And-A-Half Bus.

CHARACTERISTICS

Phase & Ground Overcurrent Units are available in the following current ranges:

Range	Taps					
0.5 - 2 Amps.	0.5	0.75	1.0	1.25	1.5	2
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2	3	4	5	6	8

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the phase overcurrent units is shown in Fig. 7.

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 of lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 amp. tap 6.5 ohms d-c resistance
2.0 amp. tap 0.15 ohms d-c resistance

ENERGY REQUIREMENTS

PHASE & GROUND OVERCURRENT UNIT – 60 CYCLES

Ampere Range	Tap	VA at Tap Value	P.F. Angle	VA at 5 Amps.	P.F. Angle
	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
.5-2	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
1-4	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
2-8	4	1.3	38	2.1	37
	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29

Current Ratings

Rating of the Overcurrent Units (Phase & Ground)

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.5-2	5	100
1-4	8	140
2-8	8	140

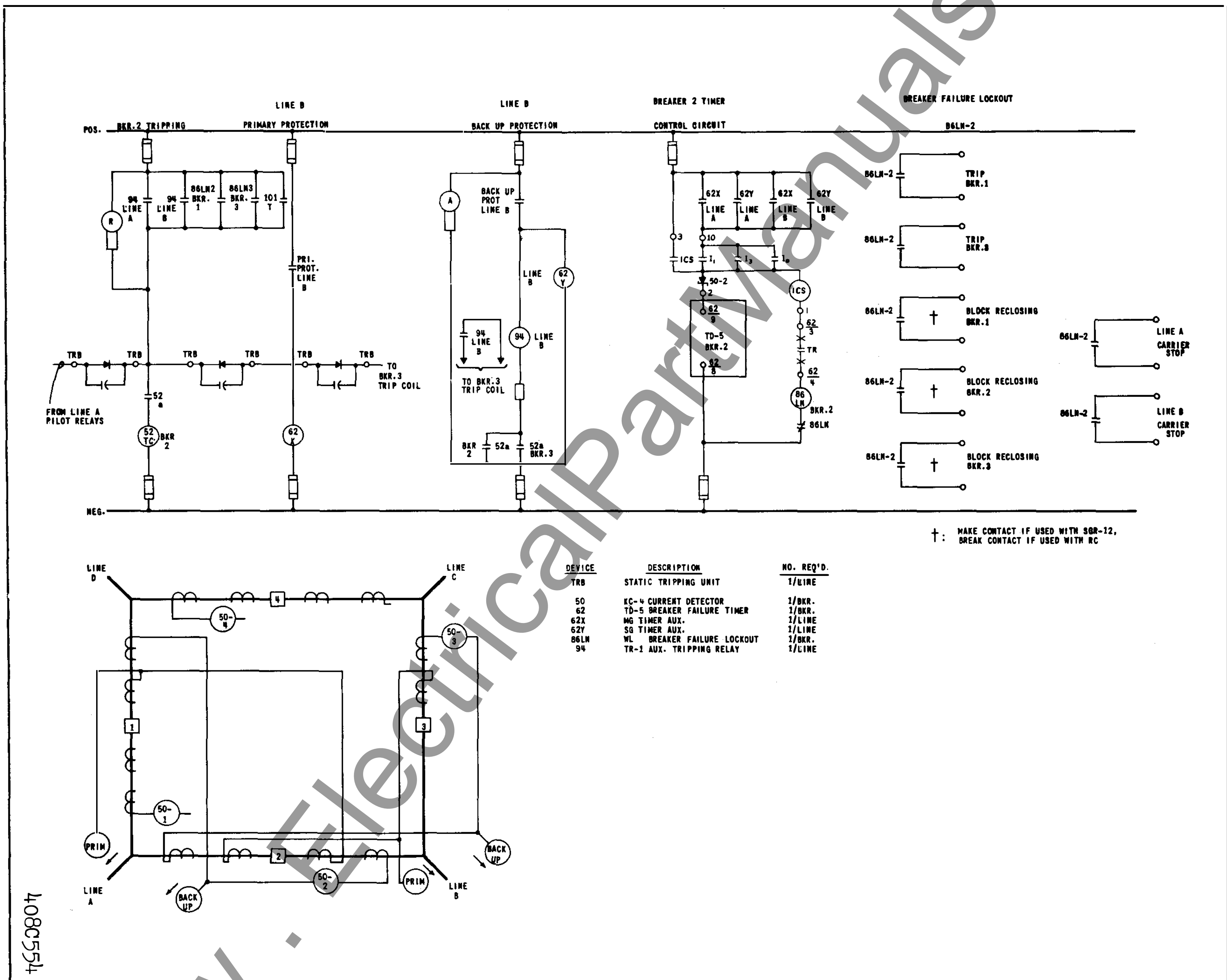


Fig. 6. Simplified External Schematic of the KC-4 for Breaker Failure Protection of a Ring Bus.

SETTINGS

Phase & Ground Overcurrent Unit

The pickup current setting is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION *Since the tap block connector screw carries operating current, be sure that the-screw is turned tight.*

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Indicating Contactor Switch (ICS.)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt d-c type WL relay switch or equivalent, use the 0.2 ampere tap; for 48-volt d-c applications set in 2 tap and use WL coil S#304C209G01.

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 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 information, refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under "SETTINGS," should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Phase & Group Overcurrent Unit

1. Contact Gap — The gap between the stationary and moving contacts with the relay in the de-energized position should be approximately .020."

2. Minimum Trip Current — The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

Indicating Contactor Switch (ICS)

Close the phase or ground 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836HO1 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.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

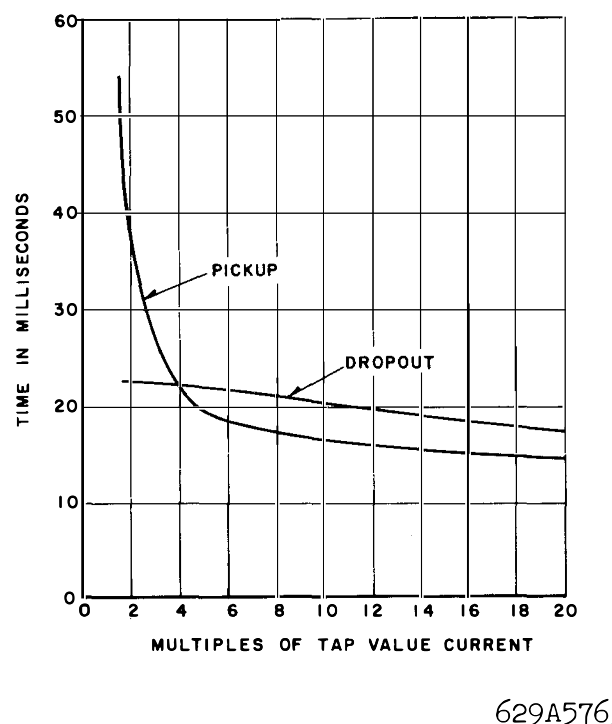


Fig. 7 Maximum Pick-Up and Drop-Out Time. Curves for the Phase Overcurrent Unit

Phase & Ground Overcurrent Unit

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in the stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, e.e., against the right side of the bridge. Advance the stationary contact until the contacts just close. Then back off the stationary contact 2/3 of one turn for a gap of approximately .020." The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact is position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver of similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ±5% of tap value.

If adjustment of pick-up current in between tap settings is desired, insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

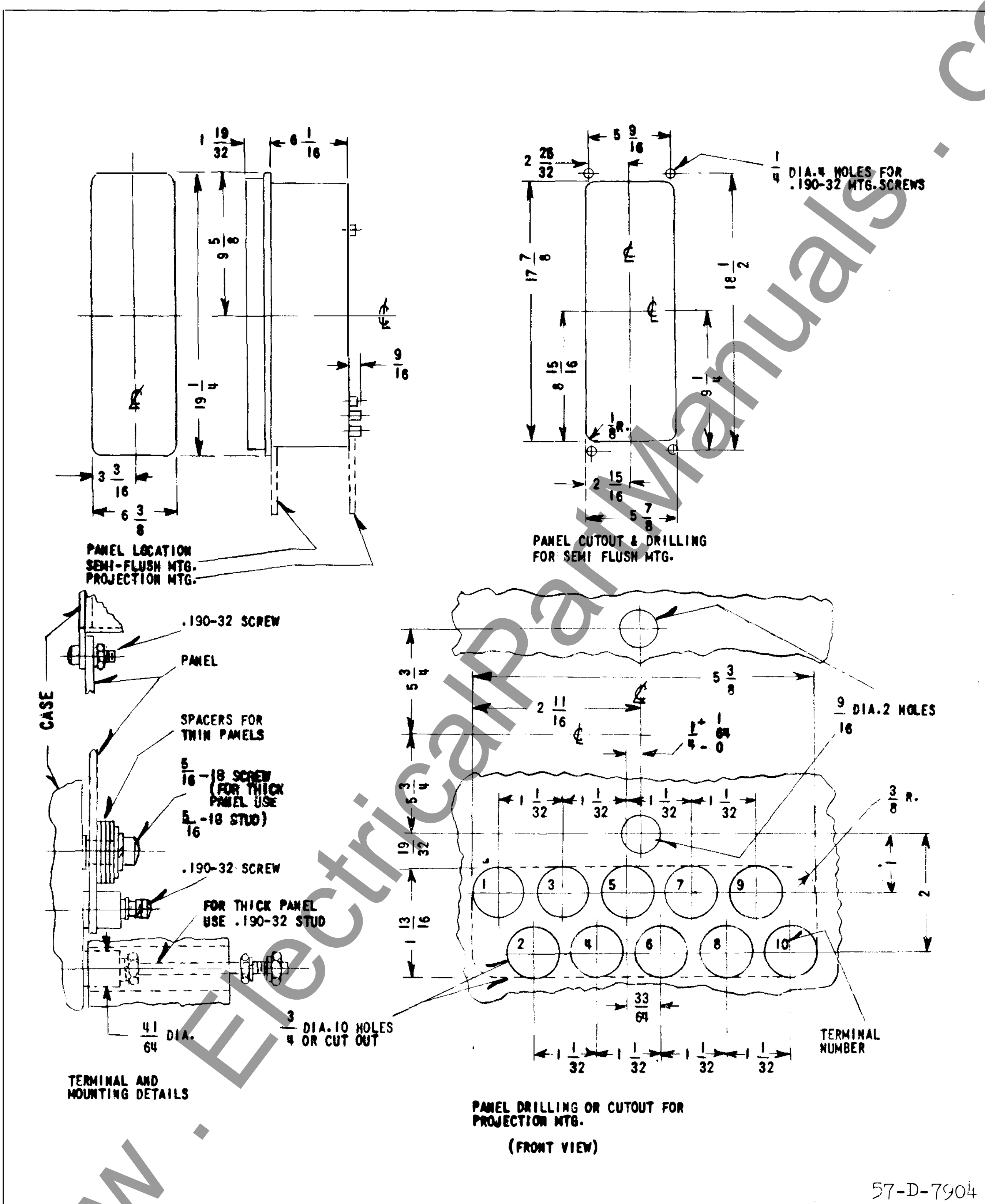


Fig. 8. KC-4 in FT 41 Case

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES SC, SC-1, SV AND SV-1 RELAYS

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

APPLICATION

The types SC and SC-1 current relays and the types SV and SV-1 voltage relays are applicable where an instantaneous plunger relay of high accuracy is required. These relays are suitable for protective service, and for auxiliary service where some of their special features are desired. They are adjustable over a wide range of voltage or current, are provided with mechanical operation indicators, and have a calibrated scale which indicates the pick-up setting. Both contacts can readily be changed from "make" to "break". The volt-ampere burden is low.

The type SC and SV relays have a high ratio of drop-out to pick-up (90 to 98%) and are particularly suitable for fault detector relays. The type SC-1 and SV-1 relays have a lower ratio of drop-out to pick-up. This lower ratio may be desirable in some applications, and it makes possible a plunger pull characteristic which permits the operation of a latching device. The latch is combined with the mechanical operation indicator, and prevents further motion of the moving contacts after the relay has operated.

CONSTRUCTION

The types SC, SC-1 and SV and SV-1 relays operate on the solenoid principle. A U-shaped iron frame, mounted on the moulded base, supports the coil and serves as the external magnetic path for the coil. The coil surrounds a core and flux shunt. The upper end of the core is threaded and projects through the upper side of the frame, to which it is fastened by a nut. A tube threaded on the outside at its lower end is assembled in the core, and the threaded end extends below the core. A graphite bushing, which is the lower bearing for the plunger shaft, is assembled in the lower end of this threaded tube. It is held in place by two split spring sleeves, one above and one below the bearing. The split sleeves must be compressed to insert them in the tube and they will remain at any position in which they are placed. The bearing for the upper end of the plunger shaft is a graphite bushing which is pressed in the upper end of the core. This bearing is visible when the plunger is in the energized position. The plunger itself does not touch the walls of the tube in which it moves.

A flux shunt which surrounds the core is screwed on the tube, and its lower end projects below the relay frame. The position of this shunt determines the pick-up setting of the relay. The lower end of the shunt is beveled and knurled, so that it can be grasped by the fingers and turned to change the setting. A calibrated scale plate is mounted adjacent to the shunt. A groove just above the knurl in the lower end of the shunt serves as an index mark, and the relay pick-up setting is indicated by the calibration scale marking which is adjacent to the groove.

The construction of the plunger, core and flux shunt (which differ in details in the various types of these relays) causes the plunger to float in its energized position, without being held against a stop, even when energized much above the pick-up value. Consequently, there is negligible noise and the contacts are free from chatter, even on heavy overloads and in 25 cycle applications.

The core, shunt and plunger construction also provides the high ratio of drop-out to pickup in the SC and SV relays. This ratio is above 90% for any pick-up setting. In the latch type relays it is necessary for the plunger to rise with sufficient force to operate the latch positively and to deflect the stationary contacts sufficiently to prevent their opening, when the relay is de-energized, due to play in the latch. It is necessary to have a lower ratio of drop-out to pick-up in, order to obtain this characteristic, and this lower ratio may be desirable in some applications where the latch is not required. The plunger

SUPERSEDES I.L. 41-766.1A
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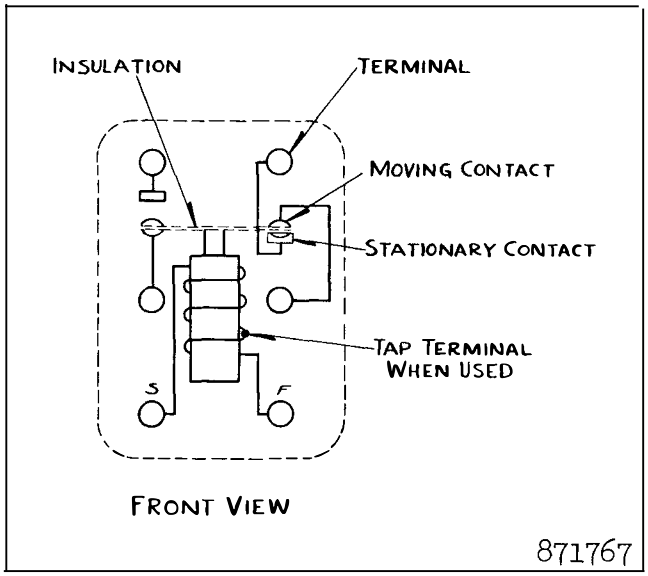


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

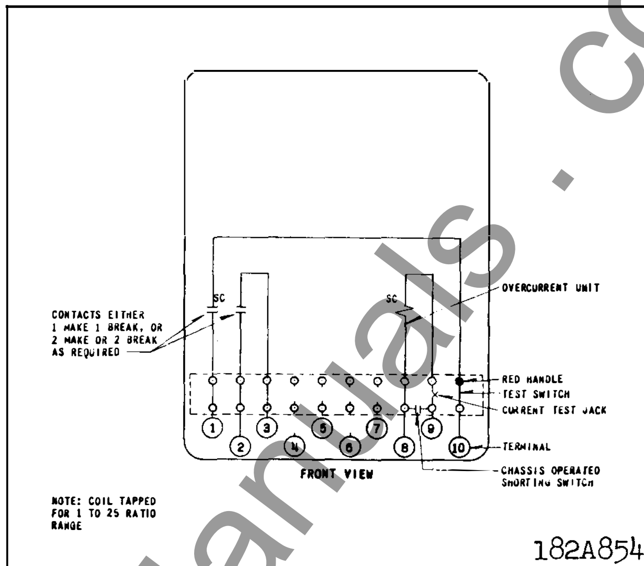


Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

floats in its operated position just as in the SC and SV relays. The drop-out ratio varies somewhat for different shunt positions, but is constant for any one setting.

The shunt is held in any desired position by pressure from a curved arm made of sheet spring steel, which is fastened to the bottom of the coil frame at the rear of the shunt. This spring arm is shaped to extend around the shunt to the front of the relay, and in its normal position it exerts sufficient pressure against the shunt to prevent any creeping of the shunt or undesired change of setting. The front end of the spring arm has a bent-over tab on which thumb-pressure may be applied to move the arm out of contact with the shunt while the position of the latter is being changed.

The stationary contacts are assembled on slotted brackets. These are held in position on the base by filister-head screws which are threaded into the terminal inserts. Lock-washers are assembled inside the moulded terminal bushings between the inserts and the base, as a safeguard against loosening of the screws. By rotating the bracket on its mounting screw and moving it along its slot, the contact assembly can be made either normally open or normally closed. The moving contacts are mounted on a Micarta insulation plate which is secured to the threaded end of the plunger shaft by a nut. The front edge of this insulation plate operates the indicator. The rear portion of the plate is slotted and a post screwed to the frame passes through this slot to prevent the plate from rotating.

The moving contacts are double-faced so that they can be "make" or "break" and are connected to the base terminals by flexible leads. All contacts are pure silver. The contacts will carry 5 amperes continuously, and will interrupt 5 amperes at 115 volts A-C, or 1 ampere at 125 volts D-C.

The mechanical operation indicators used on these relays are shockproof, and can be used to indicate on the up stroke or down stroke of the plunger. The indicator is reset by pulling out the knurled stud which projects through the cover nut. The indicator should be reset after each relay operation because otherwise there may be a one or two percent decrease in the operating value of the relay. The operation indicator is assembled at the factory to indicate on the up stroke of the plunger, but by removing the two mounting screws which fasten the indicator to the main frame, turning the indicator bracket around and at the same time swinging the indicator flag 180° about its shaft, the indicator can be set to indicate on the down stroke of the plunger. The rivet weight must be removed from the indicator flag and the latch screen turned around to complete the assembly.

In certain applications, an extremely wide range of current adjustment is desirable, and certain styles of SC and SC-1 relays have been provided with tapped coils to meet this requirement. The coil taps are brought out to a tap block mounted on the lower end of the relay frame or on the relay sub-base, depending on the type of case used. The connector plate on the tap block is marked with the minimum pick-up value of

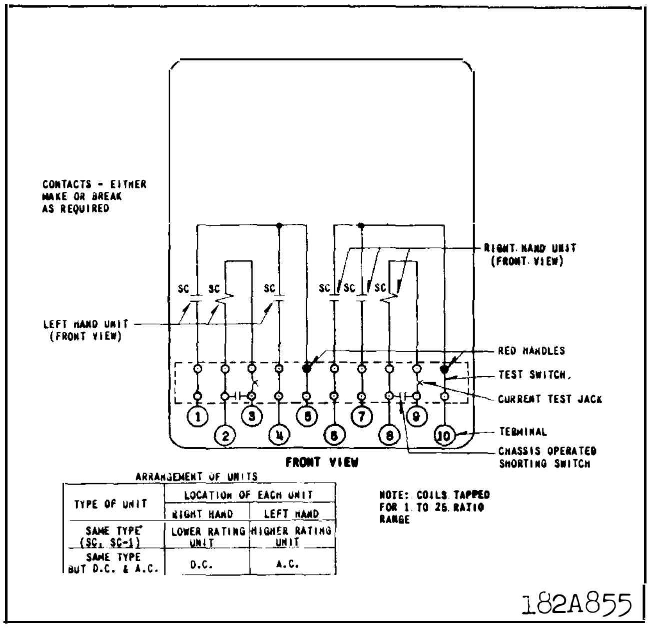


Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

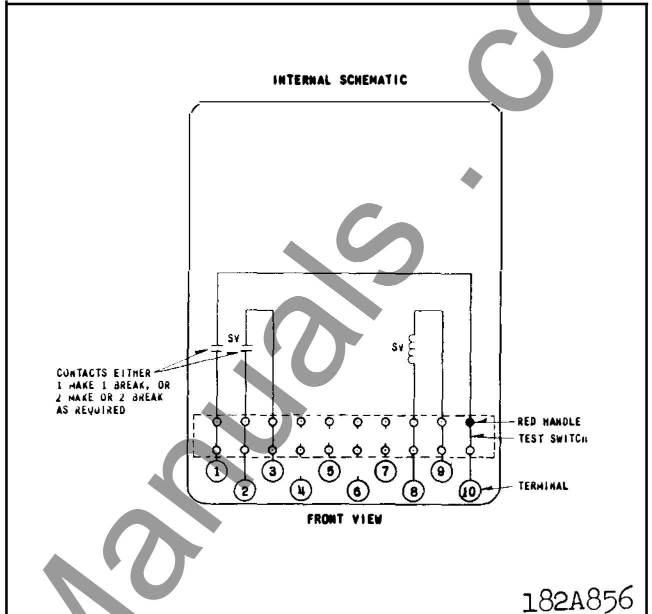


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

each tap, and the shunt is adjusted in the usual manner to obtain any pick-up setting between taps. The scale plate is not calibrated for the relays with tapped coils, as there is not sufficient space for marking a scale for each tap. However, the scale plate is supplied in order that a customer may mark on it the individual relay setting or settings if desired.

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.

ADJUSTMENTS AND MAINTENANCE

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

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

Several factors may affect the drop-out ratio of the relay. Whatever affects the ratio does do because either the drop-out or pick-up or both are affected. Obviously, incorrect assembly or interchange of parts, such as the use of the SC plunger with the SV core tube, will alter the electrical characteristics. However, the factor most likely to be encountered in service is friction. This may be due to dirt or foreign material * between the plunger shaft and its bearings, to excessive pressure of the indicator screen on the indicator, or to leads so mis-shaped that they tend to rotate or tilt the moving contact insulation plate with appreciable force.

In order to remove the plunger and shaft assembly, it is necessary to remove the setscrew and nut at the top of the shaft. The spool-shaped bushing assembled on the upper end of the plunger shaft has a portion of

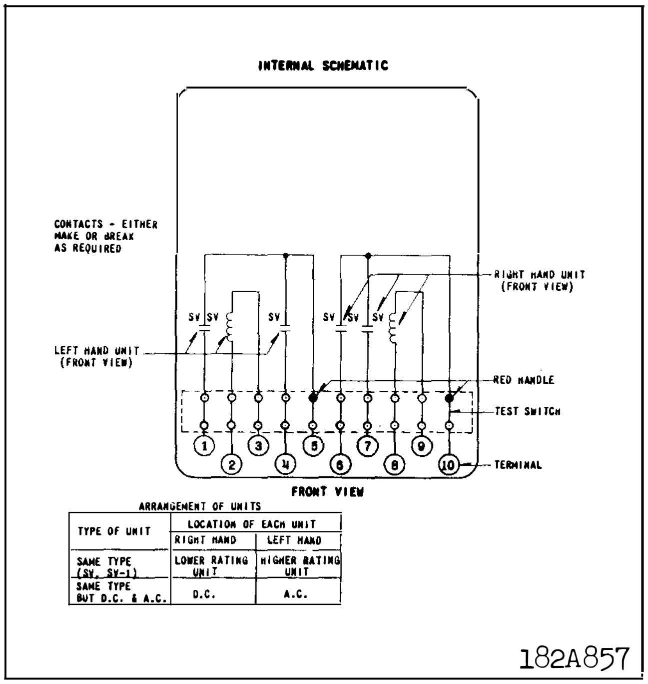


Fig. 5. Internal Schematic of the Double Unit Type SV or SV-1 Relay in the Type FT32 Case.

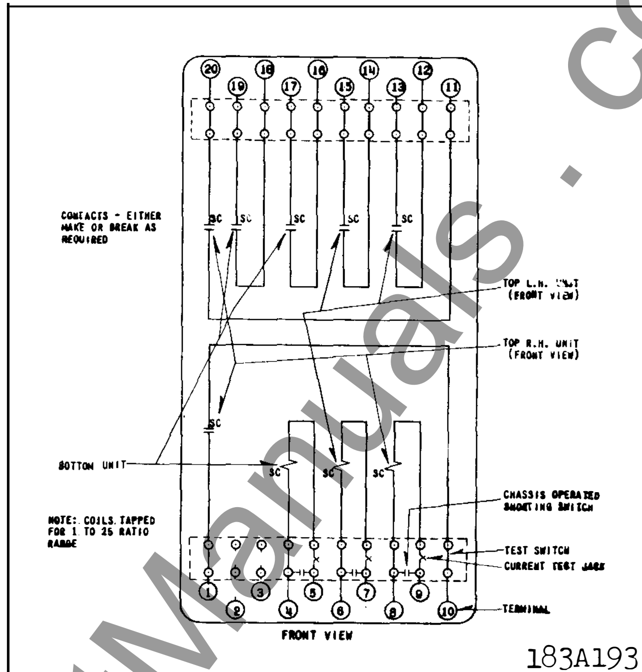


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

its center section machined off so that the shaft is exposed at this point and can be prevented from turning by gripping shaft and bushing with a pair of long-nose pliers while removing the set screw and nut. Then by pressing down with the fingers on the upper end of the shaft, the lower split sleeve which retains the lower bearing will be forced out of the threaded tube, the bearing will drop out freely, and the upper split sleeve will be forced out far enough to permit grasping it for removal. The shaft and plunger assembly then can be removed.

The shaft and plunger assembly should be handled carefully to avoid bending the shaft or damaging the bearing surfaces. The shaft should never be gripped on its upper bearing surface, below the spool-shaped bushing, when loosening the nut and setscrew, as this would almost certainly damage the bearing surface. The shaft bearing surfaces should not be cleaned or polished with any abrasive material, as the abrasive particles might become imbedded in the shaft and cause difficulty later. The plunger shaft and bearings may be cleaned by wiping them carefully with a clean, lint-less cloth. This may be moistened with benzene or some other cleaning solvent if necessary. Use no lubricant on the plunger shaft or bearings when re-assembling the relay, since this will eventually become gummy and prevent proper operation. It is recommended that the shaft be cleaned at intervals of approximately two years. When replacing the lower bearing and the split sleeves, the shorter sleeve (assembled below the bearing) should be pushed in until it is flush with the end of the threaded tube.

The mounting holes in the operation indicator screen are slotted so that its position can be adjusted. For relays in which the moving contacts are not latched in the operated position, the screen should be so located that the indicator positively enters the screen opening when the contacts barely touch. For latch-type relays, the screen should be so located that good contact is still obtained when the relay is de-energized. The pressure of the screen against the indicator may be adjusted by bending the screen between its lower end and the large elongated hole. This pressure should be such that the indicator will be held at any further position to which it is moved after entering the screen opening. However, the minimum amount of pressure necessary to obtain this adjustment should not be exceeded appreciably, since the pick-up value, and consequently the ratio, will be affected. The purpose of this pressure is to eliminate indicator rattle which might otherwise occur under certain energized conditions.

The moving contact leads pass through insulation sleeves assembled on the shanks of the terminal clips

CHARACTERISTICS OF TYPES SC AND SC-1 RELAYS

Type	Frequency	Range of Adjustment Amps.	Max. Amps. Continuous	Watts 5 Amps. 60 Cycles	V.A. at 5 Amps. 60 Cycles	Dropout Ratio-AC	Dropout Ratio-DC
SC	DC, 25 to 60 C.	.5-2	1.5	99	225	90-98%	65-80%
SC	DC, 25 to 60 C.	1-4	3	28	65	90-98%	65-80%
SC	DC, 25 to 60 C.	2-8	6	6.9	19	90-98%	65-80%
SC	DC, 25 to 60 C.	4-16	12	1.5	5	90-98%	65-80%
SC	DC, 25 to 60 C.	10-40	25	.24	.7	90-98%	65-80%
SC	DC, 25 to 60 C.	20-80	40	.07	.16	90-98%	65-80%
SC	DC, 25 to 60 C.	40-160	40	.03	.05	90-98%	65-80%
SC	DC, 25 to 60 C.	4-100*	10-15-20	1.7-0.6-0.18	5-1-0.2	90-98%	65-80%
SC-1	DC, 25 to 60 C.	.5-2	1.5	100	210	35-60%	25-40%
SC-1	DC, 25 to 60 C.	1-4	3	24	60	35-60%	25-40%
SC-1	DC, 25 to 60 C.	2-8	6	6	16	35-60%	25-40%
SC-1	DC, 25 to 60 C.	4-16	12	1.5	5	35-60%	25-40%
SC-1	DC, 25 to 60 C.	10-40	25	.25	.65	35-60%	25-40%
SC-1	DC, 25 to 60 C.	20-80	40	.07	.16	35-60%	25-40%
SC-1	DC, 25 to 60 C.	40-160	40	.03	.05	35-60%	25-40%
SC-1	DC, 25 to 60 C.	4-100*	10-15-20	1.7-0.6-0.18	5-1-0.2	35-60%	25-40%

* Coil has taps on which minimum pickups are 10 and 30 amperes.

CHARACTERISTICS OF SV AND SV-1 RELAYS

	Type	Frequency (Cycles)	Range of Adjustment Volts	Max. Volts Continuous	Watts at 115 V. AC (125 V. for DC)	V.A. at 115 V.	Dropout Ratio
✱	SV	60	7-16	16	–	–	90-98%
	SV	60	70-160	160	3.4	7.3	90-98%
✱	SV	60	140-320	320	–	–	90-98%
✱	SV	60	280-640	640	–	–	90-98%
	SV	50	70-160	180	2.8	6.1	90-98%
	SV	25	70-160	200	1.5	2.5	90-98%
	SV	DC	50-150	150	4.8	–	65-80%
✱	SV	DC	100-300	300	–	–	65-80%
✱	SV-1	60	7-16	16	–	–	40-80%
	SV-1	60	70-160	160	4.1	8.5	40-80%
✱	SV-1	60	140-320	320	–	–	40-80%
✱	SV-1	60	280-640	640	–	–	40-80%
	SV-1	50	70-160	180	3.5	7.1	40-80%
	SV-1	25	70-160	200	1.4	3.2	40-80%
	SV-1	DC	50-150	150	4.8	–	25-40%
✱	SV-1	DC	100-300	300	–	–	25-40%

NOTES:--Standard current relays are calibrated on 60 cycles. This calibration is approximately correct for 25 cycle and DC applications, but there will be discrepancies of 10% to 15% at some points of scale.

Values of watts and volt-amperes in the tables are average for various plunger and shunt position.

For the SC relay, volt-amperes for pickup at minimum setting are approximately 3.4 and 1.4 for 60 and 25 cycles. Watts at minimum setting are approximately 1.0, .65 and .57 for 60 cycles, 25 cycles and DC respectively. Multiply values by 16 for approximate burdens at maximum setting.

For the SC-1 relay, volt-amperes for pickup at minimum setting are approximately 3.5 and 1.3 for 60 and 25 cycles. Watts at minimum settings are 1.3, .7 and .57 for 60 cycles, 25 cycles and d-c respectively Multiply values by 16 for approximate burdens at maximum setting.

*The V.A. burdens of the SC and SC-1 relays at 3, 10 and 20 times minimum pickup current are approximately 31, 240 and 770 V.A. respectively.

Dropout ratio varies somewhat with pickup adjustment but will be approximately constant for any given pickup setting. Limits in tables include variables such as friction and other individual relay variations.

Maximum continuous volts given for the SV and SV-1 relays for A-C are for the relay set for minimum pickup. With the relay set for maximum pickup the continuous voltage can be increased 10 to 20%.

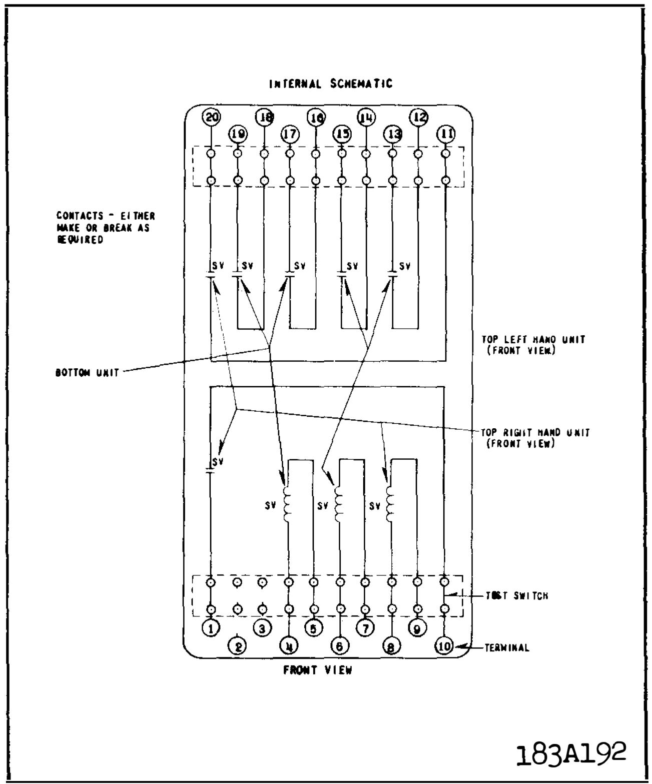


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

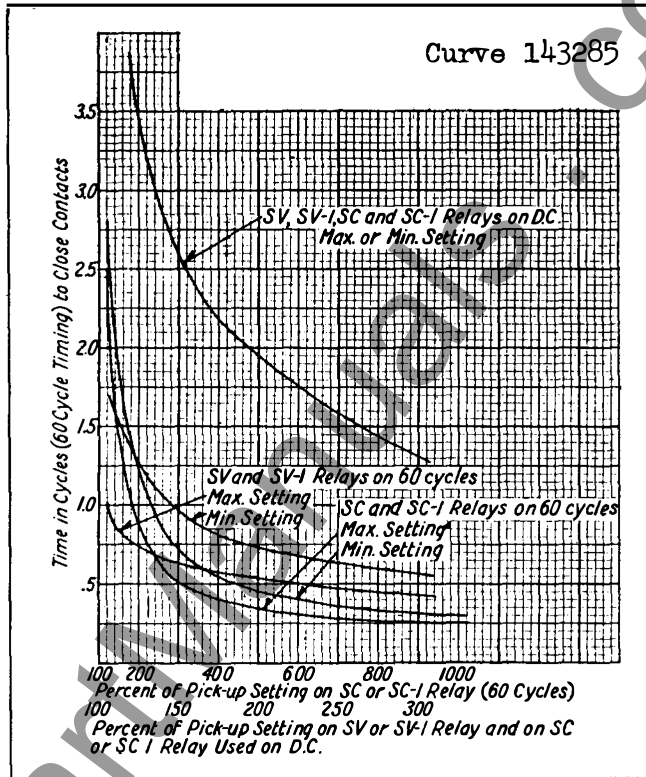


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

which are attached to the base terminals. These sleeves are notched at their upper ends, and the notches are toward the center of the relay. The leads are bent at approximately a right angle where they pass out through the notches, which aids in preventing them from coming into contact with the stationary contact brackets. Figure 11 shows properly coiled and assembled moving contact leads.

Although the moving contact leads are very flexible, if the leads have been pulled out of their original shape by handling they may exert sufficient side pressure on the shaft bearing or twisting force against the guide post to cause appreciable friction and wear. If this condition continues for a long period of time, the resulting wear may affect the relay calibration or or the dropout ratio noticeably. In extreme cases the wear may progress to a degree which may occasionally cause failure of the plunger to drop down when the relay is de-energized.

Correct shaping of the leads is not difficult, and they may be checked readily by removing the guide post and the nut at the top of the shaft. The plunger should be held in the raised position, either by energizing the relay or by pressing lightly against the collar under the insulation plate after raising the plunger manually. With the plunger raised, the insulation plate should be oscillated slightly in a horizontal plane by twisting it horizontally and releasing it. If in several trials the plate comes to rest with the center line of the contacts approximately parallel to the base and with its mounting hole fairly well centered with the end of the shaft, if the plate does not tip appreciably, and if the leads have a safe clearance to the stationary contact brackets, the leads are properly shaped.

If this check shows that re-shaping is necessary, it may be possible to obtain sufficient correction by bending the leads sharply where they emerge from the insulation sleeves. One or two pairs of tweezers are tools for re-shaping the leads. If it is necessary to re-coil the leads, they should be wound around a rod having a diameter of approximately 5/32". The coils then should be stretched out just enough to avoid side pull or twisting force on the plunger assembly.

In all relays except the SV-1 relay for A-C, if the stationary contacts are assembled so that they close when the relay is energized, they should be located so that they barely touch the moving contacts when

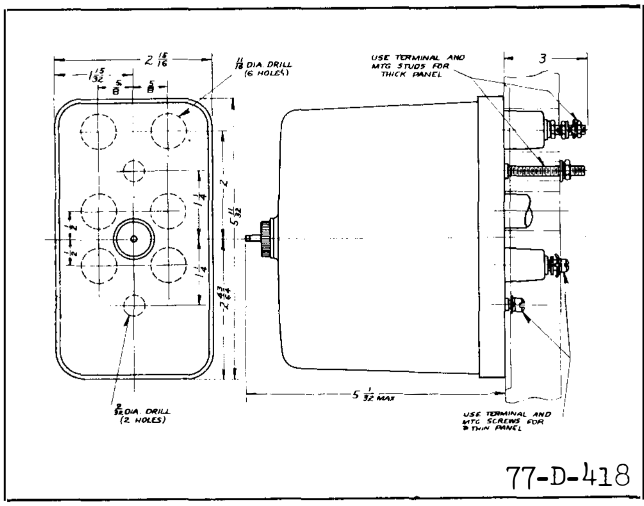


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

the latter are 5/32'' above the de-energized position. The moving contacts can be held in this position while the adjustment is being made by inserting a 5/32'' spacer between the shaft collar and the top of the core. This dimension should be 3/16'' on the SV-1 relay for A-C. Both contacts should touch at the same time when the plunger is raised. When the plun- is moved upward against its stop, there should be a slight deflection of the stationary contact stop springs, but this should not exceed 1/32''. When the stationary contacts are reversed so that they are closed when the relay is de-energized, they should be located so that they just touch the moving contacts when the latter are 1/32'' above the de-energized position. On some relays it may be found that when the contacts are used in this position the relay may operate at values a few percent below the scale markings. The adjustments specified for the stationary contacts are important. Failure to observe them may cause improper relay operation, either directly or after a period of service. Contact position should not be used as a means of altering the ratio of dropout to pickup.

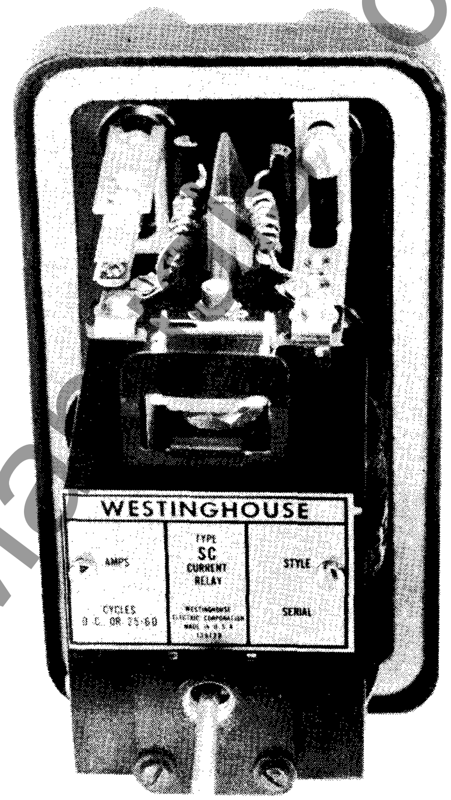


Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

RENEWAL PARTS

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

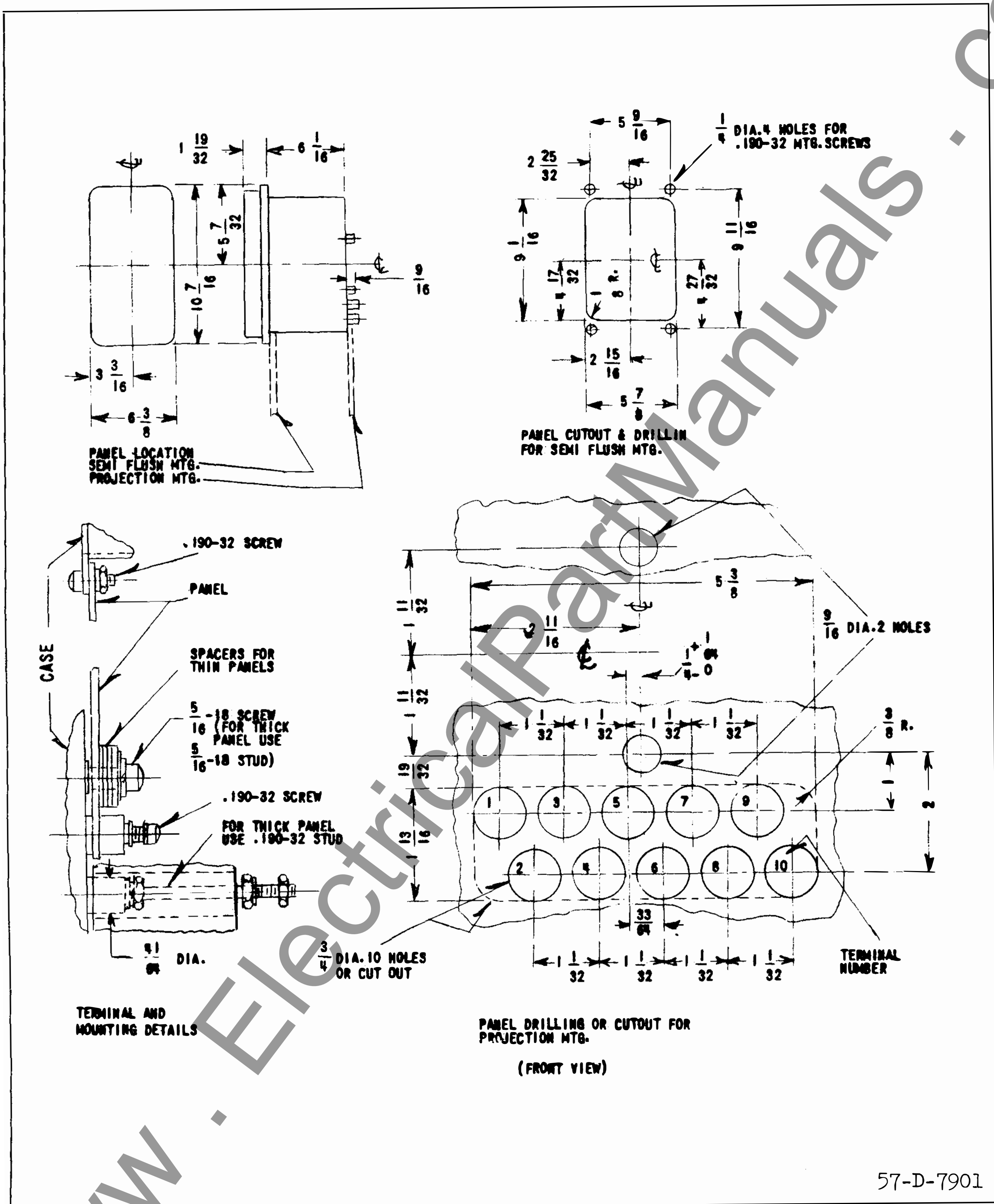


Fig. 11. Outline & Drilling Plan for Single & Double Unit Relays in the Type FT21 Case.

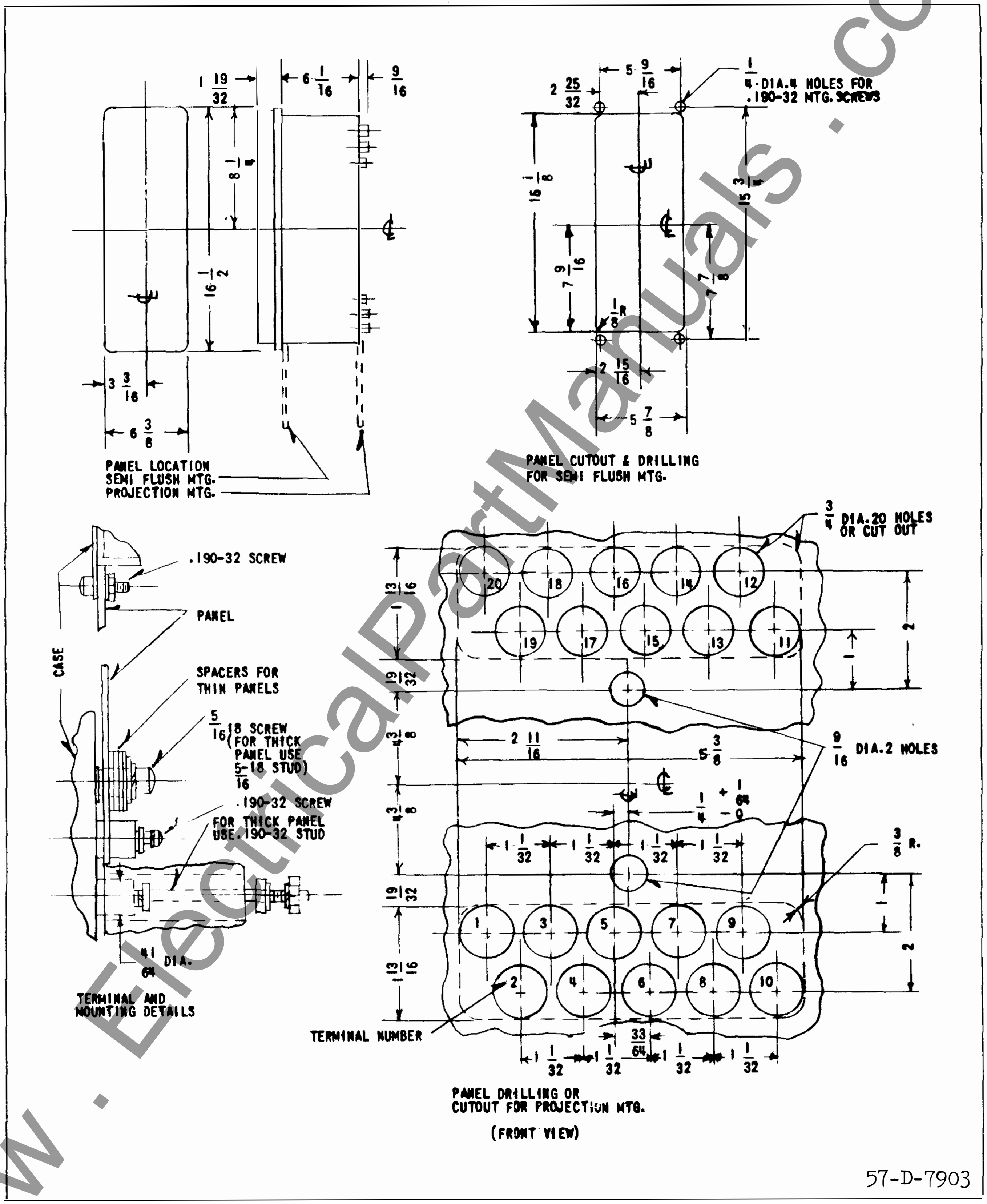


Fig. 12. Outline & Drilling Plan for Three Unit Relays in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-3 CURRENT DETECTOR RELAY

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

APPLICATION

The type KC-3 is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other relays. It is well suited to breaker-failure relaying for indicating the presence or lack of current flow in the circuit breaker. The relay can be applied where the phase units are to be operated indefinitely in the picked up position well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load) the 98% or better dropout ratio of the phase units is advantageous.

These instructions apply for two relay varieties, as shown in the internal schematics of Figs. 3 and 4. The two differ only in the terminal 14 connections. The relays connected per Fig. 3 will suffice in most cases. Use the relay per Fig. 4 where the ICS-2 contact is needed for an external seal-in. Note, however, that the circuits associated with terminals 10, 11 and 14 of Fig. 4 should not be used where more than one KC-3 relay connects to a common breaker-failure timing circuit. Otherwise all of the KC-3 targets connected to this timing circuit may operate on a breaker-failure operation.

Breaker-failure relaying offers advantages over remote back-up protection. It is faster and more sensitive than remote back-up methods. In addition, it is selective, whereas remote back-up protection is frequently non-selective. Fig. 2 shows some fault conditions where breaker-failure relaying could improve the quality of back-up protection. Note that the generating-station high-voltage bus uses a breaker-and-a-half arrangement. Lines interconnect the station to systems S_1, S_2, and S_3.

If there is no malfunctioning, fault L will be cleared by line relays tripping breakers 5, 6, and 9. However, assume that the breaker-6 mechanism sticks so that current flow through breaker 6 is not interrupted. Now back-up protection must function. If remote backup is relied upon, time-delay relays must trip remote breakers 7 and 8. In addition, the local generator feed through breaker 6 must be interrupted by tripping breaker 4. However, if breaker-failure protection is installed, the fault is cleared by tripping breaker 3. Note that this provided selective tripping, since as much of the system as possible was left intact. If breakers 4, 7, and 8 must trip, the local generator is lost and unnecessary separation of the generating station from power systems S_1 and S_2 results. Also, the tapped load is interrupted unnecessarily instead of being left tied to system S_2.

Remote backup, in addition to not being selective, may not be sensitive enough because of the relatively small proportion of the total fault current following in any one line. For example, in Fig. 2 there may be very little current flow in breakers 7 and 8 for fault L because of the large current contribution by the local machines at the generating station. Thus, it may be difficult or impossible at breakers 7 and 8 to detect adjacent line faults without depending upon sequential tripping. If the generator feed is interrupted for fault L, such as by tripping breaker 4, the current through breakers 7 and 8 may increase sufficiently for the relays to operate and trip breakers 7 and 8. However, the system is by now cut to pieces, and because of the long time delay in clearing the fault, the remainder of the system may be unstable.

Although breaker-failure protection offers many advantages, remote backup cannot be completely eliminated. For example, assume that breaker 3 fails

SUPERSEDES I.L. 41-776A
Complete Revision

EFFECTIVE SEPTEMBER 1961

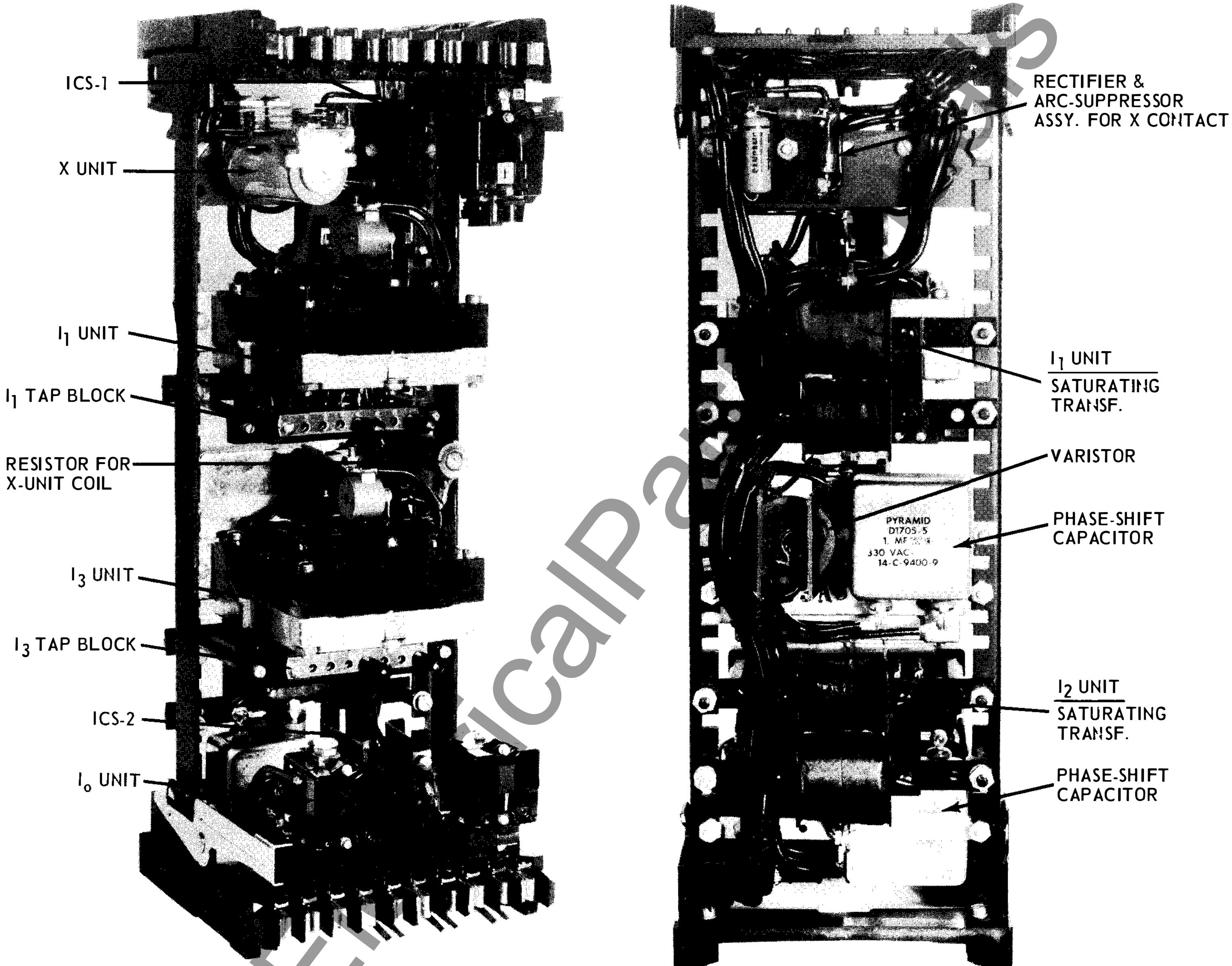


Fig. 1. Type KC-3 Relay Without Case.

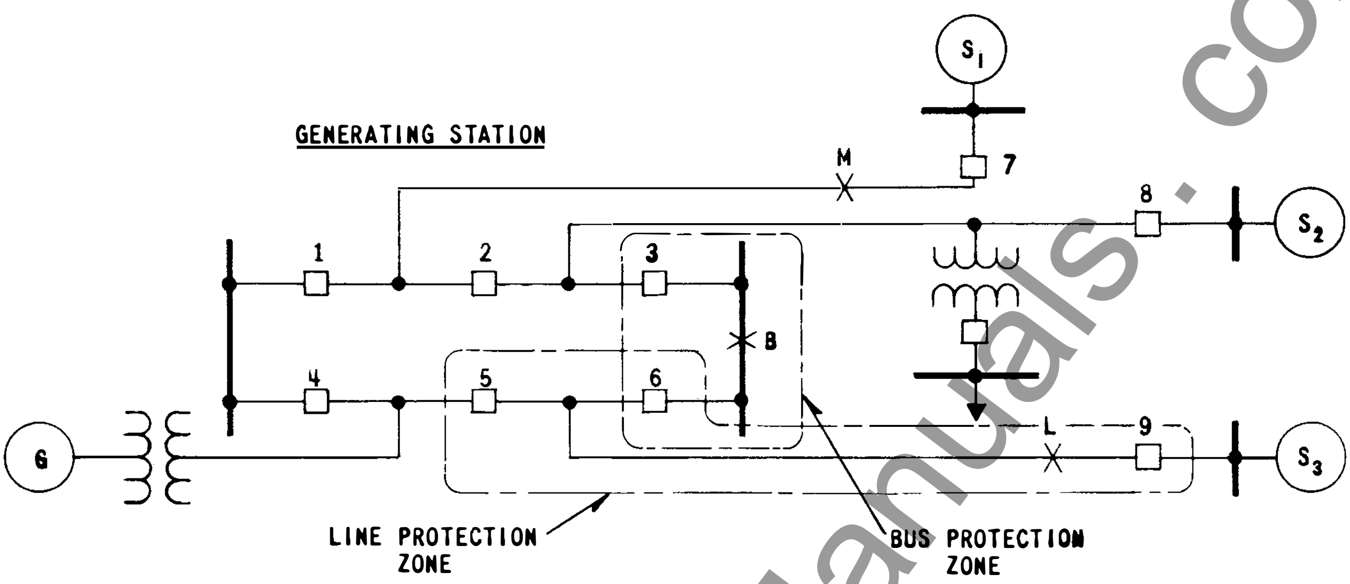


Fig. 2. Sample System to Show Advantages of Breaker-Failure Protection.

for bus-fault B in Fig. 2. Breaker-failure protection will promptly trip breaker 2, but the fault is still fed by breaker 8. Likewise, if breaker 2 fails with a line fault at M, a remote breaker must trip to clear the fault. Breaker-failure protection trips breaker 3, but breaker 8 still feeds the fault. Although breaker-failure protection does not complete the job in these examples, it does expeditiously trip the local breaker, making it easier for the remote relays to detect the fault.

CONSTRUCTION

Phase Overcurrent Unit (I_1 & I_3)

The phase overcurrent unit is an induction-cylinder unit. The time-phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

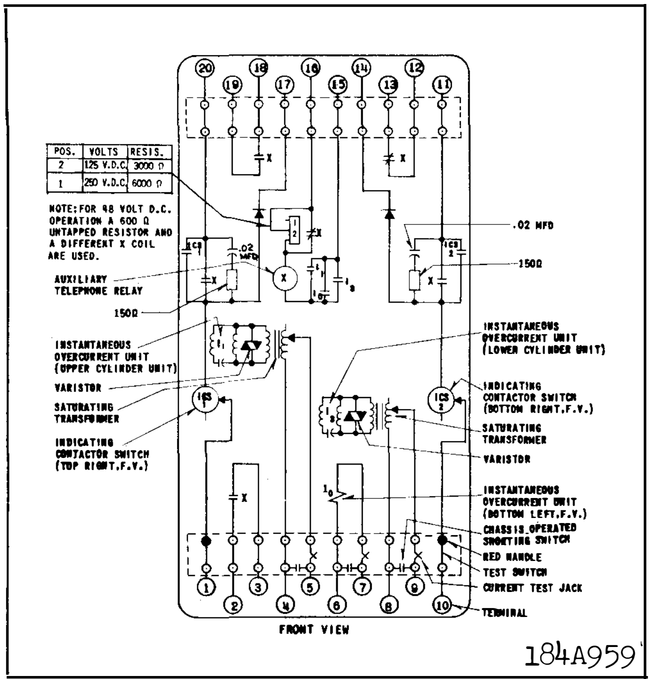


Fig. 3. Internal Schematic of the Type KC-3 Relay in FT42 Case. (For S#290B243A – Series).

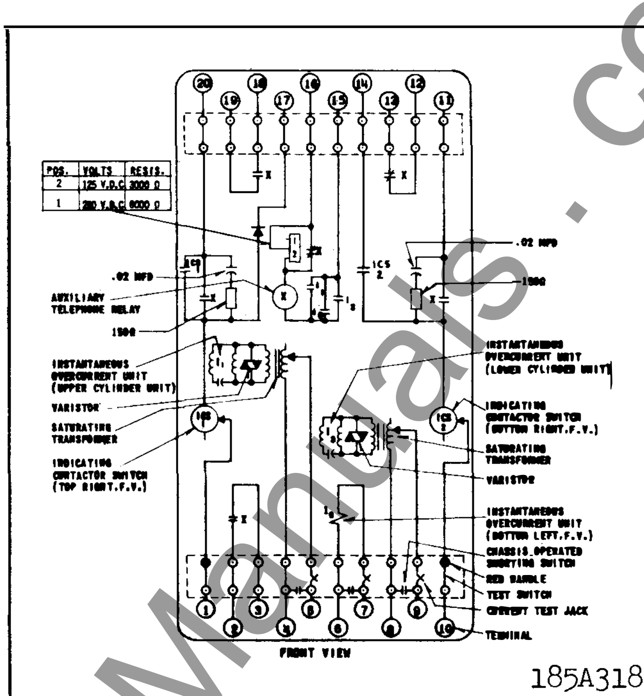


Fig. 4. Internal Schematic of the Type KC-3 Relay in FT42 Case with ICS-2 Contact to Separate Terminal.

When the current in the overcurrent unit exceeds the pick-up value the contacts close to energize the auxiliary relay (X).

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden on the operating CT.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

Ground Overcurrent Unit (I_o)

The ground overcurrent unit is a small a-c operated 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 auxiliary relay (X) circuit.

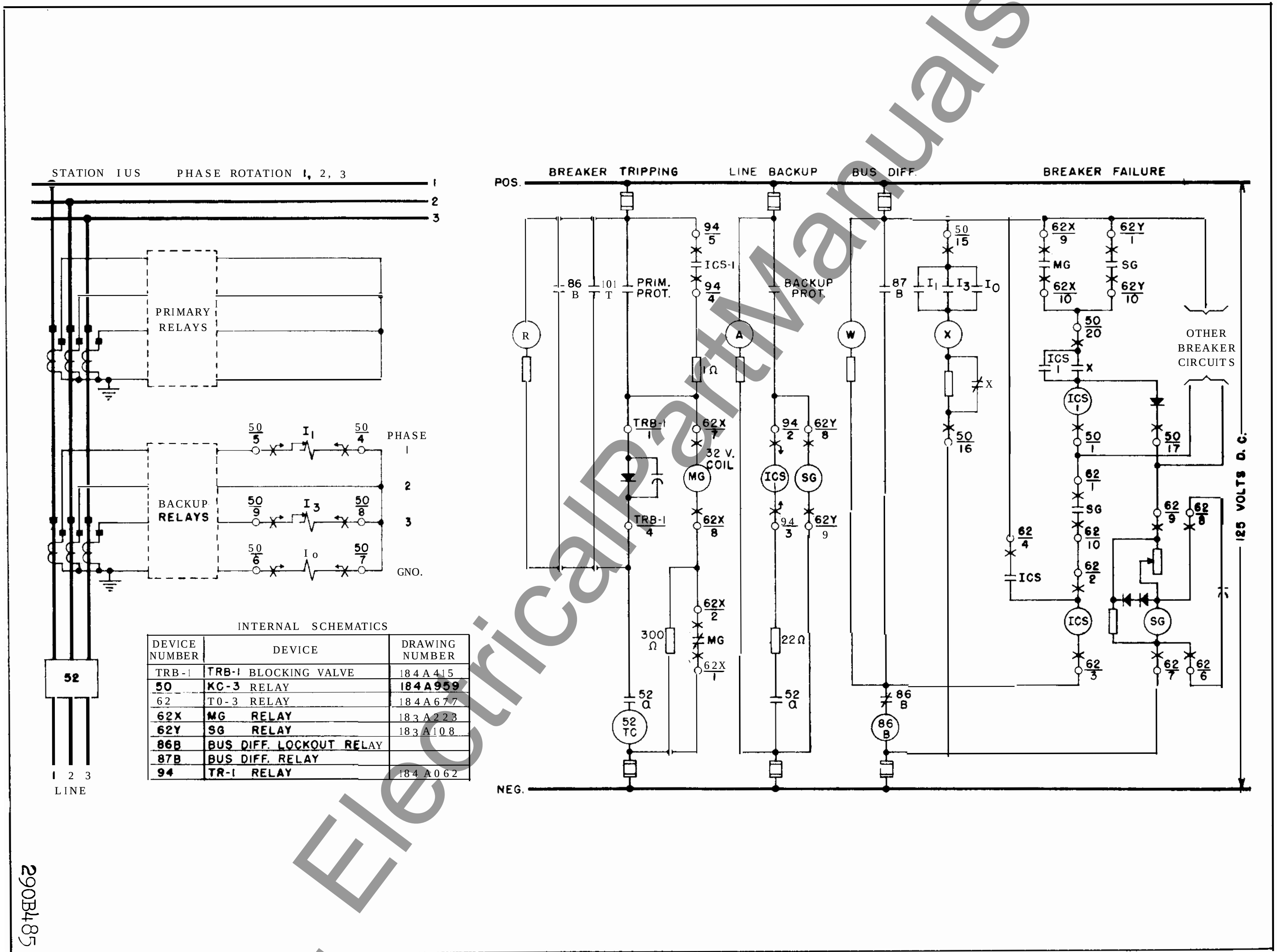
A core screw accessible from the top of the switch provides the adjustable pickup range. A calibrated scale is located to the rear of the core screw.

Auxiliary Unit (X)

The auxiliary relay is a multicontact telephone type of relay having a single coil. Four normally open contacts and one normally closed contact (all of which are electrically isolated) are brought out to the relay terminals. Two normally open contacts operate indicating contactor switches for identification of circuit operation.

Indicating Contactor Switch Unit (ICS-1 and ICS-2)

The indicating contactor switch is a small d-c operated 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



DEVICE NUMBER	DEVICE	DRAWING NUMBER
TRB-1	TRB-1 BLOCKING VALVE	184A415
50	KC-3 RELAY	184A959
62	TO-3 RELAY	184A677
62X	MG RELAY	183A223
62Y	SG RELAY	183A108
86B	BUS DIFF. LOCKOUT RELAY	
87B	BUS DIFF. RELAY	
94	TR-1 RELAY	184A062

Fig. 5. External Schematic of the KC-3 Relay for Breaker-Failure Protection of a Single Bus/Single Breaker Arrangement.

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

General

When any one of the overcurrent units (I_1, I_3 or I_0) operates, it energizes the X unit. When used for breaker-failure relaying, one or more of the X-unit contacts supervise the breaker-failure timing circuits to prevent other breakers from being unnecessarily tripped. When the proper breaker successfully interrupts the fault current the KC-3 relay quickly disables the breaker-failure timing circuit. In addition, where the line relays trip two breakers such as on a ring bus, the KC-3 selects which of the two breakers has failed. When the phase overcurrent units I_1 and I_3 are set above load-current level, the KC-3 also functions as a fault detector to prevent undesired tripping by test personnel. The following paragraphs describe KC-3 operation in more detail for different system bus connections.

Single Bus/Single Breaker Arrangement

Unless something fails, current flow in the breaker should cease shortly after the trip circuit is energized. The time interval between these two occurrences will be the breaker-interrupting time. If this interruption does not occur, breaker-failure relaying will initiate the tripping of other breakers. Fig. 5 shows how this is accomplished. Unless something fails either the primary or back-up relays initiate tripping of the faulted line breaker. Note that the primary and back-up relays connect to separate sets of current transformers and d-c supplies. This way a failure in one or the other circuits will not disable all of the protection.

When the primary protection operates it energizes 62X; the back-up protection energizes 62Y. Contacts of these two auxiliaries start the breaker-failure timer 62, through the KC-3 contact 50X. If the line breaker fails to clear the fault, contact 50X remains closed. The SG contact of timer 62 closes, energizing the bus lock-out relay 86B through 62X or 62Y and 50X contacts. Relay 86B then trips all the breakers on the bus.

The TRB-1 rectifier in the primary — protection circuits of Fig. 5 blocks the flow of red-light supervision current through the 62X coil. If the KC-3 phase overcurrent units are set above load current, a 50X contact may be inserted in series with the 62X coil to block the red-light currents. Then, the TRB-1 is not needed.

An MG-6 relay performs the 62X function in Fig. 5. Actually an SG will suffice unless a directional-comparison blocking system provides the primary protection. With this system two MG-6 contacts seal around the RRG and RRP contacts. (Refer to drawing 540D542 for the details of this arrangement.)

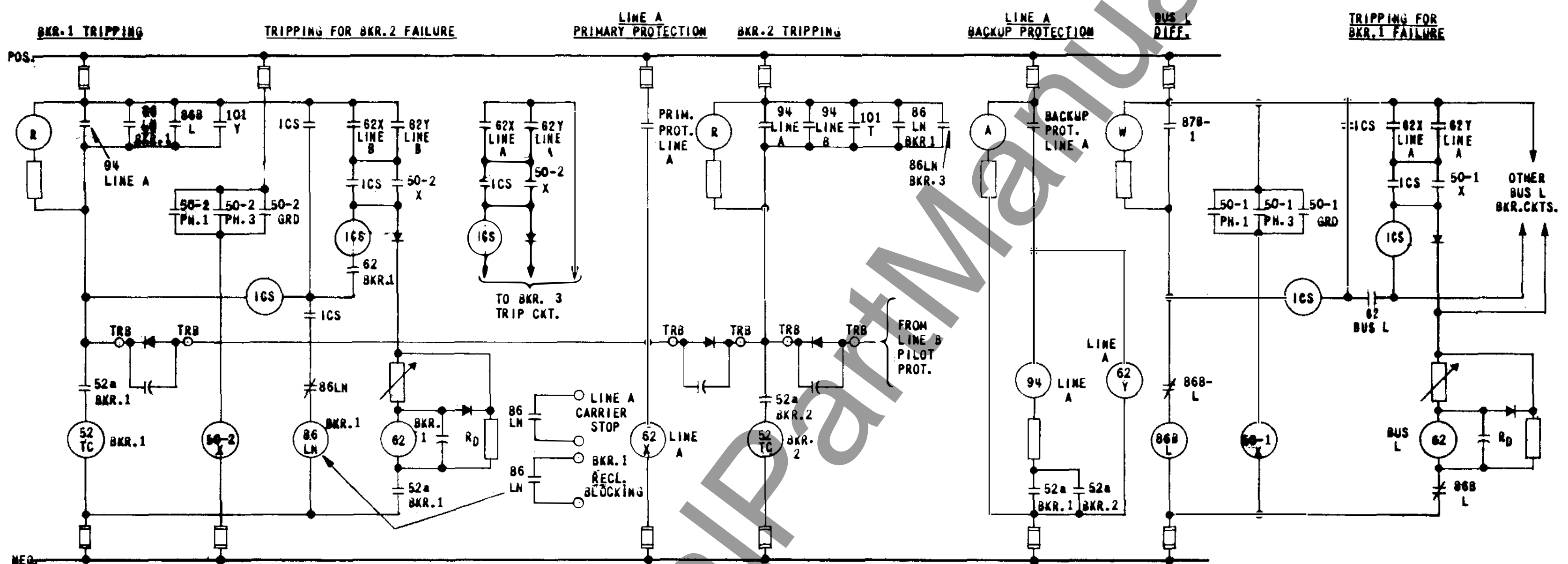
Breaker-and-a-Half Arrangement

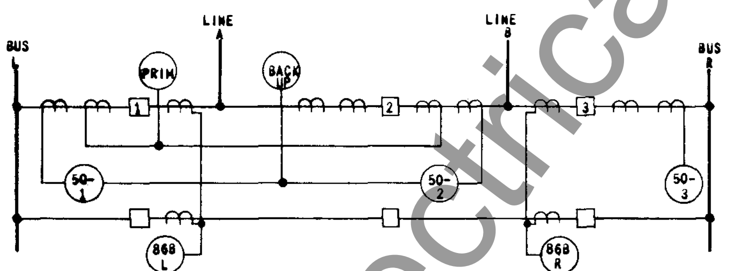
Typical trip and control circuits for breaker-failure back-up protection for the breaker-and-a-half bus arrangement are shown in Fig. 6. The trip circuits are shown for breaker 1 and breaker 2 and the line-A protection. Similar circuits would exist for breaker 3 and line B. Protection against a breaker-1 or breaker-2 failure for line-A faults is included.

Assuming a failure of breaker 2 for a fault on line B, the breaker-failure timer 62 associated with breaker 1 is energized by 62X or 62Y from line B. Since the KC-3 current detector 50-2 which is supplied by breaker-2 current does not drop out, 62 of breaker 1 operates to trip breaker 1. When 62-ICS is operated by breaker-1 trip current, 86LN is energized. One 86LN contact stops the transmission of a blocking signal on line A, allowing the remote pilot relays to trip the remote line-A breaker, if they detect the fault. Thus, the fault on line B is now cleared. Another 86LN contact blocks high-speed reclosing of breaker 1. Other 86LN contacts energize the breaker-1 and breaker-2 trip-coil circuits to provide for a trip-free operation should either breaker be prematurely closed in.

An essential function, the selection of the faulty breaker, is performed by the KC-3. Relays 62X and 62Y indicate that the fault has not been cleared, but they are unable to define for a line-A fault whether breaker 1 or breaker 2 is still feeding current to the fault. The 50-1 or 50-2 KC-3 performs this job.

Now, if breaker 1 fails for a fault on line A, bus L is cleared. This is accomplished by the bus L breaker-failure timer which is energized by the line-A relay 62X or 62Y contact. When 62 operates, 86B is energized to dump bus L. For this sequence, the current detector 50-1 selects the faulty breaker.





DEVICE	DESCRIPTION	NO. REQ'D
TRB	STATIC TRIPPING UNIT	1/LINE
50	KC-3 CURRENT DETECTOR	1/BKR.
62	TD-3 BKR. FAILURE TIMER	2/BAY & 1/BUS
62X	MG TIMER AUX.	1/LINE
62Y	SG TIMER AUX.	1/LINE
86B	BUS DIFF. LOCKOUT AUX.	1/BUS
86LN	WL-6 BKR. FAIL. LOCKOUT	2/BAY
87B	BUS DIFF.	3/BUS
94	TR-1 AUX. TRIPPING RELAY	1/LINE

Fig. 6. Simplified External Schematic of the Type KC-3 for Breaker-Failure Protection of a Breaker-and-a-Half Bus.

Note that the bus L timer circuit in Fig. 6 is the same as that used with the single bus/single breaker arrangement in Fig. 5. An identical timer circuit (not shown) is associated with bus R in Fig. 6. There are also timers for each bay (e.g., associated with breakers 1 and 3). These trip the appropriate outside breaker for a middle breaker failure. These timer circuits are associated with the breaker to be tripped. This same approach is used for ring buses, as will now be explained.

Ring Bus Arrangement

The circuits for the ring bus are shown in Fig. 7 with trip and control circuits outlined for breaker 2, together with line-B primary and back-up protection circuits. As with the breaker-and-a-half scheme, the primary protection uses tripping rectifiers, and the backup uses an auxiliary relay to trip two breakers. As before, the 62X and 62Y relays are operated by the primary and back-up relays, respectively.

Assume a failure of breaker 1 for a fault on line D. Line-D relay 62X or 62Y is operated and energizes breaker-2 timer. Since KC-3 50-1 remains energized by the breaker-1 current, 62 operates to trip breaker 2. The ICS unit of relay 62 also operates to energize relay 86LN during breaker-2 tripping. Relay 86LN blocks breaker-2 reclosing and sets up the breaker-2 trip circuit to provide a trip-free operation if this breaker is closed in prematurely.

Now assume that breaker 3 fails for a fault on line C. Again, breaker 2 should be tripped. Breaker-2 timer is energized through 50-3 and line-C 62X or 62Y contact. Relay 62X or 62Y indicates a line-C fault, and 50-3X selects breaker 3 as faulty. Relay 62 times out to trip breaker 2 and also to energize 86LN.

Relay 86LN cannot determine which carrier blocking signal should be interrupted, since a breaker-2 trip occurs when either breaker 1 or 3 fails. Therefore, relay 5 is used in conjunction with relay 86LN to stop carrier on line A or line B when breaker 2 trips. Relay 5 is energized by the primary relays. If breaker 1 fails for a fault on line D, relay 5 of line D is energized, setting up the line-A carrier stop circuit so that when relay 86LN is operated in the breaker-2 trip circuit, carrier blocking will be removed from line A to permit remote carrier relay tripping. Otherwise, line A continues to feed the fault through breaker 2 until a back-up relay operates or until the fault burns clear.

CHARACTERISTICS

The Phase Overcurrent Units are available in the following current ranges:

Range	Taps					
0.5 - 2 Amps.	0.5	0.75	1.0	1.25	1.5	2
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2	3	4	5	6	8

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the phase overcurrent units and telephone relay is shown in Fig. 8. The Ground Overcurrent Unit is available in the 0.5 - 2 or 1 to 4 ampere range. The pickup setting is continuously adjustable over the range. The pickup and dropout time of the ground overcurrent unit and telephone relay is shown in Fig. 9.

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 of lead located in front of the tap block to the desired setting by means of a screw connection.

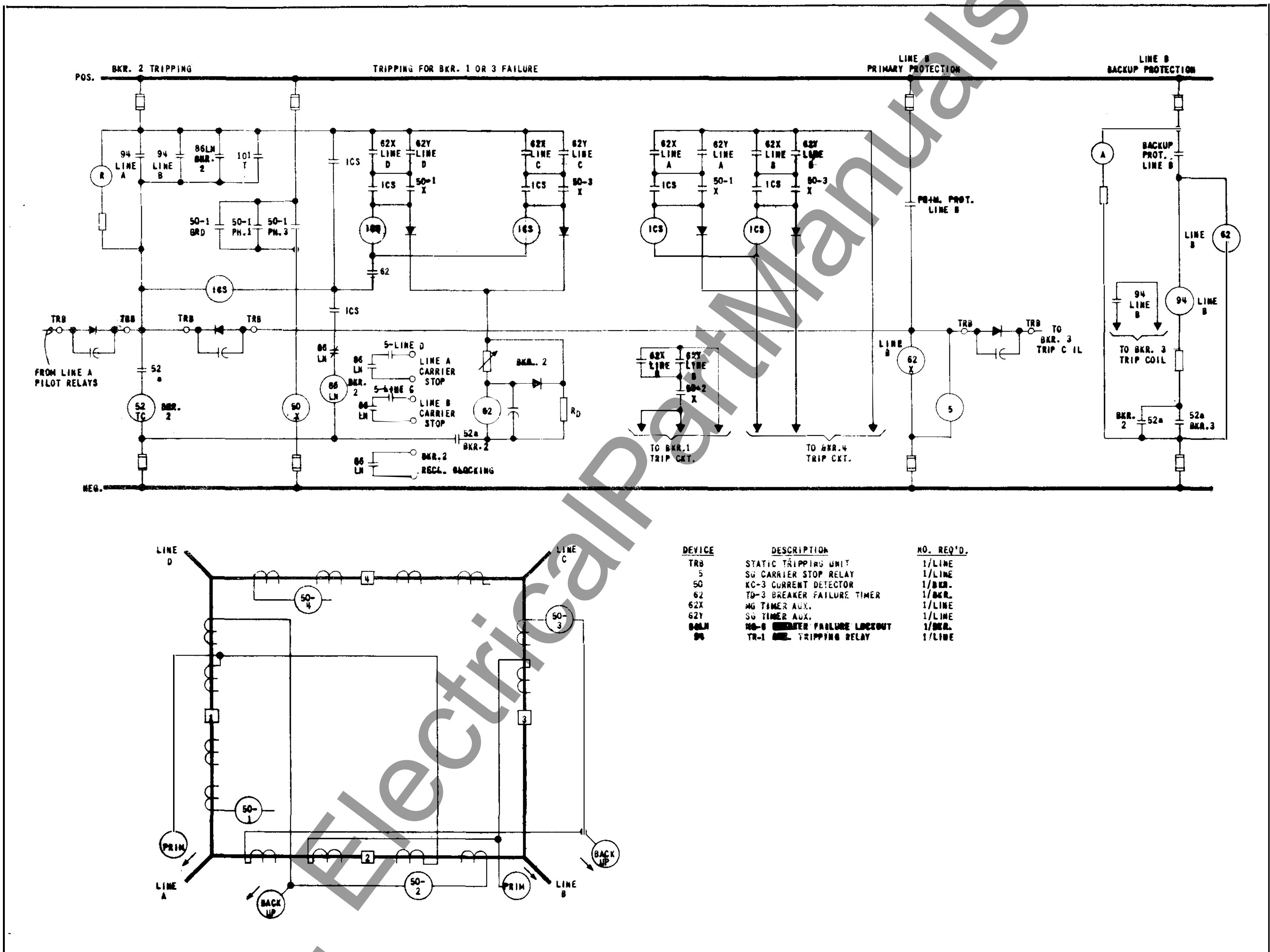
Trip Circuit Constants

Indicating Contactor Switch —
0.2 amp. tap 6.5 ohms d-c resistance
2.0 amp. tap 0.15 ohms d-c resistance

Auxiliary Relay (X)

With rated voltage applied, the contact closing time upon energization and the contact opening time upon de-energization is approximately 5 milliseconds.

The rectifiers S#508C320H14 320P silicon rectifiers have a peak inverse voltage rating of 700 volts d-c.



DEVICE	DESCRIPTION	NO. REQ'D.
TRB	STATIC TRIPPING UNIT	1/LINE
5	SG CARRIER STOP RELAY	1/LINE
50	KC-3 CURRENT DETECTOR	1/BKR.
62	TD-3 BREAKER FAILURE TIMER	1/BKR.
62X	MG TIMER AUX.	1/LINE
62Y	SG TIMER AUX.	1/LINE
86LN	[illegible] BREAKER FAILURE LOCKOUT	1/BKR.
94	TR-1 [illegible] TRIPPING RELAY	1/LINE

Fig. 7. Simplified External Schematic of the Type KC-3 for Breaker-Failure Protection of a Ring Bus.

ENERGY REQUIREMENTS

PHASE OVERCURRENT UNIT (I_1 & I_3) – 60 CYCLES

Ampere Range	Tap	VA at Tap Value	P.F. Angle	VA at 5 Amps.	P.F. Angle
.5-2	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
1-4	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
2-8	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29

GROUND OVERCURRENT UNIT (I_0) – 60 CYCLES

Ampere Range	VA at Min. Pickup	VA at Max. Pickup	VA at 5 Amps.
0.5-2	4.5	32	215
1-4	4.5	32	53

Current Ratings

Rating of Phase Overcurrent Unit (I_1 & I_3)

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.5-2	5	100
1-4	8	140
2-8	8	140

Rating of Ground Overcurrent Unit

Ampere Range	One Second Rating (Amperes)
0.5-2	18
1-4	36

SETTINGS

Phase Overcurrent Unit (I_1 & I_3)

The pickup current setting is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION *Since the tap block connector screw carries operating current, be sure that the screw is turned tight.*

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Ground Overcurrent Unit (I_o)

The core screw must be adjusted to the value of pickup current desired.

Auxiliary Relay (X)

With the 125/250 volt relays the tapped resistor in series with the auxiliary relay (X) is shipped from the factory for operation on 125 volts d.c. For 250 volt operation move the lead connection from the tap position to the full resistance connection. The resistor in the 48 volt relay is not tapped.

Indicating Contactor Switch (ICS-1 and ICS-2)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt d-c type WL relay switch or equivalent, use the 0.2 ampere tap; for 48-volt d-c applications set in 2 tap and use WL coil S#304C209G01.

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 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 information, refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under "SETTINGS," should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Phase Overcurrent Unit (I_1 & I_3)

1. Contact Gap — The gap between the stationary and moving contacts with the relay in the de-energized position should be approximately .020."

2. Minimum Trip Current — The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

Ground Overcurrent Unit (I_O)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The contact gap should be approximately 5/64" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Indicating Contactor Switch (ICS-1 and ICS-2)

Close the auxiliary telephone 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

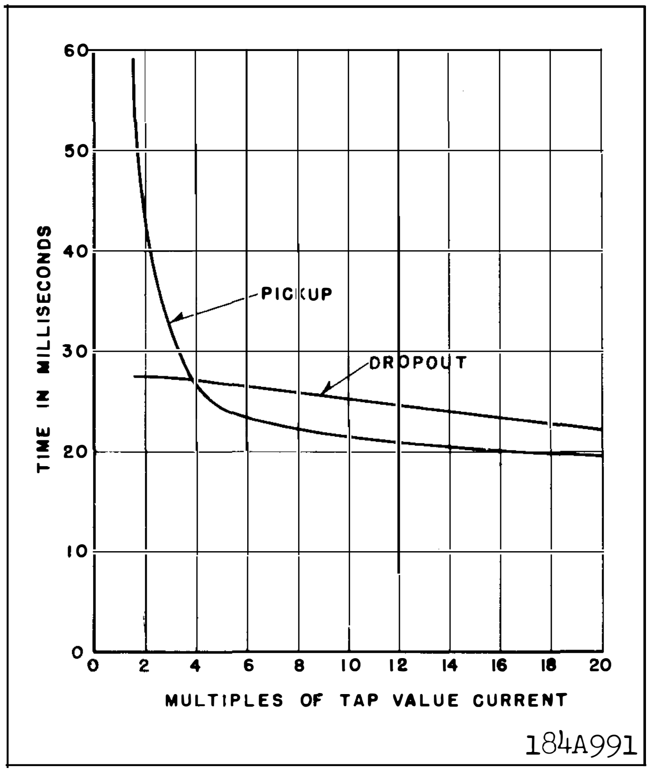


Fig. 8. Maximum Pick-Up and Drop-Out Time. Curves for the Phase Overcurrent Unit Plus Auxiliary Unit.

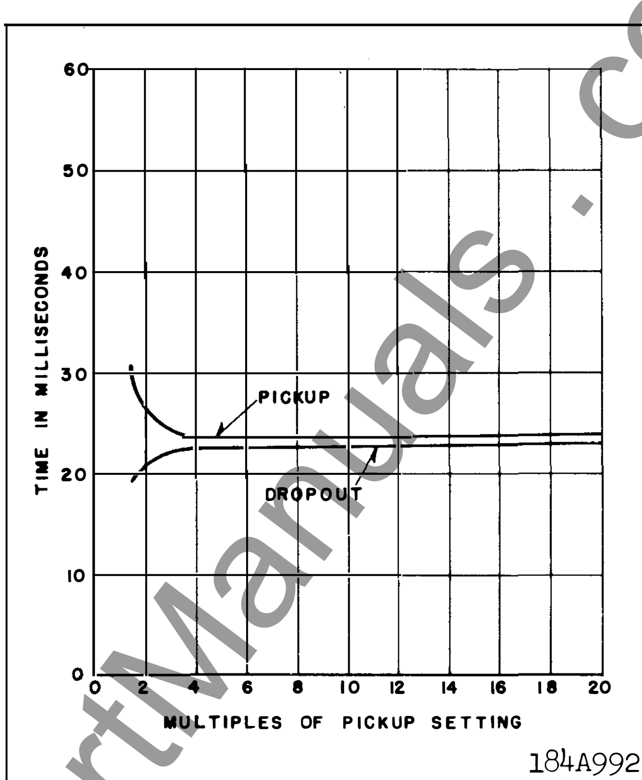


Fig. 9. Maximum Pick-Up and Drop-Out Time. Curves for the Ground Overcurrent Unit Plus Auxiliary Unit.

Auxiliary Relay (X)

Block one of the phase overcurrent cylinder unit contacts closed and apply rated d-c voltage to the proper relay terminals. Observe that all of the normally open contacts close and all the normally closed contacts open.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. 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.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been distrubed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

Phase Overcurrent Unit (I_1 & I_3)

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in the stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, e.e., against the right side of the bridge. Advance the stationary contact until the contacts

just close. Then back off the stationary contact 2/3 of one turn for a gap of approximately .020." The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ±5% of tap value.

If adjustment of pick-up current in between tap settings is desired, insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

Ground Overcurrent Unit

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The contact gap should be approximately 5/64" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Indicating Contactor Switch (ICS-1 and ICS-2)

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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

To increase the pickup current remove the molded cover and bend the springs out or away from the cover. To decrease the pickup current bend the springs in toward the cover.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Auxiliary Relay (X)

Block the cylinder unit contact closed. Apply rated voltage and see that all the normally open contacts close by means of a neon lamp. Also see that the normally closed contacts make a good contact with the coil de-energized by noting some deflection of the contacts. With the relay de-energized check to see that a good contact is made across the resistor in series with the coil by measuring approximately zero resistance at the resistor terminals.

The contact gap should be approximately .020". The armature rest may be adjusted slightly to achieve this, but care should be exercised so as not to affect the normally closed contacts.

The armature residual screw may be adjusted to vary contact follow of the normally open contacts but the residual gap should not be less than .002".

RENEWAL PARTS

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

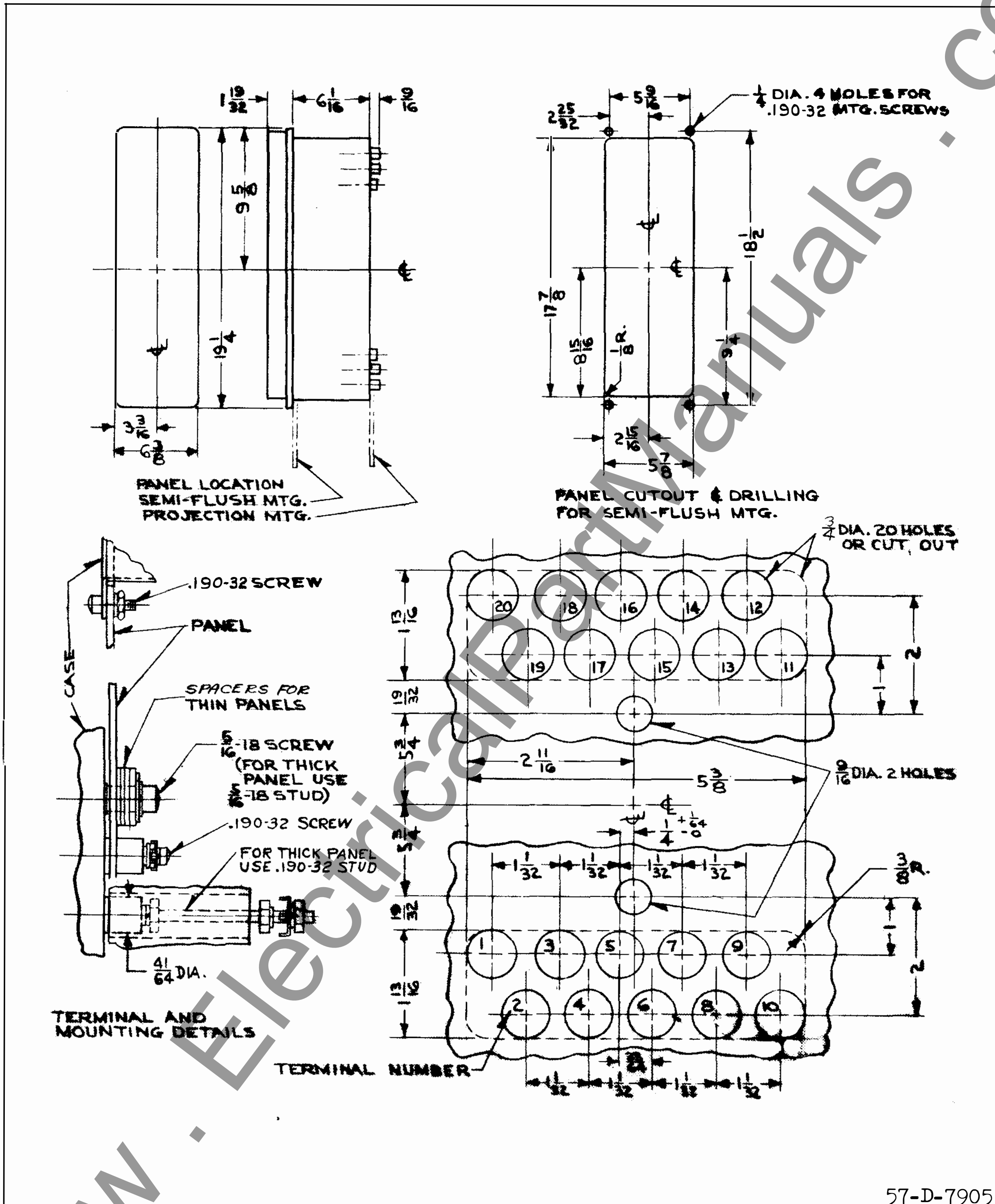


Fig. 10. Outline and Drilling Plan for the Type KC-3 Relay in FT-42 Case.

WESTINGHOUSE ELECTRIC CORPORATION
RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-4 OVERCURRENT RELAY

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

APPLICATION

The type KC-4 is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other relays. It is well suited to breaker-failure relaying for indicating the presence or lack of current flow in the circuit breaker. The relay can be applied where the phase units are to be operated indefinitely in the picked up position well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load) the 98% or better dropout ratio of the phase units is advantageous.

Breaker-failure relaying offers advantages over remote back-up protection. It is faster and more sensitive than remote back-up methods. In addition, it is selective, whereas remote back-up protection is frequently non-selective. Fig. 2 shows some fault conditions where breaker-failure relaying could improve the quality of back-up protection. Note that the generating-station high-voltage bus uses a breaker-and-a-half arrangement. Lines interconnect the station to systems S_1, S_2, and S_3.

If there is no malfunctioning, fault L will be cleared by line relays tripping breakers 5, 6, and 9. However, assume that the breaker-6 mechanism sticks so that current flow through breaker 6 is not interrupted. Now back-up protection must function. If remote backup is relied upon, time-delay relays must trip remote breakers 7 and 8. In addition, the local generator feed through breaker 6 must be interrupted by tripping breaker 4. However, if breaker-failure protcction is installed, the fault is cleared by tripping breaker 3. Note that this provided selective tripping, since as much of the system as possible was left intact. If breakers 4, 7, and 8 must trip, the local generator is lost and unnecessary separation of the generating station from power systems S_1 and S_2 results. Also, the tapped load is interrupted unnecessarily instead of being left tied to system S_2.

Remote backup, in addition to not being selective, may not be sensitive enough because of the relatively small proportion of the total fault current following in any one line. For example, in Fig. 2 there may be very little current flow in breakers 7 and 8 for fault L because of the large current contribution by the local machines at the generating station. Thus, it may be difficult or impossible at breakers 7 and 8 to detect adjacent line faults without depending upon sequential tripping. If the generator feed is interrupted for fault L, such as by tripping breaker 4, the current through breakers 7 and 8 may increase sufficiently for the relays to operate and trip breakers 7 and 8. However, the system is by now cut to pieces, and because of the long time delay in clearing the fault, the remainder of the system may be unstable.

Although breaker-failure protection offers many advantages, remote backup cannot be completely eliminated. For example, assume that breaker 3 fails for bus-fault B in Fig. 2. Breaker-failure protection will promptly trip breaker 2, but the fault is still fed by breaker 8. Likewise, if breaker 2 fails with a line fault at M, a remote breaker must trip to clear the fault. Breaker-failure protection trips breaker 3, but breaker 8 still feeds the fault. Although breaker-failure protection does not complete the job in these examples, it does expeditiously trip the local breaker, making it easier for the remote relays to detect the fault.

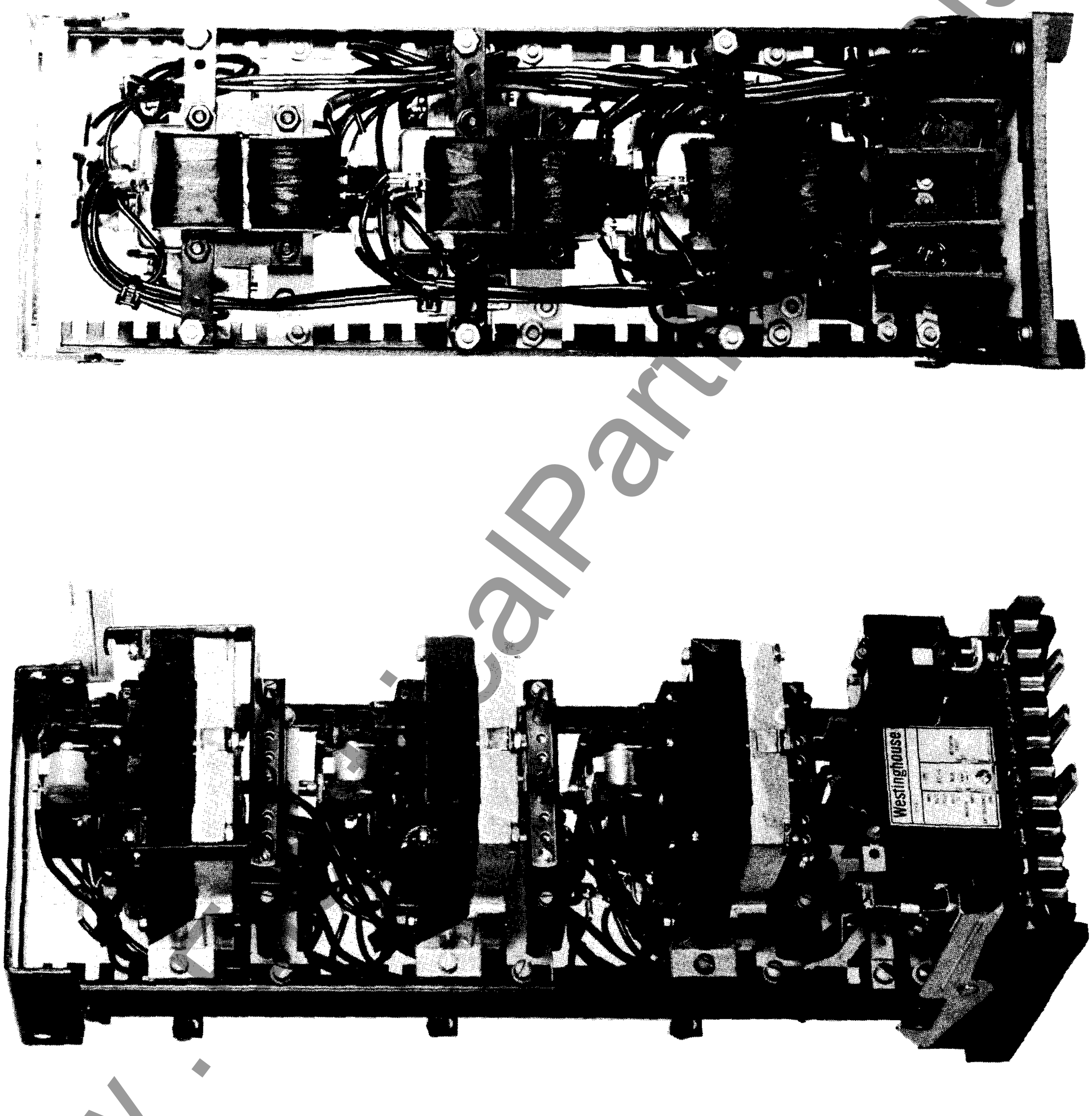


Fig. 1. Type KC-4 Relay Without Case.

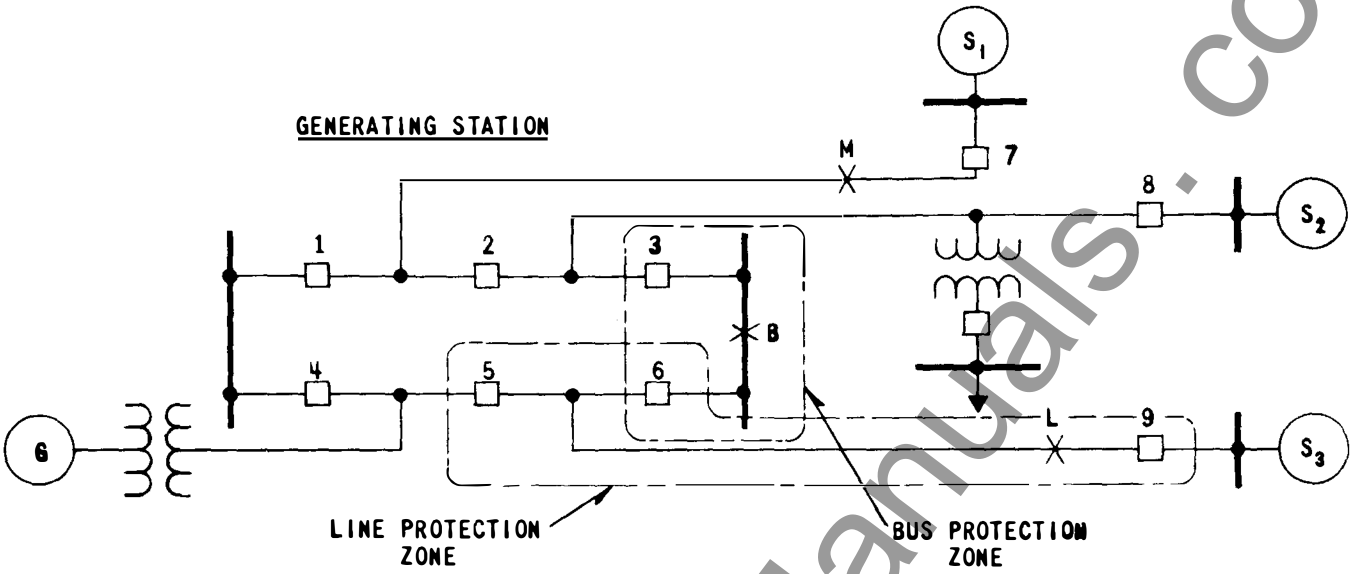


Fig. 2. Sample System to Show Advantages of Breaker-Failure Protection.

CONSTRUCTION

The type KC-4 relays consists of two phase instantaneous overcurrent units, (I_1 and I_3), one one ground instantaneous unit (I_0), and an indicating contactor switch (ICS). The principal component parts of the relay and their location are shown in Figures 1 and 3.

Phase and Ground Instantaneous Overcurrent Units (I_1, I_3, I_o)

Each instantaneous overcurrent unit consists of an induction cylinder unit, capacitor, varistor, and a transformer. The components are connected such that a contact closing torque is produced when the current exceeds a specified value.

Induction Cylinder Unit

Mechanically, the cylinder unit is composed of four basic components: a diecast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another, and a capacitor is connected in series with one pair of coils. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearings, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

Transformer

The transformer is a saturating type consisting of a tapped primary winding and a secondary winding. A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction cylinder unit and phase shifting capacitor.

Indicating Contactor Switch Unit (ICS.)

The indicating contactor switch is a small d-c operated 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 valve of the switch.

OPERATION

Instantaneous Overcurrent Unit

Operation of the instantaneous overcurrent unit occurs when the primary current of the transformer exceeds a value as marked on the tap plate. Upon application of current to the transformer, a voltage is induced in the secondary winding. This voltage is impressed upon the parallel connected pairs of cylinder unit coils. The capacitor connected in series with one pair of coils shifts the current flowing in these coils in reference to the current flowing in the other pair of coils. As a result, the air gap fluxes of the cylinder unit are out of phase and a contact closing torque is produced.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pickup current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

General Operation Of Scheme

When the proper breaker successfully interrupts the fault current the KC-4 relay quickly disables

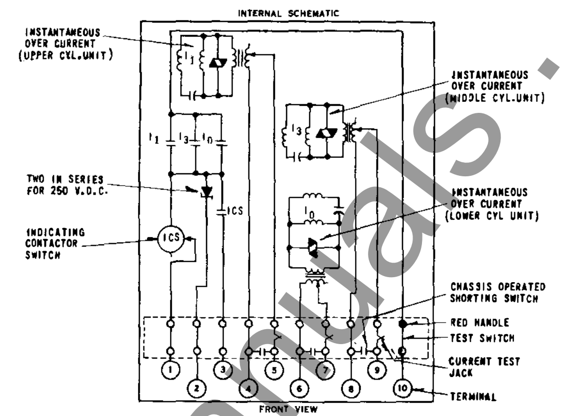


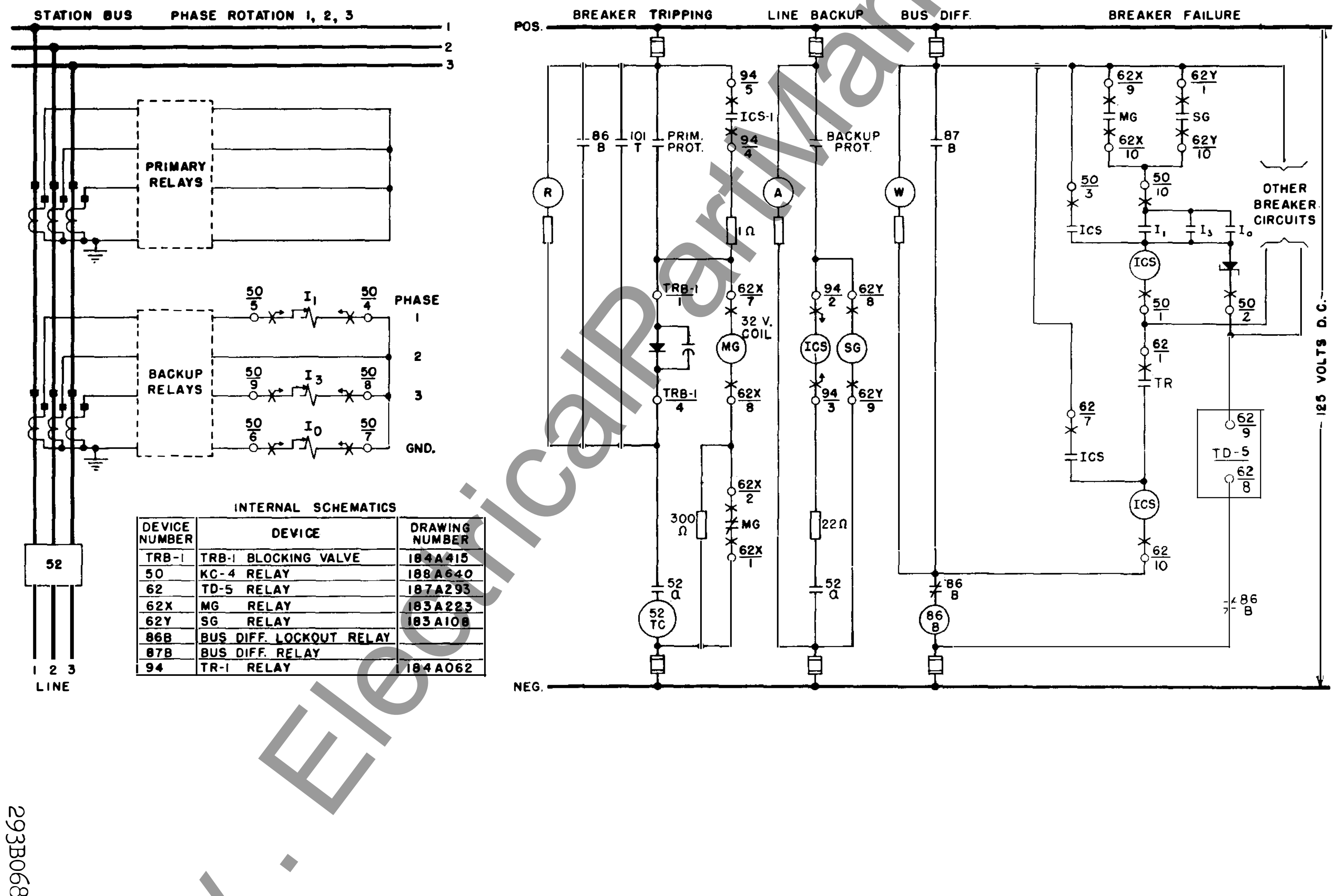
Fig. 3. Internal Schematic of the KC-4 Relay in the FT-41 Case.

the breaker-failure timing circuit. In addition, where the line relays trip two breakers such as on a ring bus, the KC-4 selects which of the two breakers has failed. When the phase overcurrent units I_1 and I_3 are set above load-current level, the KC-4 also functions as a fault detector to prevent undesired tripping by test personnel. The following paragraphs describe KC-4 operation in more detail for different system bus connections.

Single Bus/Single Breaker Arrangement

Unless something fails, current flow in the breaker should cease shortly after the trip circuit is energized. The time interval between these two occurrences will be the breaker-interrupting time. If this interruption does not occur, breaker-failure relaying will initiate the tripping of other breakers. Fig. 4 shows how this is accomplished. Unless something fails either the primary of back-up relays initiate tripping of the faulted line breaker. Note that the primary and back-up relays connect to separate sets of current transformers and d-c supplies. This way a failure in one or the other circuits will not disable all of the protection.

When the primary protection operates, it energizes 62X; the back-up protection energizes 62Y. Contacts of these two auxiliaries start the breaker-failure timer 62, through the KC-4 contacts. If the line breaker fails to clear the fault, KC-4 contacts remains



INTERNAL SCHEMATICS

DEVICE NUMBER	DEVICE	DRAWING NUMBER
TRB-1	TRB-1 BLOCKING VALVE	184A415
50	KC-4 RELAY	188A640
62	TD-5 RELAY	187A293
62X	MG RELAY	183A223
62Y	SG RELAY	183A108
86B	BUS DIFF. LOCKOUT RELAY	
87B	BUS DIFF. RELAY	
94	TR-1 RELAY	184A062

Fig. 4. External Schematic of the KC-4 Relay for Breaker Failure Protection of a Single Bus/ Single Breaker Arrangement

closed. The contact of timer 62 closes, energizing the bus lock-out relay 86B through 62X or 62Y and KC-4 contacts. Relay 86B then trips all the breakers on the bus.

The TRB-1 rectifier in the primary – protection circuits of Fig. 4 blocks the flow of red-light supervision current through the 62X coil.

An MG-6 relay performs the 62X function in Fig. 4. Actually an SG will suffice unless a directional-comparison blocking system provides the primary protection. With this system two MG-6 contacts seal around the RRG and RRP contacts. (Refer to drawing 540D542 for the details of this arrangement.)

Breaker- and-a-Half Arrangement

Typical trip and control circuits for breaker-failure back-up protection for the breaker-and-a-half bus arrangement are shown in Fig.5. The trip circuits are shown for breaker 1 and breaker 2 and the line-A protection. Similar circuits would exist for breaker 3 and line B. Protection against a breaker-1 or breaker-2 failure for line-A faults is included.

Assuming a failure of breaker 2 for a fault on line B, the breaker-failure timer 62 associated with breaker 1 is energized by 62X or 62Y from line B. Since the KC-4 current detector 50-2 which is supplied by breaker-2 current does not drop out, 62 of breaker 1 operates to trip breaker 1. When 62-ICS is operated by breaker-1 trip current, 86LN is energized. One 86LN contact stops the transmission of a blocking signal on line A, allowing the remote pilot relays to trip the remote line-A breaker, if they detect the fault. Thus, the fault on line B is now cleared. Another 86LN contact blocks high-speed reclosing of breaker 1. Other 86LN contacts energize the breaker-1 and breaker-2 trip-coil circuits to provide for a trip-free operation should either breaker be prematurely closed in.

An essential function, the selection of the faulty breaker, is performed by the KC-4. Relays 62X and 62Y indicate that the fault has not been cleared, but they are unable to define for a line-A fault whether breaker 1 or breaker 2 is still feeding current to the fault. The 50-1 or 50-2 KC-4 performs this job.

Now, if breaker 1 fails for a fault on line A, bus L is cleared. This is accomplished by the bus L breaker-failure timer which is energized by the line-A relay 62X or 62Y contact. When 62 operates, 86B is energized to dump bus L. For this sequence, the current detector 50-1 selects the faulty breaker.

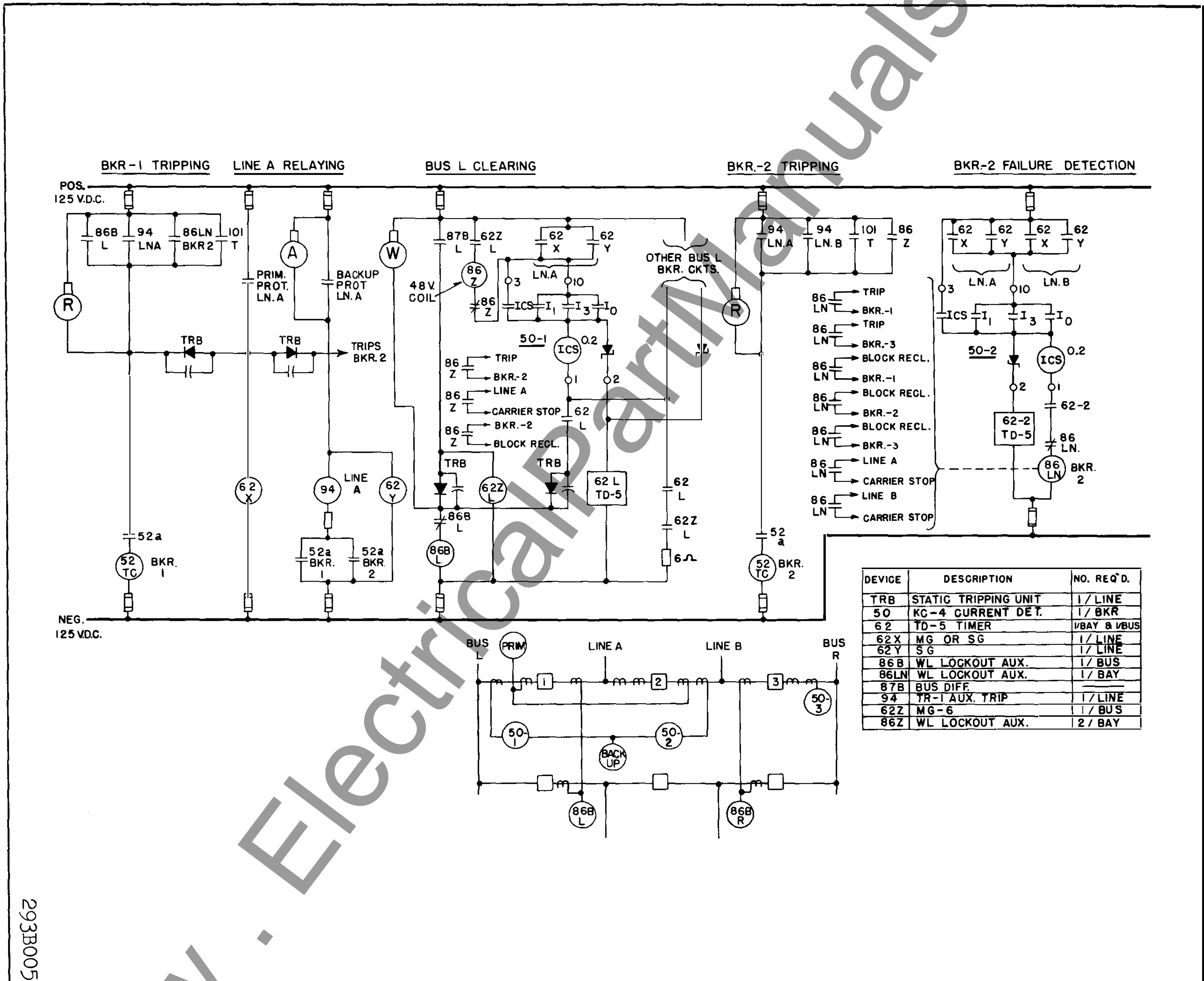
Note that the bus L timer circuit in Fig. 5 is the same as that used with the single bus/single breaker arrangement in Fig. 4. An identical timer circuit (not shown) is associated with bus R in Fig. 5. There are also timers for each bay (e.g., associated with breakers 1 and 3). These trip the appropriate outside breaker for a middle breaker failure. These timer circuits are associated with the breaker to be tripped. This same approach is used for ring buses, as will now be explained.

Ring Bus Arrangement

The circuits for the ring bus are shown in Fig. 6 with trip and control circuits outlined for breaker 2, together with line-B primary and back-up protection circuits. As with the breaker-and-a-half Scheme, the primary protection uses tripping rectifiers, and the backup uses an auxiliary relay to trip two breakers. As before, the 62X and 62Y relays are operated by the primary and back-up relays, respectively.

Assume a failure of breaker 2 for a fault on line B. Line-B relay 62X or 62Y is operated and energizes breaker-2 timer. Since current detector 50 for breaker 2 remains energized by the breaker-2 current, 62 operates to energize relay 86LN. Relay 86LN trips breakers 1 and 3, blocks reclosing on breakers 1,2, and 3, and stops carrier on lines A and B. The tripping of breaker 3 and the stopping of carrier of line B is unnecessary, since it is assumed that the protective relays have already accomplished these results. Although unnecessary, these functions do no harm and simplify the circuitry by permitting the 86LN relay to trip breakers and stop carrier symmetrically, without regard to whether the fault is on line A or line B.

The purpose of stopping carrier on line A is to remove carrier blocking to permit remote carrier relay relay tripping. Otherwise, line A continues to feed the fault through breaker 2 until a back-up relay operates or until the fault burns clear.



DEVICE	DESCRIPTION	NO. REQ'D.
TRB	STATIC TRIPPING UNIT	1/LINE
50	KC-4 CURRENT DET.	1/BKR
62	TD-5 TIMER	1/BAY & 1/BUS
62X	MG OR SG	1/LINE
62Y	SG	1/LINE
86B	WL LOCKOUT AUX.	1/BUS
86LN	WL LOCKOUT AUX.	1/BAY
87B	BUS DIFF.	——
94	TR-1 AUX. TRIP	1/LINE
62Z	MG-6	1/BUS
86Z	WL LOCKOUT AUX.	2/BAY

Fig. 5. Simplified External Schematic of the Type KC-4 for Breaker Failure Protection of a Breaker-And-A-Half Bus.

CHARACTERISTICS

Phase & Ground Overcurrent Units are available in the following current ranges:

Range	Taps					
0.5 - 2 Amps.	0.5	0.75	1.0	1.25	1.5	2
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2	3	4	5	6	8

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the phase overcurrent units is shown in Fig. 7.

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 of lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 amp. tap 6.5 ohms d-c resistance
2.0 amp. tap 0.15 ohms d-c resistance

ENERGY REQUIREMENTS

PHASE & GROUND OVERCURRENT UNIT – 60 CYCLES

Ampere Range	Tap	VA at Tap Value	P.F. Angle	VA at 5 Amps.	P.F. Angle
	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
.5-2	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
1-4	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
2-8	4	1.3	38	2.1	37
	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29

Current Ratings

Rating of the Overcurrent Units (Phase & Ground)

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.5-2	5	100
1-4	8	140
2-8	8	140

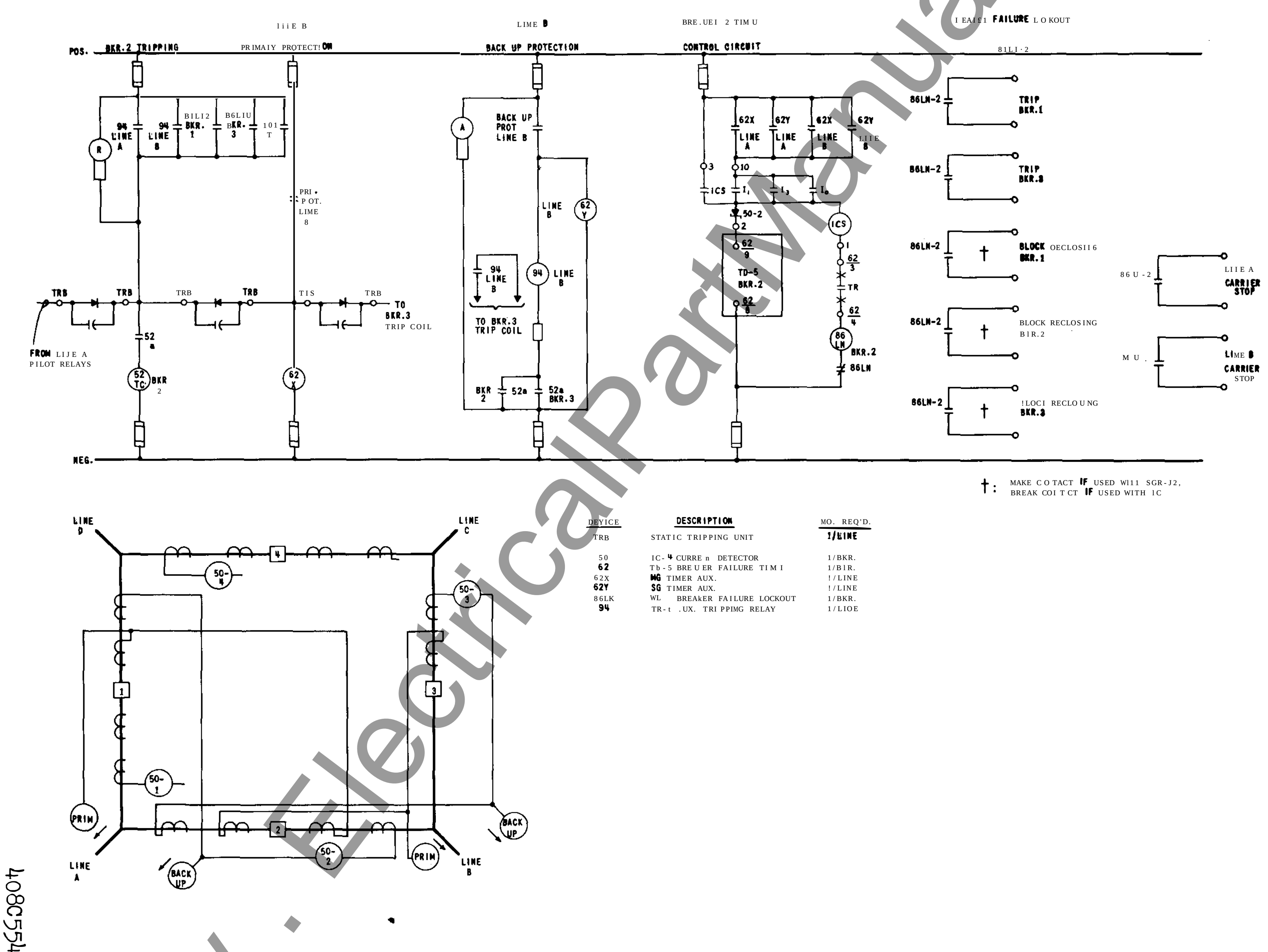


Fig. 6. Simplified External Schematic of the KC-4 for Breaker Failure Protection of a Ring Bus.

SETTINGS

Phase & Ground Overcurrent Unit

The pickup current setting is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION *Since the tap block connector screw carries operating current, be sure that the-screw is turned tight.*

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Indicating Contactor Switch (ICS.)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt d-c type WL relay switch or equivalent, use the 0.2 ampere tap; for 48-volt d-c applications set in 2 tap and use WL coil S#304C209G01.

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 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 information, refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under "SETTINGS," should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Phase & Group Overcurrent Unit

1. Contact Gap – The gap between the stationary and moving contacts with the relay in the deenergized position should be approximately .020."

2. Minimum Trip Current – The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

Indicating Contactor Switch (ICS)

Close the phase or ground 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836HO1 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.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

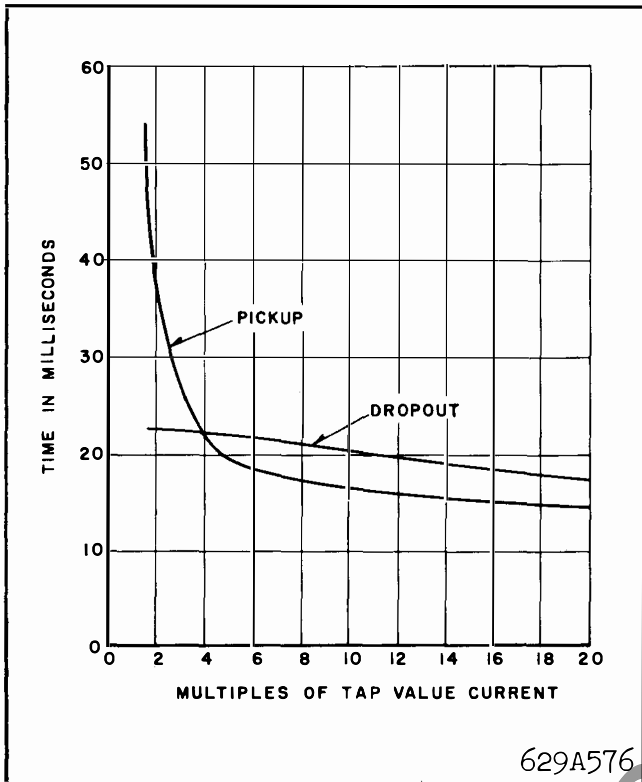


Fig. 7 Maximum Pick-Up and Drop-Out Time. Curves for the Phase Overcurrent Unit

Phase & Ground Overcurrent Unit

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in the stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, e.e., against the right side of the bridge. Advance the stationary contact until the contacts just close. Then back off the stationary contact 2/3 of one turn for a gap of approximately .020." The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact is position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver of similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ±5% of tap value.

If adjustment of pick-up current in between tap settings is desired, insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

To increase the pickup current remove the molded cover and bend the springs out or away from the cover. To decrease the pickup current bend the springs in toward the cover.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

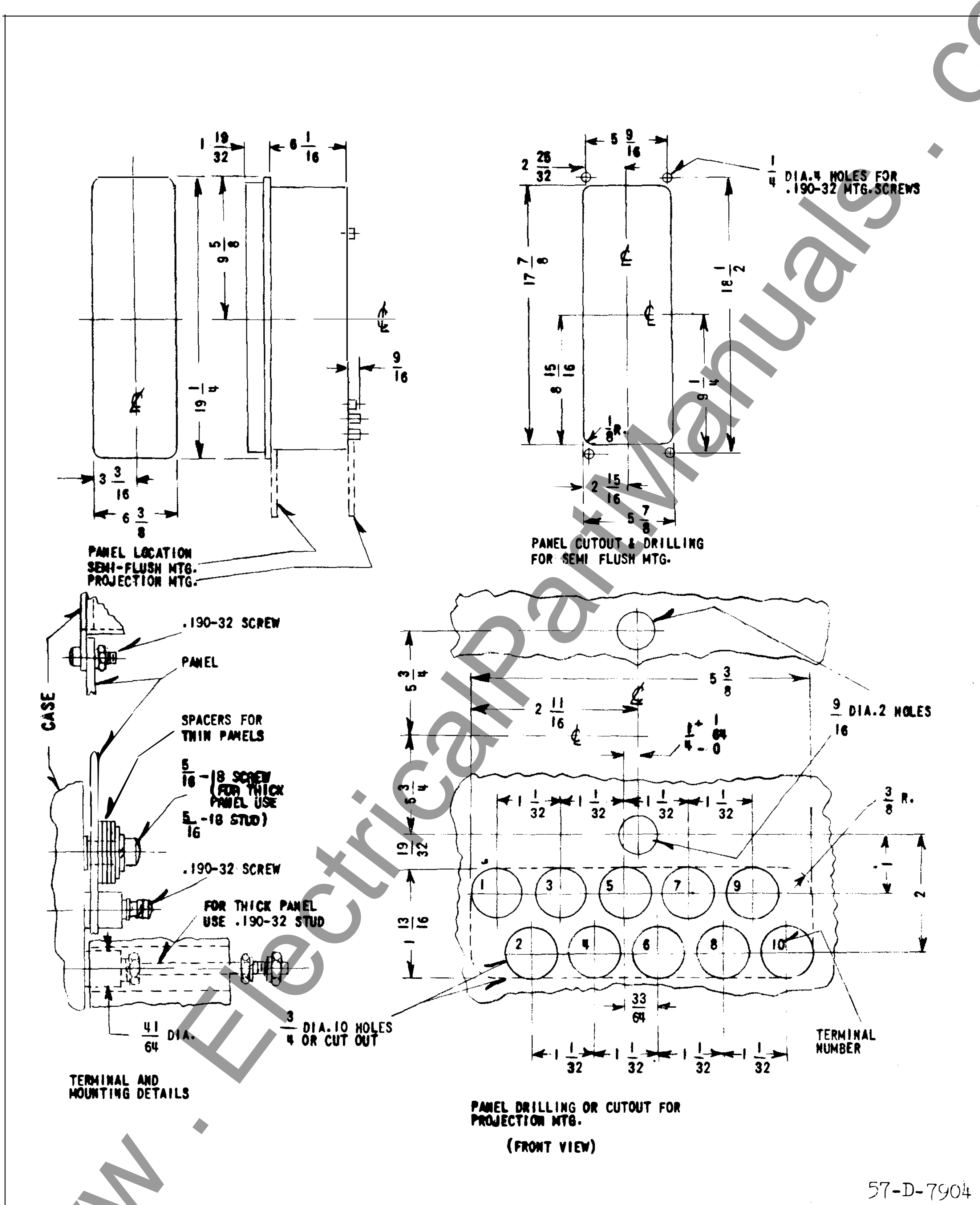


Fig. 8. KC-4 in FT 41 Case

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-2 HIGH SPEED OVERCURRENT RELAY

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

NOTE: These Instructions apply to 50 and 60 Hz. Relays.

○ APPLICATION

The type KC-2 relay is a two unit high speed overcurrent level detector. As an example, it may be used as a fault detector for KD-10 distance relays. It may be operated continuously picked up, if the application requires, without experiencing excessive wear.

CONSTRUCTION AND OPERATION

The type KC-2 relay consists of two high speed overcurrent cylinder units and an indicating contactor switch.

OVERCURRENT UNIT (I)

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the normally open contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

SUPERSEDES I.L. 41-776.2D, dated Jan. 1977

○ Denotes change from superseded Issue

EFFECTIVE MAY 1978

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden on the operating CT.

The primary of the transformer is tapped and brought out a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The indicating contactor switch is a small dc operated 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.

CHARACTERISTICS

The relay is available in the follolwing current ranges:

Range	Taps					
0.5 - 2 amps	0.5	0.75	1.0	1.25	1.5	2
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2	3	4	5	6	8
4 - 16	4	6	8	9	12	16
10 - 40	10	15	20	24	30	40

The tap value is the minimum current required to just close the overcurrent relay contacts. For pick-up settings in between taps refer to the section under adjustments.

CONTACTS

The moving contact assembly in the overcurrent unit has been factory adjusted for low contact bounce performance and should not be disturbed.

TRIP CIRCUIT

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

TRIP CIRCUIT CONSTANT

Indicating contactor Switch (ICS)

1 ampere rating: 0.1 ohms dc resistance
0.2/2.0 ampere rating: 0.2 tap — 6.5 ohms
2 tap — 0.15 ohms

SETTINGS

OVERCURRENT UNIT (I)

The only setting required is the pickup current setting which is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION: Since the tap block connector screw carried operating current, be sure that the screw is turned tight.

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

INDICATING CONTACTOR SWITCH (ICS)

No setting is required for relays with a 1.0 ampere unit. For relays with a 0.2/2.0 ampere unit, connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125- or

250-volt dc type WL relay switch, or equivalent, use the 0.2 ampere tap; for 48-volt dc applications set the unit in a tap 2 and use a Type WL relay with a S#304C209G01 coil, or equivalent.

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.

ADJUSTMENTS & MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustment, other than those covered under "SETTINGS", should be required.

ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order.

OVERCURRENT UNIT (I)

Contact Gap – The gap between the stationary and moving contact with the relay in the de-energized position should be approximately .020".

The pickup of the overcurrent unit can be checked by interting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not less than 1.0 ampere nor greater than 1.2 amperes for the 1 ampere ICS. The current should not be greater than the particular ICS tap setting being used for the 0.2-2.0 ampere ICS. The operation indicator target should drop freely.

The contact gap should be approximately 0.047" for the 0.2/2.0 ampere unit and 0.070" for the 1.0 ampere unit between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

ROUTINE MAINTENANCE

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. 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.

CALIBRATION

Use the following procedure for calibrating the relay when taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

OVERCURRENT UNIT (I)

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, i.e., against the right side of the bridge.

   Move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact of 2/3 of one turn for a contact gap of approximately .020".

   The clamp holding the stationary contact need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

   With the tap screw in the desired tap hole, pass rated ac current through the relay terminals.

   The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

   Adjust the spring until the contacts close. With this adjustment, the pick-up of the relay for any other tap setting should be within ±5% of tap value.

   If settings in between taps are desired, place the tap screw in the next lower tap hole and adjust the spring until the contacts just close at the desired pick-up current.

INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not less than 1.0 ampere nor greater than 1.2 amperes for the 1 ampere ICS. The current should not be greater than the particular ICS tap setting being used for the 0.2-2.0 ampere ICS. The operation indicator target should drop freely.

The contact gap should be approximately 0.047" for the 0.2/2.0 ampere unit and 0.070" for the 1.0 ampere unit between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

RATINGS OF OVERCURRENT UNIT
50 & 60 Hz

Range	Continuous Rating Amps	One Second Rating Amps
.5 – 2	5	100
5 – 4	8	140
2 – 8	8	140
4 – 16	10	200
10 – 40	10	200

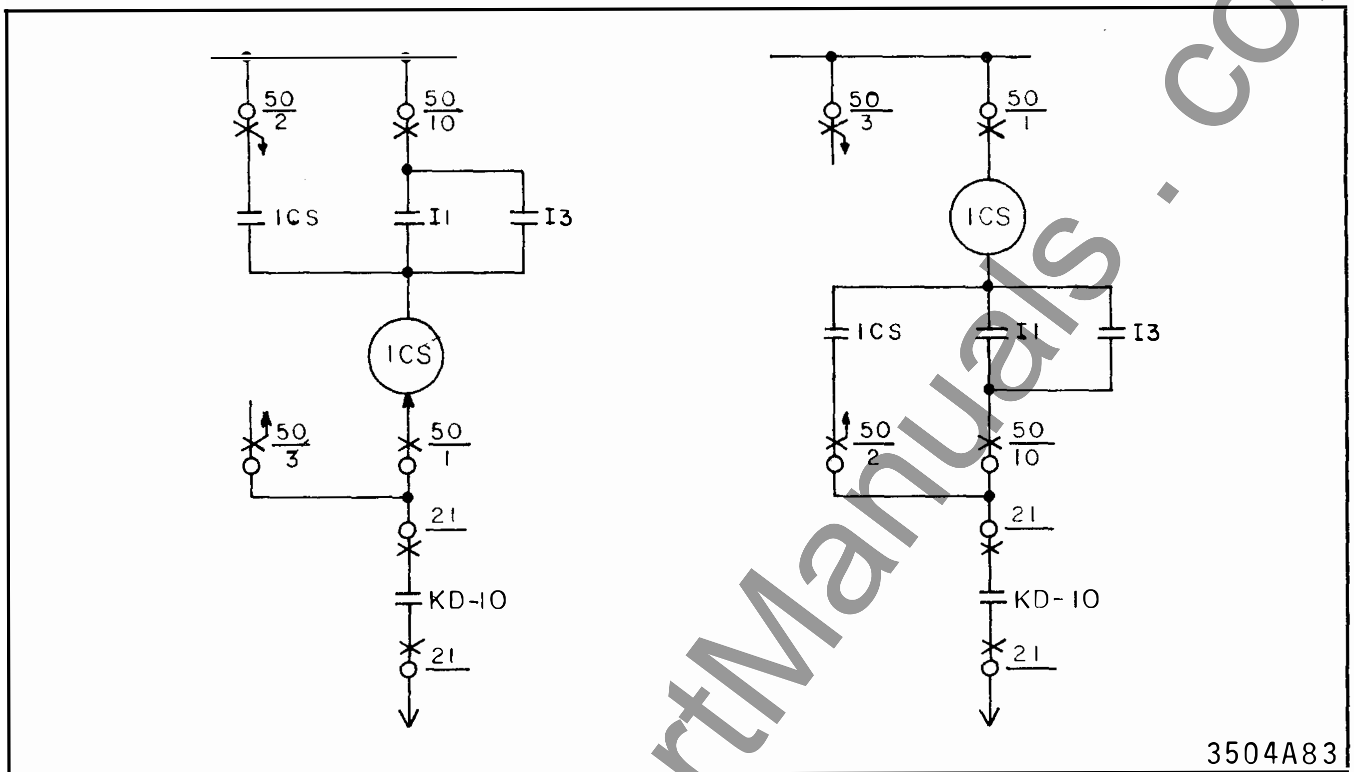


Fig. 1. External Connection of KC-2 Relay for Supervising the Distance Phase Relay.

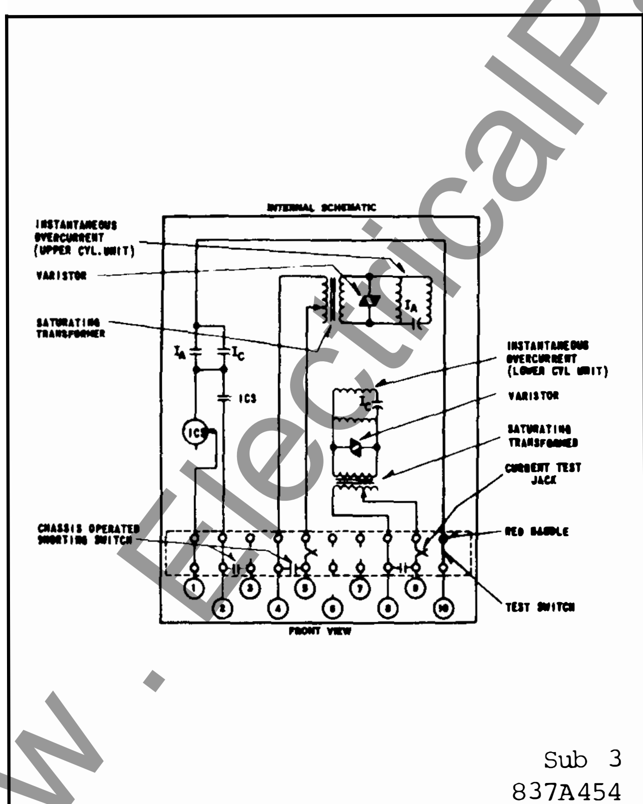


Fig. 2. Internal Schematic of KC-2 with Tapped ICS.

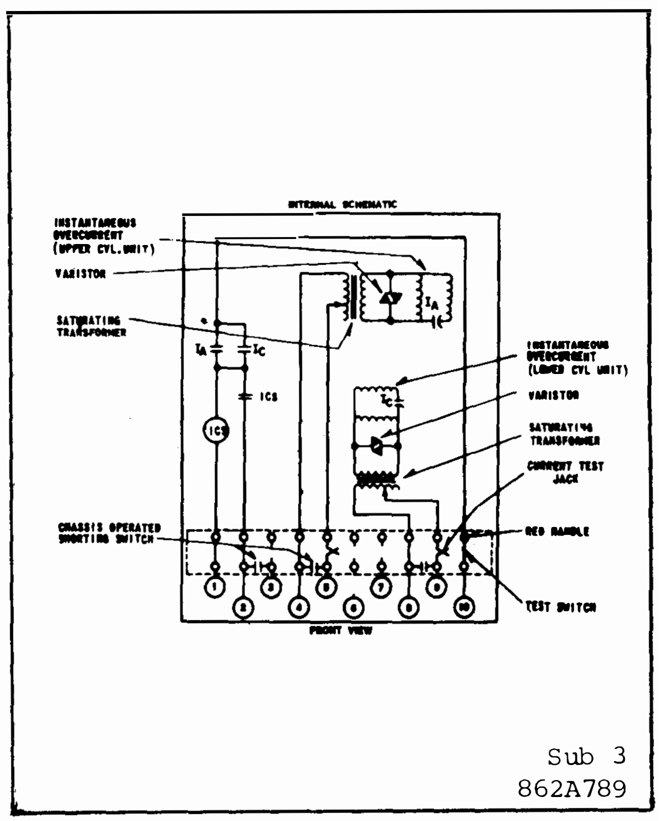


Fig. 3. Internal Schematic of KC-2 Relay with 1 Amp ICS Unit.

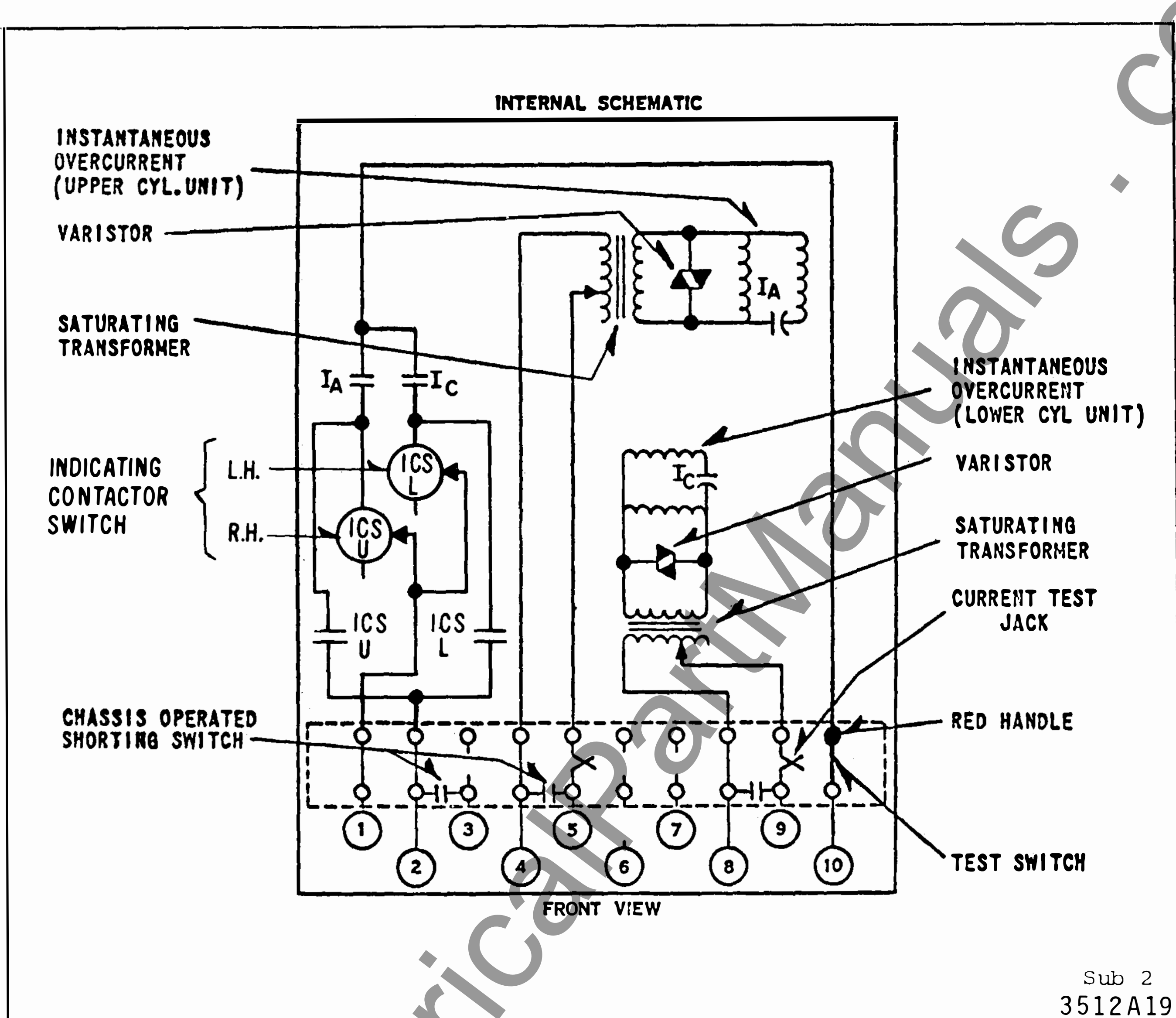


Fig. 4. Internal Schematic of KC-2 Relay with two Tapped ICS units.

ENERGY REQUIREMENTS
BURDEN DATA OF OPERATING CURRENT CIRCUIT
KC-2 50 HZ

AMPERE RANGE	TAP	VA AT TAP VALUE	PF ANGLE	VA AT 5 AMPS.	PF ANGLE
.5 – 2	.5	.35	36	24	34
	.75	.36	33	13	32
	1	.37	32	8.0	31
	1.25	.39	31	5.5	30
	1.5	.41	29	4.5	28
	2	.43	27	2.8	26
1 – 4	1	.35	35	8.8	34
	1.5	.38	31	4.8	30
	2	.41	29	2.8	28
	2.5	.44	27	2.0	27
	3	.47	25	1.4	25
	4	.53	23	.92	23
2 – 8	2	1.04	45	6.2	45
	3	1.1	41	3.2	41
	4	1.2	36	2.0	36
	5	1.3	33	1.2	33
	6	1.4	31	1.0	31
	8	1.7	27	0.6	27
4 – 16	4	1.26	43	2.1	42
	6	1.5	40	0.9	40
	8	1.6	37	.5	37
	9	1.7	34	.4	34
	12	2.0	31	.35	31
	16	2.2	28	.20	28
10 – 40	10	1.9	39	.45	39
	15	3.6	36	.40	36
	20	5.8	34	.35	34
	24	7.8	31	.30	31
	30	10.5	29	.27	29
	40	17.5	27	.25	27

Fig. 5. Burden Data

ENERGY REQUIREMENTS
BURDEN DATA OF OPERATING CURRENT CIRCUIT
60 HERTZ

RANGE AMPS	TAPS	VOLT-AMPERES TAP VALUE CURRENT	POWER FACTOR ANGLE φ °	VOLT AMPERES AT 5 AMPERES	POWER FACTOR ANGLE φ °
.5 – 2	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
1 – 4	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
2 – 8	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29
4 – 16	4	1.5	51	2.4	51
	6	1.7	45	1.2	45
	8	1.8	40	0.7	40
	9	1.9	38	0.6	38
	12	2.2	34	0.37	34
	16	2.5	30	0.24	31
10 – 40	10	1.7	28	.43	28
	15	2.4	21	.27	21
	20	3.1	16	.20	17
	24	3.6	15	.15	15
	30	4.2	12	.11	13
	40	4.9	11	.08	12

Fig. 6. Burden Data

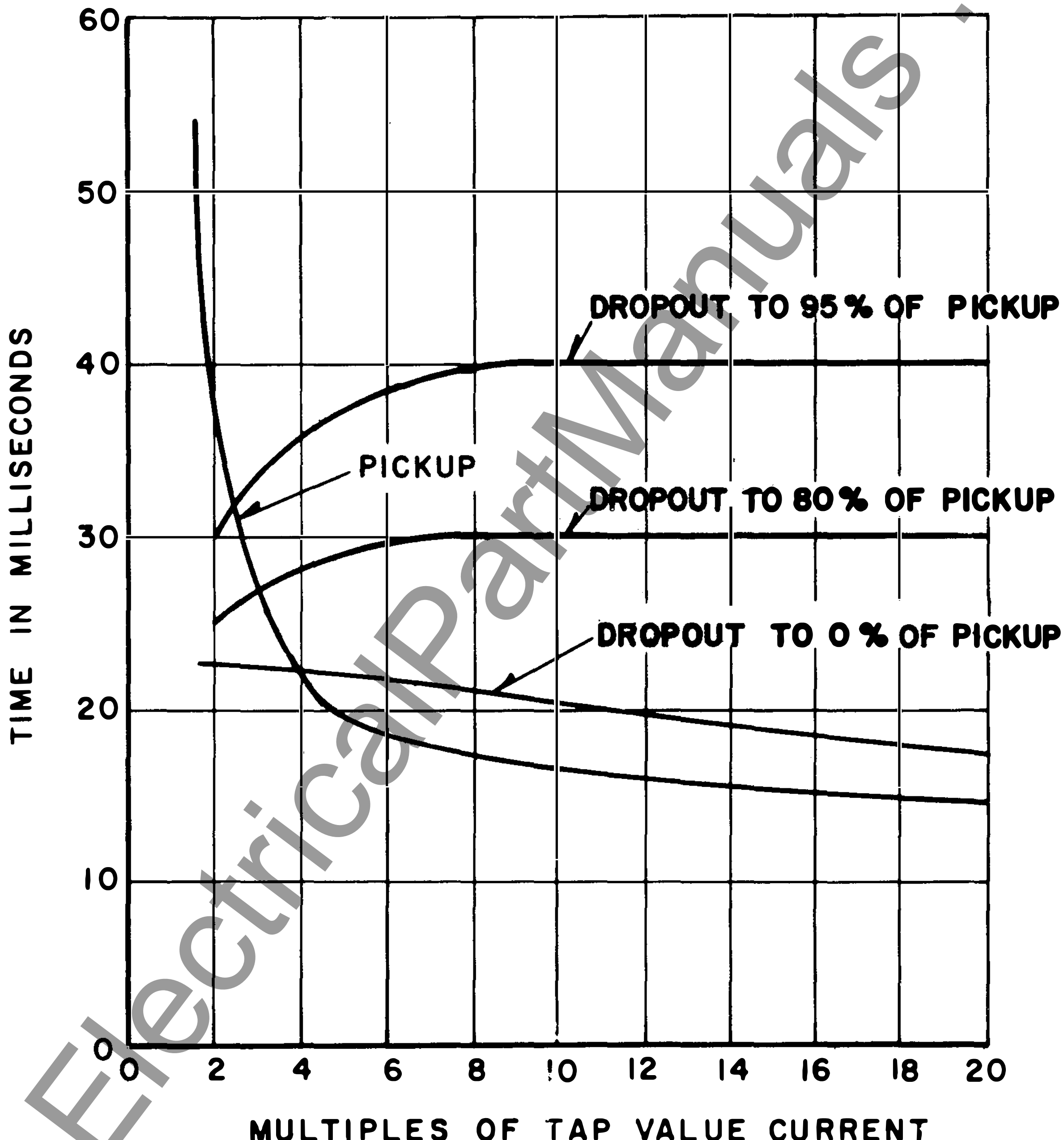


Fig. 7. Maximum Pickup and Dropout Time Curves for the Phase and Ground Overcurrent Unit.

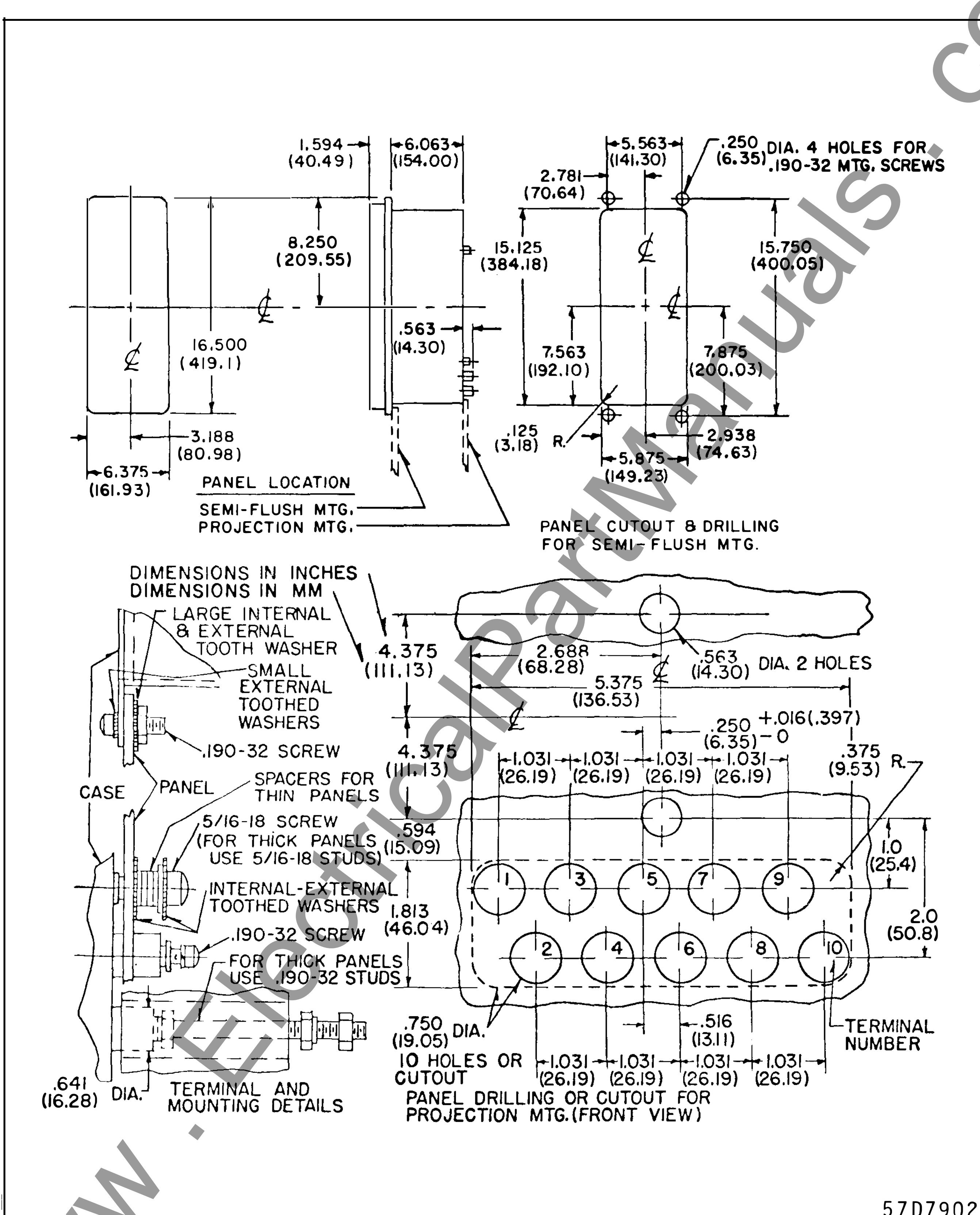


Fig. 8. Outline and Drilling (FT-31 Case).

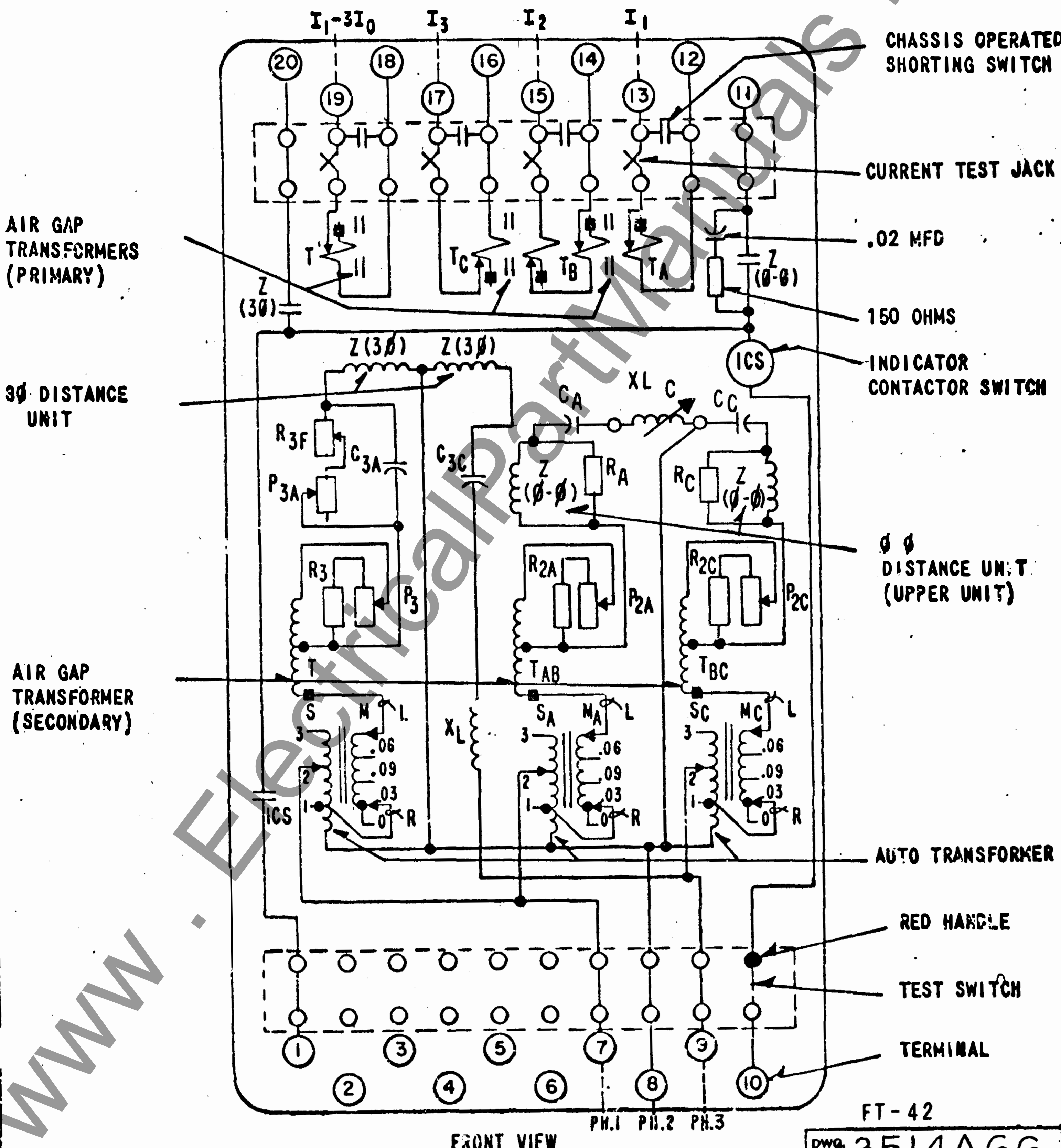
WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

DISTANCE RELAY - TYPE KD-10 (1 AMP I.C.S.)
IN TYPE FT-42 CASE
INTERNAL SCHEMATIC

DIMENSIONS IN INCHES



FT-42

WESTINGHOUSE ELECTRIC CORPORATION - RELAY - INSTRUMENT DIVISION - NEWARK, N.J., U.S.A.

3514A66

D-905713-29

MFG. DWG 1318D78 REF

DWG. NO. 3514A66

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-4 OVERCURRENT RELAY

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

APPLICATION

The type KC-4 is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other relays. It is particularly suited for breaker-failure relaying schemes, in which it indicates the presence or lack of current flow in the protected circuit breaker. The relay can be applied where the phase units are to be operated indefinitely in the picked up position, set well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load) the 98% or better dropout ratio of the phase and ground units is advantageous.

Specific breaker failure schemes using the KC-4 relay, with detailed explanations, are given in the OPERATION section.

CONSTRUCTION

The type KC-4 relay consists of two phase instantaneous overcurrent units, (I_A and I_C), one ground instantaneous unit (I_0), and an indicating contactor switch (ICS). The principal component parts of the relay and their location are shown in Figure 1.

PHASE AND GROUND INSTANTANEOUS OVERCURRENT UNITS

(I_A, I_C, I_O)

Each instantaneous overcurrent unit consists of an induction cylinder unit, capacitor, varistor, and a transformer. The components are connected such that a contact closing torque is produced when the current exceeds a specified value.

INDUCTION CYLINDER UNIT

Mechanically, the cylinder unit is composed of four basic components: a diecast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another, and a capacitor is connected in series with one pair of coils. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub

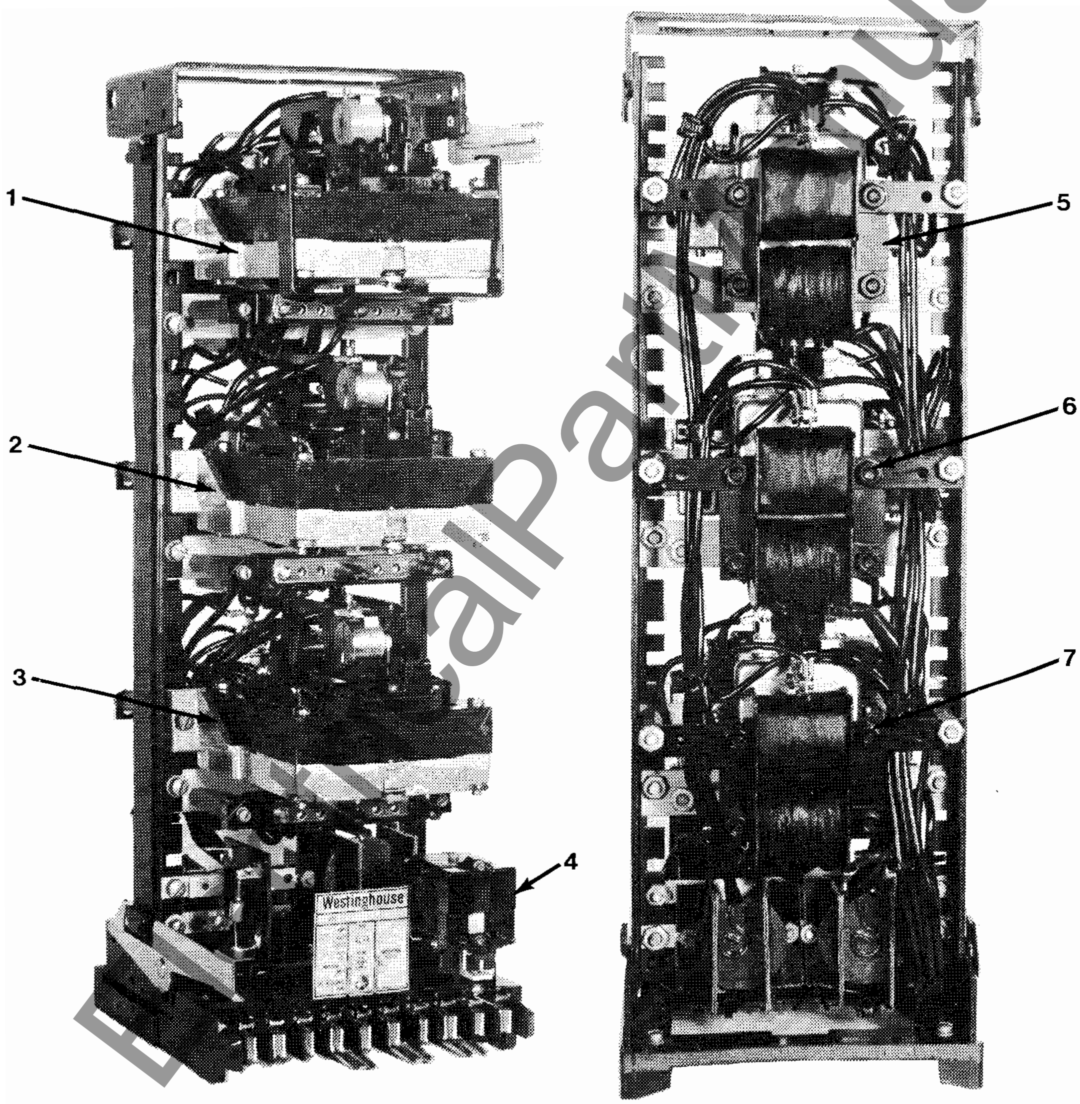
All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-776.1H, DATED MAY 1977
COMPLETE REVISION

EFFECTIVE DECEMBER 1977

which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearings, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.



FRONT VIEW   REAR VIEW

1-I_A UNIT   2-I_C UNIT   3-I_O OR I_B UNIT   4-INDICATING CONTACTOR SWITCH

5-I_A SATURATING TRANSFORMER   6-I_C SATURATING TRANSFORMER

7-I_O OR I_B SATURATING TRANSFORMER

Fig. 1. Type KC-4 Relay Without Case.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

TRANSFORMER

The transformer is a saturating type consisting of a tapped primary winding and a secondary winding. A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction cylinder unit and phase shifting capacitor.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The indicating contactor switch is a small dc operated 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

INSTANTANEOUS OVERCURRENT UNIT

Operation of the instantaneous overcurrent unit occurs when the primary current of the transformer exceeds a value as marked on the tap plate. Upon application of current to the transformer, a voltage is induced in the secondary winding. This voltage is impressed upon the parallel connected pairs of cylinder unit coils. The capacitor connected in series with one pair of coils shifts the current flowing in these coils in reference to the current flowing in the other pair of coils. As a result, the air gap fluxes of the cylinder unit are out of phase and a contact closing torque is produced.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pickup current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

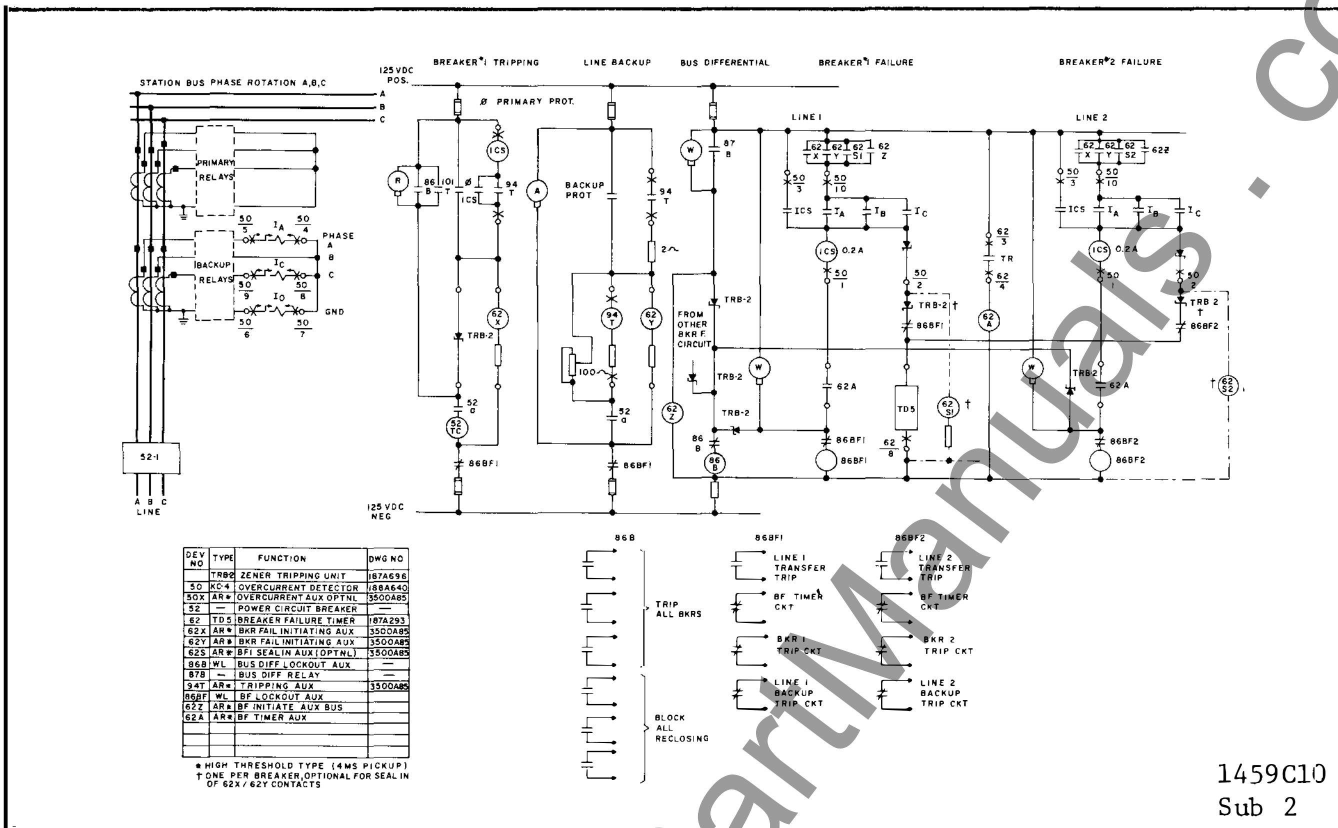
BREAKER FAILURE SCHEMES USING THE KC-4 RELAY

The following explanations frequently refer to the type TD-5 timing relay, which is usually used in conjunction with the KC-4 relay for breaker failure protection. For detailed data on the TD-5, refer to instruction leaflet 41-579.1.

SINGLE BUS/SINGLE BREAKER ARRANGEMENT

In a properly functioning breaker, current flow should cease shortly after the trip circuit is energized. The time interval between trip-circuit energization and current flow cessation is the breaker-interrupting time. If interruption doesn't occur within the specified interrupting time, the breaker is assumed to have failed and the breaker-failure relaying should initiate tripping of adjacent and/or remote breakers to isolate the protected breaker. For the single bus-single breaker configuration, all the breakers on the bus must be tripped to isolate any one of them which fails. This is readily accomplished by having the breaker-failure protection circuits energize the bus-differential lockout auxiliary 86B.

Figure 2 shows the simplest breaker-failure scheme using the KC-4 relay. Primary and backup line relays connected to separate current transformers and separately-fused dc supplies so that a failure in either circuit will not disable all of the protection. When primary protection operates, it energizes auxiliary relay 62X and the breaker trip coil simultaneously. Similarly, backup relays energize both tripping auxiliary 94T and auxiliary 62Y simultaneously. 62X and 62Y are known as breaker-failure initiate (BFI) auxiliaries. The closure of contacts 62X and 62Y provide a signal in the breaker failure scheme that breaker tripping



DEV NO	TYPE	FUNCTION	DWG NO
	TRB2	ZENER TRIPPING UNIT	187A696
50	KC-4	OVERCURRENT DETECTOR	188A640
50X	AR*	OVERCURRENT AUX OPTNL	3500A85
52	—	POWER CIRCUIT BREAKER	—
62	TD5	BREAKER FAILURE TIMER	187A293
62X	AR*	BKR FAIL INITIATING AUX	3500A85
62Y	AR*	BKR FAIL INITIATING AUX	3500A85
62S	AR*	BFI SEALIN AUX (OPTNL)	3500A85
86B	WL	BUS DIFF LOCKOUT AUX	—
87B	—	BUS DIFF RELAY	—
94T	AR*	TRIPPING AUX	3500A85
86BF	WL	BF LOCKOUT AUX	
62Z	AR*	BF INITIATE AUX BUS	
62A	AR*	BF TIMER AUX	

* HIGH THRESHOLD TYPE (4MS PICKUP)
† ONE PER BREAKER, OPTIONAL FOR SEAL IN OF 62X / 62Y CONTACTS

Fig. 2. External Connections for the KC-4 Relay – Breaker Failure Protection of a Single Bus/Single Breaker Arrangement – One Timer per Bus.

has been initiated. They energize the TD-5 breaker-failure timer (62) through the KC-4 (50) contacts, which have already closed in response to the same fault which operated the line relays. If the breaker interrupts fault current as expected, the KC-4 drops out and the TD-5 timer is de-energized before it times out; no further action is taken. But if current flow continues beyond the expected time limit, the TD-5 delay expires and the output (TR) contact of the TD-5 energizes the 62A auxiliary relay for contact multiplication. 62A contact energizes the 86B lockout auxiliary to strip the bus and block reclosing.

Note that, in figure 2, each breaker has its own line protection relays, BFI auxiliary and KC-4 current detector; but that all of these funnel into a single TD-5 timer. This is done for ecomony since the same tripping device, 86B, is energized regardless of which breaker fails. Targeting of the particular failed breaker is accomplished by the ICS in the associated KC-4 in conjunction with the 62X and 62Y BFI contacts for that line. The zener blocking diode inside each KC-4, connected to terminal 50-2, isolates the multiple trip circuits of the KC-4's from one another so that only the target of the failed breaker will drop.

After the TD-5 has operated and picked up 62A, the 62A contact also energizes the 86BF auxiliary relay. Refer to the primary breaker tripping circuit. If a fault occurs and the breaker operating mechanism is stuck (the most frequent type of breaker failure), line relays energize the trip coil with no effect. The breaker failure scheme will operate the initiate backup tripping, eliminating threats to power system integrity. However, dc current will continue to flow in the primary relay ICS and in the breaker trip coil, uninterrupted by the stuck 52a contact. The trip coil, and other devices in the tripping path, are only intermittently rated and may disintegrate or ignite before operators or repair crews can intervene. For this reason, a normally-closed 86BF contact is shown in series with the trip circuit, to interrupt dc current flow.

After the TD-5 has operated, a sneak path may be created through the supervising lamp for the

86BF coil, backwards through the closed 62A contact, through the KC-4 terminals 1 and 2, and finally into terminal 9 of the TD-5. This sneak current may prevent the TD-5 from dropping out, a normally-closed 86BF contact cuts off the TD-5.

In the primary breaker-tripping circuit, the TRB-2 blocking diode prevents red supervising-light current from flowing in the 62X coil.

In both the primary and the backup tripping circuits, the 62X and 62Y coils are connected to follow the protective relay contacts and should never be connected in series with 52a contacts. Otherwise, BFI is lost when the breaker functions mechanically, opening 52a, but fails to interrupt current flow. The resistor in parallel with the 94T auxiliary dissipates 625 Watts in a 125 Vdc control scheme. It draws sufficient current to hold an ICS in the line backup tripping circuits picked up, and may burn if the 52a contact doesn't open. A 86BF contact deenergizes the backup circuit to prevent this.

For a bus fault, the 87B relay contact energizes the 86B lockout auxiliary to strip the bus and block reclosing. The blocking valves TRB-2 prevent the 87B from energizing the 86BF auxiliaries. However, in case of breaker failure during a bus fault, the BFI auxiliary 62Z relay is picked up by 87B. The closure of contact 62Z provides a signal in the breaker failure scheme to energize the TD-5 timer, then picks up the corresponding 86BF auxiliary. 86BF contact initiates the transfer trip for isolating the faulted bus.

Figure 2 also shows how BFI seal-in can be provided when one timer is used per bus. The TD-5 relay containing the TX relay cannot be used here. A separate 62S auxiliary relay is provided for each breaker, each with a TRB-2 blocking diode to isolate the circuits on multiple breakers from one another.

Figure 3 shows a breaker-failure scheme for the same bus arrangement. The key differences are that (a) now a separate TD-5 timer is dedicated to each breaker; and (b) in this scheme BFI seal-in is provided by the TX auxiliary in TD-5.

The telephone relay coil TX in parallel with the TD-5 timer 62 is optionally used to seal-in 62X and 62Y contacts. When the KC-4 contacts and 62X or Y contacts are both closed, both the timer circuit and TX are energized; TX seals around 62X and Y so that only the opening of the KC-4 contacts can stop the timer. This may be needed when 62X and Y are energized by potential-polarized distance relays. If a close-in fault occurs so that the polarizing potential collapses completely, the distance relay will reset after stored energy in the polarizing circuit damps out (usually 15 to 30 ms). This will cause dropout of 62X or Y, even if the breaker has failed and the fault remains. The TX contact will keep the timer energized for this critical situation, allowing the breaker failure scheme to function and strip the bus.

In figure 3, the ICS in the TD-5 now provides the seal-in and target functions, since a separate TD-5 is dedicated to each breaker.

With the KC-4 connected adjacent to the dc positive supply as shown in figure 3, a 50X auxiliary relay can be connected between terminal 2 of the KC-4 and dc negative. 50X then follows the KC-4 and provides contact multiplication. This allows the KC-4 to perform other non-breaker-failure functions. For example, a 50X contact can be used to supervise a distance relay trip circuit to prevent false-tripping on loss of ac potential supply.

Although using a separate timer for each breaker is more costly than the scheme of figure 2, there are several performance advantages:

(1) For a fault which begins on one line and subsequently spreads to another (such as can occur on a double-circuit tower), the common timer in figure 2 will energized by the initial fault. However, even if the breaker clears the first line affected, the 62X and Y contacts and KC-4 relay of the second faulted line will keep the timer energized. The time delay may expire and the bus may be stripped before the second breaker clears the fault, even though no breaker failed.

(2) If the breakers on the bus have different interrupting times, a common timer must be

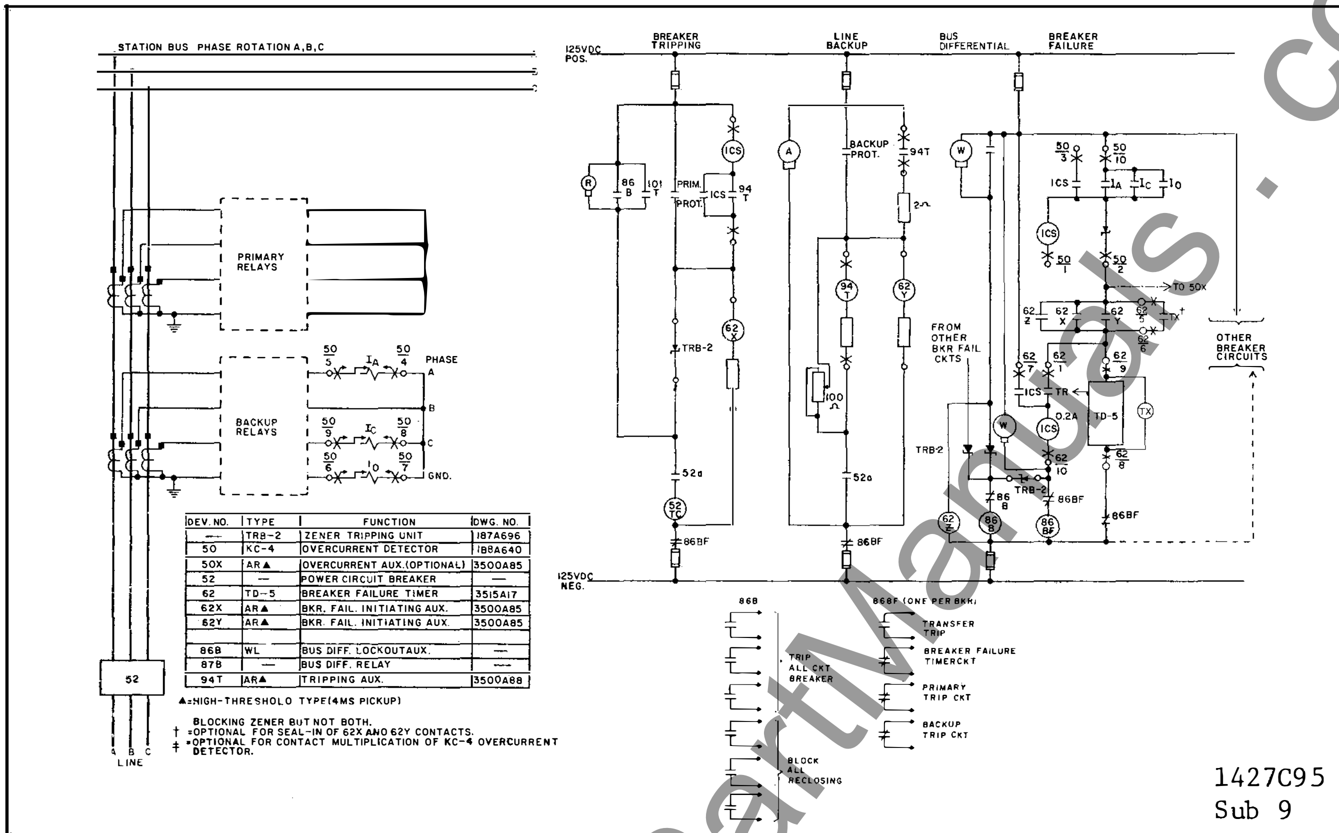


Fig. 3. External Connections for the KC-4 Relay – Breaker Failure Protection of a Single Bus/Single Breaker Arrangement with One Timer per Breaker.

set to accommodate the slowest breaker. Separate timers provide faster backup clearing for fast breakers.

(3) With separate timers, the bus can be reconfigured without rewiring the breaker failure circuits.

(4) If BFI seal-in is needed it is easy to obtain with separate timers. With a single timer, auxiliary relays and blocking diodes must be added whose cost mitigates the timer savings.

BREAKER-AND-A-HALF ARRANGEMENT

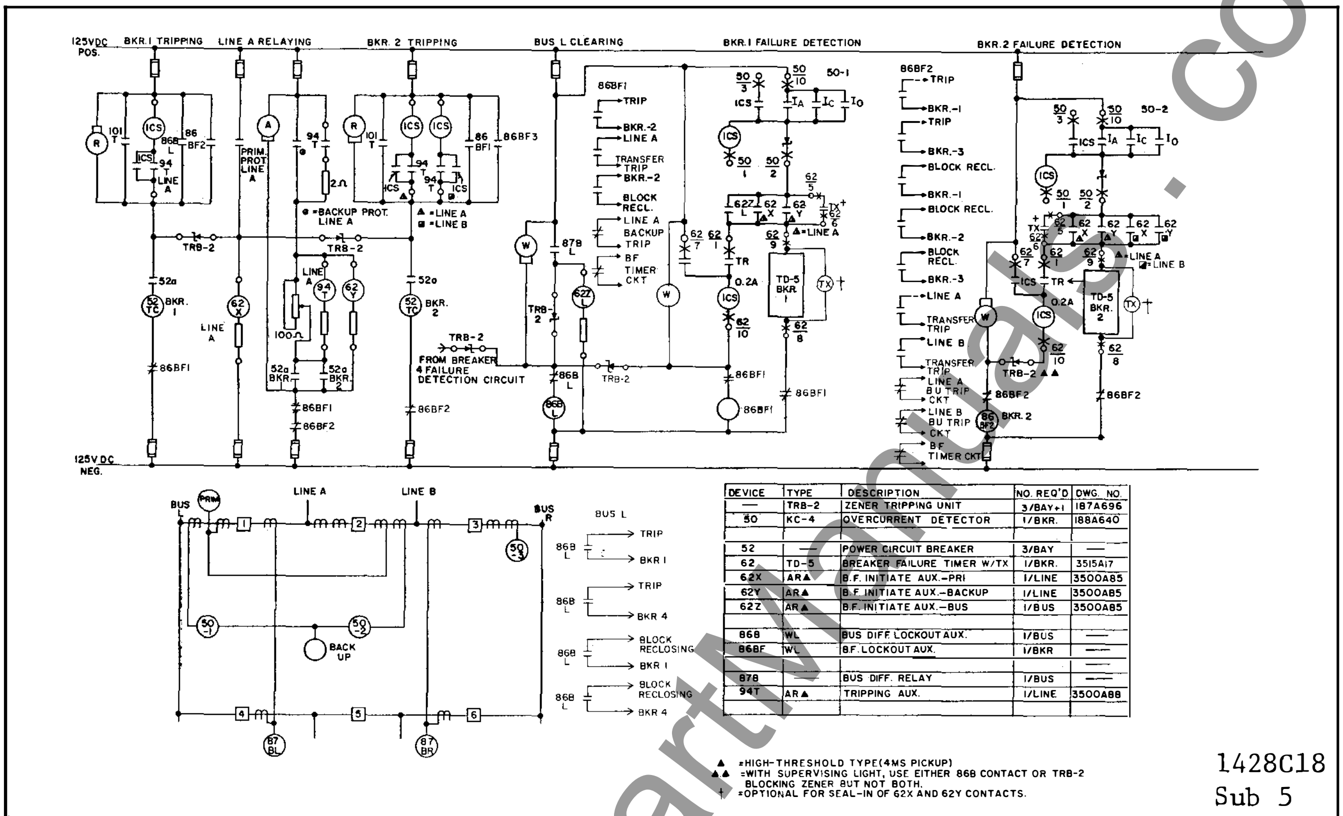
Figure 4 show breaker-failure protection circuits for a breaker-and-a-half bus arrangement, with one timer for each breaker.

The basic functioning of the scheme of figure 4 is the same as for the single bus-single breaker case.

First, consider the breaker 1 failure detection circuit as an example for a breaker adjacent to a bus. Breaker-failure timing is initiated not only for faults on line A, but on bus L as well. Auxiliary relay 62Z-L in the Bus-L clearing circuit provides BFI to breaker-failure schemes for breakers 1, 4, and others on bus L whenever a bus fault occurs and bus differential relay 87B-L operates.

For a bus fault on L and a failure of breaker 1, the timer 62 will energize lockout switch 86BF directly which will in turn cause tripping and reclose blocking of breaker 2 and transfer tripping of breakers at the remote end of line A. The timer 62 also energizes lockout switch 86B-L through a TRB-2 blocking diode; this is not detrimental but is redundant since 86B-L was already tripped by the bus relay 87B-L.

Now consider a fault on line A and a failure of breaker 1. BFI is provided by 62X and Y. The timer 62 will energize 86Z and 86B-L through TRB-2 as just described. In this case, breaker 2 and remote-breaker tripping were already accom-



DEVICE	TYPE	DESCRIPTION	NO. REQ'D	DWG. NO.
—	TRB-2	ZENER TRIPPING UNIT	3/BAY+1	187A696
50	KC-4	OVERCURRENT DETECTOR	1/BKR.	188A640
52	—	POWER CIRCUIT BREAKER	3/BAY	—
62	TD-5	BREAKER FAILURE TIMER W/TX	1/BKR.	3515A17
62X	AR▲	B.F. INITIATE AUX.-PRI	1/LINE	3500A85
62Y	AR▲	B.F. INITIATE AUX.-BACKUP	1/LINE	3500A85
62Z	AR▲	B.F. INITIATE AUX.-BUS	1/BUS	3500A85
86B	WL	BUS DIFF. LOCKOUT AUX.	1/BUS	—
86BF	WL	B.F. LOCKOUT AUX.	1/BKR	—
				—
87B	—	BUS DIFF. RELAY	1/BUS	—
94T	AR▲	TRIPPING AUX.	1/LINE	3500A88

▲ =HIGH-THRESHOLD TYPE(4MS PICKUP)
▲▲ =WITH SUPERVISING LIGHT, USE EITHER 86B CONTACT OR TRB-2 BLOCKING ZENER BUT NOT BOTH.
† =OPTIONAL FOR SEAL-IN OF 62X AND 62Y CONTACTS.

Fig. 4. External Connections for the KC-4 Relay — Breaker Failure Protection of a Breaker-and-a-Half Bus Arrangement — One Timer per Breaker.

plished by line relays, so these actions are redundant. However, the blocking of reclosing for breaker 2, and reclose blocking at the remote terminal via the transfer-trip signal, are now provided. Also, 86B-L now strips bus L to isolate the failed breaker 1.

Now, refer to the breaker 2 failure detection circuit. BFI is provided by 62X and Y contacts for lines A and B, since a fault on either initiates tripping of breaker 2. If breaker 2 fails and the timer 62 delay expires, lockout switch 86BF is energized. Contacts of 86BF trip breakers 1 and 3, block reclosing on all 3 breakers, and transfer-trip lines A and B. Some of these actions are redundant-for example, a line A fault does not require re-tripping of breaker 1. But none of these redundant actions are detrimental. Remember that transfer-tripping of the remote end of the faulted line isn't really redundant since it performs the important additional function of blocking reclosing at the remote terminal.

The TX relay is shown providing optional seal-in of BFI contacts as described for the single-bus single-breaker case above.

As mentioned before, on breaker failure protection, a separate timer for each breaker has an advantage over a common timer per bus, and also most of the breaker-and-a-half bus arrangements are applied to the rather high voltage system. Therefore, it is recommended that a separate timer be applied for each breaker for the breaker-and-a-half bus arrangement.

RING BUS ARRANGEMENT

Figure 5 shows the line and breaker-failure protection circuits for a ring bus. The symmetry of the bus permits a simple circuit for the latter function. Using breaker 2 as an example, BFI is provided by 62X and 62Y contacts from lines A and B, since a fault on either line initiates breaker 2 tripping. If the time delay expires, the lockout switch 86BF trips adjacent breakers 1 and 3; blocks reclosing of breakers 1, 2, and 3; and transfer-trips both line A and line B. As in the breaker-and-a-half scheme, redundant actions are allowed since they cause no difficulties and result in the simplest scheme. Recall that the transfer-tripping of the faulted line isn't really redundant since it provides the critical reclose-blocking function at the far terminal, as in the previous cases.

SETTING THE KC-4 FOR BREAKER FAILURE PROTECTION

In all of these schemes, the KC-4 phase-unit pickup should be set above maximum load but below minimum fault current levels. The residual current unit should be set below the minimum ground fault current. If the largest load exceeds the minimum fault current, the KC-4 must be set below the minimum fault, and the user must accept a slight reduction in security. At times of heavy load, the KC-4 contacts are closed even though no fault is present.

In the past, 52a contacts have occasionally been connected in parallel with the KC-4 to allow timer starting for light faults below the KC-4 setting. This practice is *not* recommended, since the 52a is closed whenever the line is in service and the security benefits of KC-4 supervision are completely lost. Also, breaker-failure protection is incomplete since opening of the 52a contact after relay operation doesn't show that fault current was actually interrupted—it only shows that the trip mechanism cycled. A lower KC-4 setting is a better alternative.

Sometimes, a transformer connected to one side of the protected breaker can present a particular setting problem. Light-current faults may occur inside the transformer for which the KC-4 relay won't pick up. Thus, no breaker-failure protection is provided when differential or sudden-pressure relays initiate tripping. To remedy this, connect a 52a contact in series with an 86T contact from the breaker-failure dc positive supply to terminal 9 of the TD-5 timer 62 (86T is a contact of the lockout switch associated with the transformer differential relay). Repeat this connection for each breaker which is adjacent to the transformer.

The 86T contact supervision insures that security is not reduced by the added connection. If a transformer fault results in 86T tripping, the timer is energized and is stopped only when 52a opens. This won't happen if the breaker is stuck, and backup tripping is initiated. The only combination of circumstances for which this connection doesn't help is a light transformer fault, and a breaker which opens but doesn't interrupt. Many utilities consider this unlikely and provide no further protection aganist it. The only alternative is to replace 52a with a separate low-set current detector, which can energize the timer only when 86T closes.

CHARACTERISTICS

Phase & Ground Overcurrent Units are available in the following current ranges:

Range	Taps					
0.5-2 Amps	0.5	0.75	1.0	1.25	1.5	2
1-4	1.0	1.5	2.0	2.5	3.0	4.0
2-8	2	3	4	5	6	8
4-16	4	6	8	9	12	16
10-40	10	15	20	24	30	40
20-80	20	30	40	48	60	80

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the overcurrent units shown in Fig. 6.

TRIP CIRCUIT

The main contacts will safely close 30 amperes at 250 volts dc 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 of lead located in front of the tap block to the desired setting by means of a screw connection.

TRIP CIRCUIT CONSTANTS

Indicating Contactor Switch –

0.2 amp. tap 6.5 ohms d-c resistance
2.0 amp. tap 0.15 ohms dc resistance
1.0 amp. tap (when supplied) 0.1 ohm dc

SETTINGS

PHASE & GROUND OVERCURRENT UNIT

The pickup current setting is made by means the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION: *Since the tap block connector screw carries operating currrent, be sure that the screw is turned tight.*

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

INDICATING CONTACTOR SWITCH (ICS)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt dc type WL relay switch or equivalent, use the 0.2 ampere tap; for 48-volt dc applications set in 2 tap and use WL coil S#304C209G01.

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 rear mounting stud or studs for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type Ft case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground wires and affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under "SETTINGS," should be required.

ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order:

Phase & Ground Overcurrent Unit

1. Contact Gap – The gap between the stationary and moving contacts with the relay in the deenergized position should be approximately .020."

2. Minimum Trip Current – The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ± 5% of tap value current.

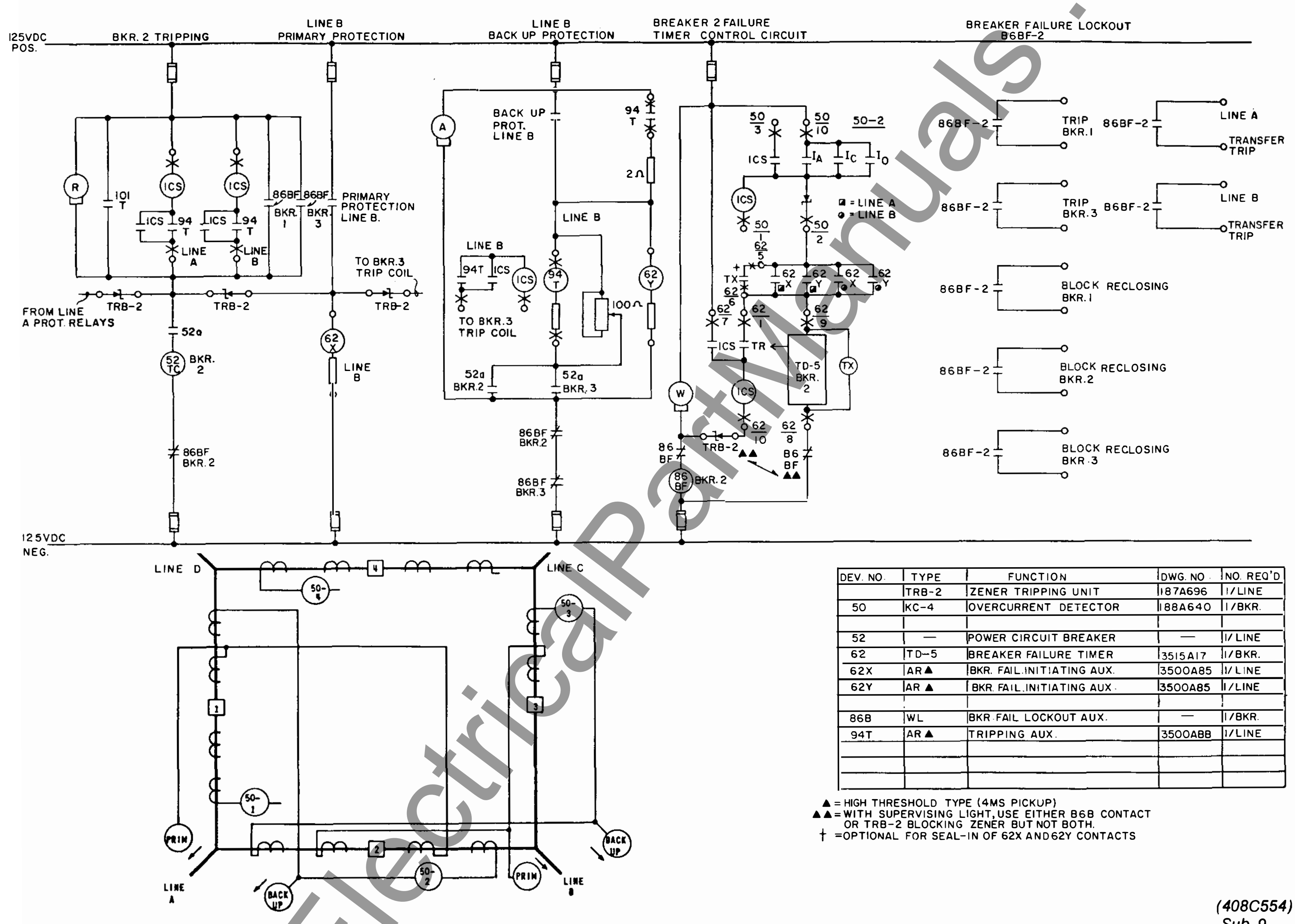
Indicating Contactor Switch (ICS)

Close the phase or ground 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

ROUTINE MAINTENANCE

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.



DEV. NO.	TYPE	FUNCTION	DWG. NO.	NO. REQ'D
	TRB-2	ZENER TRIPPING UNIT	187A696	1/LINE
50	KC-4	OVERCURRENT DETECTOR	188A640	1/BKR.
52	—	POWER CIRCUIT BREAKER	—	1/LINE
62	TD-5	BREAKER FAILURE TIMER	3515A17	1/BKR.
62X	AR ▲	BKR. FAIL. INITIATING AUX.	3500A85	1/LINE
62Y	AR ▲	BKR. FAIL. INITIATING AUX.	3500A85	1/LINE
86B	WL	BKR. FAIL LOCKOUT AUX.	—	1/BKR.
94T	AR ▲	TRIPPING AUX.	3500A88	1/LINE

▲ = HIGH THRESHOLD TYPE (4MS PICKUP)
▲▲ = WITH SUPERVISING LIGHT, USE EITHER 86B CONTACT OR TRB-2 BLOCKING ZENER BUT NOT BOTH.
† = OPTIONAL FOR SEAL-IN OF 62X AND 62Y CONTACTS

Fig. 5. External Connections for the KC-4 Relay – Breaker Failure Protection of a Ring Bus.

ENERGY REQUIREMENTS – 60 Hz

PHASE & GROUND OVERCURRENT UNIT – 60 Hz					
AMPERE RANGE	TAP	†† VA AT TAP VALUE	Ø P.F. ANGLE	†† VA AT 5 AMPS.	Ø P.F. ANGLE
	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
.5-2	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
1-4	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
2-8	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29
	4	1.5	51	2.4	51
	6	1.7	45	1.2	45
4-16	8	1.8	40	0.7	40
	9	1.9	38	0.6	38
	12	2.2	34	0.37	34
	16	2.5	30	0.24	31
	10	1.7	28	0.43	28
	15	2.4	21	0.27	21
	20	3.1	16	0.20	17
10-40	24	3.6	1.5	0.15	15
	30	4.2	12	0.11	13
	40	4.9	11	0.08	12
	20	6.6	31	0.40	31
	30	9.3	24	0.25	24
20-80	40	12	20	0.18	20
	48	13.5	18	0.14	18
	60	15.9	16	0.10	16
	80	19.2	15	0.07	15

† † Voltages taken with Rectox type voltmeter.
Ø Degrees current lags voltage.

KC-4 50Hz BURDEN DATA					
AMPERE RANGE	TAP	† † VA AT TAP VALUE	ø P.F. ANGLE	† † VA AT 5 AMPS.	ø P.F. ANGLE
.5-2	.5	.35	36	24	34
	.75	.36	33	13	32
	1	.37	32	8.0	31
	1.25	.39	31	5.5	30
	1.5	.41	29	4.5	28
	2	.43	27	2.8	26
1-4	1	.35	35	8.8	36
	1.5	.38	31	4.8	30
	2	.41	29	2.8	28
	2.5	.44	27	2.0	27
	3	.47	25	1.4	25
	4	.53	23	.92	23
2-8	2	1.04	45	6.2	45
	3	1.1	41	3.2	41
	4	1.2	36	2.0	36
	5	1.3	33	1.2	33
	6	1.4	31	1.0	31
	8	1.7	27	0.6	27
4-16	4	1.26	43	2.1	42
	6	1.5	40	0.9	40
	8	1.6	37	.5	37
	9	1.7	34	.4	34
	12	2.0	31	.35	31
	16	2.2	28	.20	28
10-40	10	1.9	39	.45	39
	15	3.6	36	.40	36
	20	5.8	34	.35	34
	24	7.8	31	.30	31
	30	10.5	29	.27	29
	40	17.5	27	.25	27

† † Voltages taken with Rectox type voltmeter.
ø Degrees current lags voltage.

CURRENT RATINGS (50 & 60 Hz)

RATING OF THE OVERCURRENT UNITS (PHASE & GROUND)		
Range	Continuous Rating (Amperes)	One Second Rating (Amperes) †
0.5-2	5	100
1-4	8	140
2-8	8	140
4-16	10	200
10-40	10	200
20-80	10	200

† Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

All contacts should be periodically cleaned. 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.

CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

Phase & Ground Overcurrent Unit

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in the stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, (aganist the right side of the bridge.) Advance the stationary contact until the contacts just close. Then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact is position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver of similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ± 5% of tap value.

If adjustment of pick-up current in between tap settings is desired, insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

Indicating Contactor Switch (ICS)

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

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

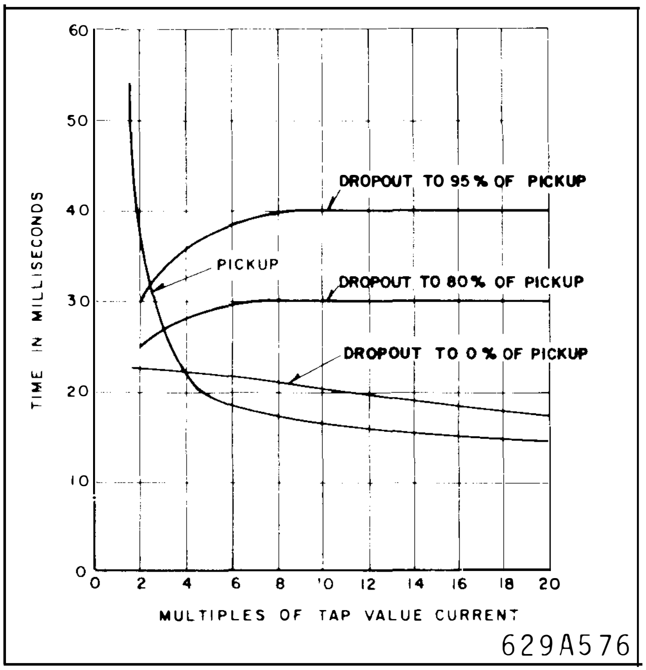


Fig. 6. Maximum Pick-Up and Drop-Out Time Curves for the Phase and Ground Overcurrent Units

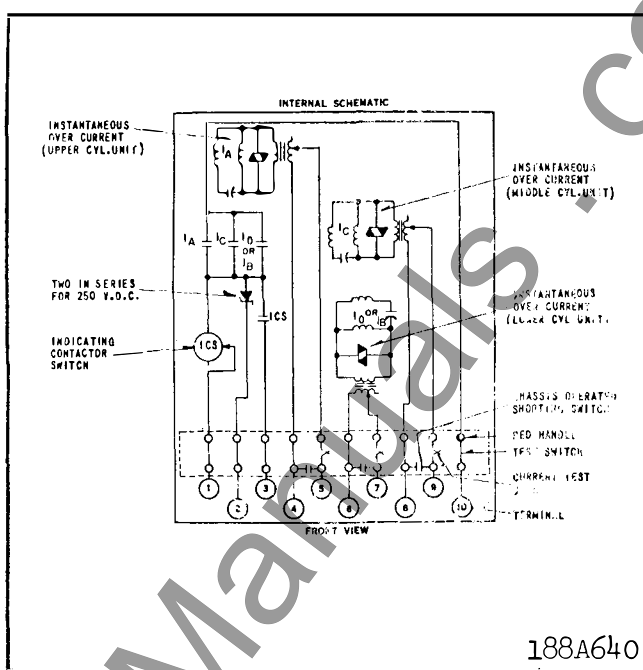


Fig. 7. Internal Schematic of the KC-4 Relay in the FT-41 Case.

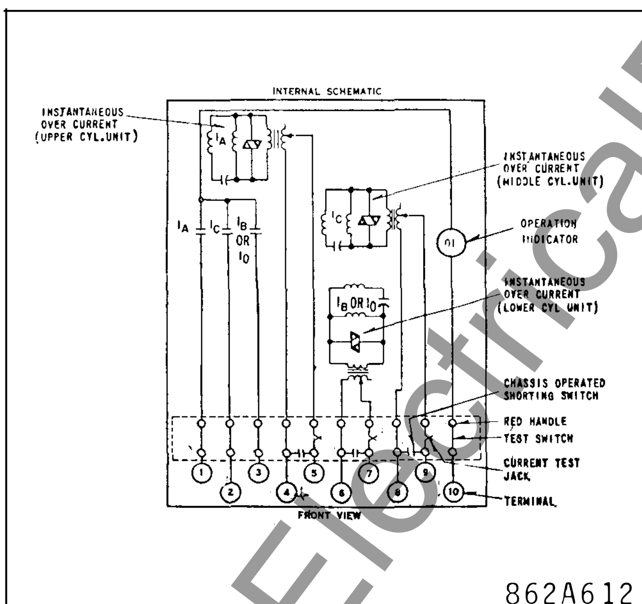


Fig. 8. Internal Schematic of the KC-4 Relay with Operation Indicator and Contacts to separate terminals in FT-41 case.

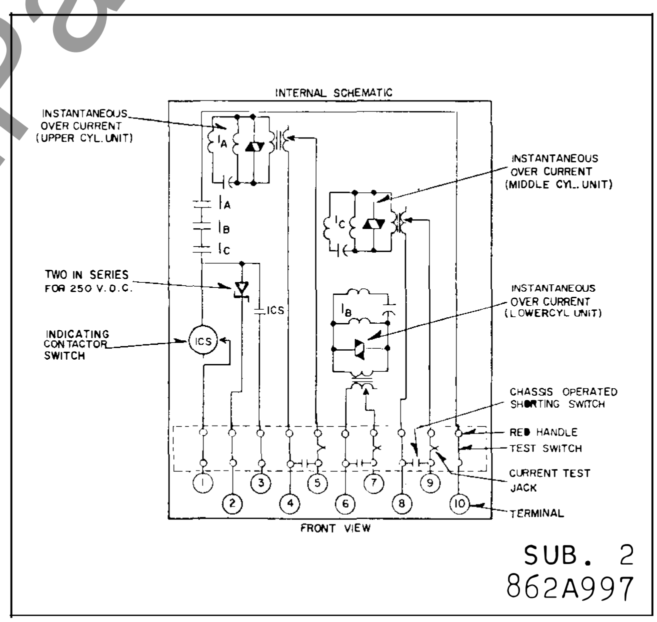


Fig. 9. Internal Schematic of the KC-4 Relay with Series Make Contacts in FT-41 Case.

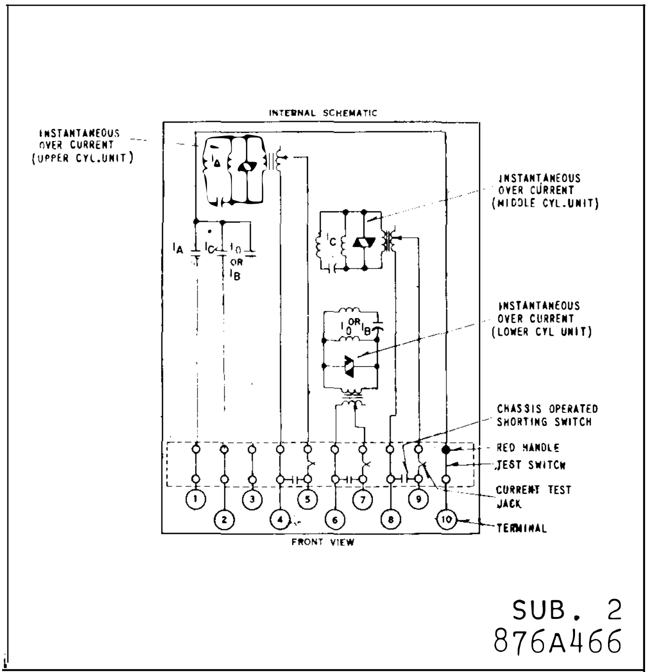


Fig. 10. Internal Schematic of the KC-4 Relay with one side of Contacts to Separate Terminals in FT-41 Case.

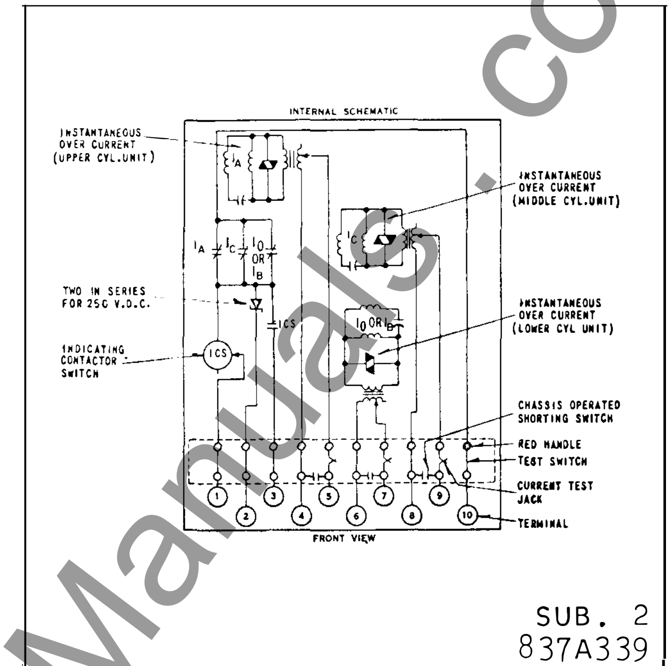


Fig. 11. Internal Schematic of the KC-4 Relay with Normally Closed Contacts in FT-41 Case.

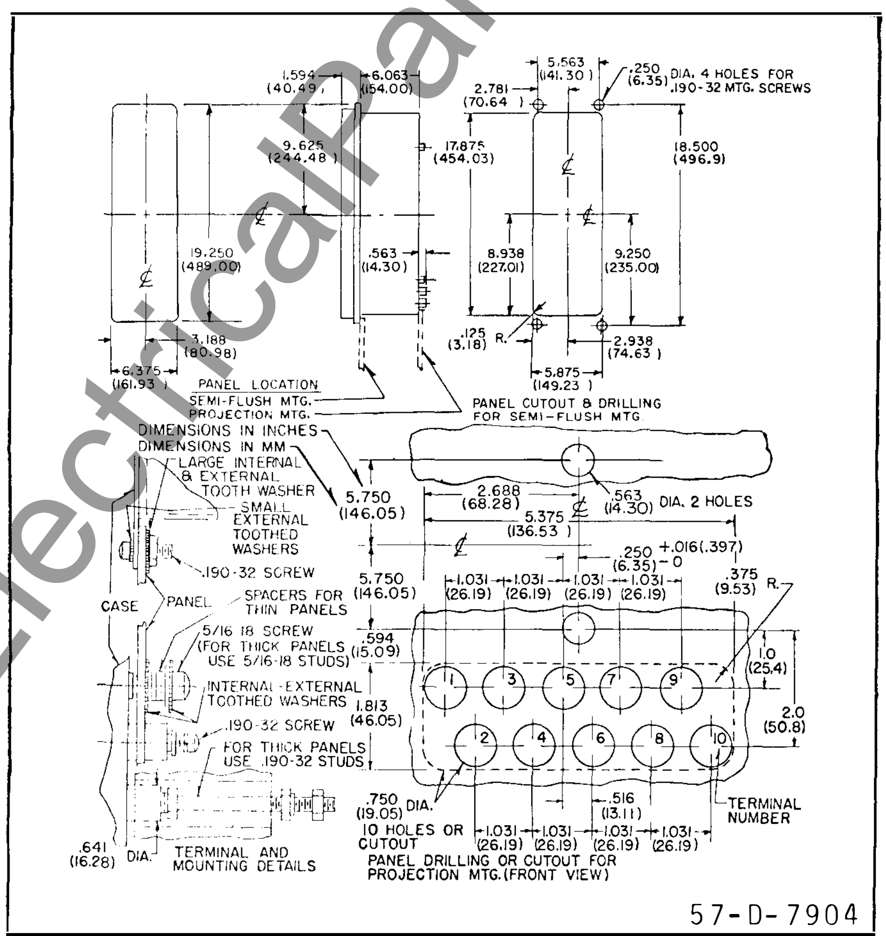


Fig. 12. Outline and Drilling Plan for the KC-4 Relay in FT-41 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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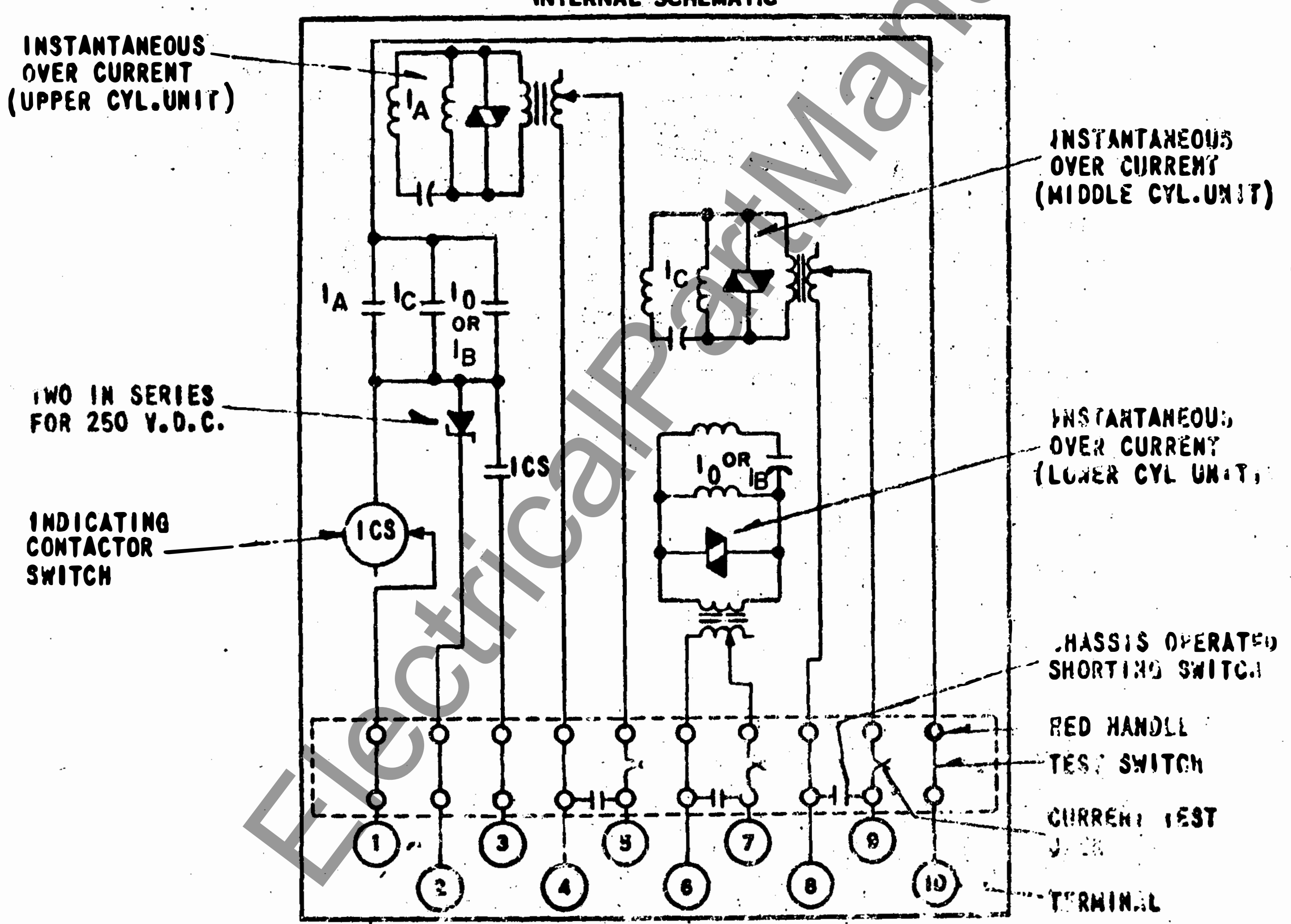
DESIGNATION IA WAS I1, IB WAS NOT ON, IC WAS I3

RELAY-TYPE KC-4 INSTANTANEOUS OVERCURRENT IN FT-41 CASE

INTERNAL SCHEMATIC



FRONT VIEW

WESTINGHOUSE ELECTRIC CORPORATION – METER DIVISION, NEWARK, N.J.

MFG. DWG 408C471 REF.

DWG NO. 188A640

WESTINGHOUSE ELECTRIC CORPORATION - RELAY-INSTRUMENT DIVISION-NEWARK, N.J., U.S.A.

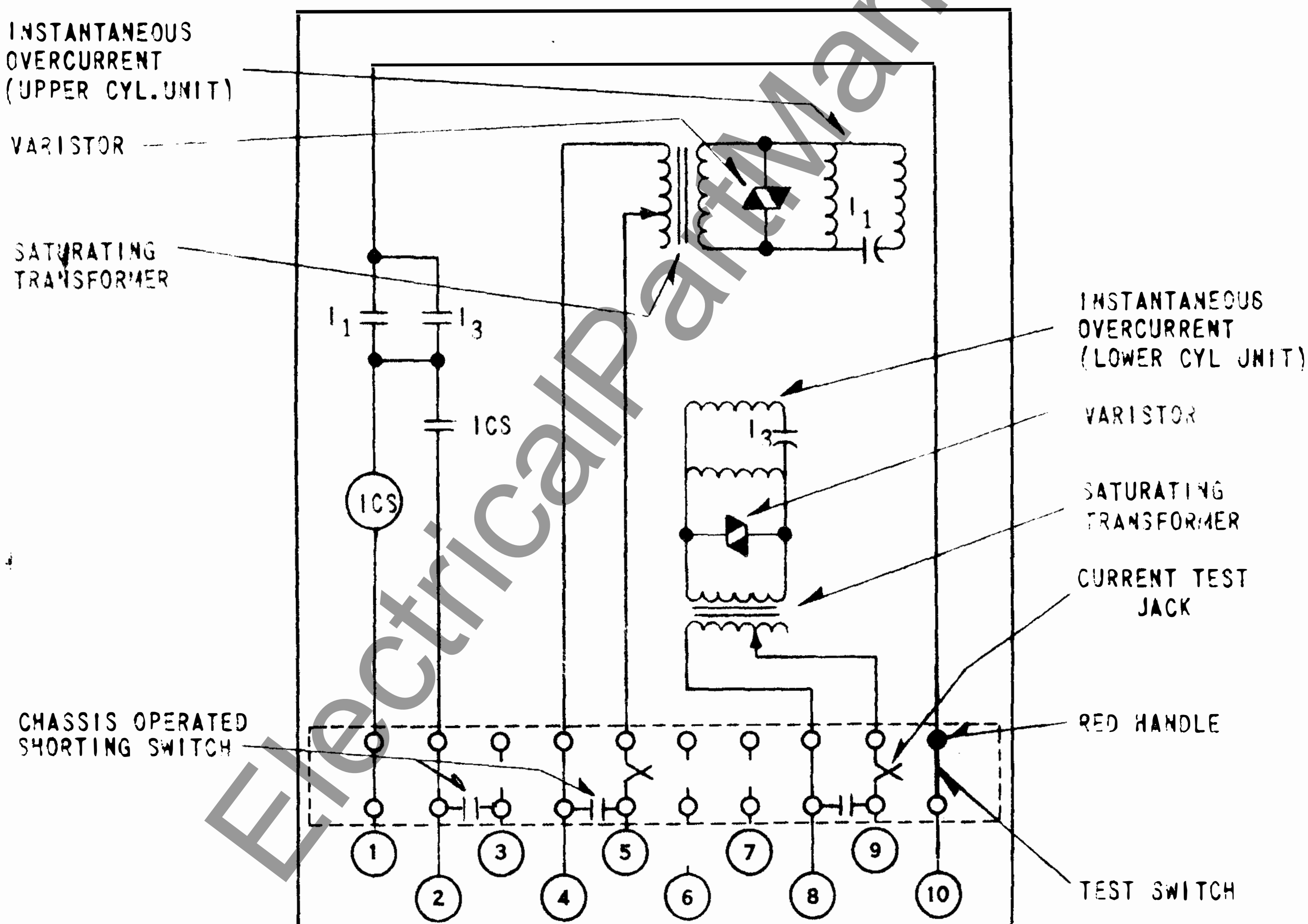
DWG. NO. 862A789 — 1

D–SPEC. 714255	DRAFTSMAN H.J.H.	CHECKER	APPROVED R.L.V.	APPROVED	S# 1963701 NE 698 AC
ES 10/10/67			10/18/67	10/18/67	

2 — CHASSIS OPER SHORTING SW WAS NOT ON TERM 2-3. SUFFIX LETTER 'A' ADDED TO RELAY STYLE 3/29/74

TYPE KC-2 INSTANTANEOUS OVERCURRENT RELAY—NON TAPPED ICS IN TYPE FT-31 CASE

INTERNAL SCHEMATIC



FRONT VIEW

FT-31

DWG. NO. 862A789

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-4 OVERCURRENT RELAY

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

APPLICATION

The type KC-4 is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other relays. It is particularly suited for breaker-failure relaying schemes, in which it indicates the presence or lack of current flow in the protected circuit breaker. The relay can be applied where the phase units are to be operated indefinitely in the picked up position, set well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load) the 98% or better dropout ratio of the phase and ground units is advantageous.

Specific breaker failure schemes using the KC-4 relay, with detailed explanations, are given in the OPERATION section.

CONSTRUCTION

The type KC-4 relay consists of two phase instantaneous overcurrent units, (I_A and I_C), one ground instantaneous unit (I_0), and an indicating contactor switch (ICS). The principal component parts of the relay and their location are shown in Figure 1.

PHASE AND GROUND INSTANTANEOUS OVERCURRENT UNITS

(I_A, I_C, I_O)

Each instantaneous overcurrent unit consists of an induction cylinder unit, capacitor, varistor, and a transformer. The components are connected such that a contact closing torque is produced when the current exceeds a specified value.

INDUCTION CYLINDER UNIT

Mechanically, the cylinder unit is composed of four basic components: a diecast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

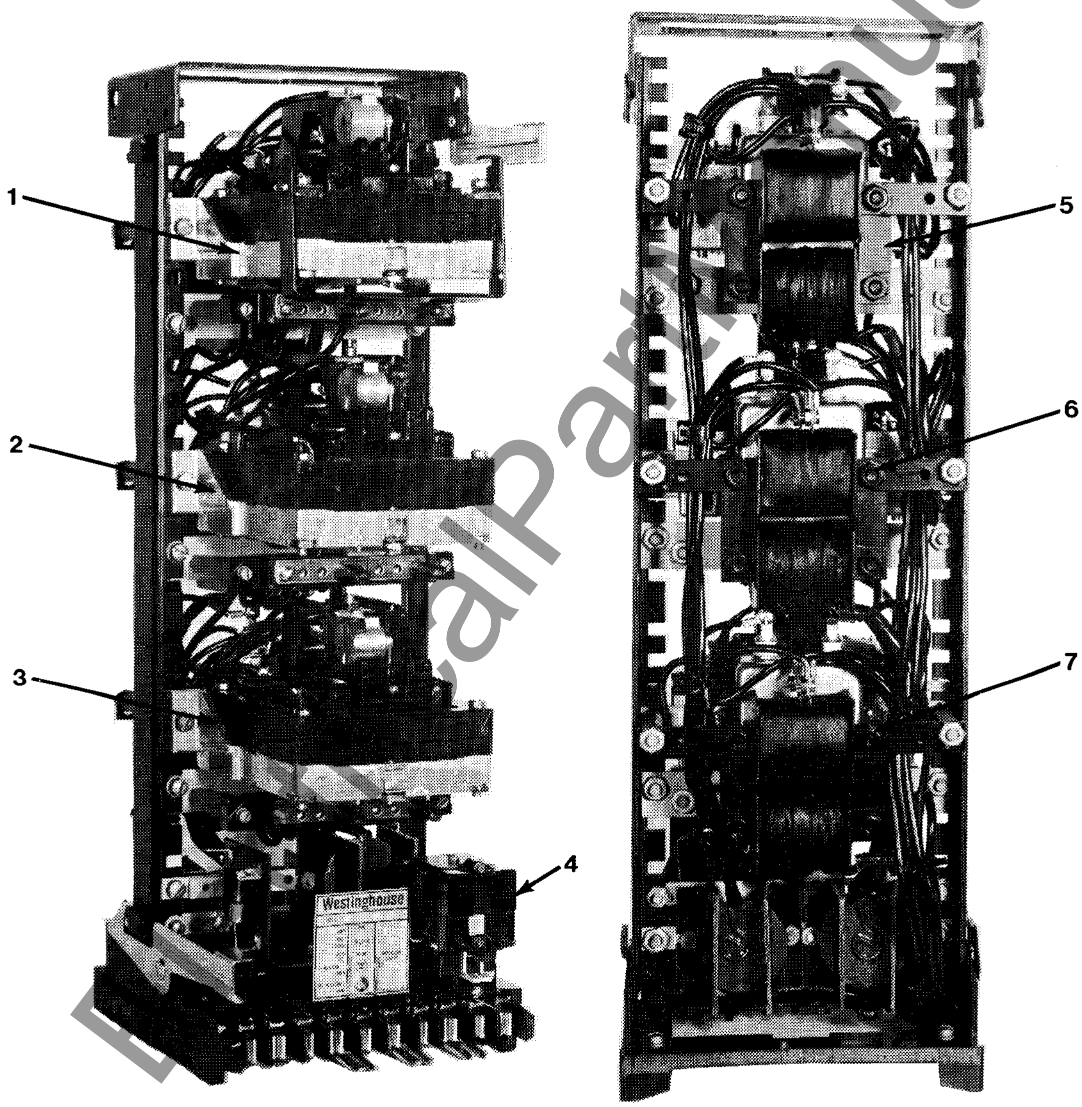
The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another, and a capacitor is connected in series with one pair of coils. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub

SUPERSEDES I.L. 41-776.1J, dated December 1977 EFFECTIVE SEPTEMBER 1980
✪ Denotes change since previous issue.

which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearings, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.



FRONT VIEW REAR VIEW

1-I_A UNIT 2-I_C UNIT 3-I_O OR I_B UNIT 4-INDICATING CONTACTOR SWITCH

5-I_A SATURATING TRANSFORMER 6-I_C SATURATING TRANSFORMER

7-I_O OR I_B SATURATING TRANSFORMER

Fig. 1. Type KC-4 Relay Without Case.

With the contact closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

TRANSFORMER

The transformer is a saturating type consisting of a tapped primary winding and a secondary winding. A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction cylinder unit and phase shifting capacitor.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The indicating contactor switch is a small dc operated 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

INSTANTANEOUS OVERCURRENT UNIT

Operation of the instantaneous overcurrent unit occurs when the primary current of the transformer exceeds a value as marked on the tap plate. Upon application of current to the transformer, a voltage is induced in the secondary winding. This voltage is impressed upon the parallel connected pairs of cylinder unit coils. The capacitor connected in series with one pair of coils shifts the current flowing in these coils in reference to the current flowing in the other pair of coils. As a result, the air gap fluxes of the cylinder unit are out of phase and a contact closing torque is produced.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pickup current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

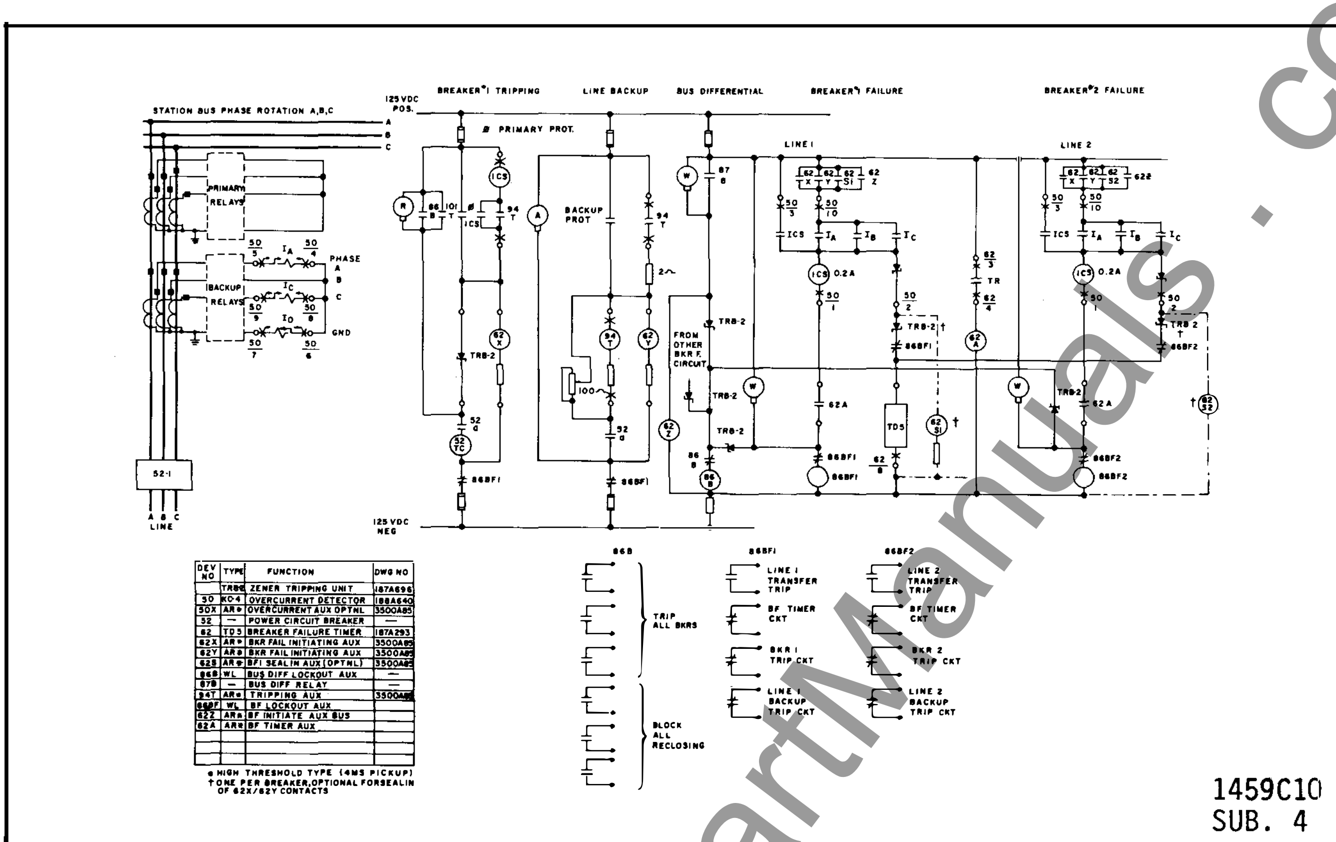
BREAKER FAILURE SCHEMES USING THE KC-4 RELAY

The following explanations frequently refer to the type TD-5 timing relay, which is usually used in conjunction with the KC-4 relay for breaker failure protection. For detailed data on the TD-5, refer to instruction leaflet 41-579.1.

SINGLE BUS/SINGLE BREAKER ARRANGEMENT

In a properly functioning breaker, current flow should cease shortly after the trip circuit is energized. The time interval between trip-circuit energization and current flow cessation is the breaker-interrupting time. If interruption doesn't occur within the specified interrupting time, the breaker is assumed to have failed and the breaker-failure relaying should initiate tripping of adjacent and/or remote breakers to isolate the protected breaker. For the single bus-single breaker configuration, all the breakers on the bus must be tripped to isolate any one of them which fails. This is readily accomplished by having the breaker-failure protection circuits energize the bus-differential lockout auxiliary 86B.

Figure 2 shows the simplest breaker-failure scheme using the KC-4 relay. Primary and backup line relays connected to separate current transformers and separately-fused dc supplies so that a failure in either circuit will not disable all of the protection. When primary protection operates, it energizes auxiliary relay 62X and the breaker trip coil simultaneously. Similarly, backup relays energize both tripping auxiliary 94T and auxiliary 62Y simultaneously. 62X and 62Y are known as breaker-failure initiate (BFI) auxiliaries. The closure of contacts 62X and 62Y provide a signal in the breaker failure scheme that breaker tripping



DEV NO	TYPE	FUNCTION	DWG NO
	TRB*	ZENER TRIPPING UNIT	187A696
50	KC-4	OVERCURRENT DETECTOR	188A640
50X	AR*	OVERCURRENT AUX OPTNL	3500A85
52	—	POWER CIRCUIT BREAKER	—
62	TD5	BREAKER FAILURE TIMER	187A293
62X	AR*	BKR FAIL INITIATING AUX	3500A85
62Y	AR*	BKR FAIL INITIATING AUX	3500A85
62S	AR*	BFI SEALIN AUX (OPTNL)	3500A85
86B	WL	BUS DIFF LOCKOUT AUX	—
87B	—	BUS DIFF RELAY	—
94T	AR*	TRIPPING AUX	3500A85
86BF	WL	BF LOCKOUT AUX	
62Z	AR*	BF INITIATE AUX BUS	
62A	AR*	BF TIMER AUX	

* HIGH THRESHOLD TYPE (4MS PICKUP)
† ONE PER BREAKER, OPTIONAL FOR SEALIN OF 62X/62Y CONTACTS

Fig. 2. External Connections for the KC-4 Relay – Breaker Failure Protection of a Single Bus/Single Breaker Arrangement – One Timer per Bus.

has been initiated. They energize the TD-5 breaker-failure timer (62) through the KC-4 (50) contacts, which have already closed in response to the same fault which operated the line relays. If the breaker interrupts fault current as expected, the KC-4 drops out and the TD-5 timer is de-energized before it times out; no further action is taken. But if current flow continues beyond the expected time limit, the TD-5 delay expires and the output (TR) contact of the TD-5 energizes the 62A auxiliary relay for contact multiplication. 62A contact energizes the 86B lockout auxiliary to strip the bus and block reclosing.

Note that, in figure 2, each breaker has its own line protection relays, BFI auxiliary and KC-4 current detector; but that all of these funnel into a single TD-5 timer. This is done for ecomony since the same tripping device, 86B, is energized regardless of which breaker fails. Targeting of the particular failed breaker is accomplished by the ICS in the associated KC-4 in conjunction with the 62X and 62Y BFI contacts for that line. The zener blocking diode inside each KC-4, connected to terminal 50-2, isolates the multiple trip circuits of the KC-4's from one another so that only the target of the failed breaker will drop.

After the TD-5 has operated and picked up 62A, the 62A contact also energizes the 86BF auxiliary relay. Refer to the primary breaker tripping circuit. If a fault occurs and the breaker operating mechanism is stuck (the most frequent type of breaker failure), line relays energize the trip coil with no effect. The breaker failure scheme will operate the initiate backup tripping, eliminating threats to power system integrity. However, dc current will continue to flow in the primary relay ICS and in the breaker trip coil, uninterrupted by the stuck 52a contact. The trip coil, and other devices in the tripping path, are only intermittently rated and may disintegrate or ignite before operators or repair crews can intervene. For this reason, a normally-closed 86BF contact is shown in series with the trip circuit, to interrupt dc current flow.

After the TD-5 has operated, a sneak path may be created through the supervising lamp for the

86BF coil, backwards through the closed 62A contact, through the KC-4 terminals 1 and 2, and finally into terminal 9 of the TD-5. This sneak current may prevent the TD-5 from dropping out, a normally-closed 86BF contact cuts off the TD-5.

In the primary breaker-tripping circuit, the TRB-2 blocking diode prevents red supervising-light current from flowing in the 62X coil.

In both the primary and the backup tripping circuits, the 62X and 62Y coils are connected to follow the protective relay contacts and should never be connected in series with 52a contacts. Otherwise, BFI is lost when the breaker functions mechanically, opening 52a, but fails to interrupt current flow. The resistor in parallel with the 94T auxiliary dissipates 625 Watts in a 125 Vdc control scheme. It draws sufficient current to hold an ICS in the line backup tripping circuits picked up, and may burn if the 52a contact doesn't open. A 86BF contact deenergizes the backup circuit to prevent this.

For a bus fault, the 87B relay contact energizes the 86B lockout auxiliary to strip the bus and block reclosing. The blocking valves TRB-2 prevent the 87B from energizing the 86BF auxiliaries. However, in case of breaker failure during a bus fault, the BFI auxiliary 62Z relay is picked up by 87B. The closure of contact 62Z provides a signal in the breaker failure scheme to energize the TD-5 timer, then picks up the corresponding 86BF auxiliary. 86BF contact initiates the transfer trip for isolating the faulted bus.

Figure 2 also shows how BFI seal-in can be provided when one timer is used per bus. The TD-5 relay containing the TX relay cannot be used here. A separate 62Z auxiliary relay is provided for each breaker, each with a TRB-2 blocking diode to isolate the circuits on multiple breakers from one another.

Figure 3 shows a breaker-failure scheme for the same bus arrangement. The key differences are that (a) now a separate TD-5 timer is dedicated to each breaker; and (b) in this scheme BFI seal-in is provided by the TX auxiliary in TD-5.

The telephone relay coil TX in parallel with the TD-5 timer 62 is optionally used to seal-in 62X and 62Y contacts. When the KC-4 contacts and 62X or Y contacts are both closed, both the timer circuit and TX are energized; TX seals around 62X and Y so that only the opening of the KC-4 contacts can stop the timer. This may be needed when 62X and Y are energized by potential-polarized distance relays. If a close-in fault occurs so that the polarizing potential collapses completely, the distance relay will reset after stored energy in the polarizing circuit damps out (usually 15 to 30 ms). This will cause dropout of 62X or Y, even if the breaker has failed and the fault remains. The TX contact will keep the timer energized for this critical situation, allowing the breaker failure scheme to function and strip the bus.

In figure 3, the ICS in the TD-5 now provides the seal-in and target functions, since a separate TD-5 is dedicated to each breaker.

With the KC-4 connected adjacent to the dc positive supply as shown in figure 3, a 50X auxiliary relay can be connected between terminal 2 of the KC-4 and dc negative. 50X then follows the KC-4 and provides contact multiplication. This allows the KC-4 to perform other non-breaker-failure functions. For example, a 50X contact can be used to supervise a distance relay trip circuit to prevent false-tripping on loss of ac potential supply.

Although using a separate timer for each breaker is more costly than the scheme of figure 2, there are several performance advantages:

(1) For a fault which begins on one line and subsequently spreads to another (such as can occur on a double-circuit tower), the common timer in figure 2 will energized by the initial fault. However, even if the breaker clears the first line affected, the 62X and Y contacts and KC-4 relay of the second faulted line will keep the timer energized. The time delay may expire and the bus may be stripped before the second breaker clears the fault, even though no breaker failed.

(2) If the breakers on the bus have different interrupting times, a common timer must be

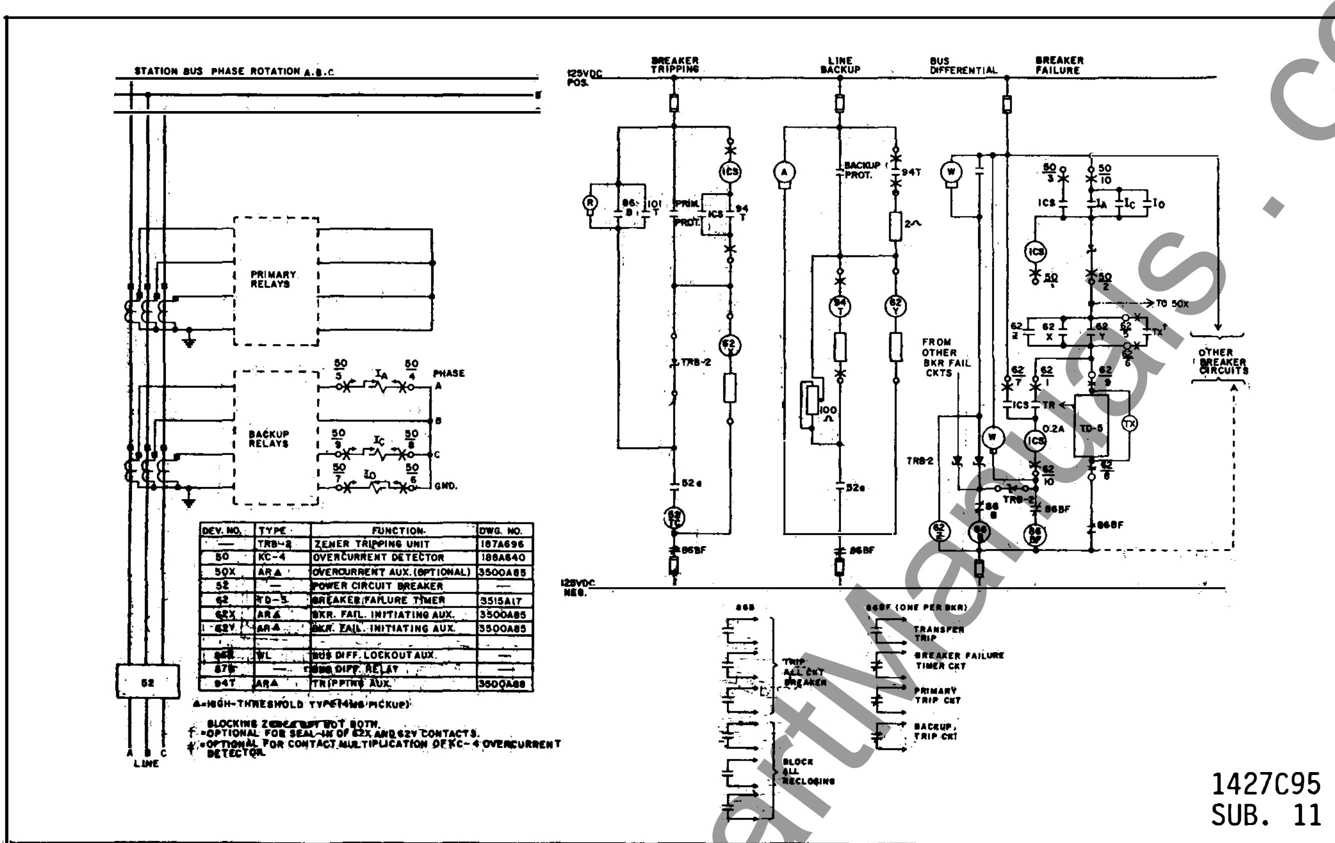


Fig. 3. External Connections for the KC-4 Relay — Breaker Failure Protection of a Single Bus/Single Breaker Arrangement with One Timer per Breaker.

set to accommodate the slowest breaker. Separate timers provide faster backup clearing for fast breakers.

(3) With separate timers, the bus can be reconfigured without rewiring the breaker failure circuits.

(4) If BFI seal-in is needed it is easy to obtain with separate timers. With a single timer, auxiliary relays and blocking diodes must be added whose cost mitigates the timer savings.

BREAKER-AND-A-HALF ARRANGEMENT

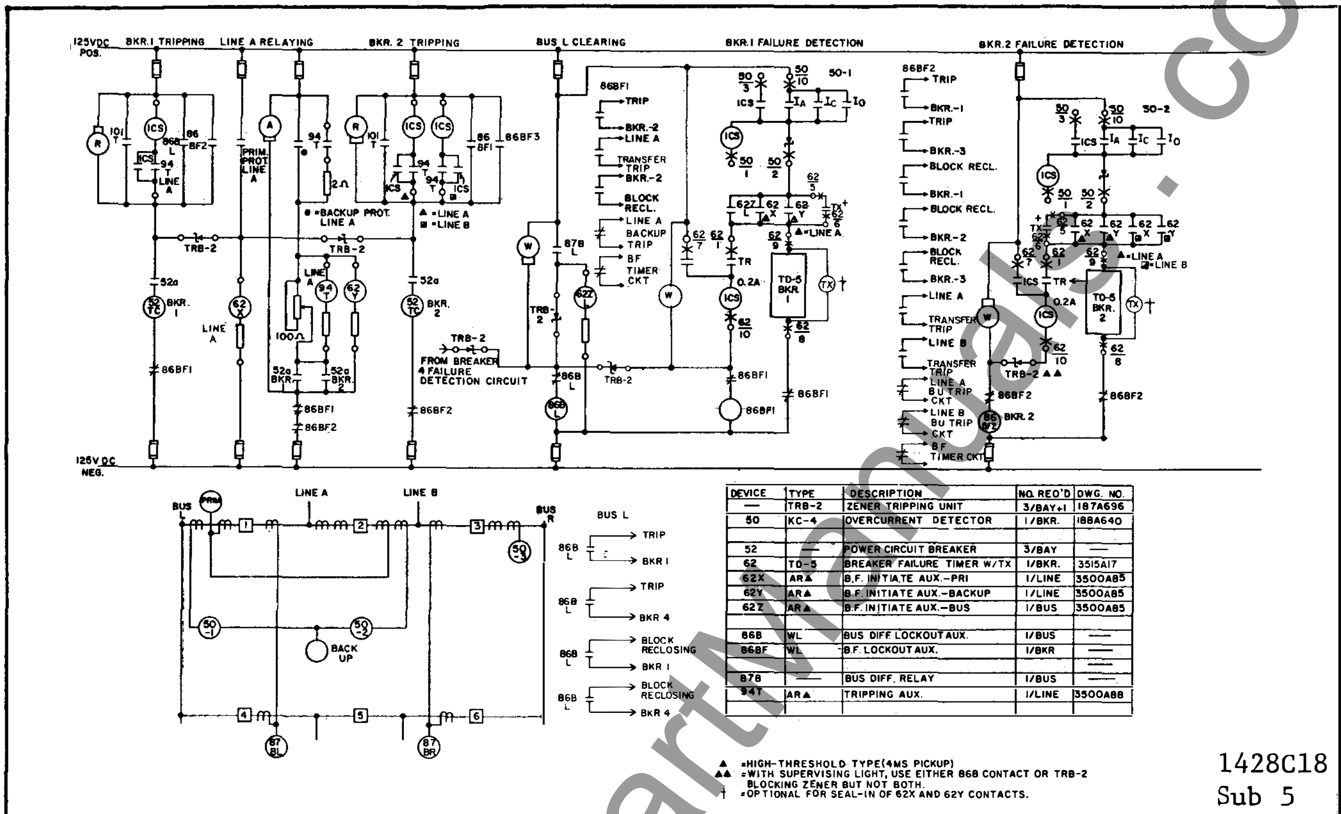
Figure 4 show breaker-failure protection circuits for a breaker-and-a-half bus arrangement, with one timer for each breaker.

The basic functioning of the scheme of figure 4 is the same as for the single bus-single breaker case.

First, consider the breaker 1 failure detection circuit as an example for a breaker adjacent to a bus. Breaker-failure timing is initiated not only for faults on line A, but on bus L as well. Auxiliary relay 62Z-L in the Bus-L clearing circuit provides BFI to breaker-failure schemes for breakers 1, 4, and others on bus L whenever a bus fault occurs and bus differential relay 87B-L operates.

For a bus fault on L and a failure of breaker 1, the timer 62 will energize lockout switch 86BF directly which will in turn cause tripping and reclose blocking of breaker 2 and transfer tripping of breakers at the remote end of line A. The timer 62 also energizes lockout switch 86B-L through a TRB-2 blocking diode; this is not detrimental but is redundant since 86B-L was already tripped by the bus relay 87B-L.

Now consider a fault on line A and a failure of breaker 1. BFI is provided by 62X and Y. The timer 62 will energize 86Z and 86B-L through TRB-2 as just described. In this case, breaker 2 and remote-breaker tripping were already accom-



DEVICE	TYPE	DESCRIPTION	NO. REQ'D	DWG. NO.
—	TRB-2	ZENER TRIPPING UNIT	3/BAY+1	187A696
50	KC-4	OVERCURRENT DETECTOR	1/BKR.	188A640
52	—	POWER CIRCUIT BREAKER	3/BAY	—
62	TD-5	BREAKER FAILURE TIMER W/TX	1/BKR.	3515A17
62X	AR▲	B.F. INITIATE AUX.-PRI	1/LINE	3500A85
62Y	AR▲	B.F. INITIATE AUX.-BACKUP	1/LINE	3500A85
62Z	AR▲	B.F. INITIATE AUX.-BUS	1/BUS	3500A85
86B	WL	BUS DIFF LOCKOUT AUX.	1/BUS	—
86BF	WL	B.F. LOCKOUT AUX.	1/BKR	—
				—
87B	—	BUS DIFF. RELAY	1/BUS	—
94T	AR▲	TRIPPING AUX.	1/LINE	3500A88

▲ =HIGH-THRESHOLD TYPE(4MS PICKUP)
▲▲ =WITH SUPERVISING LIGHT, USE EITHER 86B CONTACT OR TRB-2 BLOCKING ZENER BUT NOT BOTH.
† =OPTIONAL FOR SEAL-IN OF 62X AND 62Y CONTACTS.

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Fig. 4. External Connections for the KC-4 Relay – Breaker Failure Protection of a Breaker-and-a-Half Bus Arrangement – One Timer per Breaker.

plished by line relays, so these actions are redundant. However, the blocking of reclosing for breaker 2, and reclose blocking at the remote terminal via the transfer-trip signal, are now provided. Also, 86B-L now strips bus L to isolate the failed breaker 1.

Now, refer to the breaker 2 failure detection circuit. BFI is provided by 62X and Y contacts for lines A and B, since a fault on either initiates tripping of breaker 2. If breaker 2 fails and the timer 62 delay expires, lockout switch 86BF is energized. Contacts of 86BF trip breakers 1 and 3, block reclosing on all 3 breakers, and transfer-trip lines A and B. Some of these actions are redundant-for example, a line A fault does not require re-tripping of breaker 1. But none of these redundant actions are detrimental. Remember that transfer-tripping of the remote end of the faulted line isn't really redundant since it performs the important additional function of blocking reclosing at the remote terminal.

The TX relay is shown providing optional seal-in of BFI contacts as described for the single-bus single-breaker case above.

As mentioned before, on breaker failure protection, a separate timer for each breaker has an advantage over a common timer per bus, and also most of the breaker-and-a-half bus arrangements are applied to the rather high voltage system. Therefore, it is recommended that a separate timer be applied for each breaker for the breaker-and-a-half bus arrangement.

RING BUS ARRANGEMENT

Figure 5 shows the line and breaker-failure protection circuits for a ring bus. The symmetry of the bus permits a simple circuit for the latter function. Using breaker 2 as an example, BFI is provided by 62X and 62Y contacts from lines A and B, since a fault on either line initiates breaker 2 tripping. If the time delay expires, the lockout switch 86BF trips adjacent breakers 1 and 3; blocks reclosing of breakers 1, 2, and 3; and transfer-trips both line A and line B. As in the breaker-and-a-half scheme, redundant actions are allowed since they cause no difficulties and result in the simplest scheme. Recall that the transfer-tripping of the faulted line isn't really redundant since it provides the critical reclose-blocking function at the far terminal, as in the previous cases.

SETTING THE KC-4 FOR BREAKER FAILURE PROTECTION

In all of these schemes, the KC-4 phase-unit pickup should be set above maximum load but below minimum fault current levels. The residual current unit should be set below the minimum ground fault current. If the largest load exceeds the minimum fault current, the KC-4 must be set below the minimum fault, and the user must accept a slight reduction in security. At times of heavy load, the KC-4 contacts are closed even though no fault is present.

In the past, 52a contacts have occasionally been connected in parallel with the KC-4 to allow timer starting for light faults below the KC-4 setting. This practice is *not* recommended, since the 52a is closed whenever the line is in service and the security benefits of KC-4 supervision are completely lost. Also, breaker-failure protection is incomplete since opening of the 52a contact after relay operation doesn't show that fault current was actually interrupted—it only shows thát the trip mechanism cycled. A lower KC-4 setting is a better alternative.

Sometimes, a transformer connected to one side of the protected breaker can present a particular setting problem. Light-current faults may occur inside the transformer for which the KC-4 relay won't pick up. Thus, no breaker-failure protection is provided when differential or sudden-pressure relays initiate tripping. To remedy this, connect a 52a contact in series with an 86T contact from the breaker-failure dc positive supply to terminal 9 of the TD-5 timer 62 (86T is a contact of the lockout switch associated with the transformer differential relay). Repeat this connection for each breaker which is adjacent to the transformer.

The 86T contact supervision insures that security is not reduced by the added connection. If a transformer fault results in 86T tripping, the timer is energized and is stopped only when 52a opens. This won't happen if the breaker is stuck, and backup tripping is initiated. The only combination of circumstances for which this connection doesn't help is a light transformer fault, and a breaker which opens but doesn't interrupt. Many utilities consider this unlikely and provide no further protection aganist it. The only alternative is to replace 52a with a separate low-set current detector, which can energize the timer only when 86T closes.

CHARACTERISTICS

Phase & Ground Overcurrent Units are available in the following current ranges:

Range	Taps					
0.5-2 Amps	0.5	0.75	1.0	1.25	1.5	2
1-4	1.0	1.5	2.0	2.5	3.0	4.0
2-8	2	3	4	5	6	8
4-16	4	6	8	9	12	16
10-40	10	15	20	24	30	40
20-80	20	30	40	48	60	80

The tap value is the minimum current required to just close the overcurrent relay contacts. For pickup settings in between taps refer to the section under adjustments. The pickup and dropout time curves for the overcurrent units shown in Fig. 6.

TRIP CIRCUIT

The main contacts will safely close 30 amperes at 250 volts dc 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 of lead located in front of the tap block to the desired setting by means of a screw connection.

TRIP CIRCUIT CONSTANTS

Indicating Contactor Switch –
0.2 amp. tap 6.5 ohms d-c resistance
2.0 amp. tap 0.15 ohms dc resistance
1.0 amp. tap (when supplied) 0.1 ohm dc

SETTINGS

PHASE & GROUND OVERCURRENT UNIT

The pickup current setting is made by means the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION: *Since the tap block connector screw carries operating currrent, be sure that the screw is turned tight.*

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

INDICATING CONTACTOR SWITCH (ICS)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt dc type WL relay switch or equivalent, use the 0.2 ampere tap; for 48-volt dc applications set in 2 tap and use WL coil S#304C209G01.

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 rear mounting stud or studs for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type Ft case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground wires and affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under "SETTINGS," should be required.

ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order:

Phase & Ground Overcurrent Unit

1. Contact Gap – The gap between the stationary and moving contacts with the relay in the deenergized position should be approximately .020."

2. Minimum Trip Current – The pick-up of the overcurrent unit can be checked by inserting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ± 5% of tap value current.

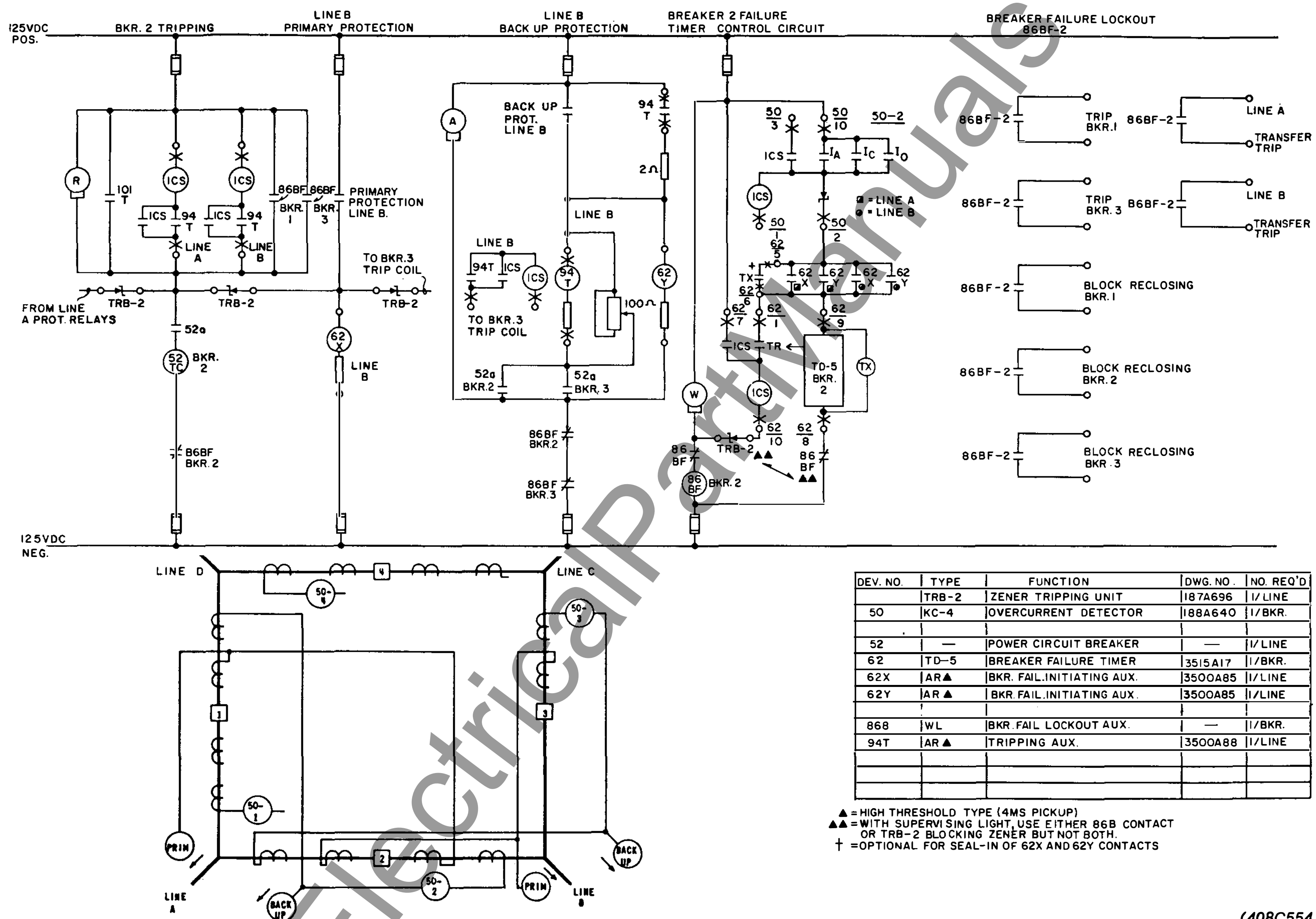
Indicating Contactor Switch (ICS)

Close the phase or ground 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

ROUTINE MAINTENANCE

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.



DEV. NO.	TYPE	FUNCTION	DWG. NO.	NO. REQ'D
	TRB-2	ZENER TRIPPING UNIT	187A696	1/LINE
50	KC-4	OVERCURRENT DETECTOR	188A640	1/BKR.
52	—	POWER CIRCUIT BREAKER	—	1/LINE
62	TD-5	BREAKER FAILURE TIMER	3515A17	1/BKR.
62X	AR▲	BKR. FAIL. INITIATING AUX.	3500A85	1/LINE
62Y	AR▲	BKR. FAIL. INITIATING AUX.	3500A85	1/LINE
868	WL	BKR. FAIL LOCKOUT AUX.	—	1/BKR.
94T	AR▲	TRIPPING AUX.	3500A88	1/LINE

▲ = HIGH THRESHOLD TYPE (4MS PICKUP)
▲▲ = WITH SUPERVISING LIGHT, USE EITHER 86B CONTACT OR TRB-2 BLOCKING ZENER BUT NOT BOTH.
† = OPTIONAL FOR SEAL-IN OF 62X AND 62Y CONTACTS

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Fig. 5. External Connections for the KC-4 Relay – Breaker Failure Protection of a Ring Bus.

ENERGY REQUIREMENTS – 60 Hz

PHASE & GROUND OVERCURRENT UNIT – 60 Hz					
AMPERE RANGE	TAP	†† VA AT TAP VALUE	Ø P.F. ANGLE	†† VA AT 5 AMPS.	Ø P.F. ANGLE
	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
.5-2	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
1-4	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
2-8	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29
	4	1.5	51	2.4	51
	6	1.7	45	1.2	45
4-16	8	1.8	40	0.7	40
	9	1.9	38	0.6	38
	12	2.2	34	0.37	34
	16	2.5	30	0.24	31
	10	1.7	28	0.43	28
	15	2.4	21	0.27	21
	20	3.1	16	0.20	17
10-40	24	3.6	1.5	0.15	15
	30	4.2	12	0.11	13
	40	4.9	11	0.08	12
	20	6.6	31	0.40	31
	30	9.3	24	0.25	24
20-80	40	12	20	0.18	20
	48	13.5	18	0.14	18
	60	15.9	16	0.10	16
	80	19.2	15	0.07	15

† † Voltages taken with Rectox type voltmeter.
Ø Degrees current lags voltage.

KC-4 50Hz BURDEN DATA					
AMPERE RANGE	TAP	†† VA AT TAP VALUE	ø P.F. ANGLE	†† VA AT 5 AMPS.	ø P.F. ANGLE
	.5	.35	36	24	34
	.75	.36	33	13	32
	1	.37	32	8.0	31
.5-2	1.25	.39	31	5.5	30
	1.5	.41	29	4.5	28
	2	.43	27	2.8	26
	1	.35	35	8.8	36
	1.5	.38	31	4.8	30
	2	.41	29	2.8	28
1-4	2.5	.44	27	2.0	27
	3	.47	25	1.4	25
	4	.53	23	.92	23
	2	1.04	45	6.2	45
	3	1.1	41	3.2	41
	4	1.2	36	2.0	36
2-8	5	1.3	33	1.2	33
	6	1.4	31	1.0	31
	8	1.7	27	0.6	27
	4	1.26	43	2.1	42
	6	1.5	40	0.9	40
4-16	8	1.6	37	.5	37
	9	1.7	34	.4	34
	12	2.0	31	.35	31
	16	2.2	28	.20	28
	10	1.9	39	.45	39
	15	3.6	36	.40	36
	20	5.8	34	.35	34
10-40	24	7.8	31	.30	31
	30	10.5	29	.27	29
	40	17.5	27	.25	27

†† Voltages taken with Rectox type voltmeter.
ø Degrees current lags voltage.

CURRENT RATINGS (50 & 60 Hz)

RATING OF THE OVERCURRENT UNITS (PHASE & GROUND)		
Range	Continuous Rating (Amperes)	One Second Rating (Amperes) †
0.5-2	5	100
1-4	8	140
2-8	8	140
4-16	10	200
10-40	10	200
20-80	10	200

† Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

All contacts should be periodically cleaned. 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.

CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

Phase & Ground Overcurrent Unit

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in the stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, (aganist the right side of the bridge.) Advance the stationary contact until the contacts just close. Then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact is position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver of similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Insert the tap screw in the minimum value tap setting and adjust the spring such that the contacts will close when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ± 5% of tap value.

If adjustment of pick-up current in between tap settings is desired, insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

Indicating Contactor Switch (ICS)

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

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

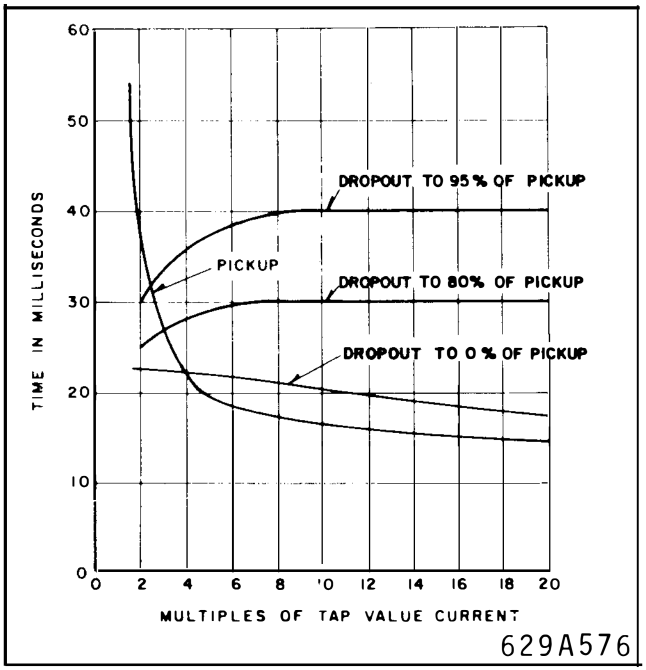


Fig. 6. Maximum Pick-Up and Drop-Out Time Curves for the Phase and Ground Overcurrent Units

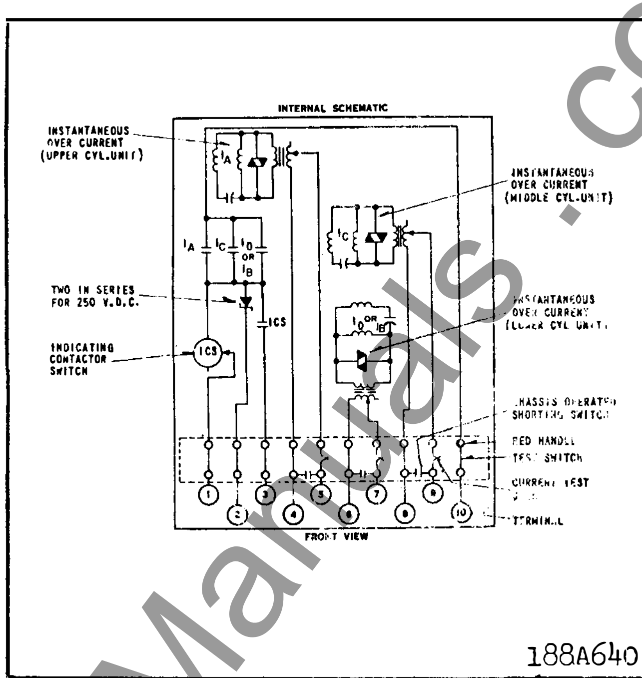


Fig. 7. Internal Schematic of the KC-4 Relay in the FT-41 Case.

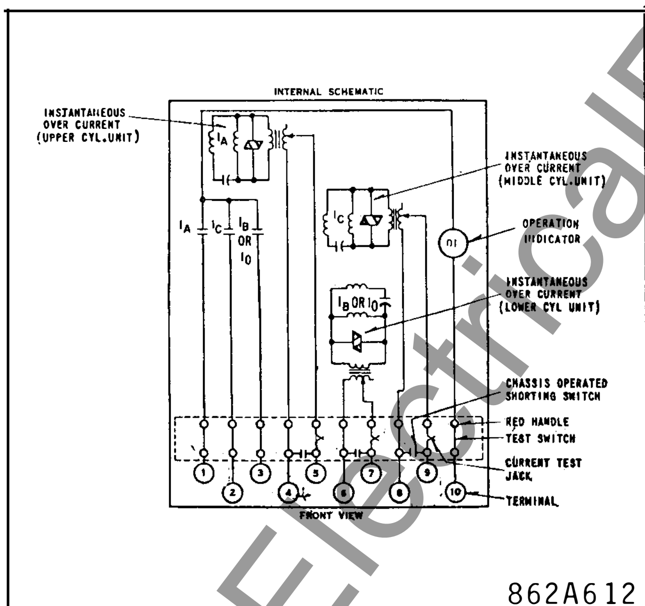


Fig. 8. Internal Schematic of the KC-4 Relay with Operation Indicator and Contacts to separate terminals in FT-41 case.

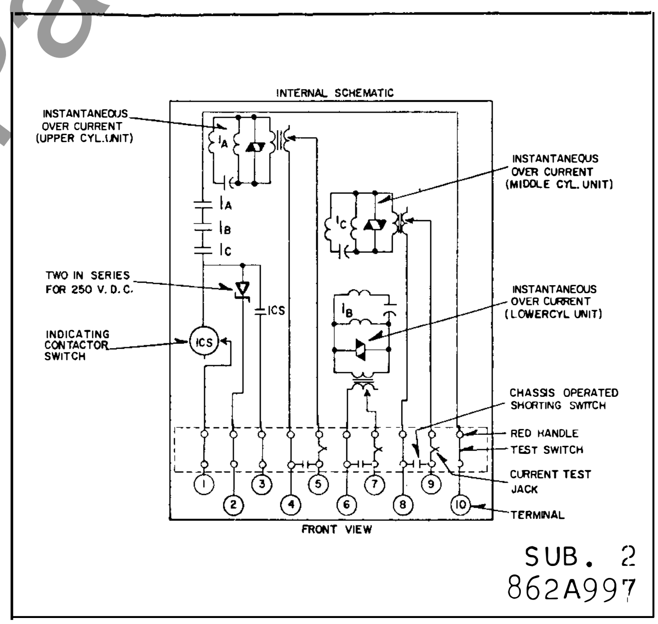


Fig. 9. Internal Schematic of the KC-4 Relay with Series Make Contacts in FT-41 Case.

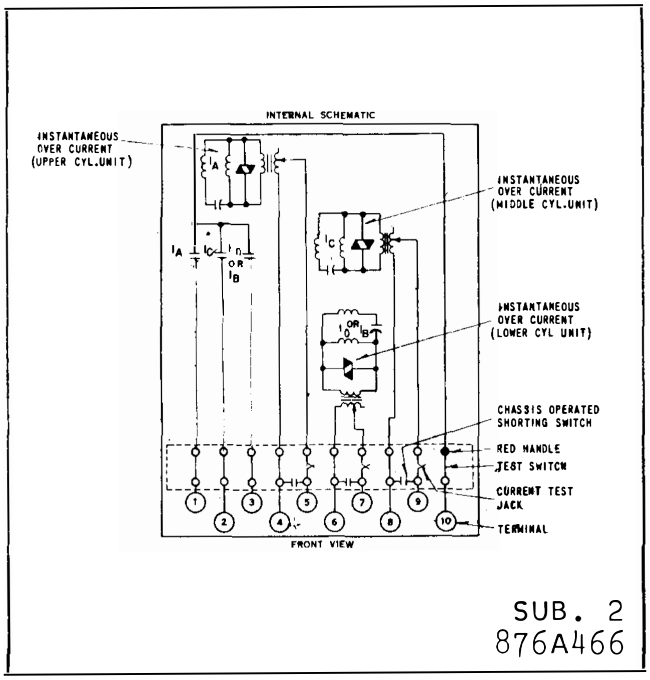


Fig. 10. Internal Schematic of the KC-4 Relay with one side of Contacts to Separate Terminals in FT-41 Case.

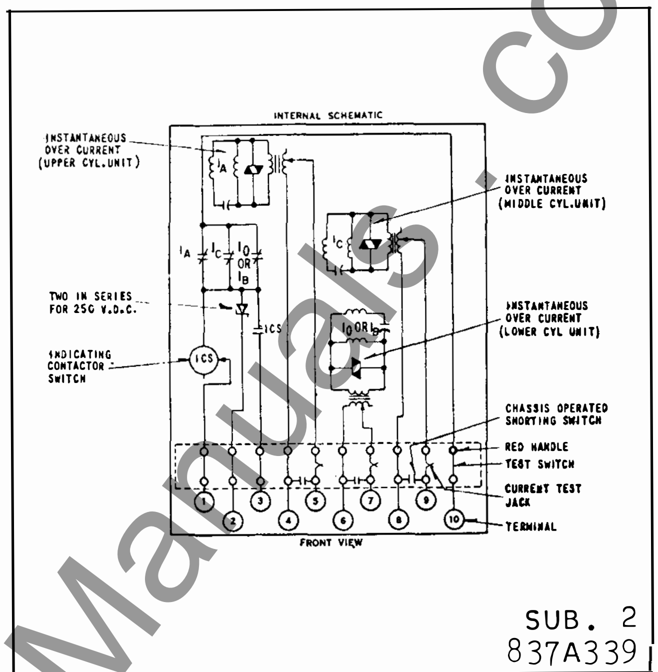


Fig. 11. Internal Schematic of the KC-4 Relay with Normally Closed Contacts in FT-41 Case.

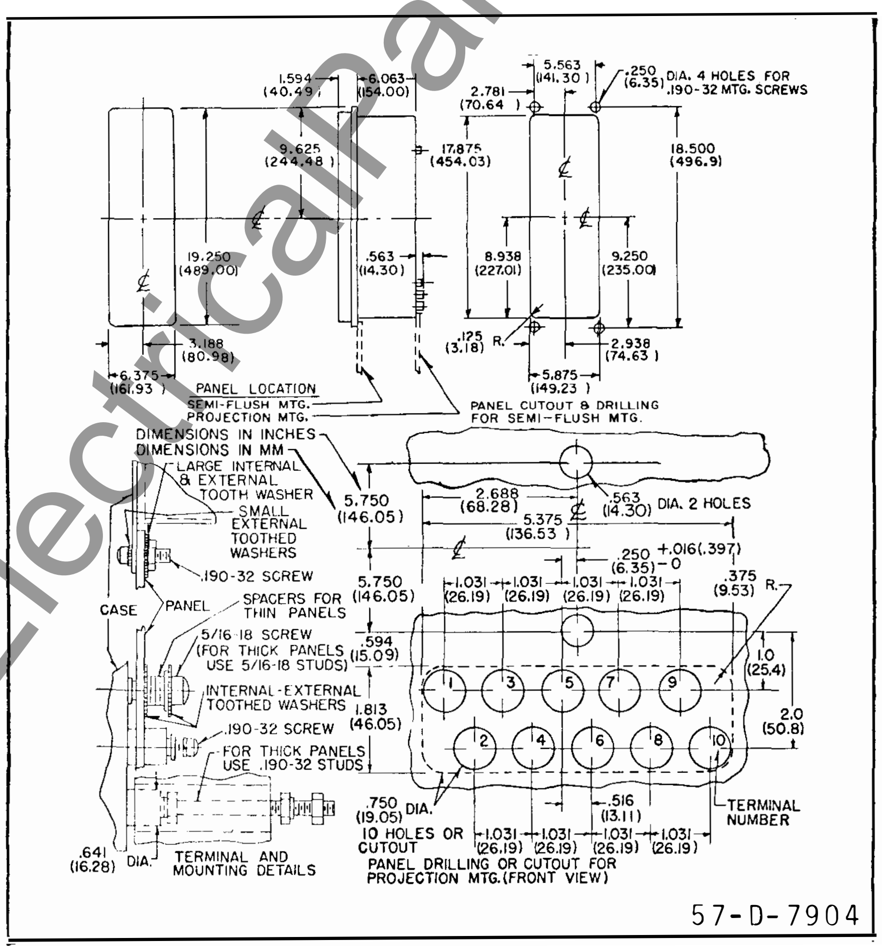


Fig. 12. Outline and Drilling Plan for the KC-4 Relay in FT-41 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-2 HIGH SPEED OVERCURRENT RELAY

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

NOTE: These Instructions apply to 50 and 60 Hz. Relays.

○ APPLICATION

The type KC-2 relay is a two unit high speed overcurrent level detector. As an example, it may be used as a fault detector for KD-10 distance relays. It may be operated continuously picked up, if the application requires, without experiencing excessive wear.

CONSTRUCTION AND OPERATION

The type KC-2 relay consists of two high speed overcurrent cylinder units and an indicating contactor switch.

OVERCURRENT UNIT (I)

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the normally open contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

SUPERSEDES I.L. 41-776.2D, dated Jan. 1977

EFFECTIVE MAY 1978

○ Denotes change from superseded issue

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden on the operating CT.

The primary of the transformer is tapped and brought out a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The indicating contactor switch is a small dc operated 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.

CHARACTERISTICS

The relay is available in the follolwing current ranges:

Range	Taps					
0.5 - 2 amps	0.5	0.75	1.0	1.25	1.5	2
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2	3	4	5	6	8
4 - 16	4	6	8	9	12	16
10 - 40	10	15	20	24	30	40

The tap value is the minimum current required to just close the overcurrent relay contacts. For pick-up settings in between taps refer to the section under adjustments.

CONTACTS

The moving contact assembly in the overcurrent unit has been factory adjusted for low contact bounce performance and should not be disturbed.

TRIP CIRCUIT

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

TRIP CIRCUIT CONSTANT

Indicating contactor Switch (ICS)

1 ampere rating: 0.1 ohms dc resistance
0.2/2.0 ampere rating: 0.2 tap – 6.5 ohms
2 tap – 0.15 ohms

SETTINGS

OVERCURRENT UNIT (I)

The only setting required is the pickup current setting which is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

CAUTION: Since the tap block connector screw carried operating current, be sure that the screw is turned tight.

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

INDICATING CONTACTOR SWITCH (ICS)

No setting is required for relays with a 1.0 ampere unit. For relays with a 0.2/2.0 ampere unit, connect the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125- or

250-volt dc type WL relay switch, or equivalent, use the 0.2 ampere tap; for 48-volt dc applications set the unit in a tap 2 and use a Type WL relay with a S#304C209G01 coil, or equivalent.

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.

ADJUSTMENTS & MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustment, other than those covered under "SETTINGS", should be required.

ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order.

OVERCURRENT UNIT (I)

Contact Gap – The gap between the stationary and moving contact with the relay in the de-energized position should be approximately .020".

The pickup of the overcurrent unit can be checked by interting the tap screw in the desired tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not less than 1.0 ampere nor greater than 1.2 amperes for the 1 ampere ICS. The current should not be greater than the particular ICS tap setting being used for the 0.2-2.0 ampere ICS. The operation indicator target should drop freely.

The contact gap should be approximately 0.047" for the 0.2/2.0 ampere unit and 0.070" for the 1.0 ampere unit between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

ROUTINE MAINTENANCE

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. 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.

CALIBRATION

Use the following procedure for calibrating the relay when taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See "Acceptance Check").

OVERCURRENT UNIT (I)

1. The upper pin bearing should be screwed down until there is approximately 1/64" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, i.e., against the right side of the bridge.

   Move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact of 2/3 of one turn for a contact gap of approximately .020".

   The clamp holding the stationary contact need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

   With the tap screw in the desired tap hole, pass rated ac current through the relay terminals.

   The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

   Adjust the spring until the contacts close. With this adjustment, the pick-up of the relay for any other tap setting should be within ±5% of tap value.

   If settings in between taps are desired, place the tap screw in the next lower tap hole and adjust the spring until the contacts just close at the desired pick-up current.

INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not less than 1.0 ampere nor greater than 1.2 amperes for the 1 ampere ICS. The current should not be greater than the particular ICS tap setting being used for the 0.2-2.0 ampere ICS. The operation indicator target should drop freely.

The contact gap should be approximately 0.047" for the 0.2/2.0 ampere unit and 0.070" for the 1.0 ampere unit between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

RENEWAL PARTS

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

RATINGS OF OVERCURRENT UNIT
50 & 60 Hz

Range	Continuous Rating Amps	One Second Rating Amps
.5 – 2	5	100
5 – 4	8	140
2 – 8	8	140
4 – 16	10	200
10 – 40	10	200

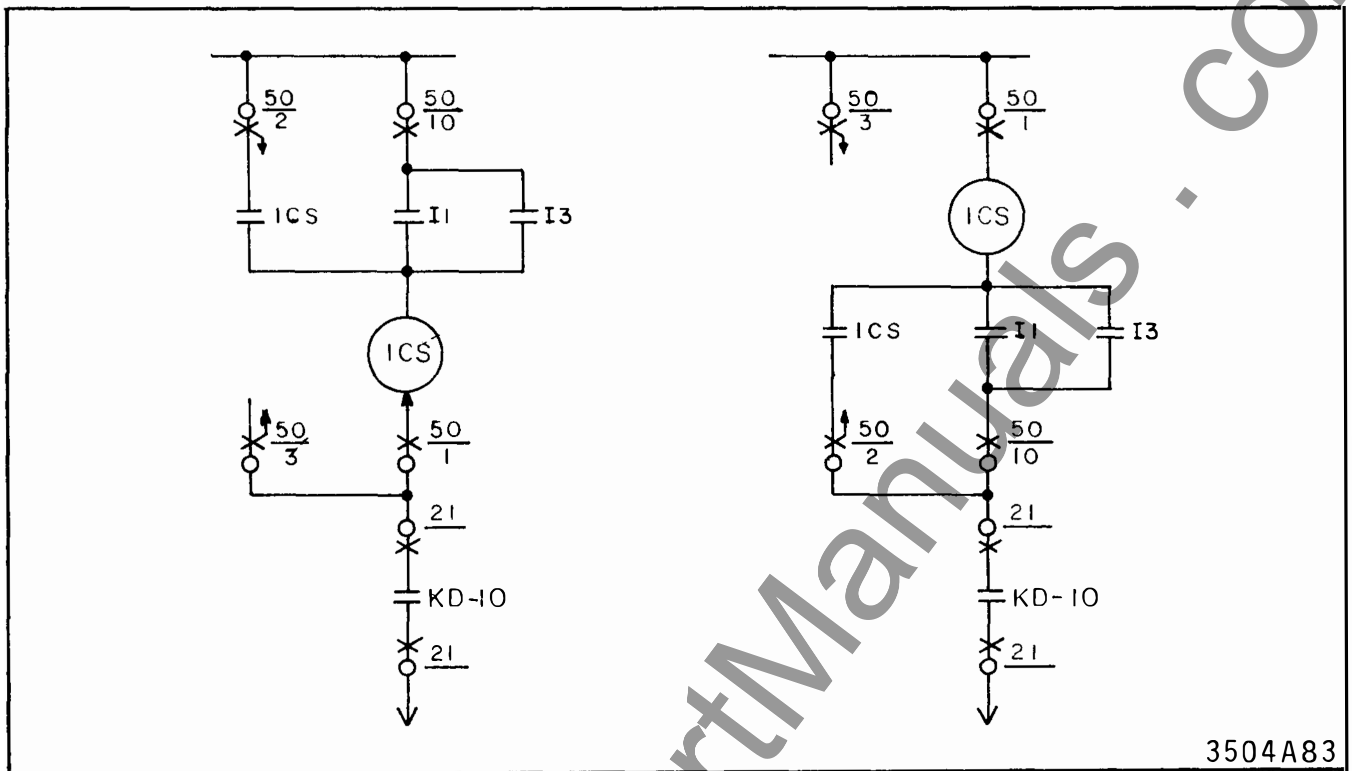


Fig. 1. External Connection of KC-2 Relay for Supervising the Distance Phase Relay.

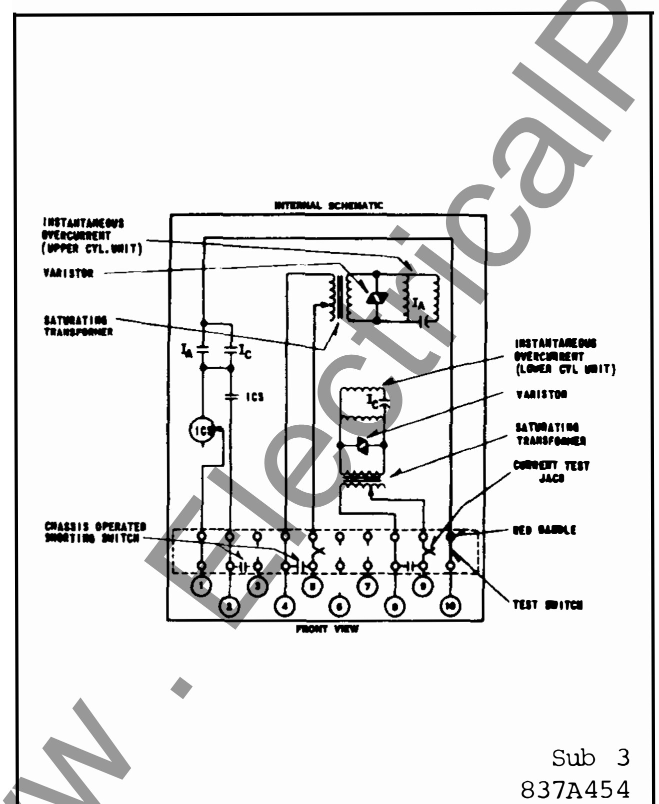


Fig. 2. Internal Schematic of KC-2 with Tapped ICS.

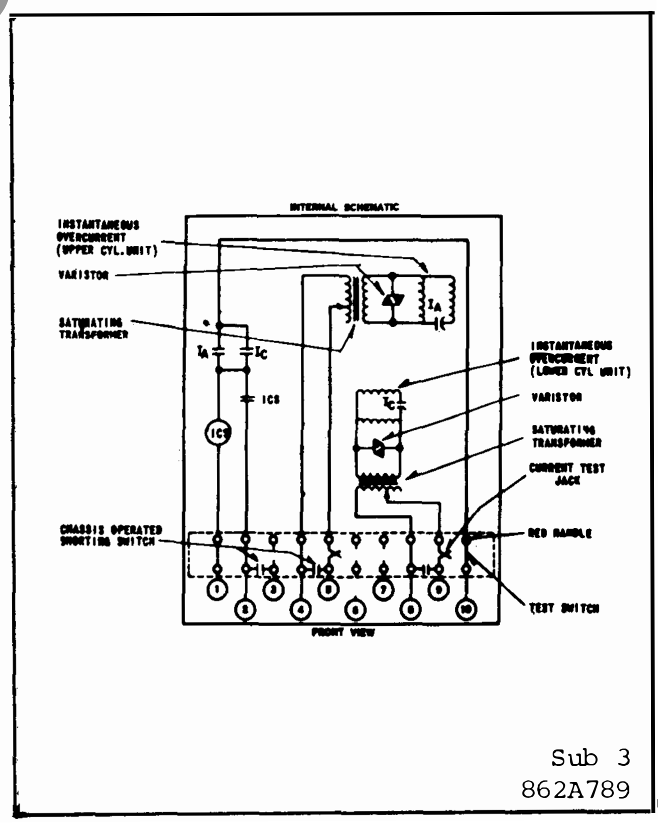


Fig. 3. Internal Schematic of KC-2 Relay with 1 Amp ICS Unit.

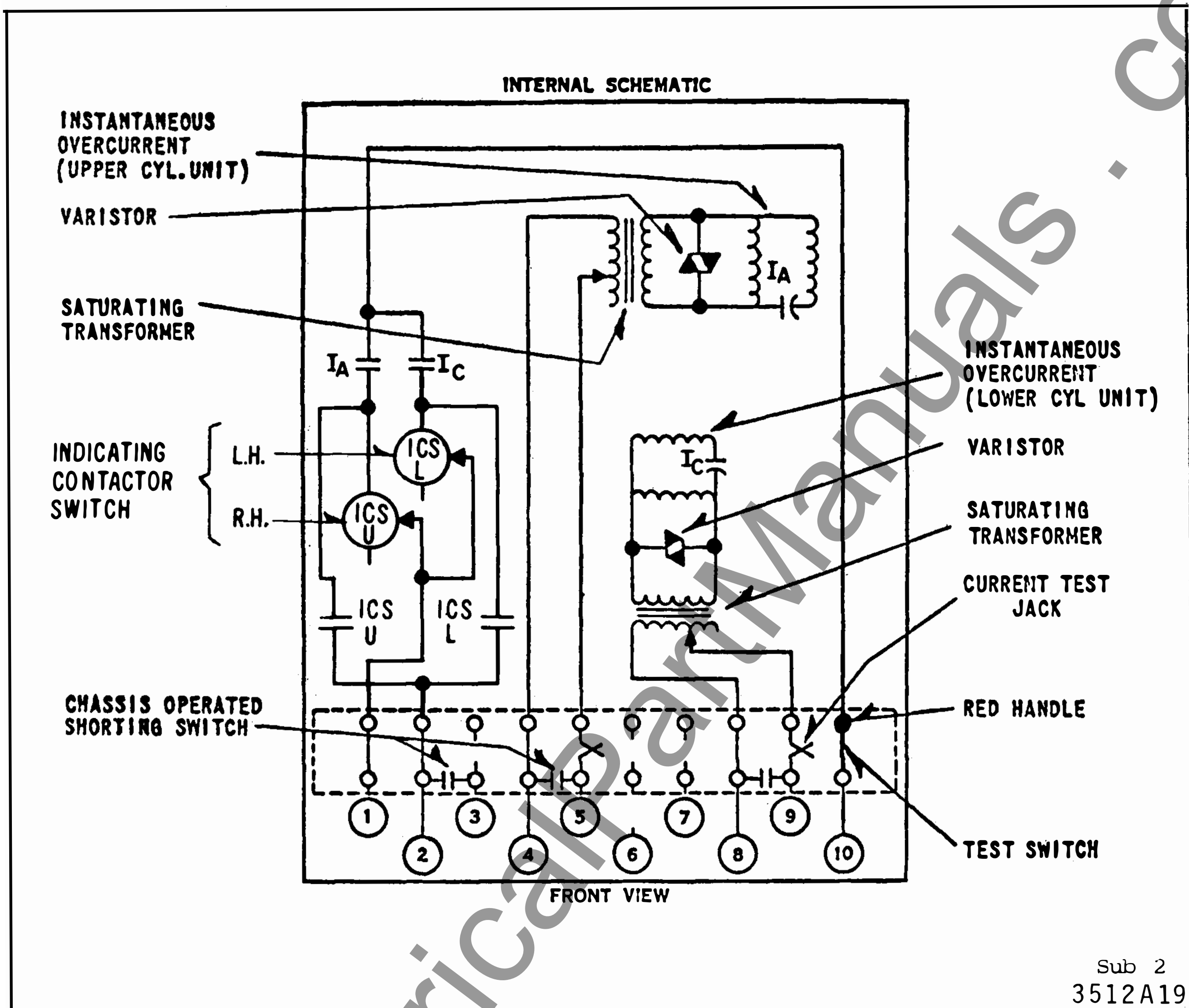


Fig. 4. Internal Schematic of KC-2 Relay with two Tapped ICS units.

ENERGY REQUIREMENTS
BURDEN DATA OF OPERATING CURRENT CIRCUIT
KC-2 50 HZ

AMPERE RANGE	TAP	VA AT TAP VALUE	PF ANGLE	VA AT 5 AMPS.	PF ANGLE
.5 – 2	.5	.35	36	24	34
	.75	.36	33	13	32
	1	.37	32	8.0	31
	1.25	.39	31	5.5	30
	1.5	.41	29	4.5	28
	2	.43	27	2.8	26
1 – 4	1	.35	35	8.8	34
	1.5	.38	31	4.8	30
	2	.41	29	2.8	28
	2.5	.44	27	2.0	27
	3	.47	25	1.4	25
	4	.53	23	.92	23
2 – 8	2	1.04	45	6.2	45
	3	1.1	41	3.2	41
	4	1.2	36	2.0	36
	5	1.3	33	1.2	33
	6	1.4	31	1.0	31
	8	1.7	27	0.6	27
4 – 16	4	1.26	43	2.1	42
	6	1.5	40	0.9	40
	8	1.6	37	.5	37
	9	1.7	34	.4	34
	12	2.0	31	.35	31
	16	2.2	28	.20	28
10 – 40	10	1.9	39	.45	39
	15	3.6	36	.40	36
	20	5.8	34	.35	34
	24	7.8	31	.30	31
	30	10.5	29	.27	29
	40	17.5	27	.25	27

Fig. 5. Burden Data

ENERGY REQUIREMENTS
BURDEN DATA OF OPERATING CURRENT CIRCUIT
60 HERTZ

RANGE AMPS	TAPS	VOLT-AMPERES TAP VALUE CURRENT	POWER FACTOR ANGLE φ °	VOLT AMPERES AT 5 AMPERES	POWER FACTOR ANGLE φ °
.5 – 2	.5	.37	39	24	46
	.75	.38	36	13	37
	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
1 – 4	1	.41	36	9.0	36
	1.5	.44	32	5.0	32
	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	0.93	24
2 – 8	2	1.1	49	6.5	48
	3	1.2	43	3.3	42
	4	1.3	38	2.1	37
	5	1.4	35	1.4	35
	6	1.5	33	1.1	33
	8	1.8	29	0.7	29
4 – 16	4	1.5	51	2.4	51
	6	1.7	45	1.2	45
	8	1.8	40	0.7	40
	9	1.9	38	0.6	38
	12	2.2	34	0.37	34
	16	2.5	30	0.24	31
10 – 40	10	1.7	28	.43	28
	15	2.4	21	.27	21
	20	3.1	16	.20	17
	24	3.6	15	.15	15
	30	4.2	12	.11	13
	40	4.9	11	.08	12

Fig. 6. Burden Data

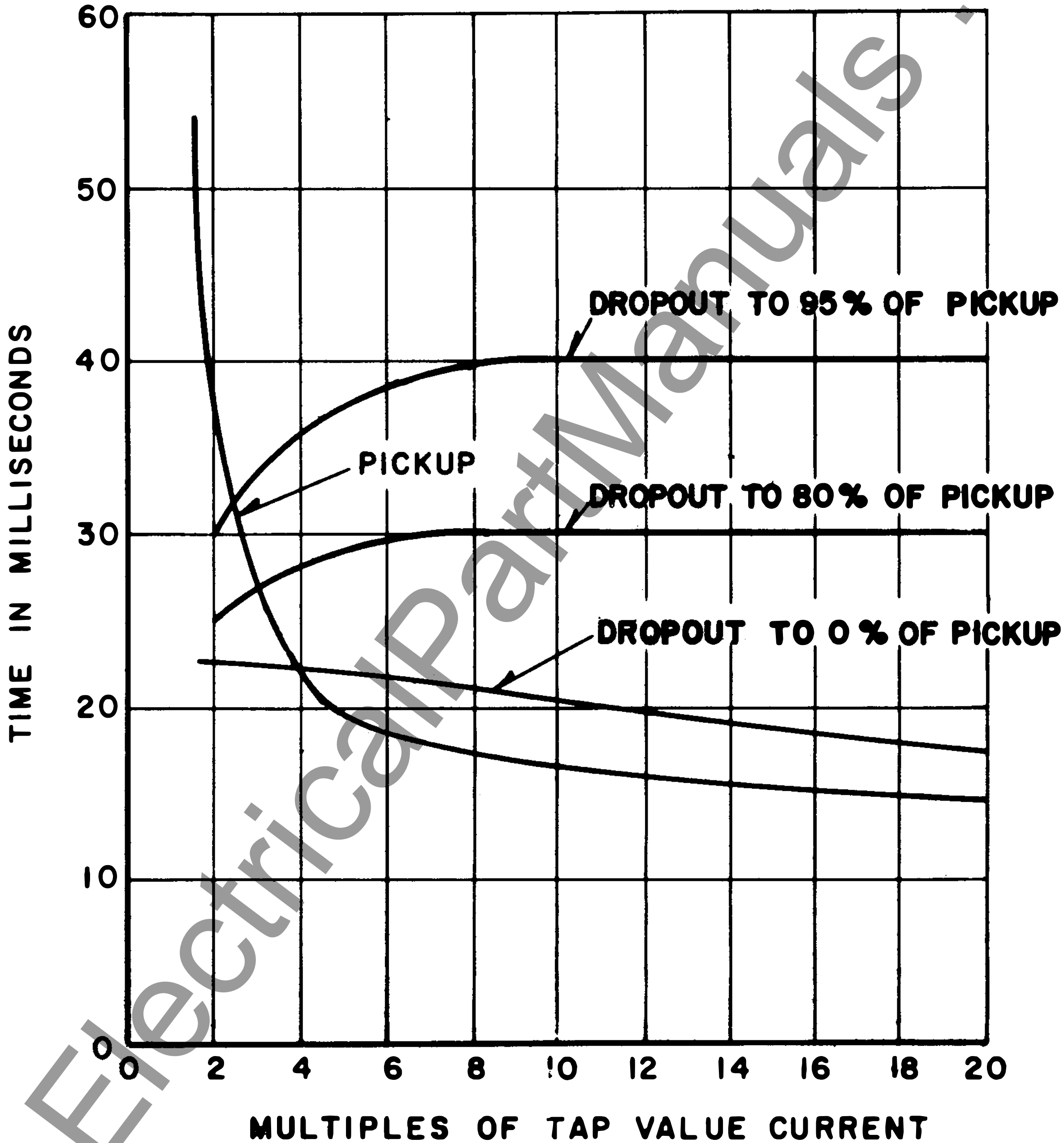


Fig. 7. Maximum Pickup and Dropout Time Curves for the Phase and Ground Overcurrent Unit.

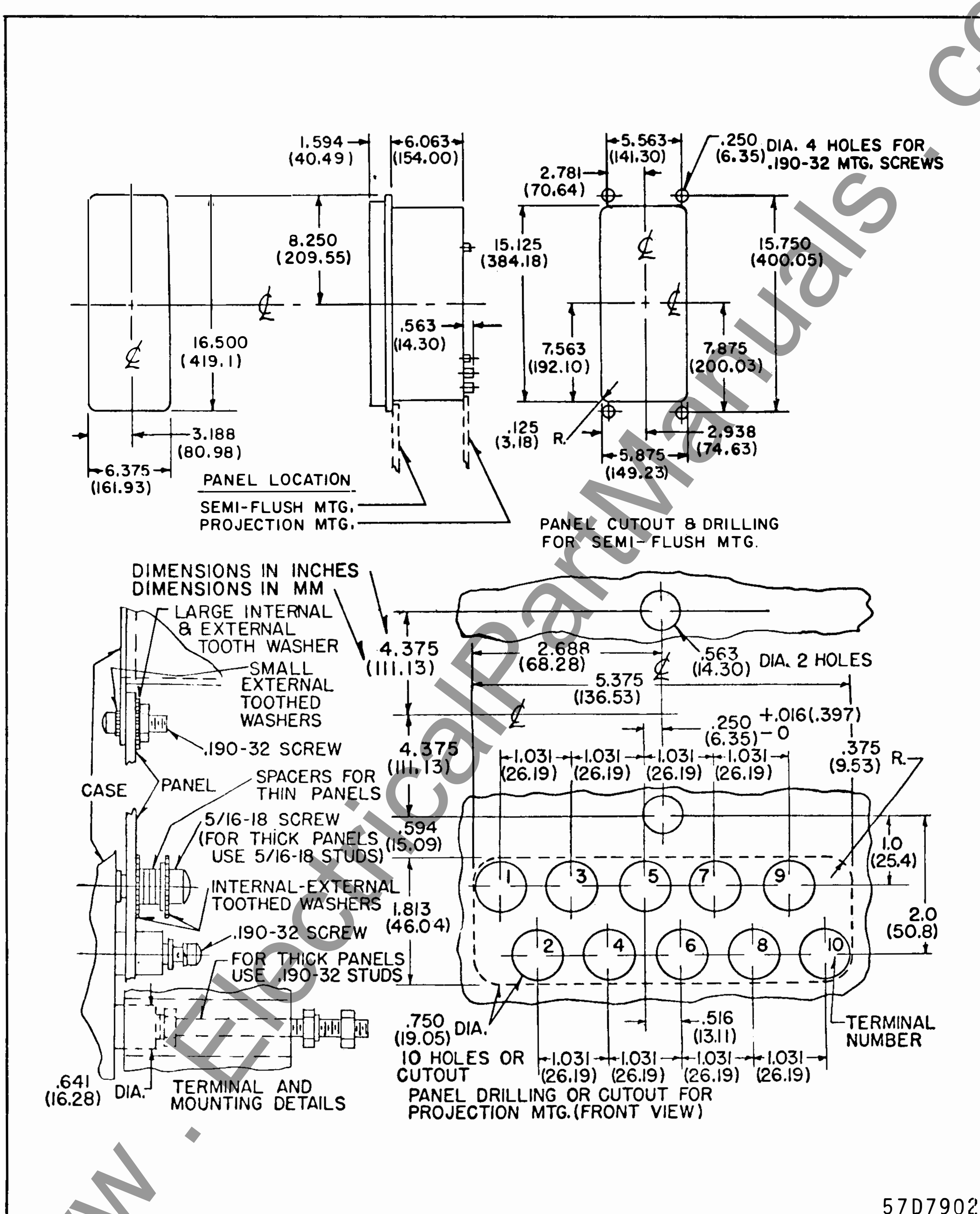


Fig. 8. Outline and Drilling (FT-31 Case).

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBFU STATIC CIRCUIT BREAKER FAILURE RELAY

CAUTION: It is recommended that the user of this equipment become acquainted with the information in these instructions before energizing the relay. Failure to do so may result in damage to the equipment. Before putting the relay into service operate the relay to check the electrical connections.

Printed Circuit Modules should not be removed or inserted while the relay is energized.

APPLICATION

The SBFU is a static relay used to detect the failure of a circuit breaker to interrupt successfully. It is used in conjunction with the primary and backup relays. Other logic inputs may be used where the fault current is insufficient to operate the current fault detector. The external schematic shows the connections for the required inputs.

The user should refer to the supplementary instruction leaflet (shown on the relay nameplate) for drawing information pertaining to a specific relay.

CONSTRUCTION

The type SBFU relay is a solid-state 19" wide rack-mounted package containing a phase and ground overcurrent unit fault detector similar to the Westinghouse Type SIU. In addition, there is an input logic module as well as an adjustable timer board. The connection of the modules as well as the type of output trip device (which may be a thyristor or relay) is shown in the particular logic drawing. The various circuit boards and their slot location is also shown. The logic drawing number is printed on the relay nameplate.

The inputs from the control voltage as well as the 62X and 62Y or other input logic is connected to the SBFU by means of a Varicon connector plug. The fault detector currents and the trip circuit connections are made to a terminal strip.

The modules are printed circuit boards with plug-in type of connectors. This permits removal of the module for replacement purposes or for use in conjunction with an extender board (S#3494A90G01) which permits access to the module test points for making measurements while the relay is energized. The plug in feature is keyed to prevent the boards from being re-inserted in the wrong location.

The overcurrent unit and timer modules have a scale plate and setting potentiometer mounted at the front of the module. This permits changes in the operating levels while the relay is in service. A knob locking device prevents accidental changes of the fault detector or timer settings.

The internal schematic and component location drawing for the various modules depicts the circuitry and description of the component values as well as location of the components and test points.

Overcurrent Unit

Consists of three input transformers, two for phase and one for ground. ✪ Some SBFU relays have four overcurrent units (Fig. 38). The transformer has a non-tapped primary winding and a center tapped secondary winding. A resistor and Zener diode (Z_A and R_C) is mounted across the secondary winding which limits the secondary voltage produced for large values of primary current.

The output of the secondary winding also feeds two parallel cuicuits located on the overcurrent unit module. One circuit consists of a phase splitting circuit which is used to convert single-phase to three-phase voltage. The other is the setting circuit which consists of a fixed resistor and a rheostat(s). The rheostat is mounted on the front of the module in conjunction with a dial plate. The dial plate is calibrated in amperes required to produce a logic

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-776.4D, dated August 1974
✪ Denotes change from superseded issue.

EFFECTIVE APRIL 1977

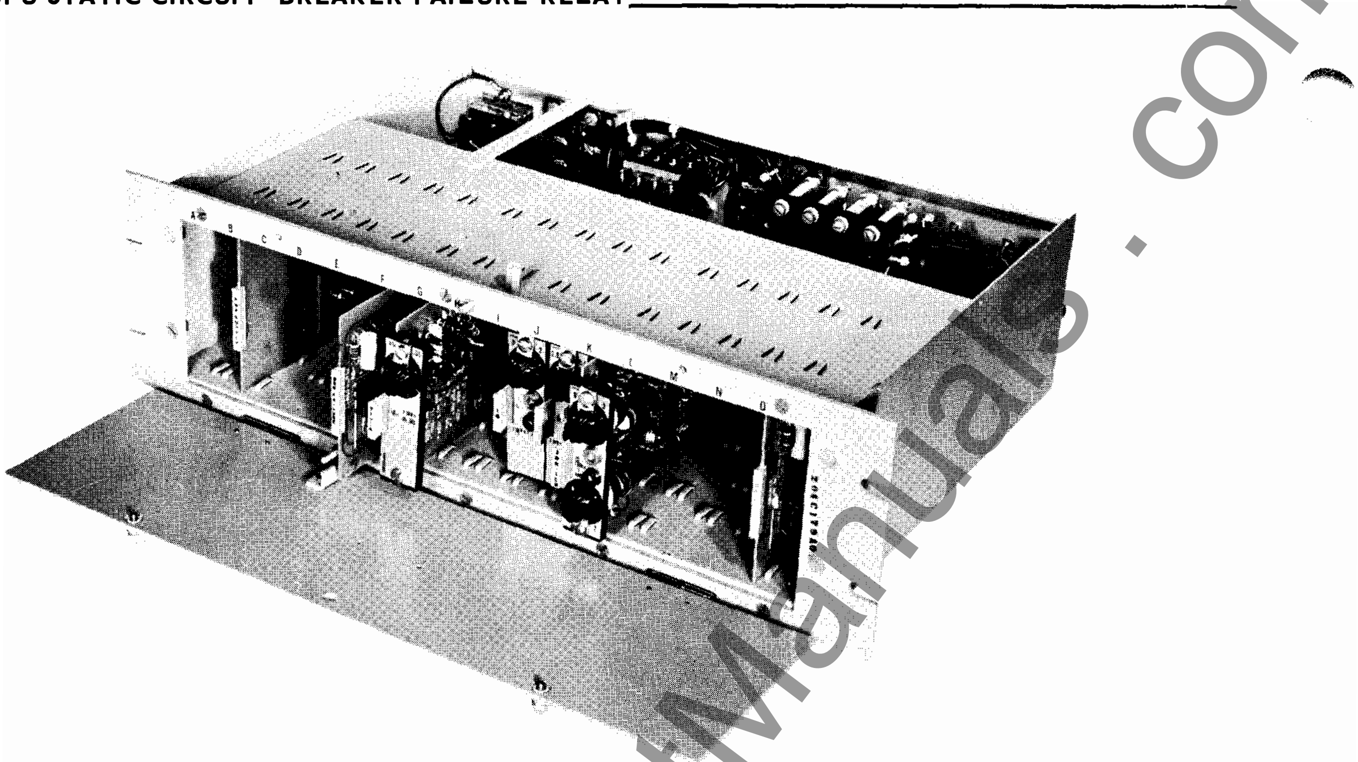


Fig. 1. Photograph (front view with door open and cards out part way).

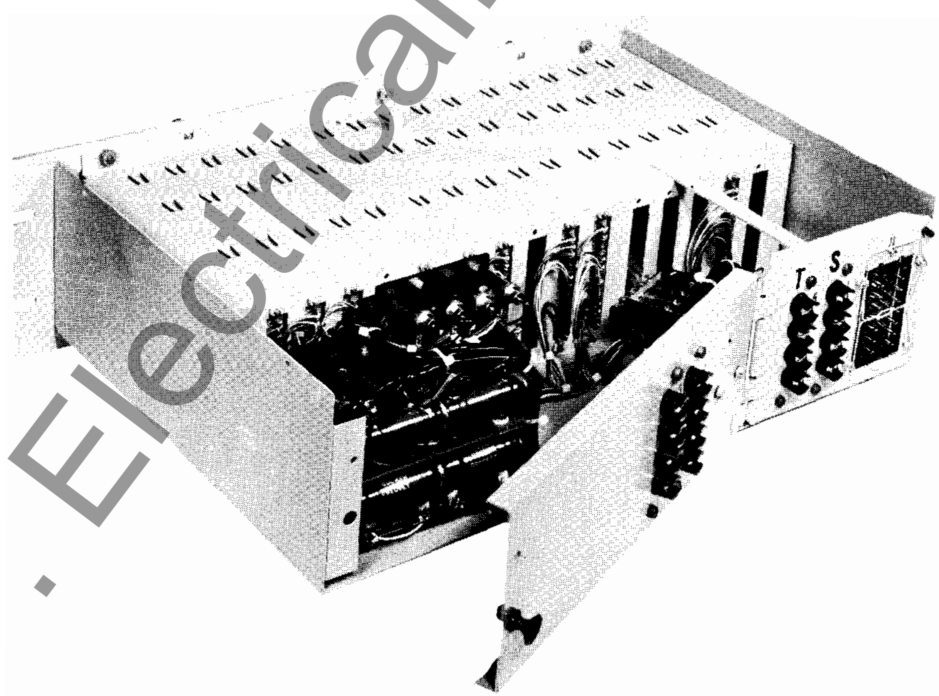


Fig. 2. Photograph (rear view with top cover off and rear door open).

"1" output (15 to 20 volts). A knob on the rheostat shaft is used to obtain the desired operate point. A locking feature prevents the knob from being accidentally changed.

Beside the setting circuit the overcurrent unit module consists of a d-c rectifier, input sensing circuit, a feedback circuit and a switching amplifier. The phase splitting adjustment potentiometer and feedback potentiometer are also located on the module. These potentiometers are factory adjusted and should not require changing. The output can be checked by means of the red and black test point jacks mounted on the front of the module. The actual electrical connections can be seen by referring to the internal schematic drawing of the module.

Breaker Failure Logic Module

This module receives the output of the overcurrent unit. It also receives the 62X and 62Y signal and performs the necessary logic function. Some relays are wired with a seal-in circuit as shown in the particular logic dwg. An 8MS time delay is used in some types to prevent undesirable operation of the seal-in circuit due to capacitive surges. In addition the input buffer is designed to respond to input signals greater than half battery voltage (Fig. 27). Figure 31 shows breaker failure logic module with high capacitive surge immunity.

Adjustable Timer Module

The timer adjust potentiometer is mounted at the front of the module along with a dial plate. A knob is mounted on the potentiometer shaft and can be held at the desired setting by means of a locking device. Some relays come supplied with two timer modules (see Fig. 38).

Trip Module

A trip module is supplied when the SBFU output is a thyristor switch. It contains the circuitry for isolating the thyristor trip supply voltage from the SBFU control voltage as well as the thyristor gate driving circuit.

Power Supply

The power supply is a transistor and Zener regulated d-c supply which is located on the power supply module. The module is used in conjunction with two external resistors (R_A and R_B), whose value depend on whether a 48-volt or 125-volt d-c control voltage is available. The output voltage is approximately 20VDC.

Output Relay

The output relay, when used, is the Westinghouse high speed Type AR with 4 normally open contacts. At least one normally open contact is connected to a terminal strip for tripping duty. The relay driver circuit is located on the power supply module or breaker failure module.

OPERATION

The overall operation can best be explained by referring to the d-c schematic and logic diagram 201C845. The 62X and 62Y input from the primary or backup relays are introduced in a logic "AND" with the overcurrent unit fault detector. The output of the breaker failure logic module then operates the adjustable timer module. The timer output then drives either a relay driver or thyristor depending on the type of output. An inductor L1 is used in conjunction with the thyristor to provide immunity to line transients.

A supplementary instruction leaflet is provided for some SBFU relays not contained in this booklet. Refer to nameplate for this number.

Overcurrent Unit

The line CT current flows through the SBFU input transformer producing a secondary voltage proportional to the current. The secondary voltage value is affected by the setting rheostat. The secondary voltage is connected to a phase splitter consisting of a capacitor and fixed resistor and a potentiometer which produce a three-phase voltage. This voltage is fed into a three-phase full wave rectifier. The output of the rectifier goes to a Zener comparer. When this voltage is high enough, the Zener conducts and allows current to flow into the base of the Q_1 transistor. When transistor Q_1 turns on, transistor Q_2 also turns on causing the voltage at the output terminal of the module to rise from approximately 0 (logic 0) to approximately 20 volts (logic 1). At the same time, a current feeds back to the input. The amount of feedback current is adjusted by a potentiometer in the feedback path which is factory calibrated for a dropout of approximately 95% of pickup.

Breaker Failure Logic Module

The 62X and 62Y inputs are connected to two buffer circuits which consist of two Zener diodes, three resistors, one capacitor and one diode. This circuitry provides immunity to transients that may be picked up by the leads leading to the input of the SBFU. The buffers are connected to a NOR circuit consisting of a transistor and resistor. The output of the NOR circuit connects to a NAND circuit in conjunction with the output of the overcurrent unit. The NAND circuit consists of two input resistors, a transistor, a base and a collector resistor. The output of the NAND circuit is connected to the output terminal of the module and should produce approximately 15 volts d-c input to the timer module.

Some modules contain an 8 MS timer for delaying the seal-in signal. The time delay may vary from 5 to 11 MS.

Adjustable Timer Module

The timer module input is a transistor OR circuit consisting of a NPN and PNP transistor. The output of the OR circuit drives a time delay circuit containing a bridge circuit. One leg of the bridge circuit is the timing potentiometer which is set for the desired time delay. The other leg has a timing capacitor in it. The opposite two legs have a bias potentiometer which establishes the timing capacitor voltage required to fire the thyristor.

The thyristor is connected across two corners of the bridge circuit. When the timing capacitor voltage exceeds the bias voltage, current flows into the gate of the thyristor turning it on. The voltage at the brush of the bias potentiometer quickly rises to approximately 18 volts. This is about 5 volts greater than the blocking Zener and therefore allows transistor Q5 to turn on. It also turns on transistor Q3 which discharges the timing capacitor. At the same time Q5 turns on, transistor Q6 turns on and a logic "1" (20 volts) appears at terminal 2 of the module.

Trip Module

The output of the adjustable timer board feeds the trip module or output relay driver whichever the case may be. Where a thyristor output is used, a trip module is required. The trip module provides a pulse for triggering the gate of the thyristor as well as providing isolation between the input power supply by means of a pulse transformer.

When the output is a relay, a trip module is not required. In that case the output of the timer feeds a relay driver circuit located on the breaker failure logic module or power supply module. The relay driver consists of a transistor, base resistor, input resistor and a zener diode connected from emitter to collector to protect the transistor from transients. The output of the relay driver circuit is connected to a relay coil which operates four sets of contacts.

CHARACTERISTICS

The overcurrent fault detector is available in 0.5-2, 1-4, 2-8, and 4-16 amp. range. Figure 3 shows the operating time of the overcurrent unit vs. multiples of pickup value. The reset time of the overcurrent unit is shown in Fig. 4. The dropout ratio is factory adjusted for approximately 95% of pickup.

The adjustable timer can be supplied with .05 to .4, .1 to 1.0; and .4 to 4.0 second time delay ranges. The timer has essentially no "over-travel", (tendency for a timer to operate after the input is removed). The recycling time of the timer is less than .01 seconds after the timer has timed out.

The timer accuracy is rated at 5% or better from 18 to 21 V. d.c. and −20 to + 60°C.

The thyristor trip output operates in approx. 1 millisecond. When a relay output is used the operating time is approx. 6-8 ms. for a 2 watt AR and 2 ms. for a 10 watt AR. A diode is connected around the coil to delay dropout by approximately 40 ms.

Some input buffers are equipped with a 6.2K shunting resistor across the buffer capacitor. In this case the "must not operate" input voltage is 50% of rated. The "must operate" input voltage is 80% of rated.

For all other buffers the "must operate" voltage is 38 VDC.

All output buffer signals are rated for 10 MA maximum at a nominal 20 VDC and 15 VDC minimum.

The tripping thyristor, when used, is rated for 5 amperes continuous and 40 amperes for 5 cycles.

Battery Drain

The battery drain in the non-operate mode is approx. 60 MA for 48 V. d.c. supply and 30 MA for 125 V. d.c. supply. This does not include the relay drain if one is used. The 2 watt 125 V. d.c. relay drain is approx. 15 MA and the 10 watt 125 V.d.c. relay is 80 MA. The 10 watt 48VDC relay draws 200 MA.

The A-C current burden is shown in Table I

The A-C current rating is shown in Table II

TABLE I
ENERGY REQUIREMENTS

AMPERE RANGE	SETTING	VOLT AMPERES AT SETTING	P.F. △ ANGLE	VOLT AMPERES AT 5 AMPERES	P.F. ANGLE
.5-2	0.50	0.06	11.5	2.8	17.5
	0.75	0.09	2	2.7	15.8
	1.00	0.13	4	2.6	14.5
	1.25	0.17	8	2.5	14.5
	1.50	0.21	12	2.3	15.5
	1.75	0.26	14	2.1	16.5
	2.00	0.31	15	2.0	18.0
1-4	1.0	0.06	10.5⊀	1.3	4
	1.5	0.10	0.5	1.1	4
	2.0	0.15	5.5	0.9	5.8
	2.5	0.19	9.0	0.8	8
	3.0	0.25	11.0	0.7	11
	3.5	0.32	14.5	0.6	14
	4.0	0.37	16.5	0.6	16
2-8	2	0.07	8⊀	0.44	6⊀
	3	0.12	1.5	0.33	1.5
	4	0.18	5.5	0.28	5.5
	5	0.25	8.5	0.25	8.5
	6	0.35	10.5	0.23	10.5
	7	0.45	13	0.22	13
	8	0.50	14	0.2	13.5
4-16	4	0.10	6⊀	0.14	5.4⊀
	6	0.15	3	0.10	3
	8	0.25	5.5	0.10	6
	10	0.35	7.5	0.09	8
	12	0.50	9	0.08	9.5
	14	0.65	9.5	0.08	10.5
	16	0.8	10	0.08	11.5

△ Current Lagging Voltage

⊀ Current Leading Voltage

TABLE II
CURRENT RATINGS

Range	Continuous	One Second
.5-2	8 Amps.	350 Amps.
1-4	10 Amps.	400 Amps.
2-8	12 Amps.	400 Amps.
4-16	15 Amps.	400 Amps.

SETTING

The only setting required is the overcurrent unit and timer unit. These are set for each overcurrent unit by means of the knob adjustment located on the front of each overcurrent unit module. Likewise, the timer setting is made by means of the front knob on the timer module.

INSTALLATION

✪ The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. The maximum ambient temperature around the chassis must not exceed 55°C. Mount the relay by means of the four slotted holes on the front of the case. Additional support should be provided toward the rear of the relay in addition to the front panel mounting. This will protect against warping of the front panel due to the extended weight within the relay case. Ground relay chassis with No. 12 AWG copper wire to grounding post.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed.

Acceptance Test

The following check is recommended to insure that the relay is in proper working order. Refer to the logic drawing pertaining to the particular relay (Dwg. No. is located on the relay nameplate) for correct terminal connections. The test drawing shown in Fig. 43 may be used.

Overcurrent Unit

Check for correct scale marking by applying current with the knob set at either end of the scale. A voltage of approximately 20 V. d.c. should appear at the test terminals (located at the front of the overcurrent unit module) when applied a-c current is within ± 10% of the scale setting.

Check the dropout ratio (94 to 98% of pickup current) by reducing the applied a-c current until the voltage at the test points falls to zero.

Timer Unit

A timing check at the minimum and maximum settings is recommended to insure that the timer module is in proper working order. This can be done at the same time an overall test of the relay is made.

Overall Test

Refer to the logic drawing and test drawing. Connect an 86 device between strip terminal 4 and negative. Connect 125 volts d-c positive to terminal 3 of the terminal strip. Connect rated voltage to to terminal J6 and J8 of the Varicon connector through normally open switches. For some logic drawings also connect rated voltage to J15, J16 and J17. Connect negative of supply to J3. Also connect positive control voltage to terminal J4 and negative control voltage to terminal J3.

Using a module extender (S#849A534G01, or 3494A90G01) remove the timer module and insert the module extender into the timer slot position in the relay. Now plug in the timer module into the module extender. This makes the timer board terminals accessible. Connect an electronic test timer so that a positive signal at terminal 2 of the timer module will stop the test timer. By using a DPST switch in series with the input to terminal J6 then the test timer can be started at the same time J6 is energized. On some relays the timer module output is connected to the relay output so that the module extender is not required.

With overcurrent unit set at minimum, apply twice pickup current, and the timer module set at 0.2 seconds, check to see that an output appears at terminal 2 of the timer board 0.2 ± .01 seconds after the switch to terminal J6 is closed. The light connected to the trip terminal should go on at the same time. Open switch to J6 and reset the light. When a seal-in feature is supplied it will be necessary to reset the overcurrent unit.

The same procedure should be repeated using I_A and then I_C input. Check also to see that an output is obtained when J8 switch is closed with an overcurrent unit input above pickup applied.

If there are other inputs such as J15 and J16 check to see that an output is obtained when either switch is closed. Also check all other outputs as shown on the logic drawing.

CALIBRATION

Overcurrent Unit

The overcurrent unit may be recalibrated if the phase splitter or feedback potentiometer adjustments have been disturbed or if components have been replaced. As a result, the scale markings may not track with the knob so that it may be necessary to readjust the knob or replace the scale plate with a new dial.

The phase splitter is adjusted with minimum setting current applied, and minimum dial setting. Adjust the phase splitter potentiometer R13 so that equal a-c voltages are measured at the input to the three-phase rectifier. (TP1, PC terminal 9 and 10).

The dial rheostat is calibrated with rated d-c voltage applied. Apply desired a-c current until a voltage of approximately 20 V. d.c. appears at the module outputs test points.

The dropout (feedback) potentiometer is adjusted by applying pickup a-c current after the feedback potentiometer has been rotated about half-way. Now lower the a-c current to 95% of pickup (or lower if desired). Increase the feedback resistance by rotating the feedback potentiometer clockwise until the 20 volts d-c at the output drops to zero.

Adjustable Timer Unit

The circuit should be first checked to see that there is no component failure. Replacement of a defective component may or may not disturb the dial calibration. If it does, repositioning of the dial knob may get the knob to track. If not, a new blank scale plate is required. Energize relay and use a card extender and hookup as in the overall acceptance test. Rotate the timing potentiometer fully clockwise for maximum time delay. Adjust the trimming potentiometer, (RBU), so that maximum delay is approximately 105% of the maximum time. Tighten knob so that the marker on the knob makes an angle of approximately 20 degrees with a vertical line. With the knob rotated fully counter-clockwise, the timing should be less than 90% of the minimum time. The knob can be readjusted in order to balance the scale mechanically with respect to the stops. With an awl or similar tool, scribe lines every .05, 0.1 or 0.4 seconds, depending on the relay range.

There are no adjustments required on the power supply, breaker logic, or trip module.

RENEWAL PARTS

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

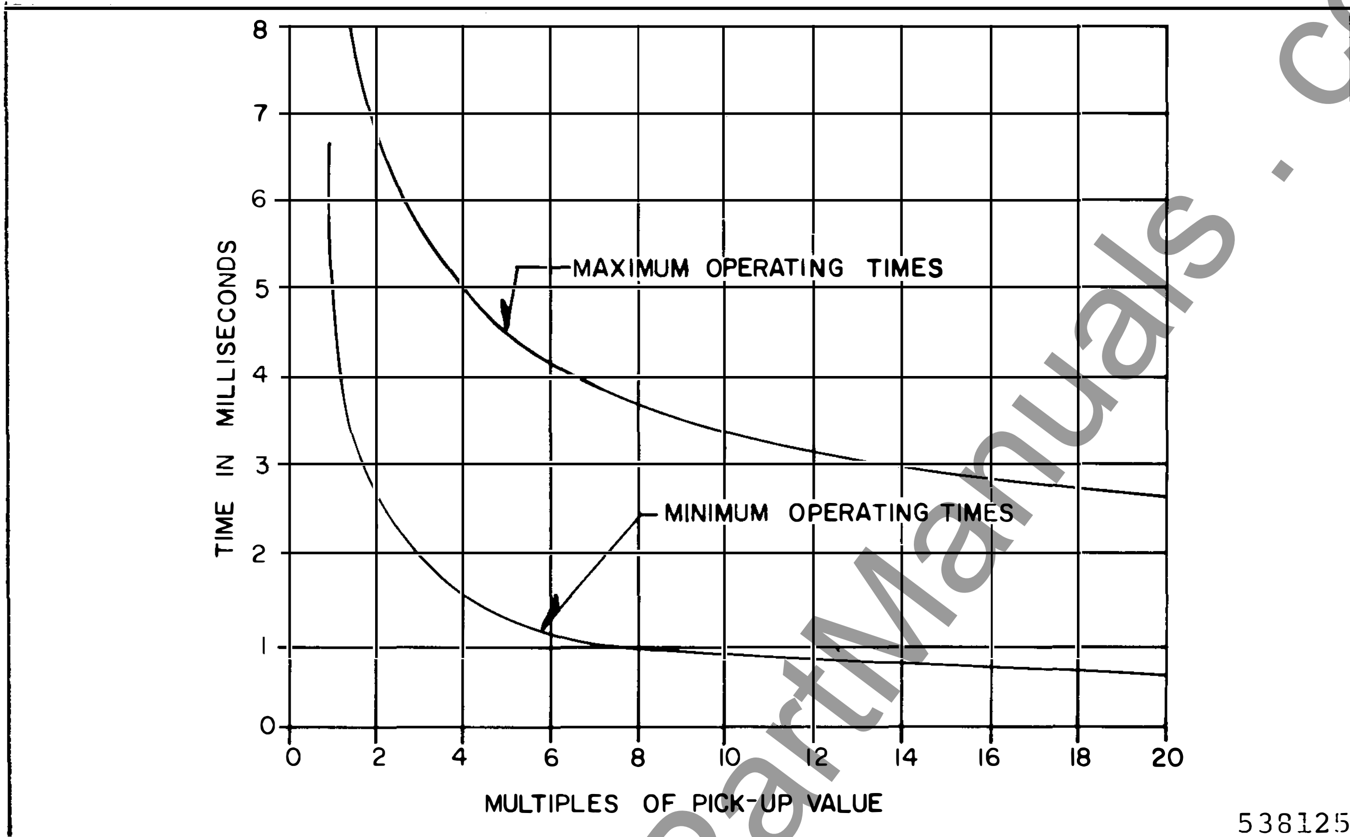


Fig. 3 Operating Time of Overcurrent Unit Module.

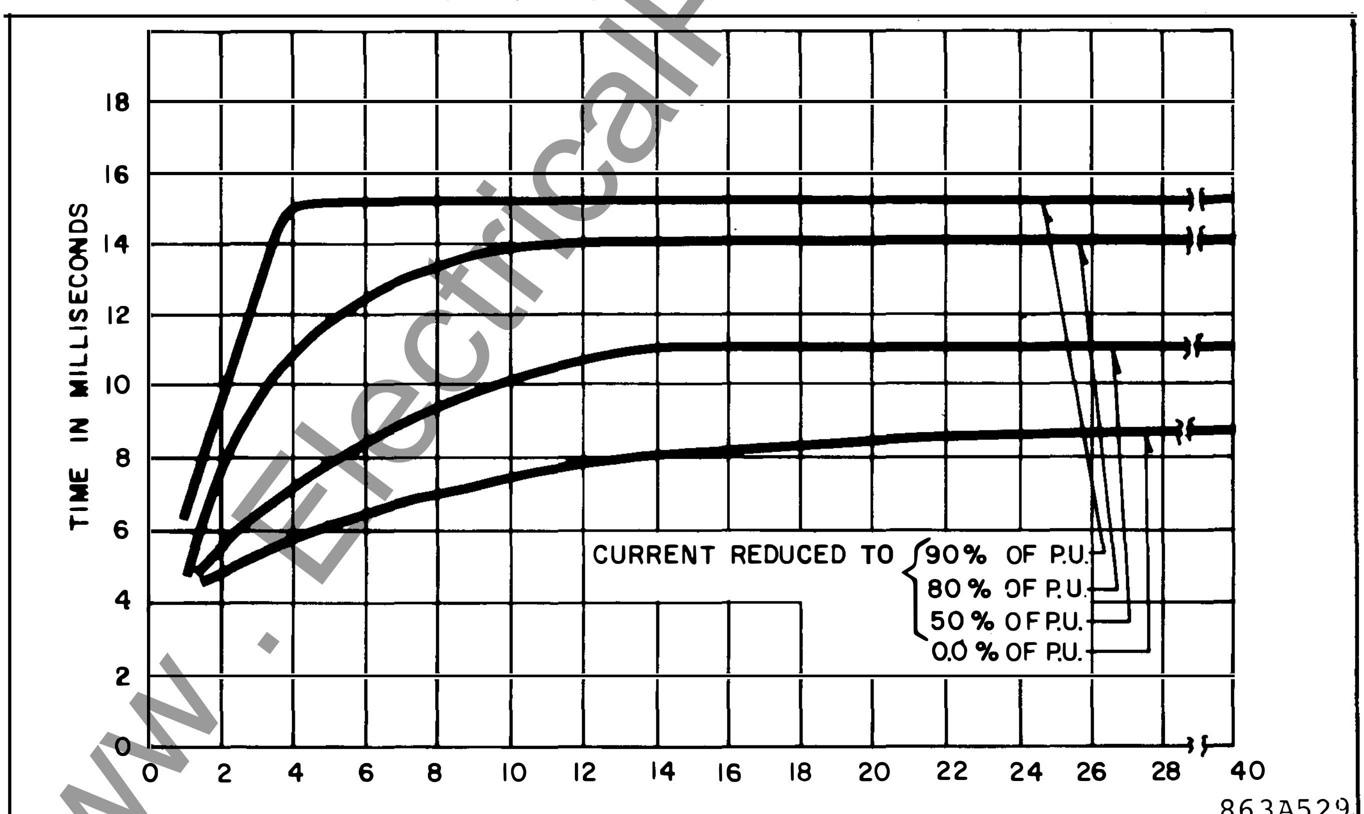
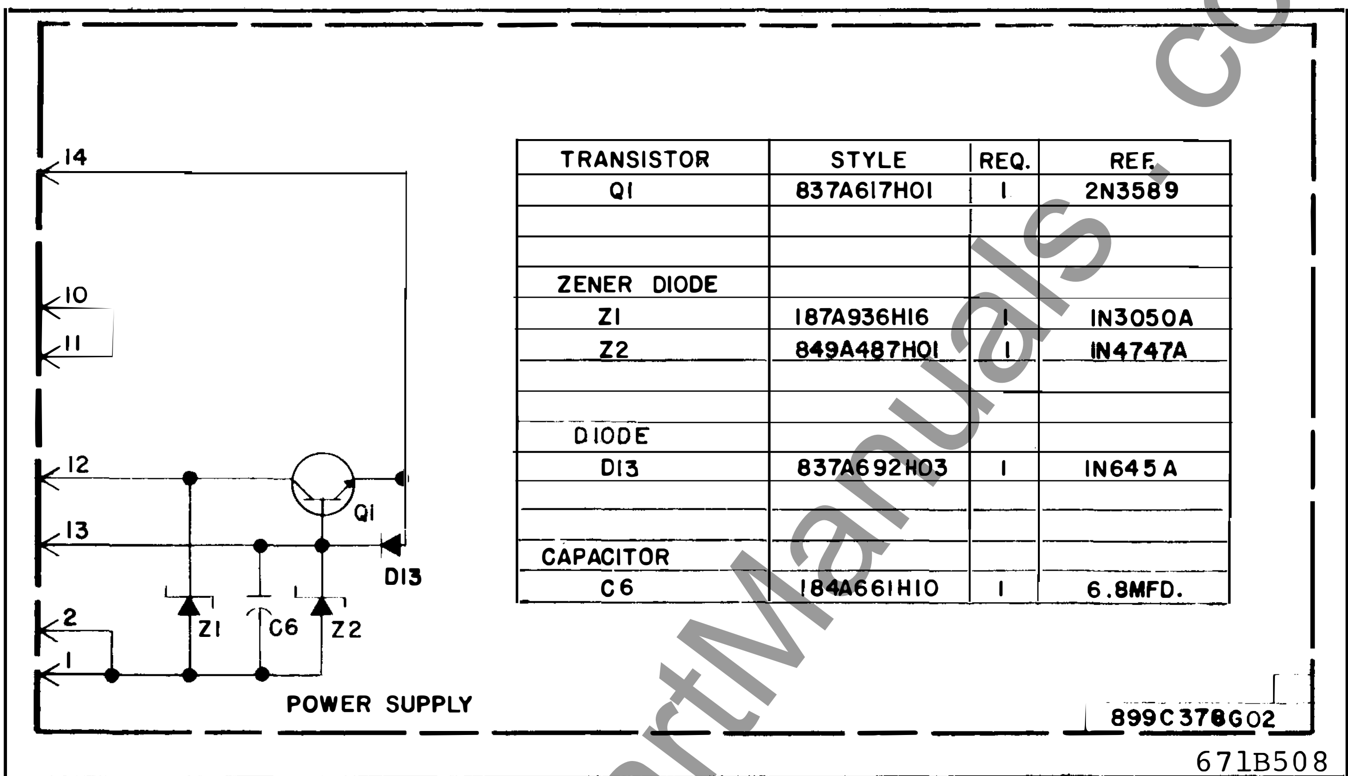


Fig. 4 Reset Time Curve of Overcurrent Unit.



TRANSISTOR	STYLE	REQ.	REF.
Q1	837A617H01	1	2N3589
ZENER DIODE			
Z1	187A936H16	1	1N3050A
Z2	849A487H01	1	1N4747A
DIODE			
D13	837A692H03	1	1N645A
CAPACITOR			
C6	184A661H10	1	6.8MFD.

Fig. 5 Power Supply Module Internal Schematic Dwg.

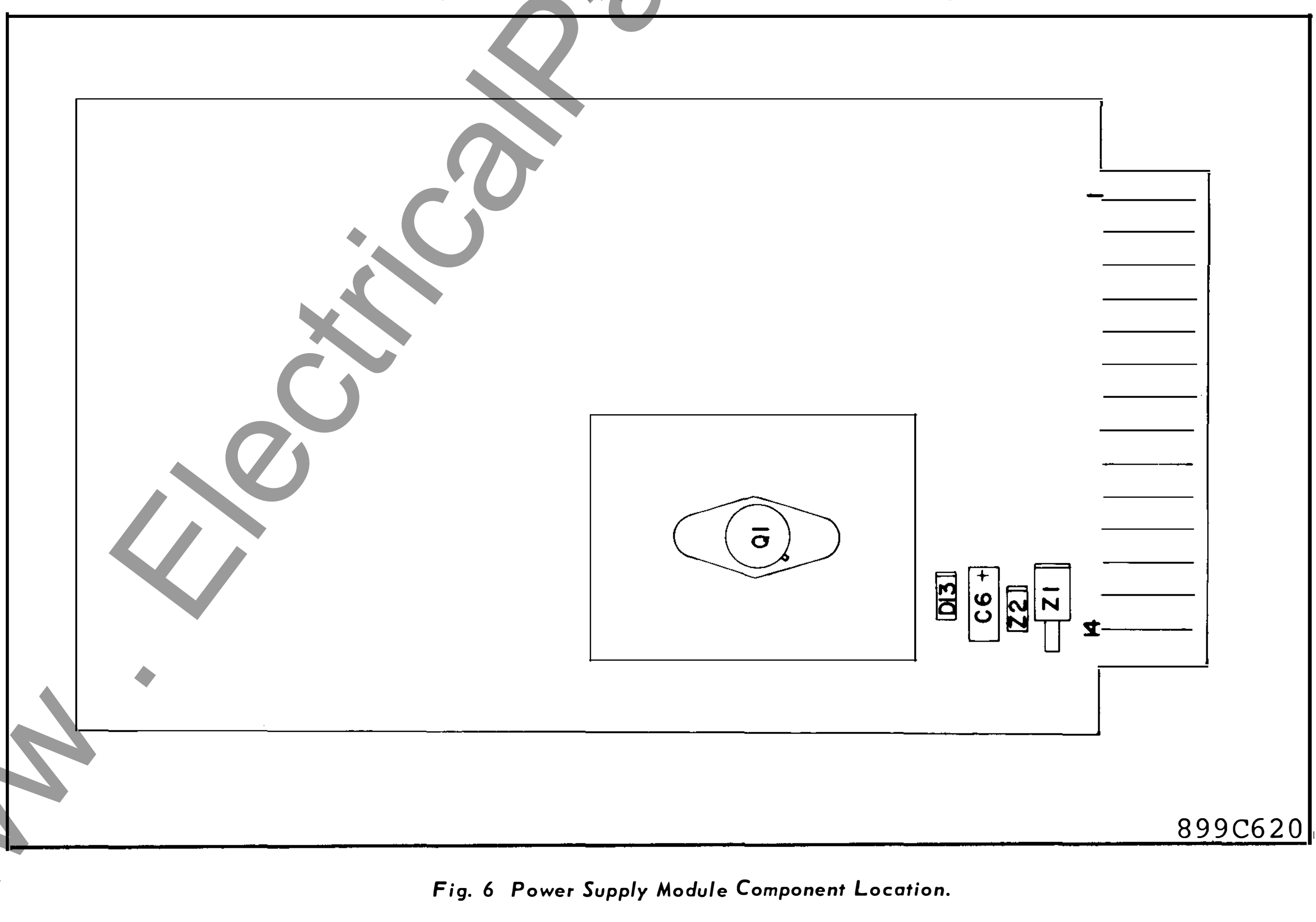
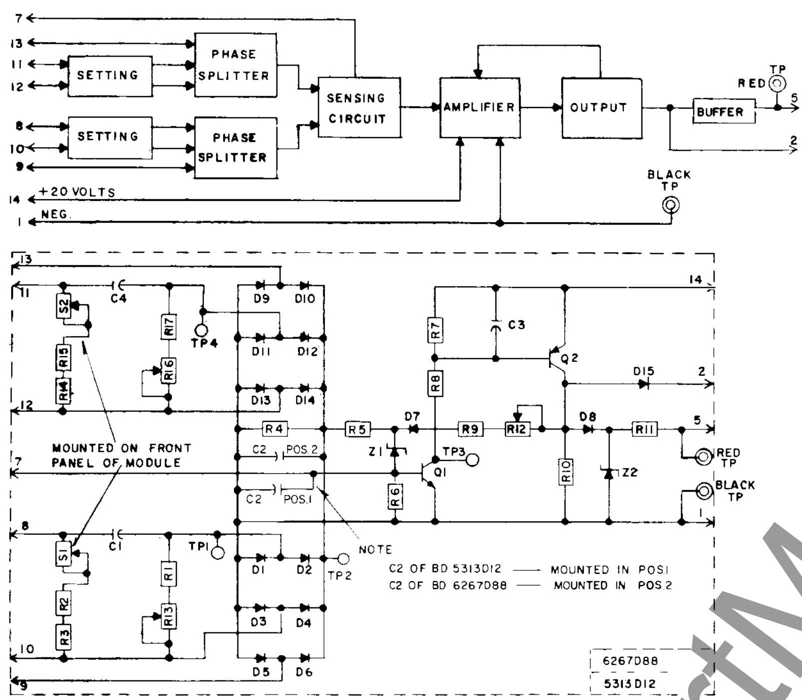


Fig. 6 Power Supply Module Component Location.

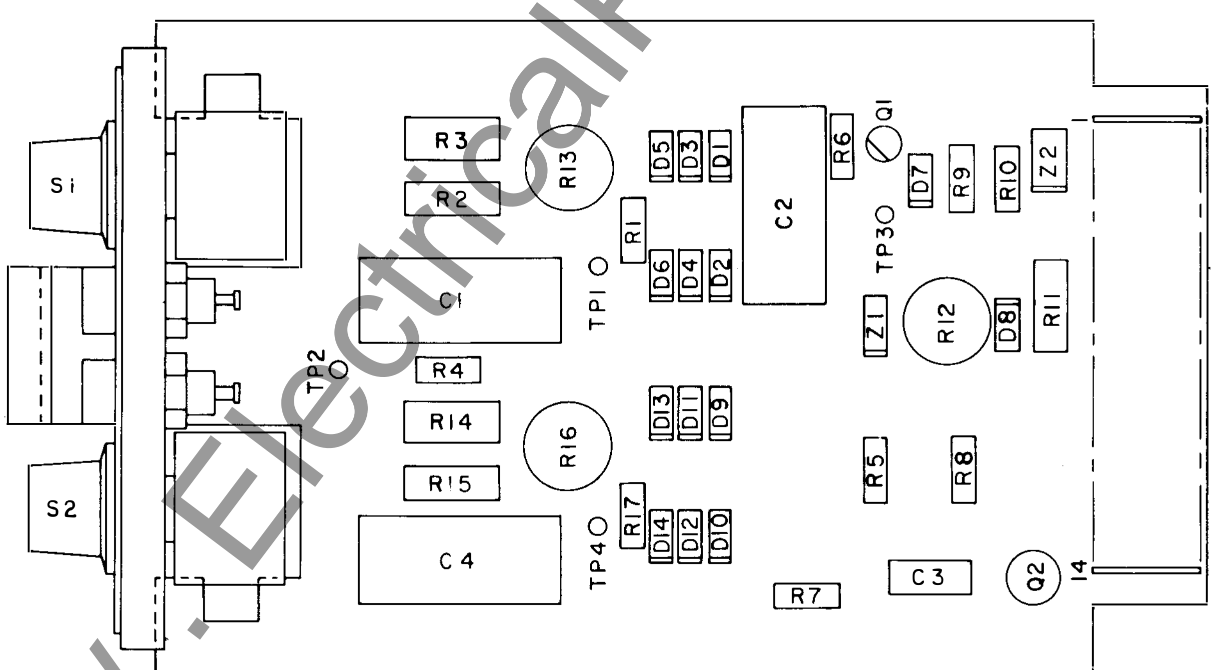


CAPACITOR	STYLE	REQ	REF.
C1-C2-C4	187A624H11	3	0.5 MFD
C3	187A506H09	1	1.5 MFD
DIODE			
D1 TO D7 - D9 TO D14	184A855H07	13	IN457A
D8-D15	837A692H03	2	IN645A
POTENTIOMETER			
S1-S2	836A635H07	2	5K-12-1/2W
R13-R16	629A430H03	2	2.5K-1/4W
R12	629A430H05	1	200K-1/4W
* RESISTOR			
R1-R17	629A531H42	2	2.7K
R2-R3-R14-R15	762A679H02	4	330Ω-3W
R11	762A679H01	1	150Ω-3W
R4	629A531H78	1	82K
R5-R6-R7	629A531H56	2	10K
R8	629A531H52	1	6.8K
R9	184A763H81	1	180K
R10	629A531H78	1	82K
TRANSISTOR			
Q1	848A851H02	1	2N3417
Q2	849A441H01	1	2N3645
ZENER DIODE			
Z1	186A797H06	1	IN957B
Z2	862A288H01	1	IN3688A

* = RESISTORS TO BE 1/2 WATT ±2% UNLESS OTHERWISE SPECIFIED

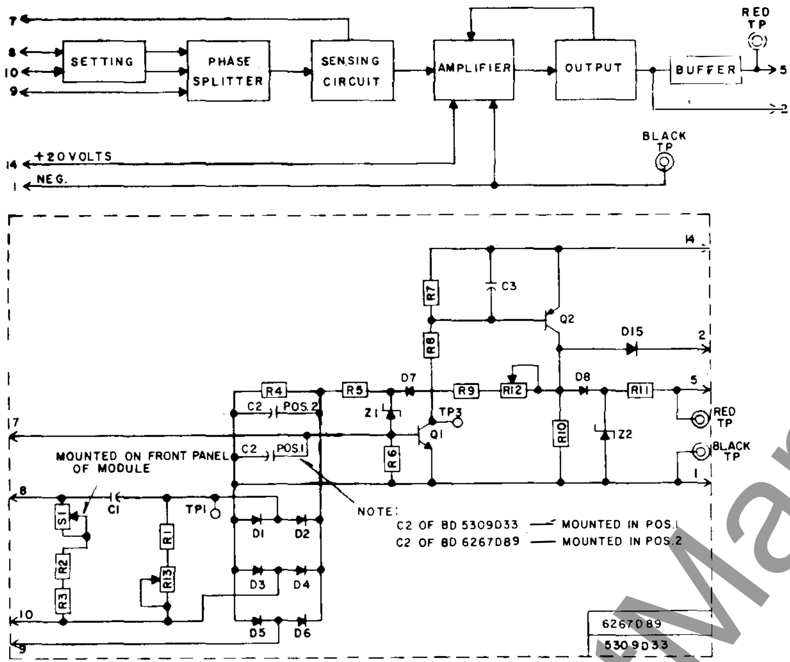
671B945

Fig. 7 Phase Overcurrent Module Internal Schematic Dwg.



671B961

Fig. 8 Phase Overcurrent Module Component Location.

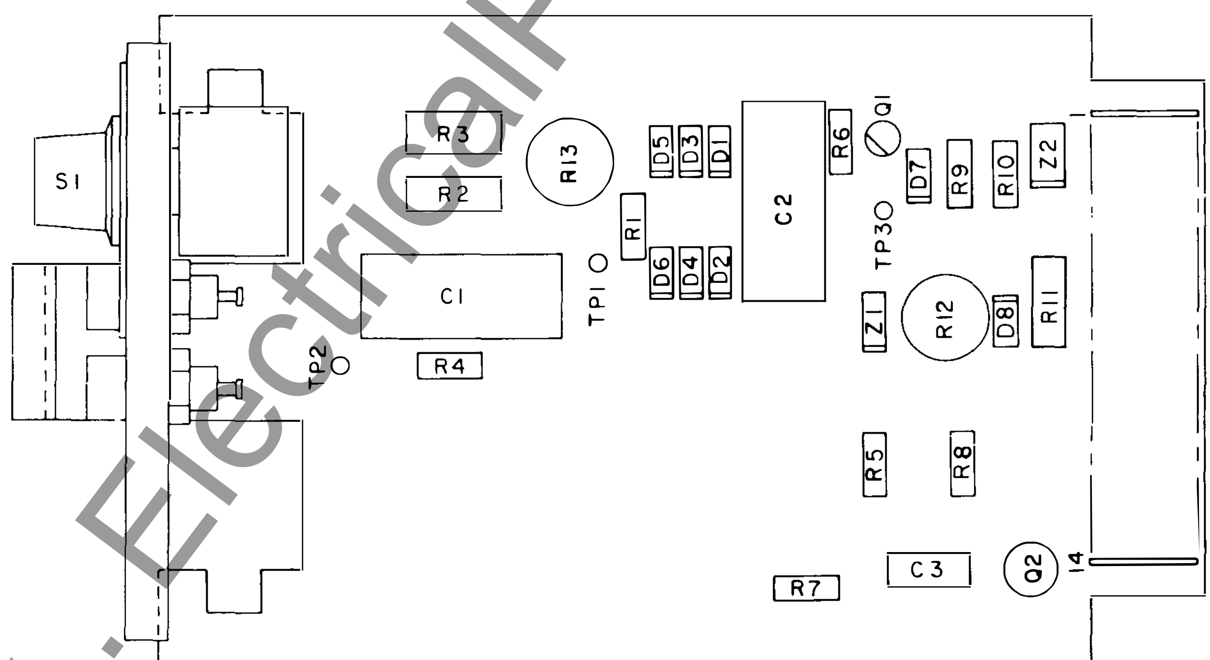


CAPACITOR	STYLE	REQ	REF.
C1 - C2	187A624H11	2	0.5 MFD
C3	187A508H09	1	1.5 MFD.
DIODE			
D1 TO D7	184A855H07	7	1N457A
D8 - D15	837A692H03	2	1N 645A
POTENTIOMETER			
S1	836A635H07	1	5K-12 1/2 W
R13	629A430H03	1	2.5K-1/4W
R12	629A430H05	1	200K-1/4W
* RESISTOR			
R1	629A531H42	1	2.7K
R2-R3	762A679H02	2	330Ω - 3 W
R11	762A679H01	1	50Ω - 3W
R4	629A531H78	1	82K
R5-R6-R7	629A531H56	2	10 K
R8	629A531H52	1	6.8K
R9	184A763H81	1	180K
R10	629A531H78	1	82 K
TRANSISTOR			
Q1	848A851H02	1	2N3417
Q2	849A441H01	1	2N3645
ZENER DIODE			
Z1	186A797H06	1	1N957B
Z2	862A288H01	1	1N3688A

* = RESISTORS TO BE 1/2 WATT ± 2% UNLESS OTHERWISE SPECIFIED

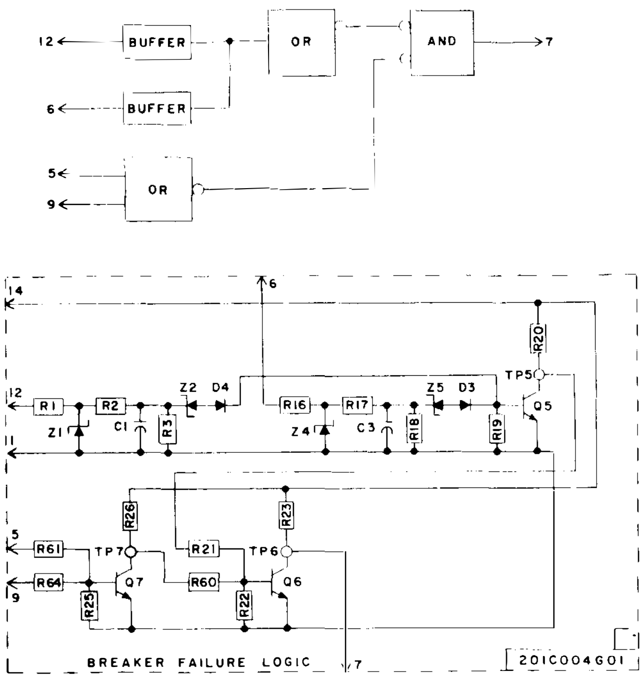
671B960

Fig. 9 Ground Overcurrent Module Internal Schematic Dwg.



671B962

Fig. 10 Ground Overcurrent Module Component Location.

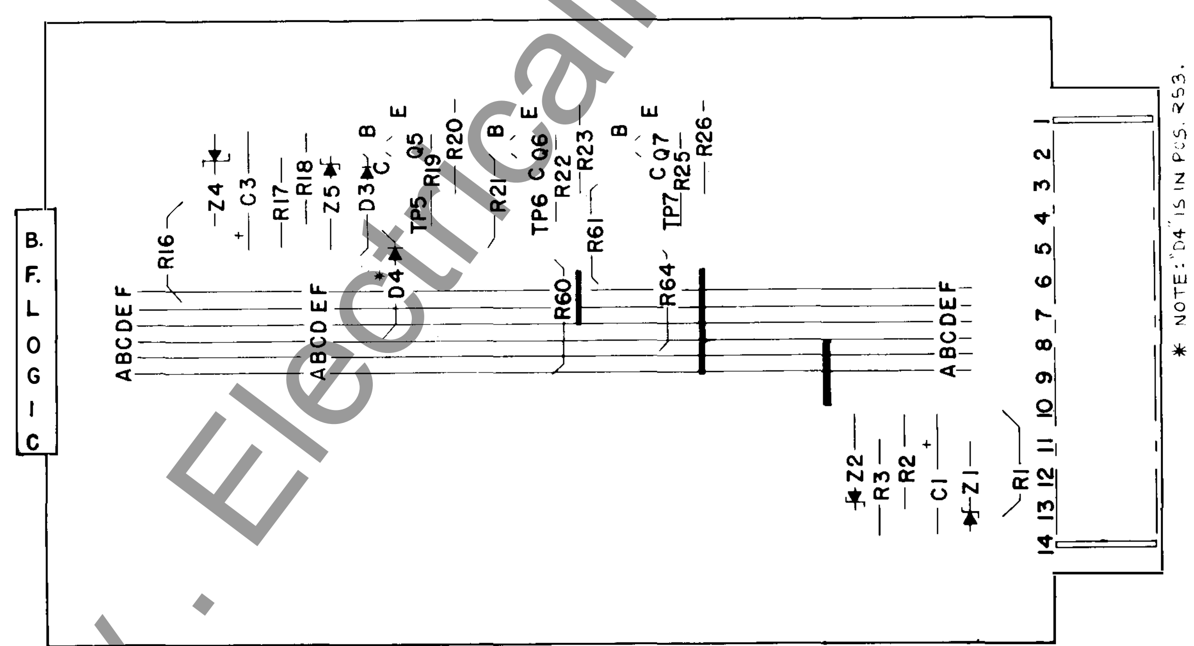


CAPACITOR	STYLE	REQ.	REF
C1 – C3	849A437H04	2	.047 MFD.
DIODE			
D3 – D4	837A692H03	2	IN645A
* RESISTOR			
R2 – R17	629A531H48	2	4.7K
R3 – R18	629A531H78	2	82 K
R19 – R22 – R25	629A531H56	3	10K
R20 – R23 – R26	629A531H52	3	6.8K
R21 – R60 – R61 – R64	629A531H66	4	27 K
R1 – R16	629A531H72	2	47K
TRANSISTOR			
Q5 – Q6 – Q7	848A851H02	3	IN3417
ZENER DIODE			
Z1 – Z4	185A212H06	2	IN3686B
Z2 – Z5	186A797H06	2	IN957B

*= RESISTORS TO BE 1/2 WATT-±2% UNLESS OTHERWISE SPECIFIED.

691B004

Fig. 11 Breaker Failure Logic Module.



691B005

Fig. 12 Breaker Failure Logic Module Component Location.

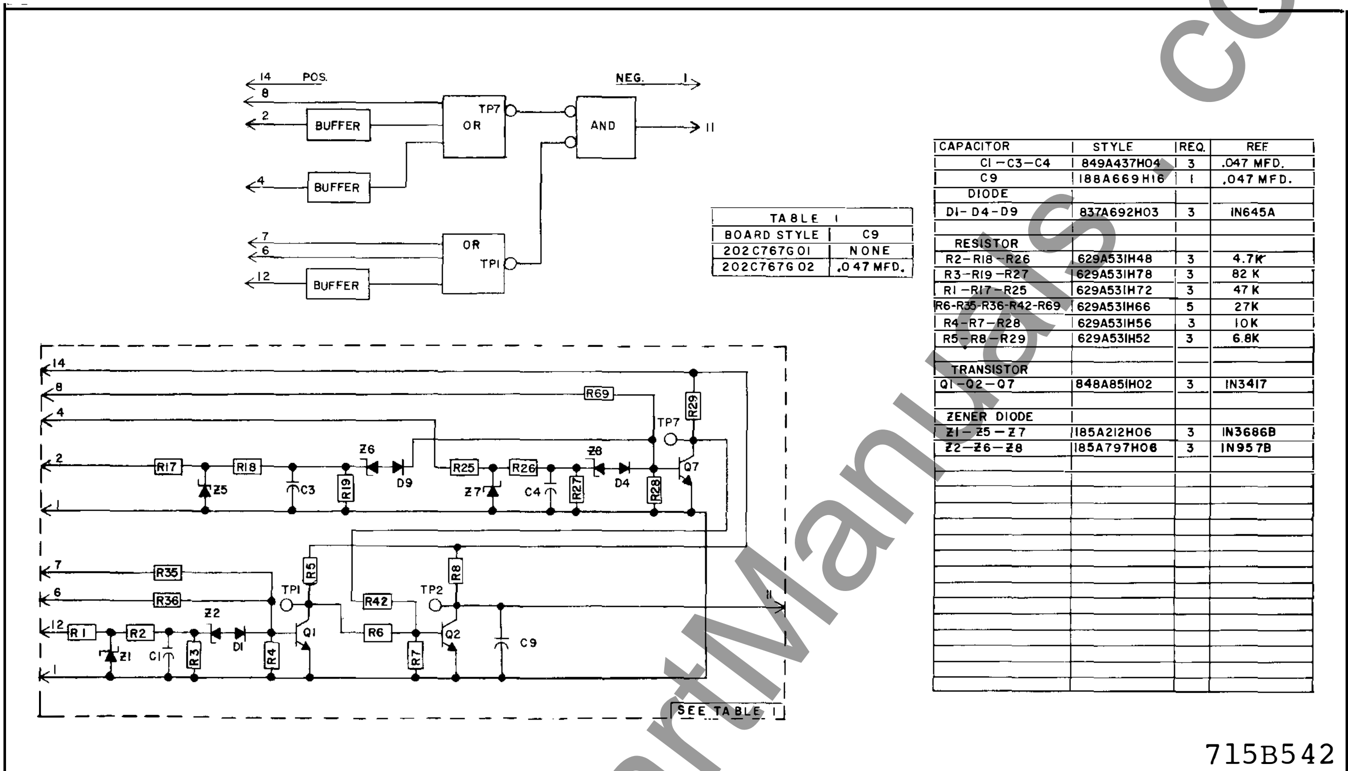


TABLE 1	
BOARD STYLE	C9
202C767G01	NONE
202C767G02	.047 MFD.

CAPACITOR	STYLE	REQ.	REF
C1-C3-C4	849A437H04	3	.047 MFD.
C9	188A669H16	1	.047 MFD.
DIODE			
D1-D4-D9	837A692H03	3	IN645A
RESISTOR			
R2-R18-R26	629A531H48	3	4.7K
R3-R19-R27	629A531H78	3	82 K
R1-R17-R25	629A531H72	3	47 K
R6-R35-R36-R42-R69	629A531H66	5	27K
R4-R7-R28	629A531H56	3	10K
R5-R8-R29	629A531H52	3	6.8K
TRANSISTOR			
Q1-Q2-Q7	848A851H02	3	IN3417
ZENER DIODE			
Z1-Z5-Z7	185A212H06	3	IN3686B
Z2-Z6-Z8	185A797H06	3	IN957B

Fig. 13 Breaker Failure Logic with Provision for 52a Contact Input and Seal-In.

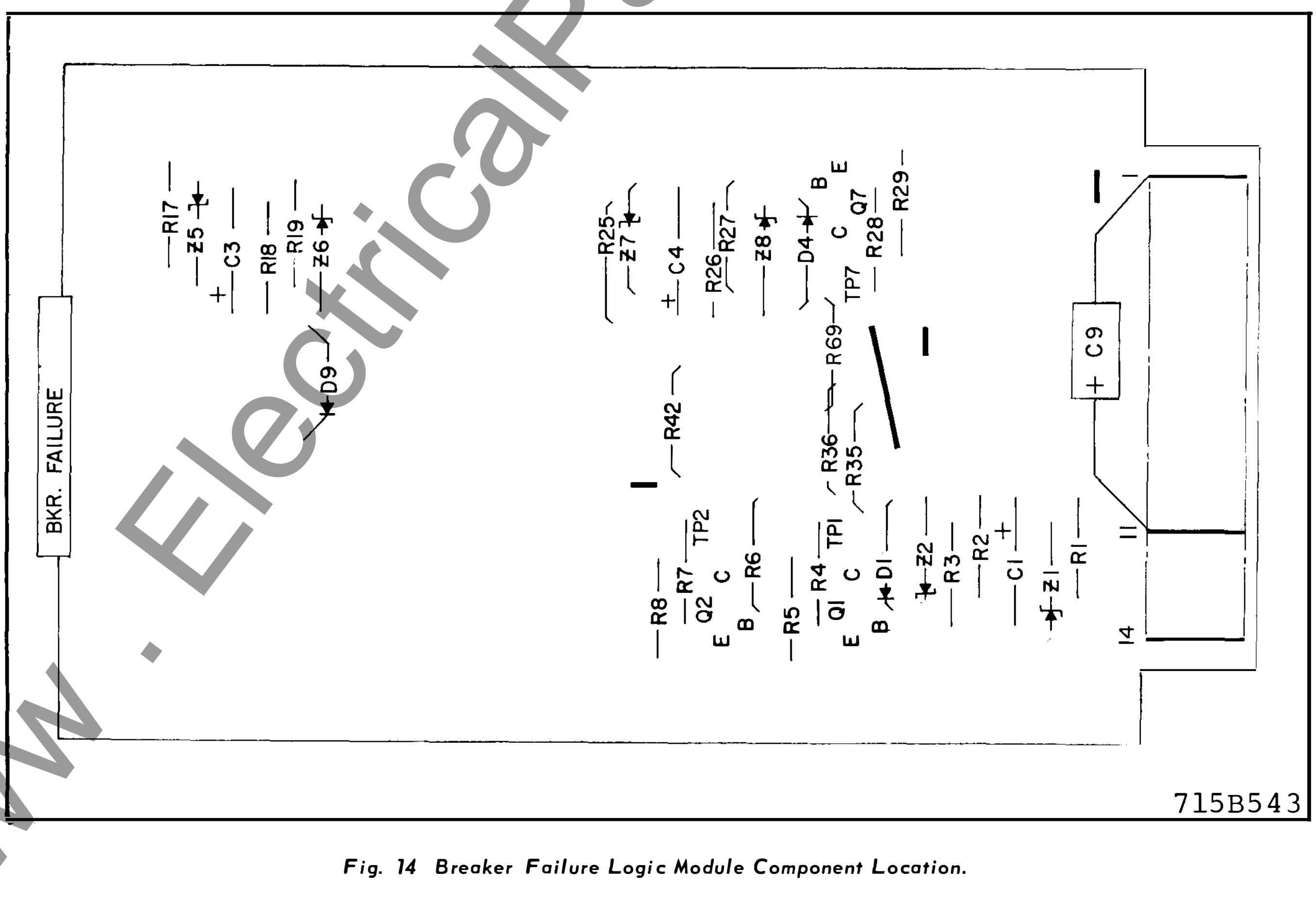


Fig. 14 Breaker Failure Logic Module Component Location.

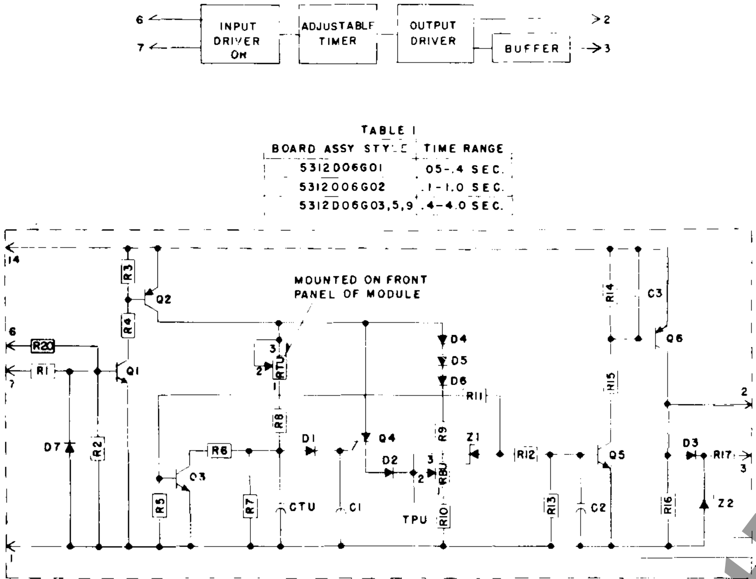


TABLE I

BOARD ASSY STYLE	TIME RANGE
5312D06G01	.05-.4 SEC.
5312D06G02	.1-1.0 SEC.
5312D06G03,5,9	.4-4.0 SEC.

SINGLE TIMER BOARD FOR RACK MOUNTED RELAY

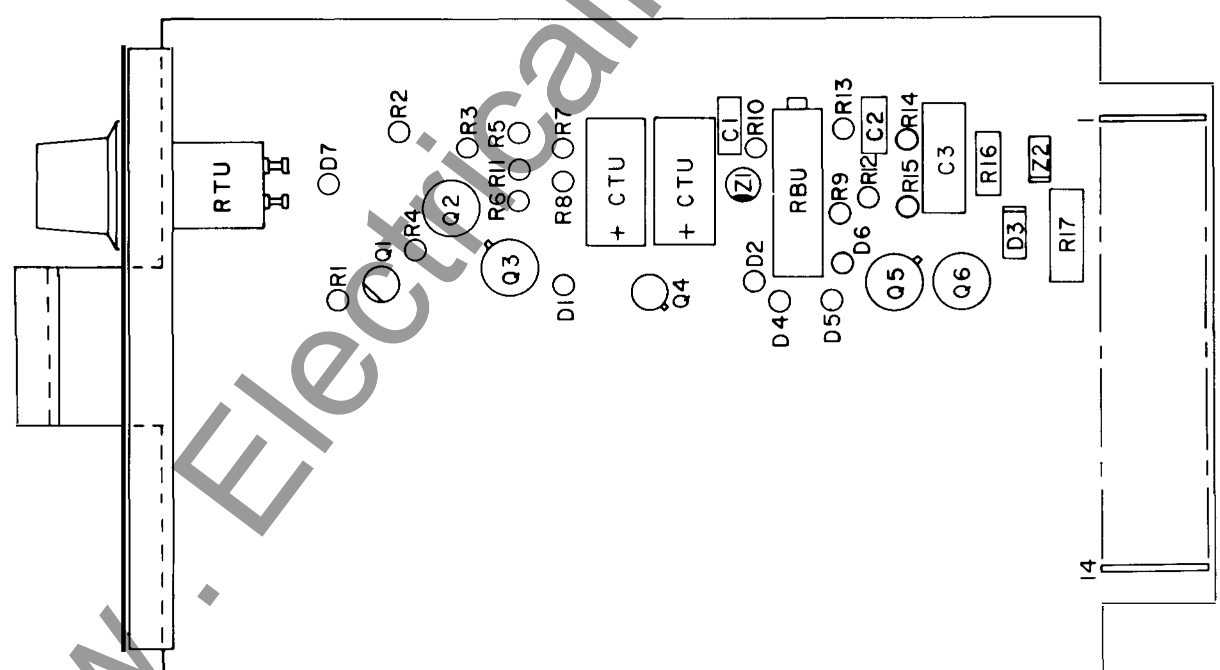
CAPACITOR	TIME RANGE	STYLE	REQ	REF
C1 C2	–	184A663H01	2	.01 MFD.
C3	–	188A669H05	1	27 MFD
CTU	.05-.4 SEC.	187A508H17	1	22 MFD.
CTU	.1-1.0 SEC	187A508H15	1	27 MFD.
CTU	.4-4.0 SEC.	187A508H15	2	27 MFD.
DIODE				
D1-D2-D4-D5-D6	–	184A855H08	5	1N459A
D7	–	184A855H08	1	1N459A
D3	–	837A692H03	1	1N645A
* RESISTOR				
R1-R16-R20	–	629A531H66	3	27K
R2-R3-R14	–	629A531H56	3	10K
R4-R15	–	629A531H52	2	6.8 K
R5-R13	–	629A531H50	2	5.6 K
R6	–	187A290H29	1	51Ω 1/2W ± 5%
R7	–	184A763H92	1	A
R8	.05-.4 SEC.	629A531H39	1	2K
R8	.1-1.0 SEC.	629A531H46	1	3.9 K
R8	.4-4.0 SEC.	629A531H51	1	6.2 K
R9-R10	–	629A531H36	2	1.5 K
R11-R12	–	629A531H32	2	1K
R17	–	762A679H01	1	150Ω 3W
POTENTIOMETER				
RBU	–	862A406H01	1	2K-5W-±10%
RTU	.05-.4 SEC.	862A303H02	1	25K-1.75W-±5%
RTU	.1-1.0 SEC.	862A303H01	1	50K-1.75W-±5%
RTU	.4-4.0 SEC.	862A303H03	1	100K-1.75W-±5%
THYRISTOR				
Q4	–	185A117H02	1	2N885
TRANSISTOR				
Q1	–	848A851H02	1	2N3417
Q2-Q6	–	849A441H01	2	2N3645
Q3-Q5	–	184A638H18	2	2N697
ZENER DIODE				
Z1	–	184A639H11	1	1N1315A
Z2	–	862A288H01	1	1N3688A

* = RESISTORS TO BE 1/2 WATT - ± 2% UNLESS OTHERWISE SPECIFIED
A = 51MEG - 1/2W - ± 5%.

SEE TABLE I FOR BOARD ASSY. STYLE

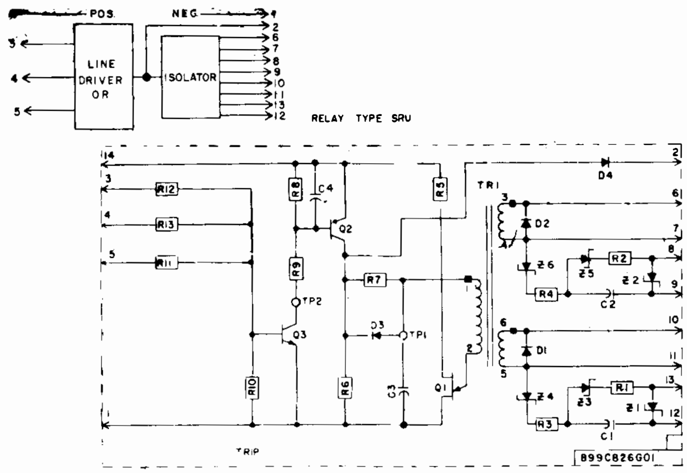
691B031

Fig. 15 Timer Module Internal Schematic.



691B032

Fig. 16 Timer Module Component Location.



CAPACITOR	STYLE	REQ.	REF.
C1-C2	187A624H05	2	2 MFD.
C3 C4	188A669H05	2	.27MFD.
DIODE			
D1 TO D4	837A692H03	4	1N645A
RESISTOR *			
R1 TO R4	187A643H19	4	470Ω-1W ±5%
R5	629A531H19	1	300Ω
R6	629A531H60	1	15K
R7	629A531H48	1	4.7K
R9	629A531H52	1	6.8K
R10 - R8	629A531H56	2	10K
R11 TO R13	629A531H66	3	27K
TRANSFORMER			
TR1	629A372H01	1	FD505
TRANSISTOR			
Q1	629A435H02	1	4JX5E695
Q2	849A441H01	1	2N3645
Q3	848A351H02	1	2N3417
ZENER DIODE			
Z3 TO Z6	629A369H01	4	1R200
[illegible]	[illegible]	2	[illegible]

*: ALL RESISTORS TO BE 1/2 WATT ± 2% UNLESS OTHERWISE SPECIFIED.

REF COMPONENT LOC 671B953

671B903

Fig. 17 Trip Module for Thyristor Output Internal Schematic.

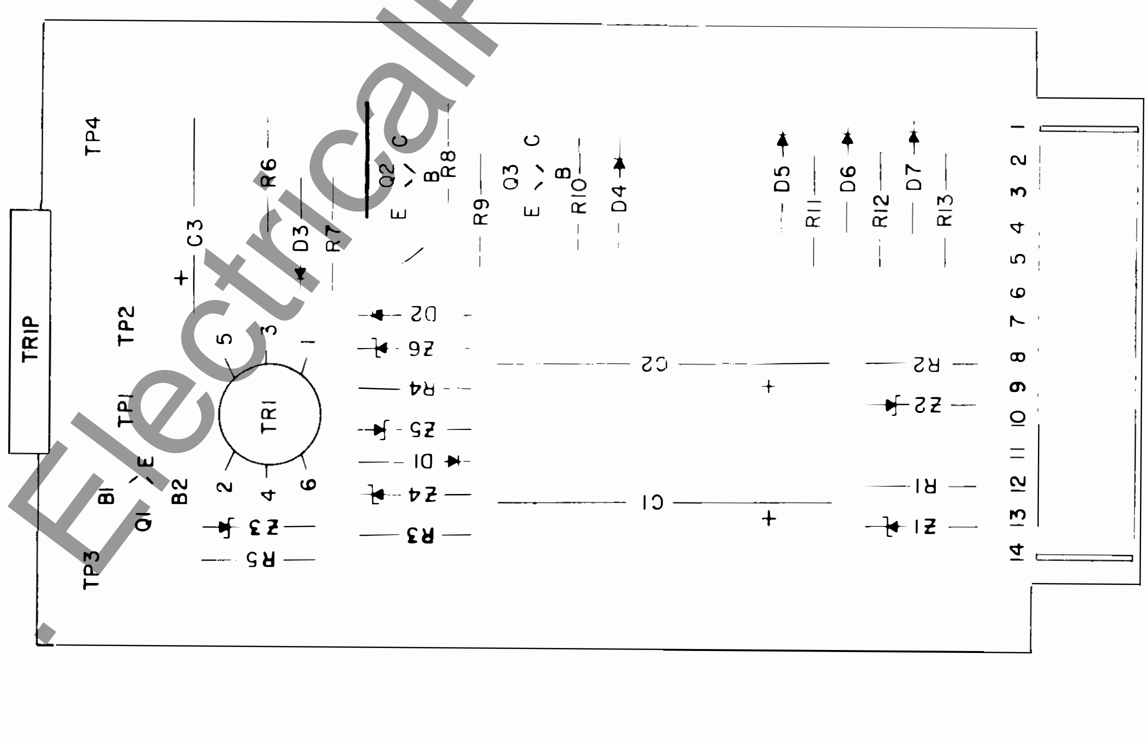
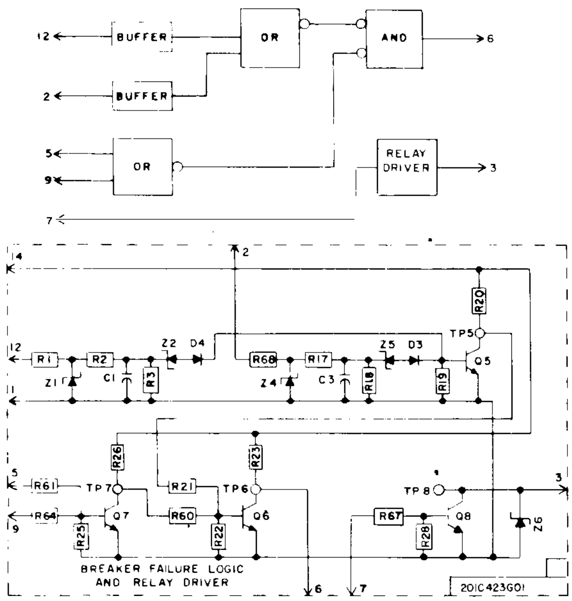


Fig. 18 Trip Module Component Location Drawing.

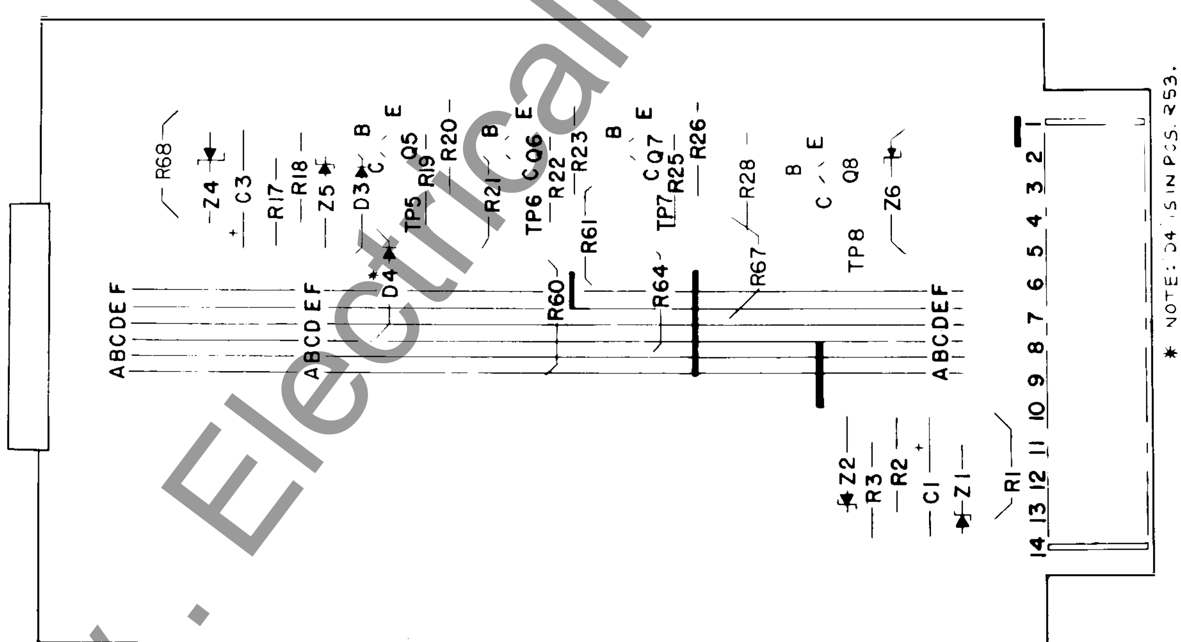


CAPACITOR	STYLE	REQ.	REF.
C1 - C3	849A437H04	2	.047 MFD.
DIODE			
D3 - D4	837A692H03	2	1N645A
* RESISTOR			
R2-R17	629A531H48	2	4.7K
R3-R18	629A531H78	2	82 K
R19-R22-R25-R28	629A531H56	4	10K
R20-R23-R26-R67	629A531H52	4	6.8K
R21-R60-R61-R64	629A531H66	4	27 K
R1-R68	629A531H72	2	47K
TRANSISTOR			
Q5-Q6-Q7	848A851H02	3	1N3417
Q8	837A617H01	1	2N3589
ZENER DIODE			
Z1 - Z4	185A212H06	2	1N3686B
Z2 - Z5	186A797H06	2	1N957B
Z6	187A936H17	1	1N3050B

*-RESISTORS TO BE 1/2 WATT-±2% UNLESS OTHERWISE SPECIFIED.

691B419

Fig. 19 Breaker Failure Logic and Relay Driver Module Internal Schematic.



691B420

Fig. 20. Breaker Failure Logic and Relay Driver Module Component Location Drawing.

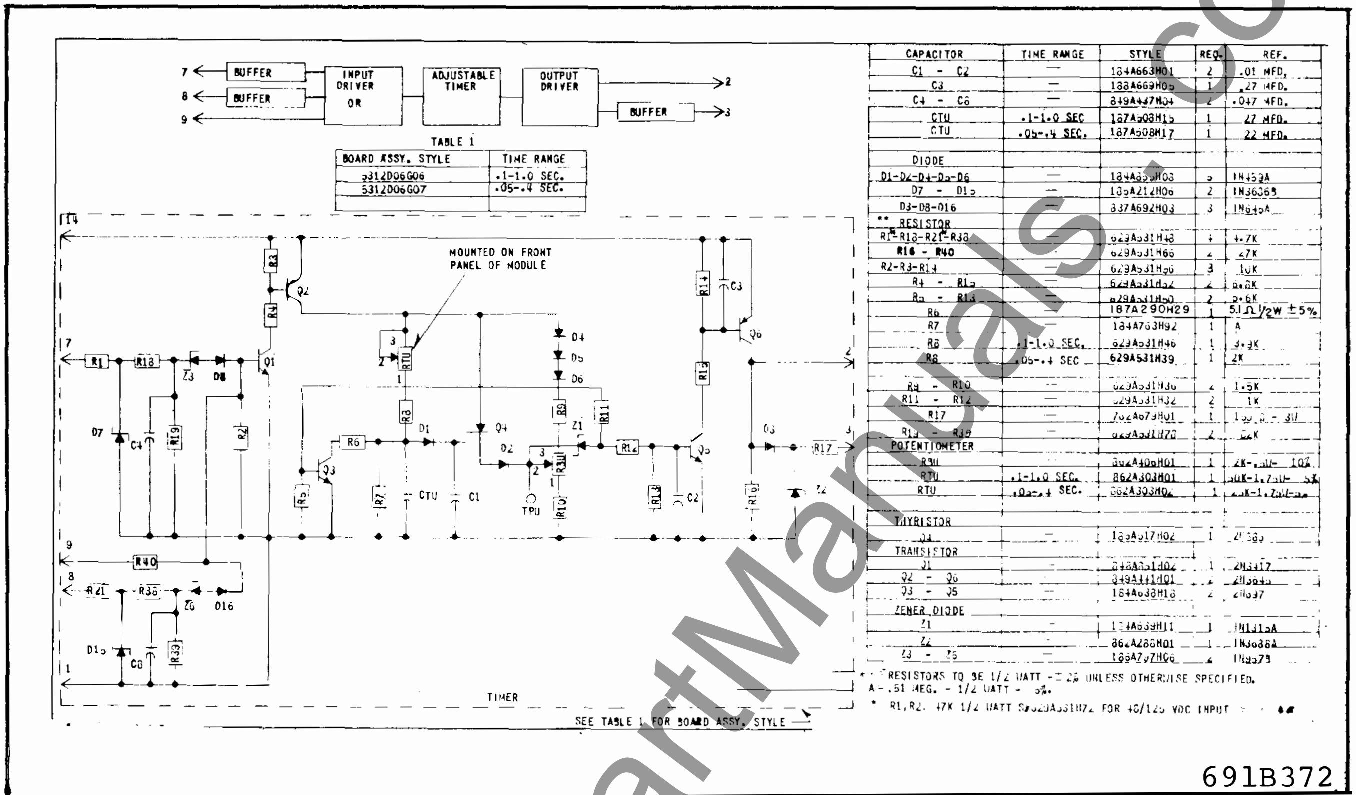


Fig. 21 Three Input Timer Module Internal Schematic.

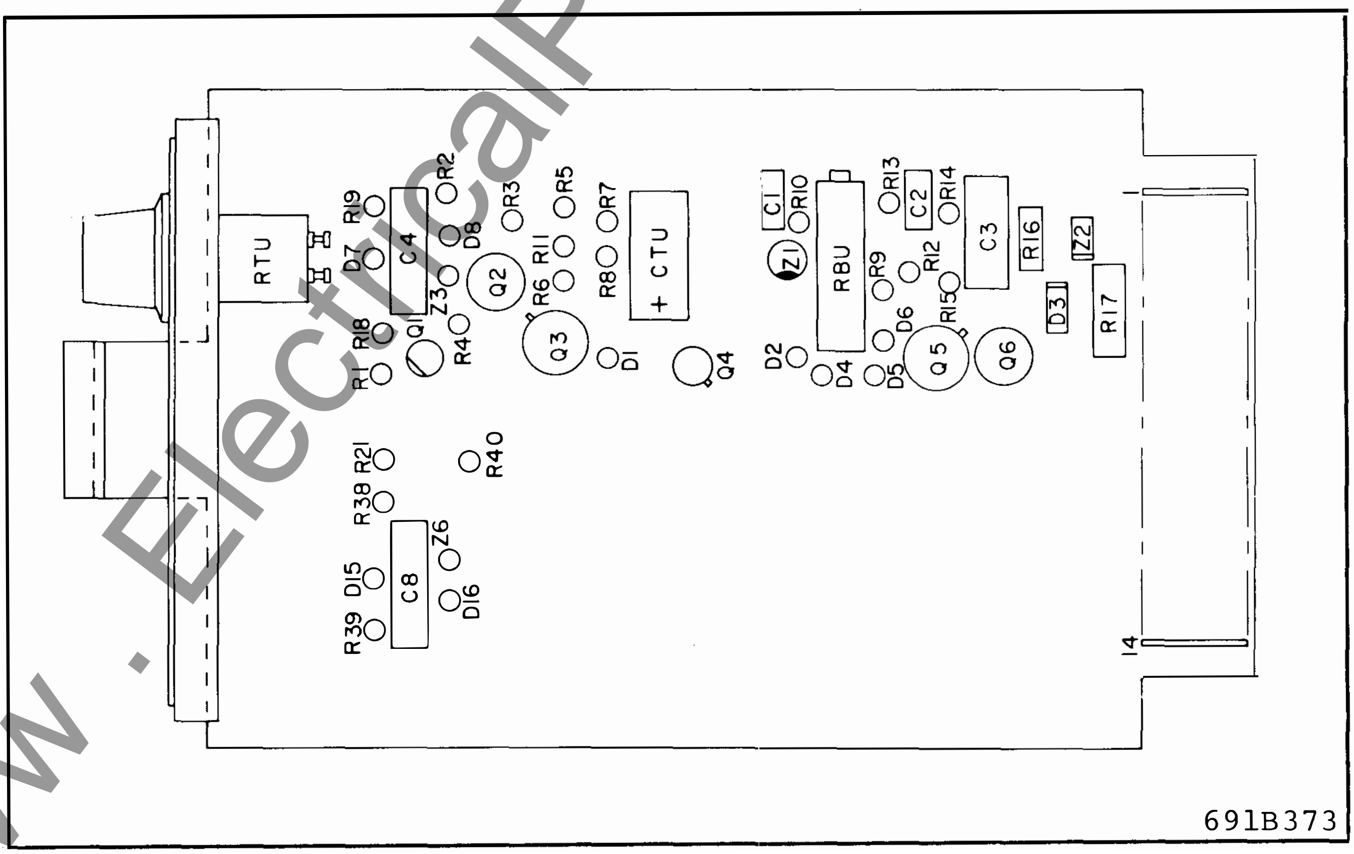
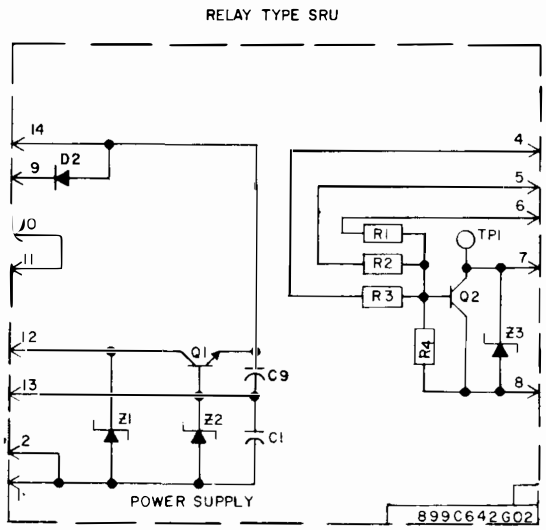


Fig. 22 Three Input Timer Module Component Location Drawing.

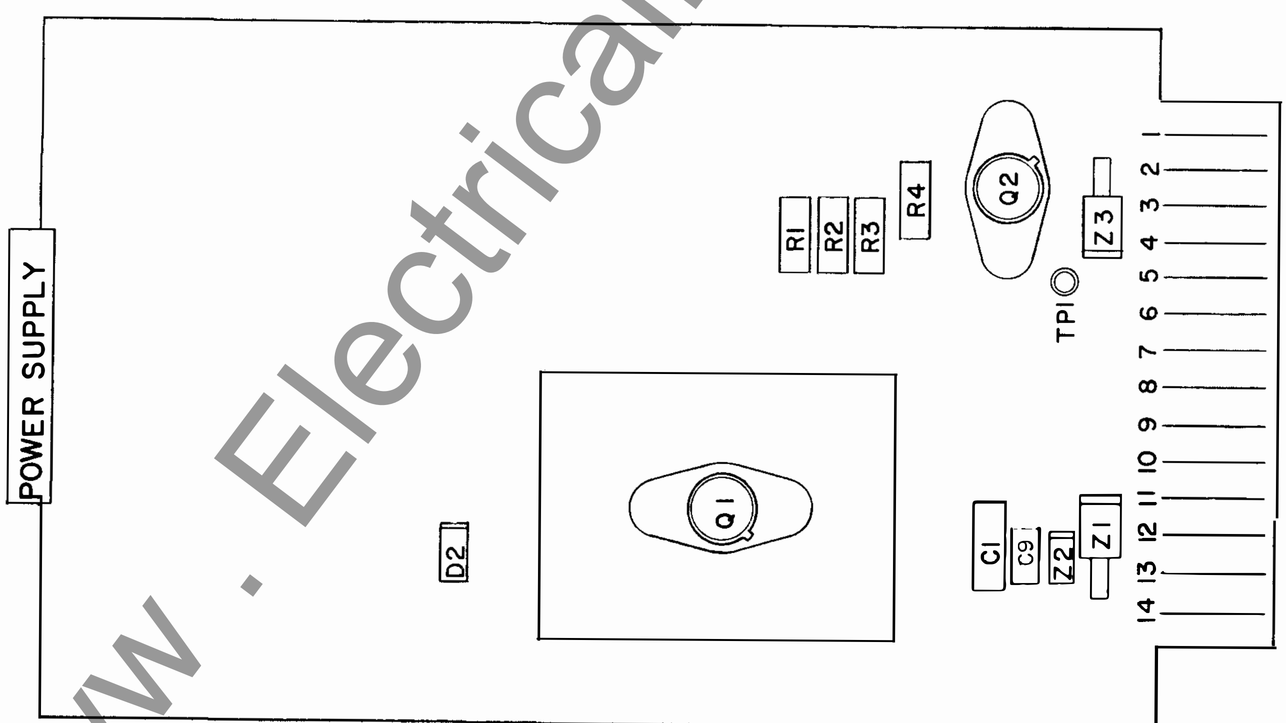


CAPACITOR	STYLE	REQ.	REF.
C1	184A661H10	1	6.8MFD.
C9	188A669H03	1	.1 MFD
DIODE			
D2	837A692H03	1	IN645A
RESISTOR *			
R1-R2-R3	629A531H39	3	2 K
R4	629A531H56	1	10 K
TRANSISTOR			
Q1—Q2	837A617H01	2	2N3589
ZENER DIODE			
Z1 - Z3	187A936H17	2	IN3050B
Z2	849A487H01	1	IN4747A

* = RESISTORS TO BE 1/2W ± 2% UNLESS OTHERWISE SPECIFIED.

691B215

Fig. 23 Power Supply and Relay Driver.



899C663

Fig. 24 Power Supply and Relay Driver Module Component Location.

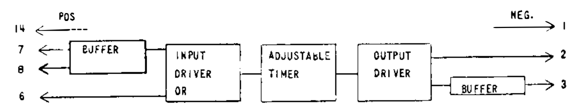
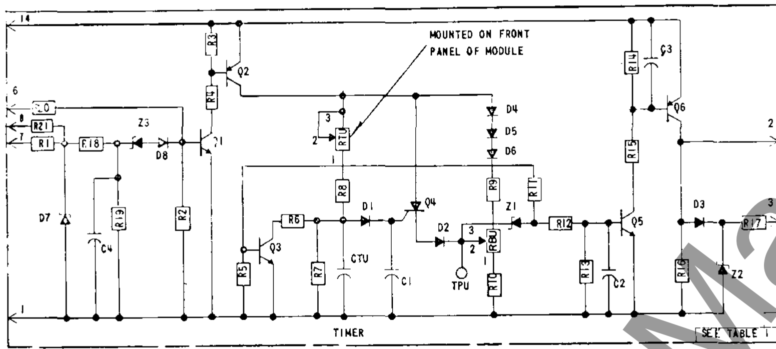


TABLE I

BOARD ASS'Y STYLE	TIME RANGE	R19	INPUT	
			TERM. 7	TERM. 8
5312D06G15	.05 — .4 SEC.	82K (629A531H78)	38 TO 140V.	———
5312D06G16	.1 — 1.0 SEC.	82K (629A531H78)	38 TO 140V.	———
5312D06G18	.05 — .4 SEC.	6.2K (629A531H51)	100 TO 140V.	38 TO 60V.
5312D06G19	.1 — 1.0 SEC.	6.2K (629A531H51)	100 TO 140V.	38 TO 60V.

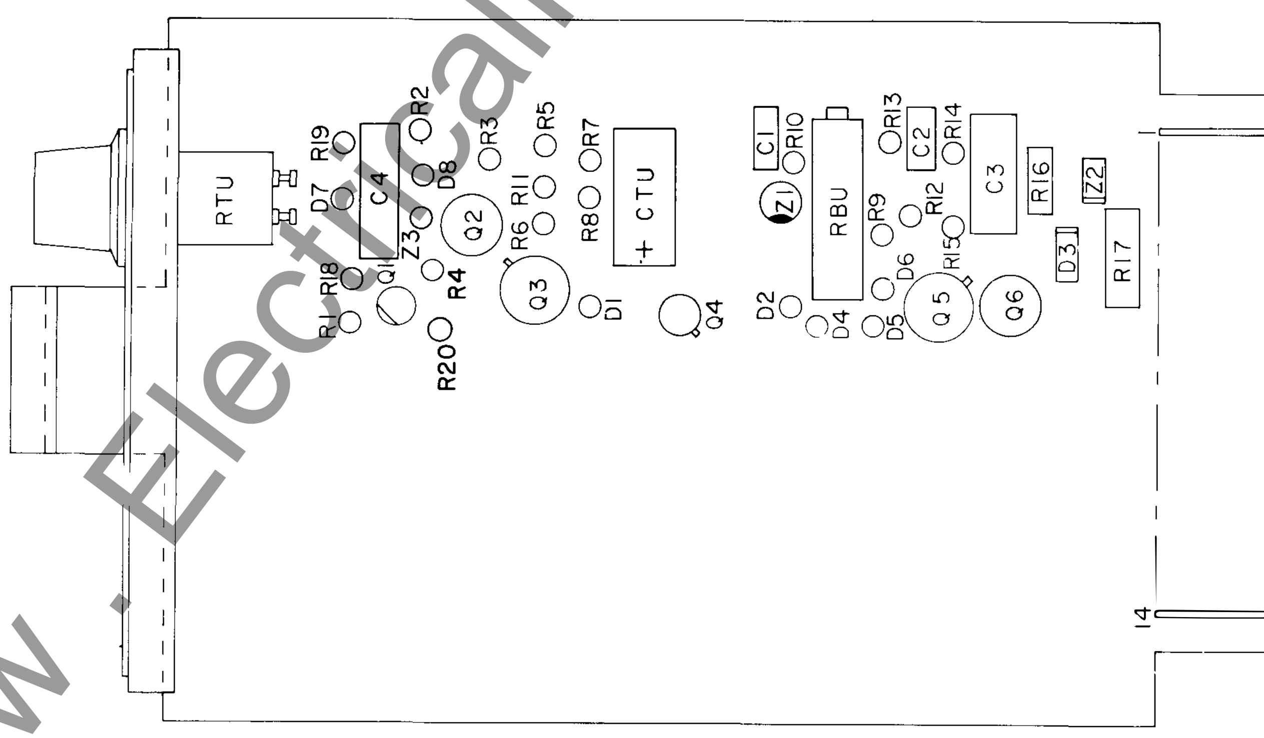


CAPACITOR	TIME RANGE	STYLE	REQ	REF.
C1-C2		184A663H01	2	.01 MFD
C3		188A669H05	1	.27 MFD
C4		849A437H04	1	.047 MFD
CTU	.05-.4 SEC.	184A661H16	1	22 MFD
CTU	.1 - 1.0 SEC.	187A508H15	1	27 MFD
DIODE				
D1-D2-D4-D5-D6		184A855H08	5	1N459A
D3-D8		837A692H03	2	1N645A
D7		185A212H06	1	1N3686 B
RESISTOR *				
R21		629A531H60	1	15K
R1		629A531H72	1	47K
R18		629A531H48	1	4.7K
R16-R20		629A531H66	2	27K
R2-R3-R14		629A531H56	3	10K
R4-R15		629A531H52	2	6.8K
R5-R13		629A531H50	2	5.6K
R6		187A290H29	1	5.1Ω 1/2W ±5
R7		184A763H92	1	A
R8	.05-.4 SEC.	629A531H39	1	2K
R9-R10		629A531H36	2	1.5K
R11-R12		629A531H32	2	1K
R17		762A679H01	1	150Ω - 3W
R19		SEE TABLE I	1	
R8	.1 - 1.0 SEC.	629A531H46	1	3.9K
POTENTIOMETER *				
RBU		862A406H01	1	2K-.5W ± 10 [illegible]
RTU	.05-.4 SEC	862A303H02	1	[illegible]
RTU	.1 - 1.0 SEC	862A303H01	1	50K-1.75W ±5%
THYRISTOR				
Q4		185A517H02	1	2N885
TRANSISTOR				
Q1		848A851H02	1	2N3417
Q2-Q6		849A441H01	2	2N3645
Q3-Q5		184A638H13	2	2N697
ZENER DIODE				
Z1		184A639H11	1	1N1315A
Z2		862A288H01	1	1N3688A
Z3		186A797H06	1	[illegible]

* = RESISTORS TO BE 1/2 WATT ± 2 % UNLESS OTHERWISE SPECIFIED
A = .51 MEG - 1/2 WATT ± 5%

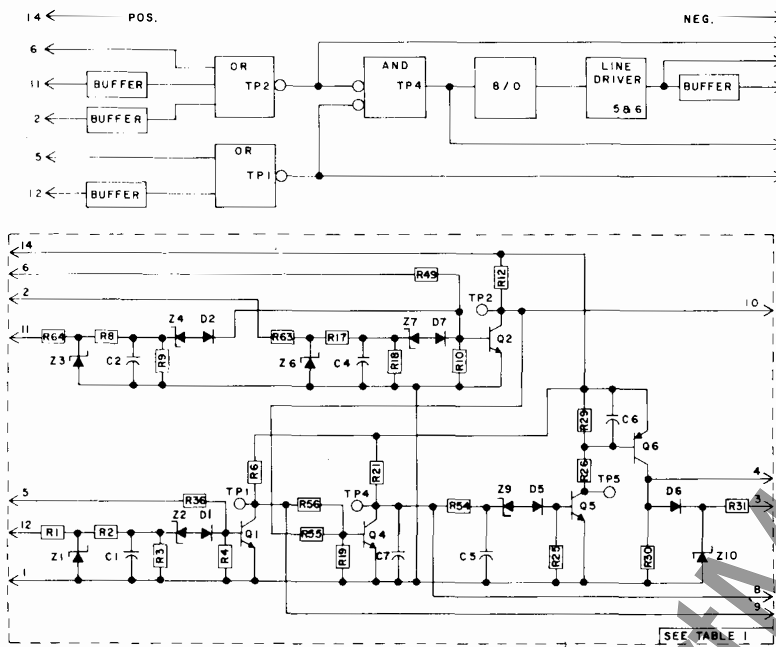
716B346

Fig. 25 Timer with High Input Threshold Voltage.



716B349

Fig. 26 Timer with High Input Threshold Voltage Module – Component Location.



CAPACITOR	STYLE	REQ.	REF.
C1-C2-C4-C7	849A437H04	4	.047 MFD.
C5	763A219H18	1	.56 MFD.
C6	188A669H05	1	.27 MFD.
DIODE			
D1-D2-D5-D6-D7	837A692H03	5	1N645A
RESISTOR ⊖			
R1-R63-R64	SEE TABLE 1	3	
R2-R8-R17	629A531H48	3	4.7 K
R3-R9-R18	629A531H51	3	6.2 K
R4-R10-R19-R25-			
R29	629A531H56	5	10 K
R6-R12-R26-R21	629A531H52	4	6.8 K
R36-R49-R54-			
R55-R56	629A531H66	5	27 K
R30	629A531H78	1	82 K
R31	762A679H01	1	150Ω·5%·3W
TRANSISTOR			
Q1-Q2-Q4-Q5	848A851H02	4	2N3417
Q6	849A441H01	1	2N3645
ZENER DIODE			
Z1-Z3-Z6	185A212H06	3	1N3686B
Z2-Z4-Z7	186A797H06	3	1N957B
Z9	837A693H06	1	1N705
Z10	862A288H01	1	1N3688A

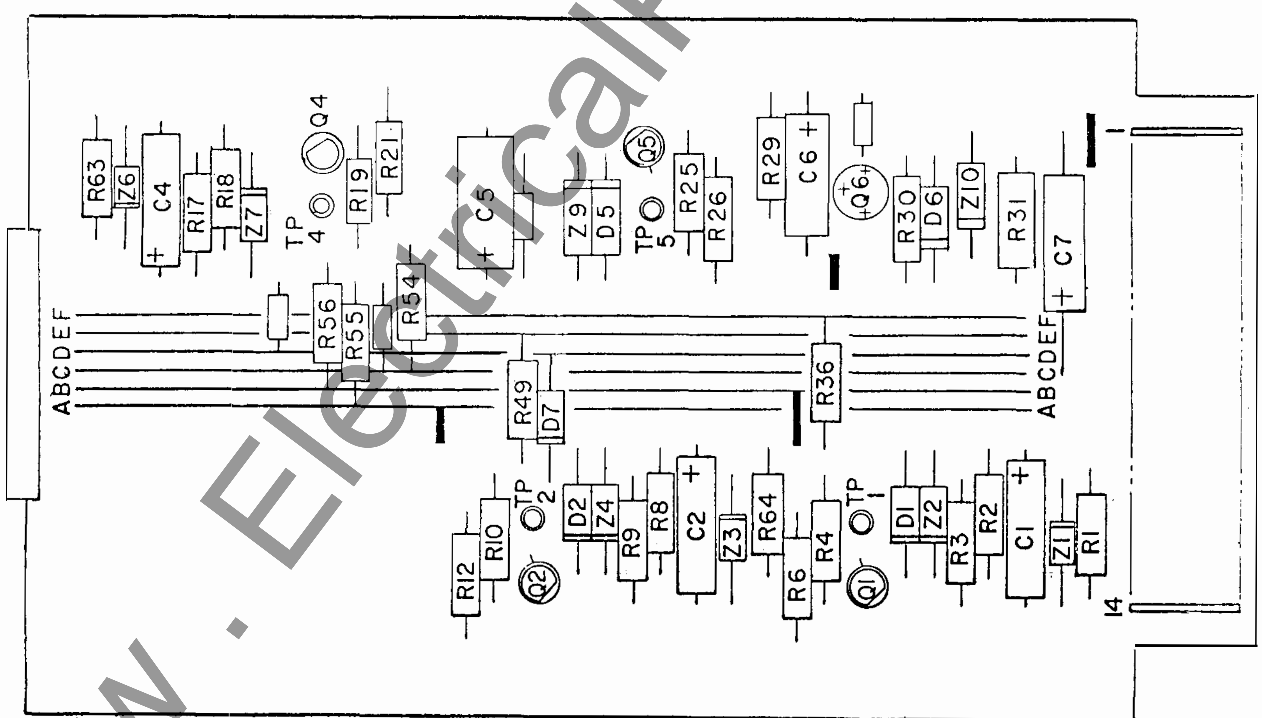
⊖ = ALL RESISTORS TO BE 1/2 W ± 2% UNLESS OTHERWISE SPECIFIED.

BD. STYLE	R1-R63-R64	TERM. 2-11-12	TERM. 5-6
205C268G01	629A531H72 (47K)	100 TO 140 V	15 TO 20 V
205C268G02	629A531H60 (15 K)	38 TO 60 V	15 TO 20 V

TABLE 1

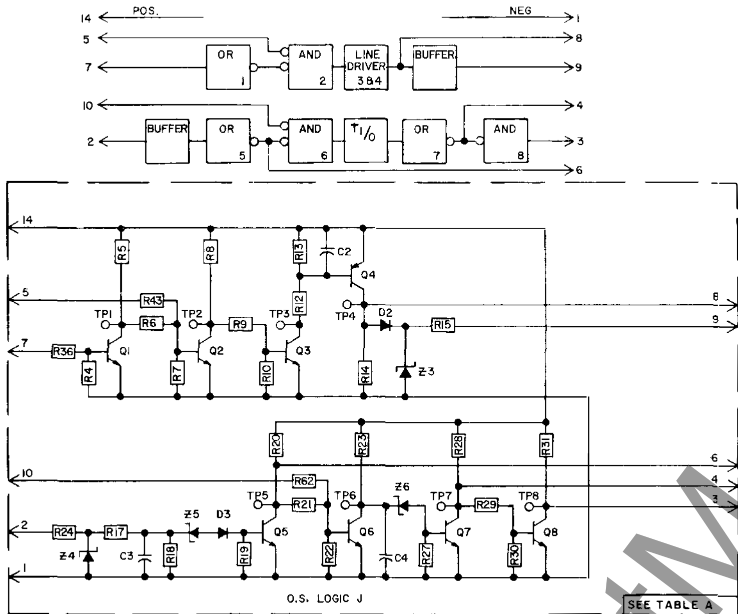
718B644

Fig. 27 Breaker Failure Logic with High Input Threshold Voltage and 8MS Seal-In Time Delay.



718B645

Fig. 28 Breaker Failure Module – Component Location – High Input Threshold Voltage and 8ms Seal-In Time Delay.



CAPACITOR	STYLE	REQ.	REF.
C2	188A669H05	1	.27 MFD.
C3	849A437H04	1	.047 MFD.
C4	SEE TABLE A		
DIODE			
D2-D3	837A692H03	2	IN645A
RESISTOR *			
R4-R7-R10-R13-R19-R22-R27-R30	629A531H56	8	10K
R5-R8-R12-R20-R23-R28-R31	629A531H52	7	6.8 K
R6-R9-R21-R29-R36-R43-R62	629A531H66	7	27 K
R17-R24	629A531H48	2	4.7K
R14-R18	629A531H78	2	82 K
R15	762A679H01	1	150 Ω 3W
TRANSISTOR			
Q1-Q2-Q3-Q5-Q6-Q7-Q8	848A851H02	7	2N3417
Q4	849A441H01	1	2N3645
ZENER DIODE			
Z3	862A288H01	1	IN3688A
Z4	185A212H06	1	IN3686B
Z5	186A797H06	1	IN957B
Z6	184A639H11	1	IN1315A

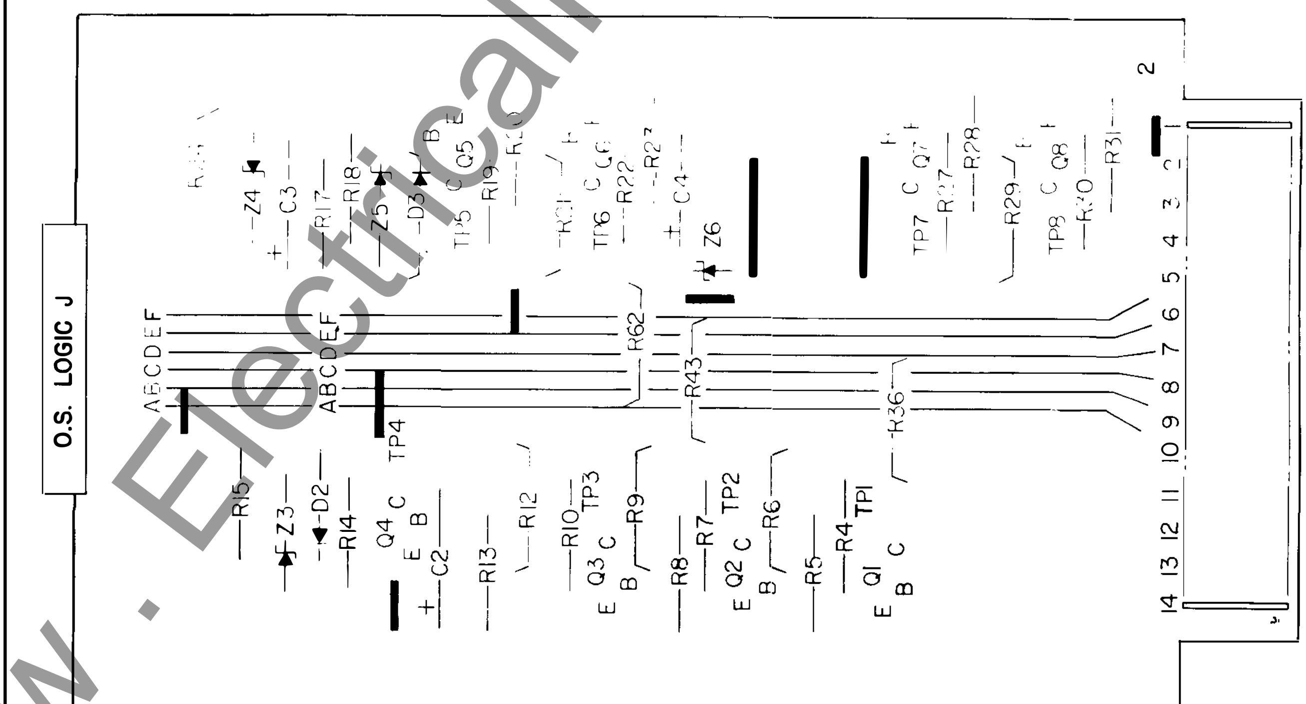
* = ALL RESISTORS TO BE 1/2 W ± 2% UNLESS OTHERWISE SPECIFIED.

TABLE A

GROUP	TIMING FOR T_1	CAPACITOR C4	STYLE	REQ
202C946G01	50/0	6.8 MFD	184A661H21	1
202C946G02	30/0	3.3 MFD	862A530H01	1

715B900

Fig. 29 Relay Enabling Logic Module—Internal Schematic.



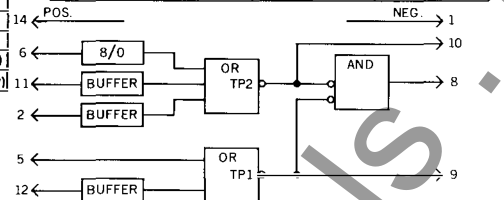
715B901

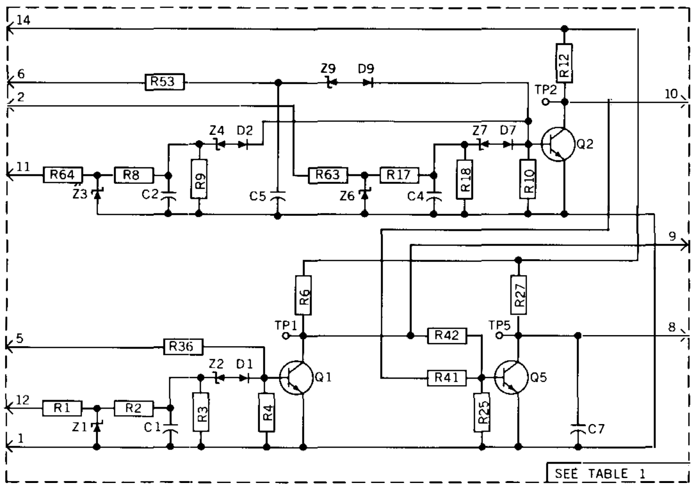
Fig. 30 Relay Enabling Logic Module—Component Location.

TABLE I

BOARD STYLE	R1-R63-R64	R2-R8-R17	R3-R9-R18		
205C364G01	629A531H72 (47K)	629A531H48(4.7K)	629A531H51(6.2K)		
205C364G02	629A531H60(15K)	629A531H48(4.7K)	629A531H51(6.2K)		
	R1	R2	R3	R8-R9-R17-R18	R63-R64
205C364G03	629A531H72 (47K)	629A531H48(4.7K)	629A531H51 (6.2K)	629A531H32 (1K)	763A921H04(8K 3W)
205C364G04	629A531H60(15K)	629A531H48(4.7K)	629A531H51(6.2K)	629A531H30(820Ω)	187A643H33(1.8K 1W)

BOARD STYLE	TERM. 2-11-12	TERM. 5-6
205C364G01 , G03	100 TO 140 VDC	15 TO 20 VDC
205C364G02, G04	38 TO 60 VDC	15 TO 20 VDC





CAPACITOR	STYLE	REQ	REF
C1-C2-C4-C7	849A437H04	4	.047MFD.
C5	763A219H18	1	.56MFD.
DIODE			
D1-D2-D7-D9	837A692H03	4	1N645A
RESISTOR *			
R1-R63-R64	SEE TABLE 1	3	
R2-R8-R17	SEE TABLE I	3	
R3-R9-R18	SEE TABLE I	3	
R4-R10-R25	629A531H56	3	10K
R6-R12-R27	629A531H52	3	6.8K
R36-R41-R42-R53	629A531H66	4	27K
TRANSISTOR			
Q1-Q2-Q5	848A851H02	3	2N3417
ZENER DIODE			
Z1-Z3-Z6	185A212H06	3	1N3686B
Z2-Z4-Z7	862A288H07	3	1N5235B
Z9	837A693H06	1	1N705

* = ALL RESISTORS TO BE 1/2W ± 2% UNLESS OTHERWISE SPECIFIED.

718B759

Fig. 31 Breaker Failure Logic Module – with High Threshold Input Voltage, 8 ms Seal-In Time Delay & High Capacitive Surge Immunity.

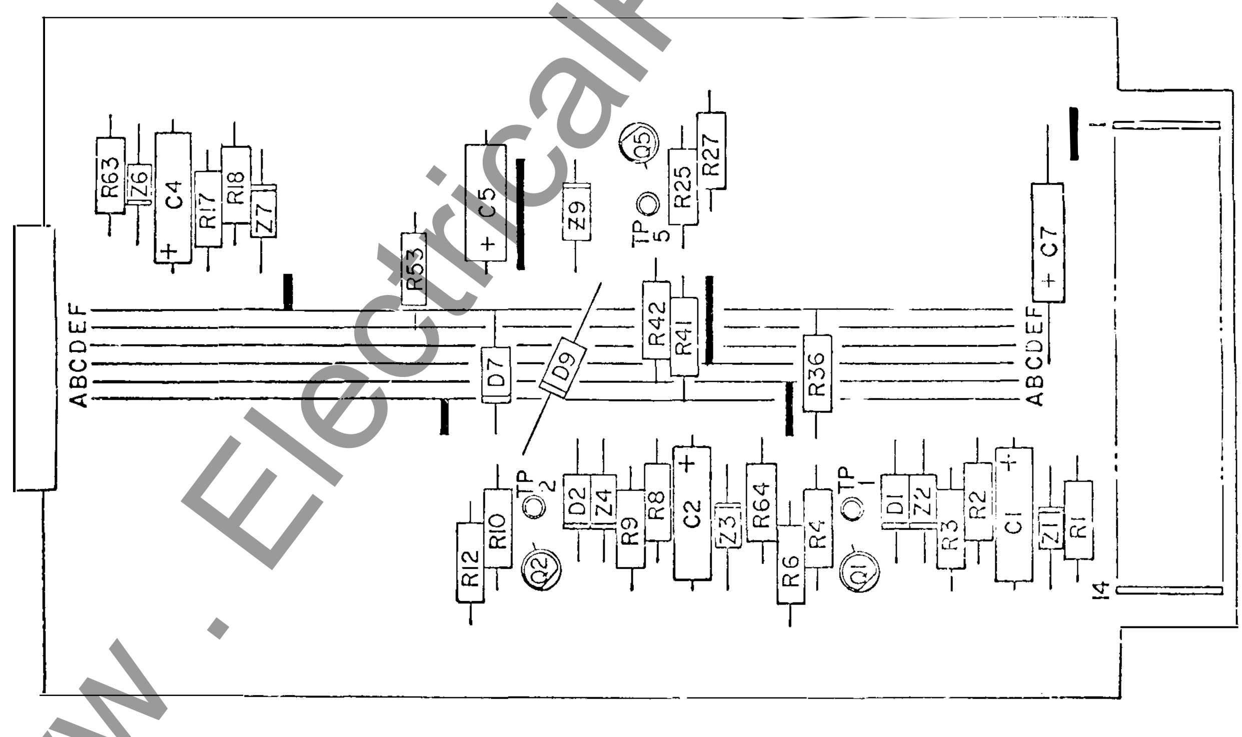
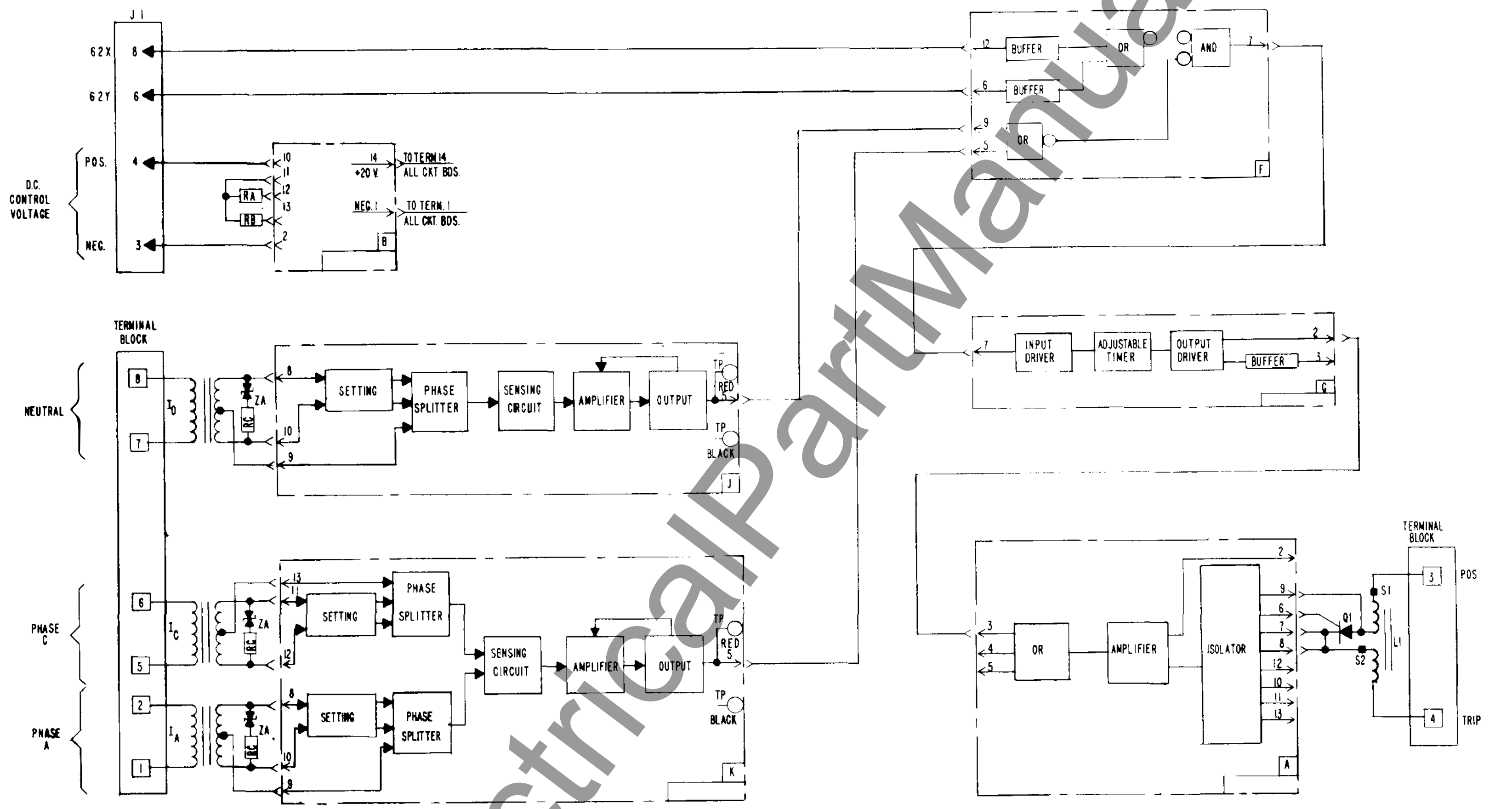


Fig. 32 Breaker Failure Logic Module – Component Location.

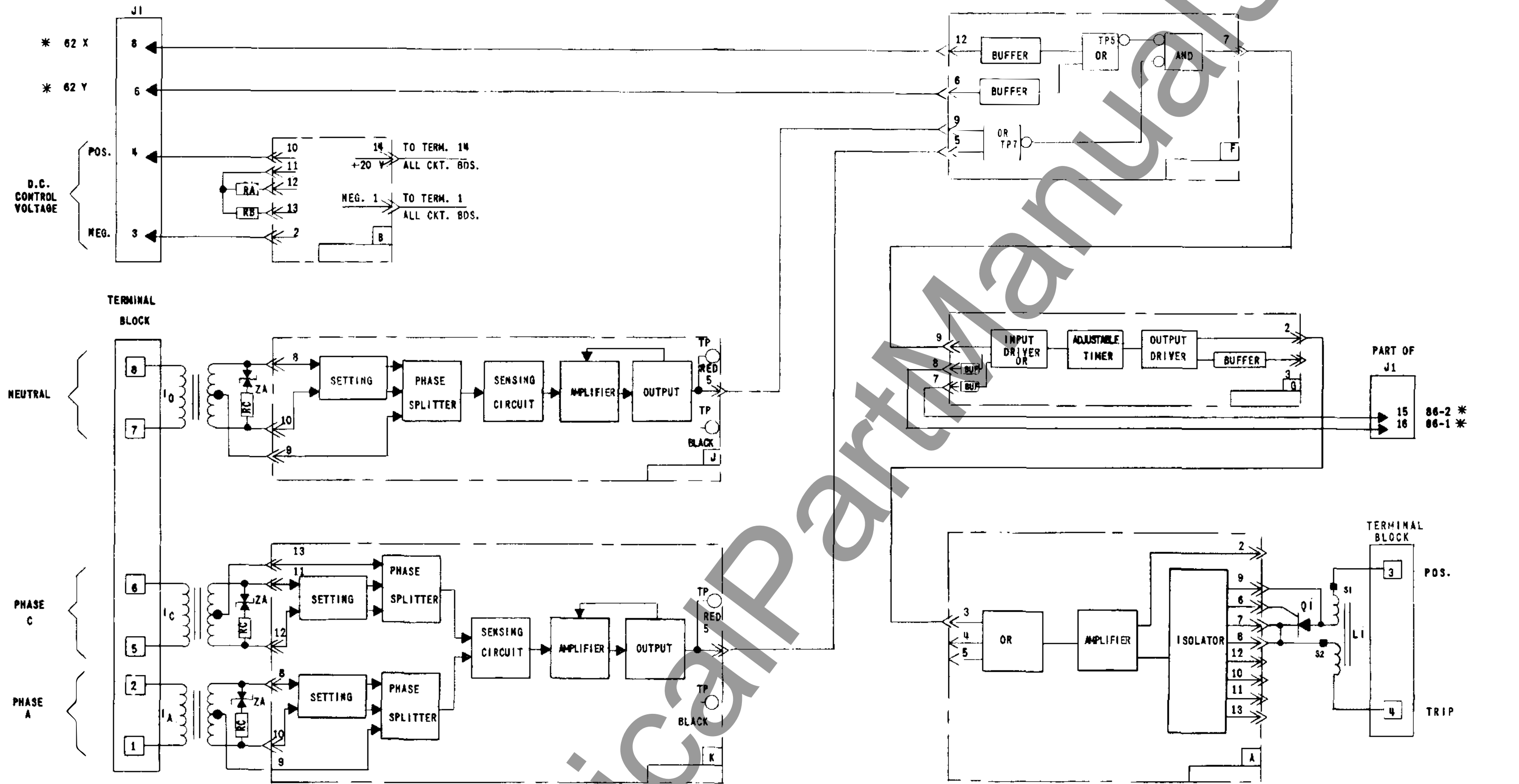


POWER SUPPLY RESISTORS		
	RA	RB
48 V.D.C.	S 1267272 150 OHMS	S 1201004 1.8K
125 V.D.C.	S 1267287 900 OHMS	S.1205214 5K

LOC.	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC.
A	TRIP S 899C826G01	671B903 671B953
B	POWER SUPPLY S 899C378G02	671B508 899C620
F	BKR. FAIL. LOGIC S201C004G01	691B004 691B005

LOC.	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC.
G	TIMER S.5312D06G01	691B031 691B032
K	IA / IC S.5313D12G03	671B945 671B961
J	IO S.5309D33G16	671B960 671B962

Fig. 33 Logic Dwg. of SBFU with Thyristor Output.



POWER SUPPLY RESISTORS		
	RA	RB
48V.D.C.	S.1267272 150 OHMS	S.1201004 1.8K
125V.D.C.	S.1267287 900 OHMS	S.1205214 5K

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC.
A	TRIP S.899C826G01	671B903 671B953
B	POWER SUPPLY S.899C378G02	671B508 899C620
F	BKR. FAIL. LOGIC SEE TABLE 2	691B004 691B005

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC.
G	TIMER SEE TABLE 2	691B372 691B373
K	IA/IC SEE TABLE 1	671B945 671B961
J	IO SEE TABLE 1	671B960 671B962

TABLE 1

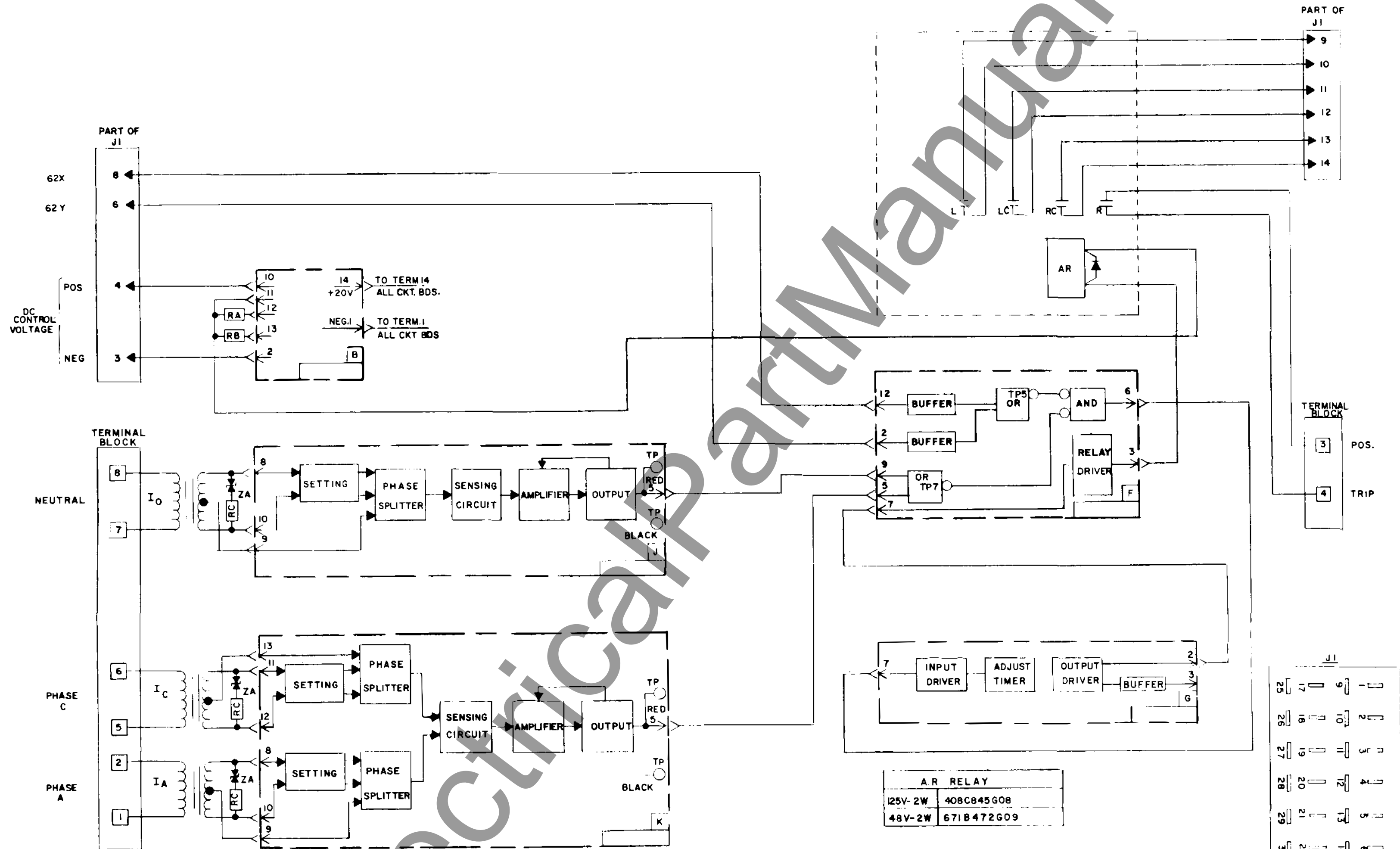
RANGE	I_0	I_A/I_C
.5 TO 2 AMP	5309033G16	
1 TO 4 AMP		5313012G02
2 TO 8 AMP		5313012G03

TABLE 2

MODULE LOCATION	RELAY STYLE 201C179A11,12&14	RELAY STYLE 201C179A26
F	201C004G01	201C004G02
G	5312D06G07	5312D06G17

201C684

Fig. 34 Logic Dwg. of SBFU with Thyristor and Three Input Timer.



A R RELAY	
125V-2W	408C845G08
48V-2W	671B472G09

TABLE I

RANGE	I_O	I_A/I_C
.5 TO 2 AMP	5309D33G16	
1 TO 4 AMP		5313D12G02
2 TO 8 AMP		5313D12G03

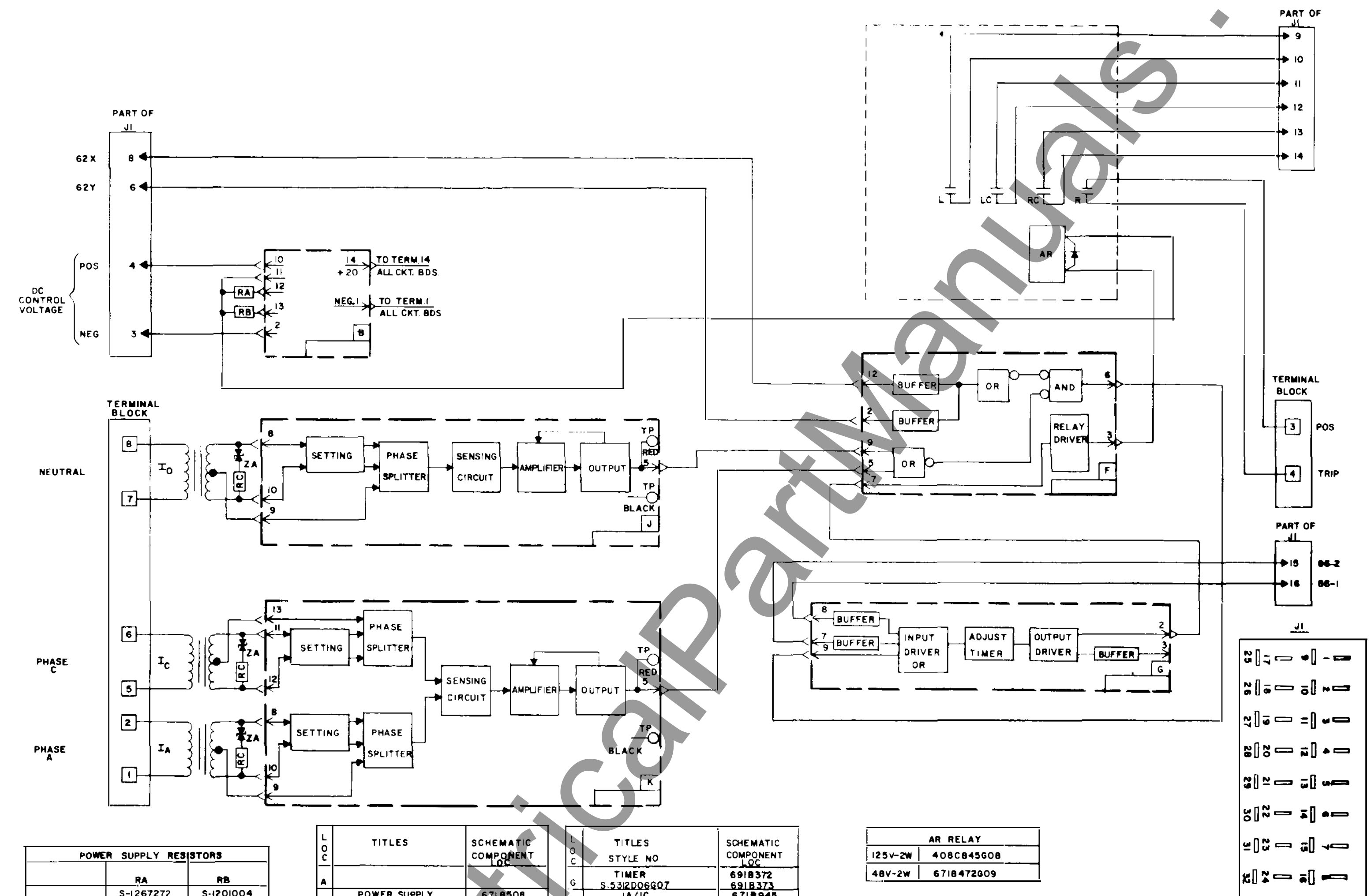
POWER SUPPLY RESISTORS		
	RA	RB
48 VDC	S.1267272 150 OHMS	S.1201004 1.8K
125 VDC	S.1267287 900 OHMS	S.1267287 5K

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC
A		
B	POWER SUPPLY 899C378G02	671B508 899C620
F	BREAKER FAILURE LOG & RELAY DRIVER S.201C423	691B419 691B420

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC
G	TIMER S.5312D06G01	691B031 691B032
K	IA/IC SEE TABLE I	671B945 671B961
J	IO SEE TABLE I	671B960 671B962

201C443

Fig. 35 Logic Dwg. of SBFU with Contact Output.



POWER SUPPLY RESISTORS		
	RA	RB
48 V.D.C.	S-1267272 150 OHMS	S-1201004 1.8K
125 V.D.C.	S-1267287 900 OHMS	S-1267287 5 K

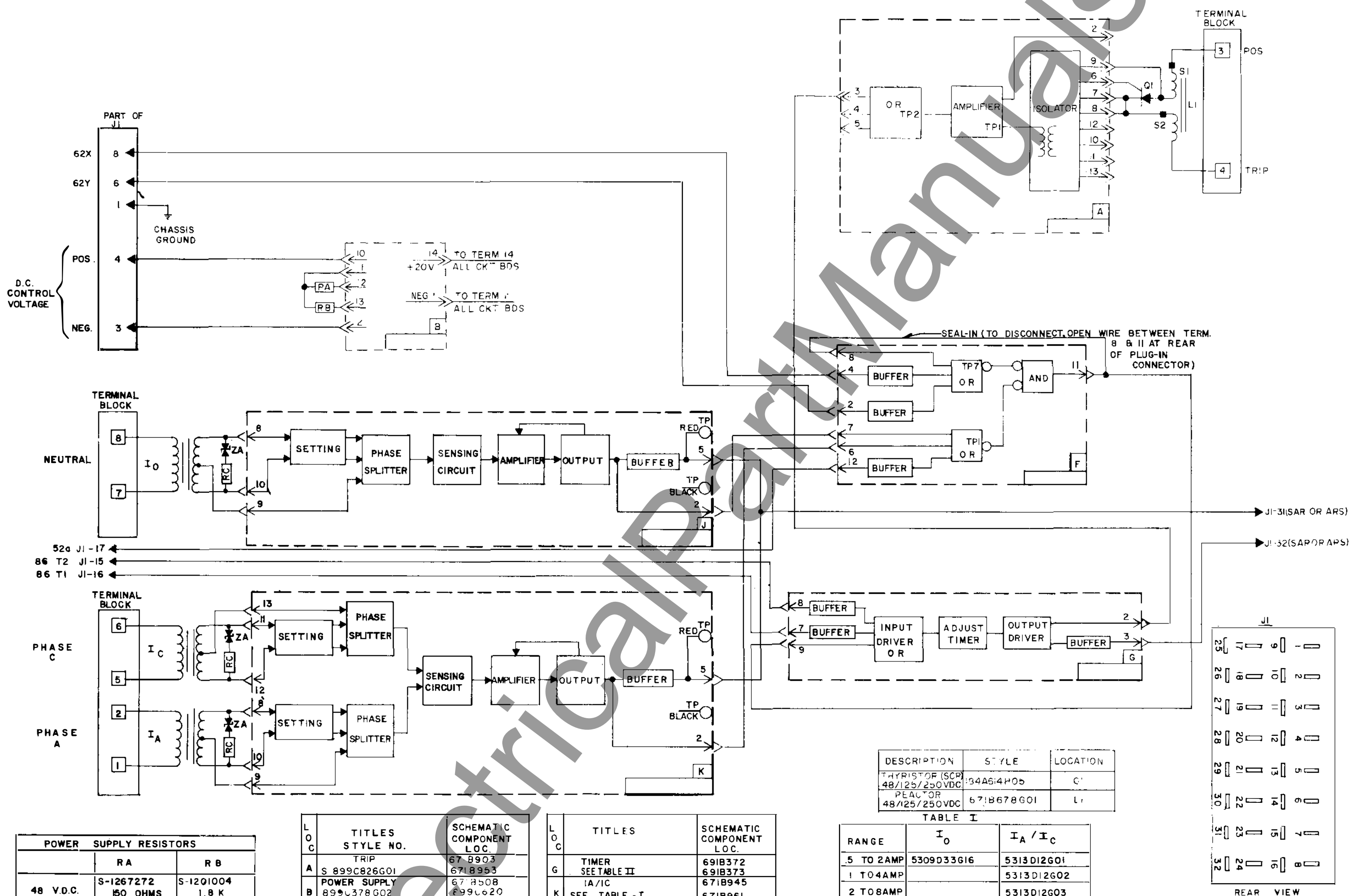
LOC	TITLES	SCHEMATIC COMPONENT LOC
A		
B	POWER SUPPLY S.899C378G02	6718508 899C620
F	BREAKER FAILURE LOGIC RELAY DRIVER S.201C423G01	6918419 6918420

LOC	TITLES STYLE NO	SCHEMATIC COMPONENT LOC
G	TIMER S.5312D06G07	6918372 6918373
K	IA/IC S.5313D12G03	6718945 6718961
J	IO S.5309D33G16	6718960 6718962

AR RELAY	
125V-2W	408C845G08
48V-2W	6718472G09

201C509

Fig. 36 Logic Dwg. of SBFU with Contact Output and Three Input Timer.



POWER SUPPLY RESISTORS		
	RA	RB
48 V.D.C.	S-1267272 150 OHMS	S-1201004 1.8 K
125 V.D.C.	S-1267287 900 OHMS	S-1205214 5 K

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOC.
A	TRIP S 899C826G01	67 8903 6718953
B	POWER SUPPLY 899C378G02	67 8508 899C620
F	BREAKER FAILURE LOGIC 202C767G02	7158542 715 8543

LOC	TITLES	SCHEMATIC COMPONENT LOC.
G	TIMER SEE TABLE II	691B372 691B373
K	IA/IC SEE TABLE - I	671B945 671B961
J	IO SEE TABLE-I	671B960 671B962

TABLE II

RANGE	STYLE NO.
.05-.4 SEC	5312D06G07
.1-1.0 SEC	5312D06G06

DESCRIPTION	STYLE	LOCATION
THYRISTOR (SCR) 48/125/250VDC	184A614H05	Q1
REACTOR 48/125/250VDC	671B678G01	L1

TABLE I

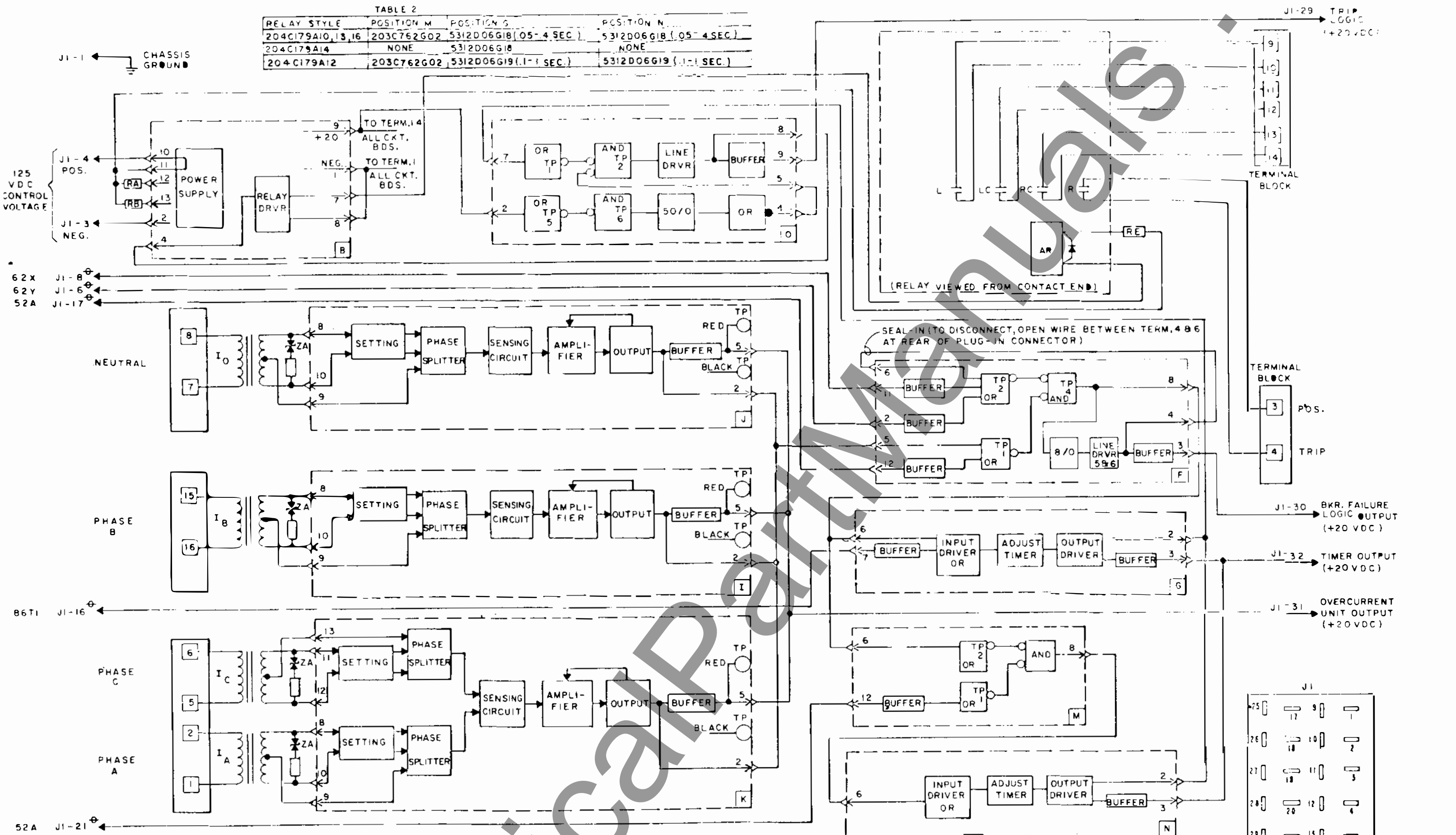
RANGE	I_O	I_A / I_C
.5 TO 2AMP	5309D33G16	5313D12G01
1 TO 4AMP		5313D12G02
2 TO 8AMP		5313D12G03

203C128

✪ *Fig. 37 Logic Dwg. of SBFU with Thyristor, Overcurrent Unit and Timer Output, 86, 52A and 62X, 62Y Contact Input with Seal-In.*

TABLE 2

RELAY STYLE	POSITION M	POSITION G	POSITION N
204C179A10,13,16	203C762G02	5312D06G18(.05-.4 SEC.)	5312D06G18(.05-.4 SEC.)
204C179A14	NONE	5312D06G18	NONE
204C179A12	203C762G02	5312D06G19(.1-1 SEC.)	5312D06G19(.1-1 SEC.)



⊕ = INPUT RANGE (+) 100 TO 140 VDC

	POWER SUPPLY RESISTORS		RELAY RESIS.	AR RELAY
RATING	RA	RB	RE	10W - 2 MSEC.
125VDC	S-1267287 900 OHMS	S-1205214 5K OHMS	S-1267293 1.5 K OHMS	S-408C845G01

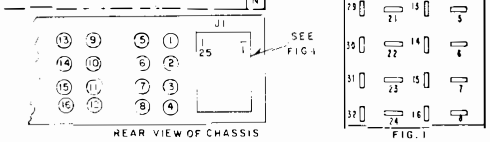
LOC	TITLES / STYLE NO.	SCHEMATIC COMPONENT LOCATION
B	POWER SUPPLY & RELAY DRIVER 899C642G02	691B215
		899C663
F	BREAKER FAILURE LOGIC 205C268G01	718B644
		718B645
G	TIMER (SEE TABLE 2)	716B346
		716B349

TABLE 1

RANGE	IB	IO	IA / IC
.5 - 2 AMP	—	5309D33G16	—
1 - 4 AMP	5309D33G27	5309D33G17	5313D12G02
2 - 8 AMP	5309D33G28	—	5313D12G03

LOC	TITLES / STYLE NO.	SCHEMATIC COMPONENT LOCATION
I	IB SEE TABLE 1	671B960
		671B962
J	IO SEE TABLE 1	671B960
		671B962
K	IA / IC SEE TABLE 1	671B945
		671B961
M	BREAKER FAILURE LOGIC (SEE TABLE 2)	716B557
		716B558
N	TIMER (.05-.4 SEC.) (SEE TABLE 2)	716B346
		716B349
O	LOGIC J 202C946G01	715B900
		715B901

REF. WIRING AND HARNESS DWG. 6289D70

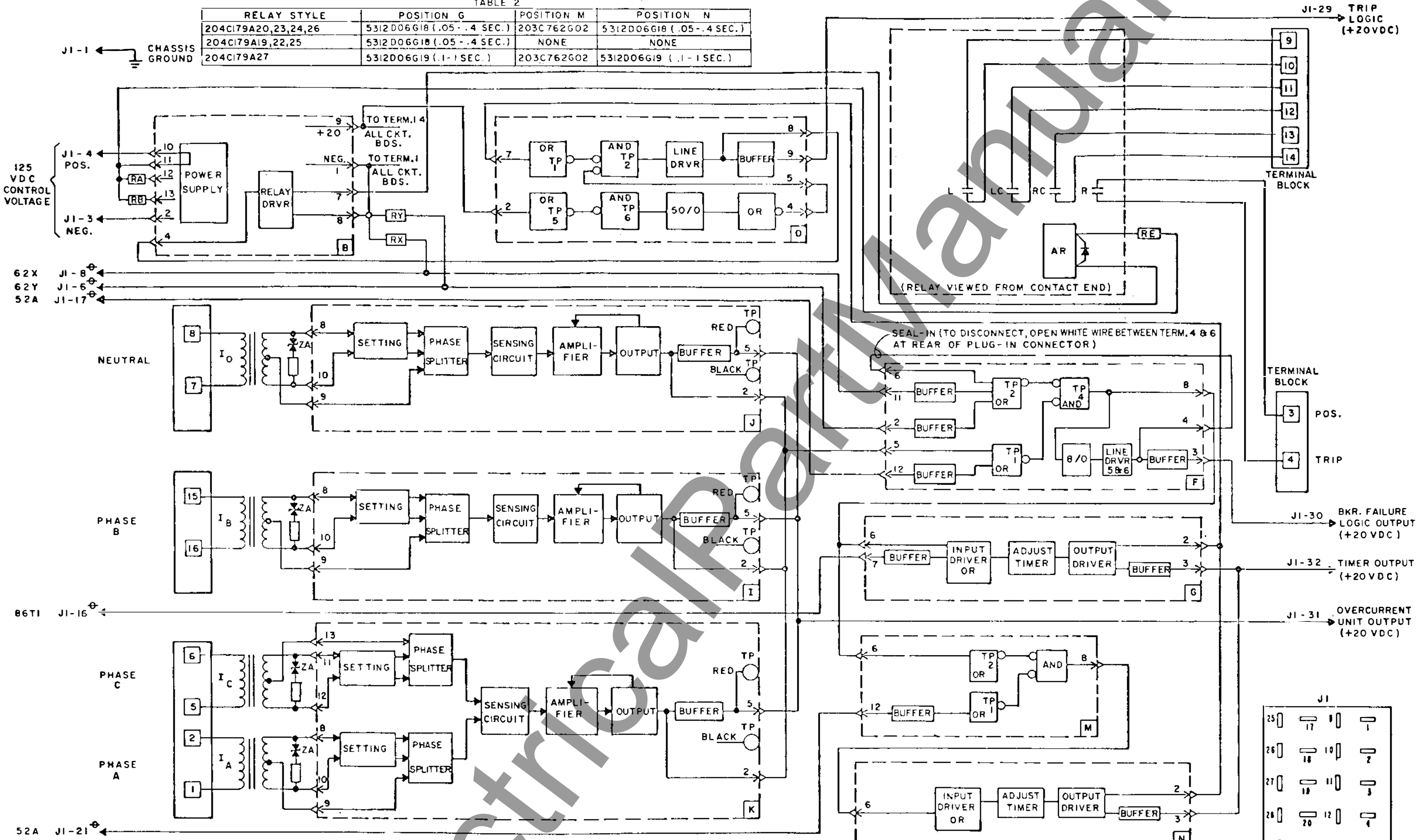


205C275

Fig. 38 Logic Drawing for 2 Timer SBFU.

TABLE 2

RELAY STYLE	POSITION G	POSITION M	POSITION N
204C179A20,23,24,26	5312D06G18 (.05-.4 SEC.)	203C762G02	5312D06G18 (.05-.4 SEC.)
204C179A19,22,25	5312D06G18 (.05-.4 SEC.)	NONE	NONE
204C179A27	5312D06G19 (.1-1 SEC.)	203C762G02	5312D06G19 (.1-1 SEC.)



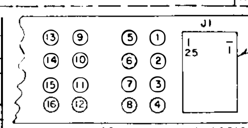
⊖ = INPUT RANGE (+) 100 TO 140 VDC

	POWER SUPPLY RESISTORS		RELAY RESIS.	RESISTORS	AR RELAY
RATING	RA	RB	RE	RX, RY	10W - 2 MSEC.
125VDC	S-1267287 900 OHMS	S-1205214 5K OHMS	S-1267293 1.5K OHMS	S-05D1328H74 3.5K	S-408C845G01

LOC	TITLES / STYLE NO.	SCHEMATIC / COMPONENT LOCATION
B	POWER SUPPLY & RELAY DRIVER 899C642G02	691B215
		899C663
F	BREAKER FAILURE LOGIC 205C268G03	718B644
		718B645
G	TIMER (SEE TABLE 2)	716B346
		716B349

LOC	TITLES / STYLE NO.	SCHEMATIC / COMPONENT LOCATION
I	IB SEE TABLE 1	671B960
		671B962
J	IO SEE TABLE 1	671B960
		671B962
K	IA / IC SEE TABLE 1	671B945
		671B961
M	BREAKER FAILURE LOGIC (SEE TABLE 2)	716B557
		716B558
N	TIMER (.05-.4 SEC.) (SEE TABLE 2)	716B346
		716B349
O	LOGIC J 202C946G01	715B900
		715B901

REF. WIRING AND HARNESS DWG. 6467D93



REAR VIEW OF CHASSIS

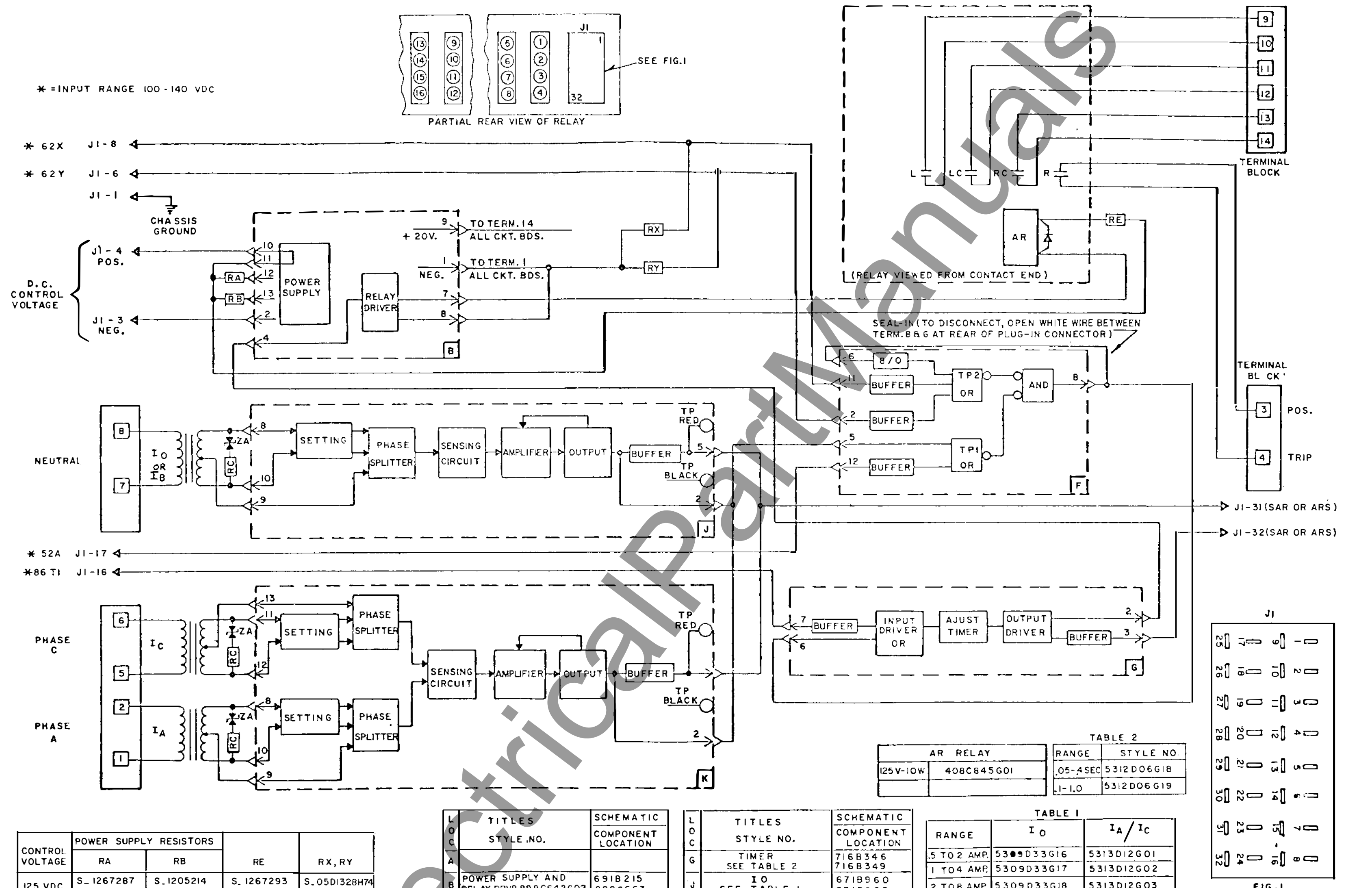
FIG. 1

TABLE 1

RANGE	IB	IO	IA / IC
.5-2 AMP	5309D33G26	5309D33G16	5313D12G01
1-4 AMP	5309D33G27	5309D33G17	5313D12G02
2-8 AMP	5309D33G28	—	5313D12G03

264C403

Fig. 39 Logic Drawing of SBFU with 4 Overcurrent Units and Two Timers. High Threshold Input Starting and Four MFD Input Surge Immunity on 62X, 62Y Input with Seal-In Circuit Connected.



CONTROL VOLTAGE	POWER SUPPLY RESISTORS		RE	RX, RY
	RA	RB		
125 VDC	S_1267287 900 OHMS	S_1205214 5K	S_1267293 1.5K	S_05D1328H74 3.5K

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOCATION
A		
B	POWER SUPPLY AND RELAY DRVR 899C642G02	691B215 899C663
F	BREAKER FAILURE LOGIC 205C364G03	718B759 718B763

LOC	TITLES STYLE NO.	SCHEMATIC COMPONENT LOCATION
G	TIMER SEE TABLE 2	716B346 716B349
J	IO SEE TABLE 1	671B960 671B962
K	IA / IC SEE TABLE 1	671B945 671B961

AR RELAY	
125V-10W	408C845G01

TABLE 2

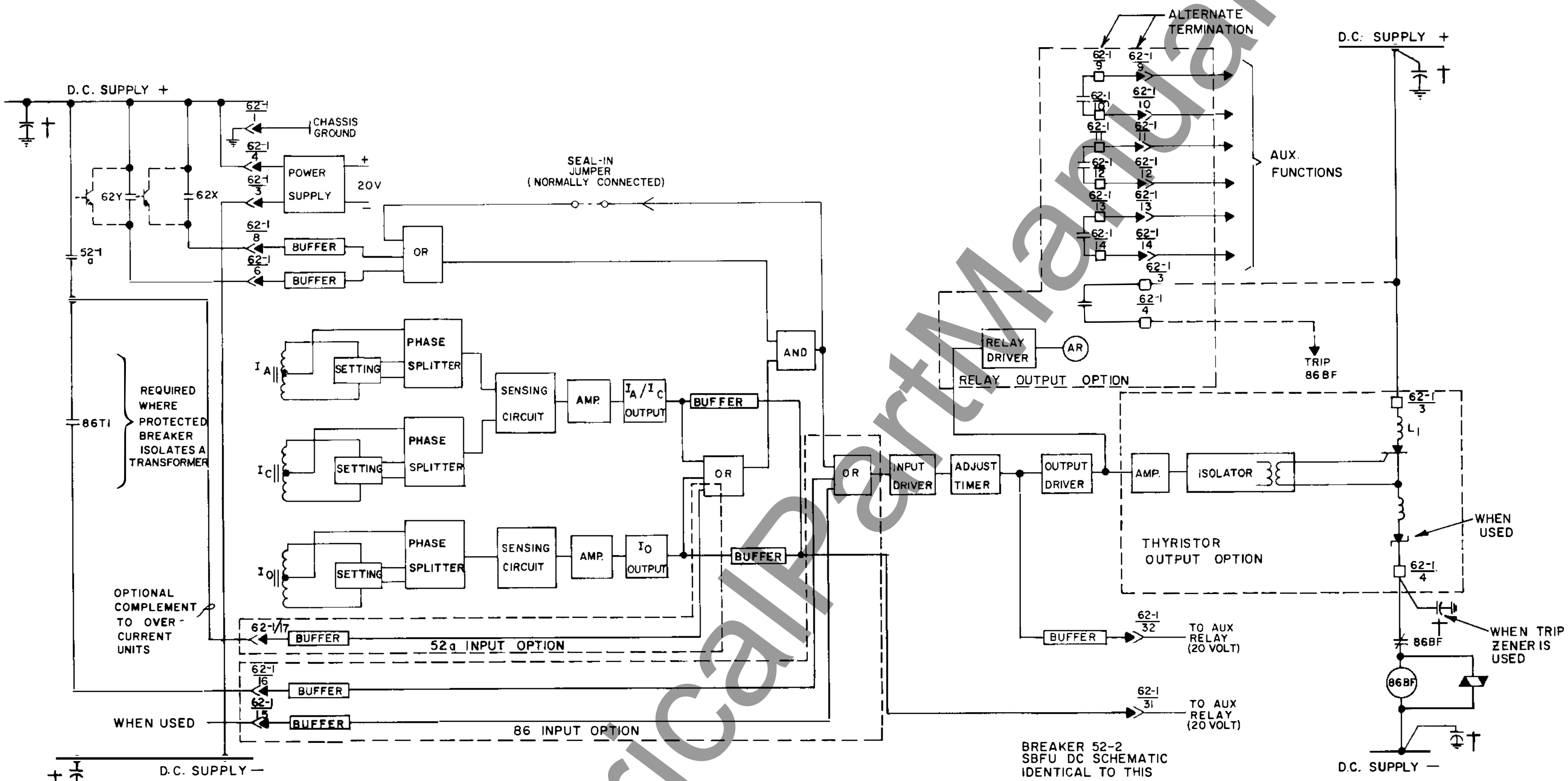
RANGE	STYLE NO.
.05-.4 SEC	5312D06G18
.1-1.0	5312D06G19

TABLE 1

RANGE	I_O	I_A / I_C
.5 TO 2 AMP.	5309D33G16	5313D12G01
1 TO 4 AMP.	5309D33G17	5313D12G02
2 TO 8 AMP.	5309D33G18	5313D12G03
4 TO 16 AMP.	5309D33G19	5313D12G04

264C402

Fig. 40 Logic drawing of SBFU with 3 Overcurrent Units & 1 Timer. High Threshold Starting and 4 MFD Input Surge Immunity on 62X, 62Y Input with Seal-In Circuit Connected.



TYPICAL 86 BF AND/OR RELAY AUX. FUNCTIONS

1. TRIP BREAKERS CONNECTED TO SAME BUS SECTION.
2. BLOCK ALL AUTOMATIC RECLOSING.
3. BLOCK MANUAL CLOSING.
4. KEY TRANSFER TRIP TRANSMITTER(S) TO TRIP REMOTE BREAKER(S) AND BLOCK RECLOSING.
5. STOP "BLOCKING" CARRIER

LEGEND

52 - CIRCUIT BREAKER
62 - SBFU
62X - CONTACT OR TRANSISTOR THAT APPLIES POSITIVE TO SBFU INPUT. INITIATED BY PRIMARY RELAYING SYSTEM COINCIDENT WITH TRIP.
62Y - CONTACT OR TRANSISTOR THAT APPLIES POSITIVE TO SBFU INPUT. INITIATED BY BACKUP RELAYING SYSTEM COINCIDENT WITH TRIP.
86BF - BREAKER FAILURE LOCKOUT RELAY.
86TI - TRANSFORMER LOCKOUT RELAY.

† – SPP SURGE PROTECTION CAPACITORS, TO BE USED WHEN SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK.

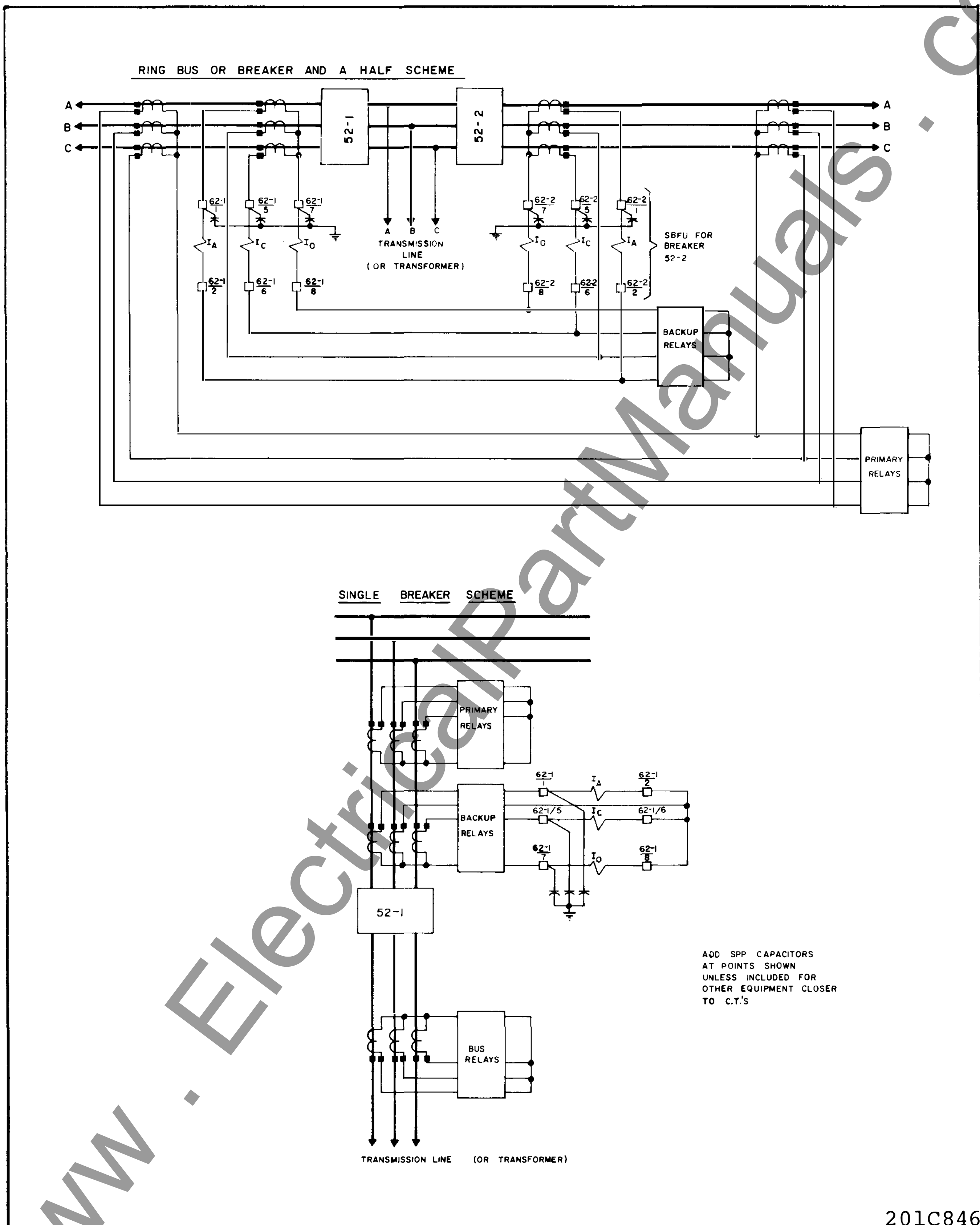
SYMBOLS

<<— PLUG CONNECTOR
□ TERMINAL BLOCK

NOTE: SEE DWG. 201C846 FOR A.C. SCHEMATIC

201C845

Fig. 41 External d-c Schematic and Logic Diagram for SBFU.



201C846

Fig. 42. External a-c Schematic for SBFU.

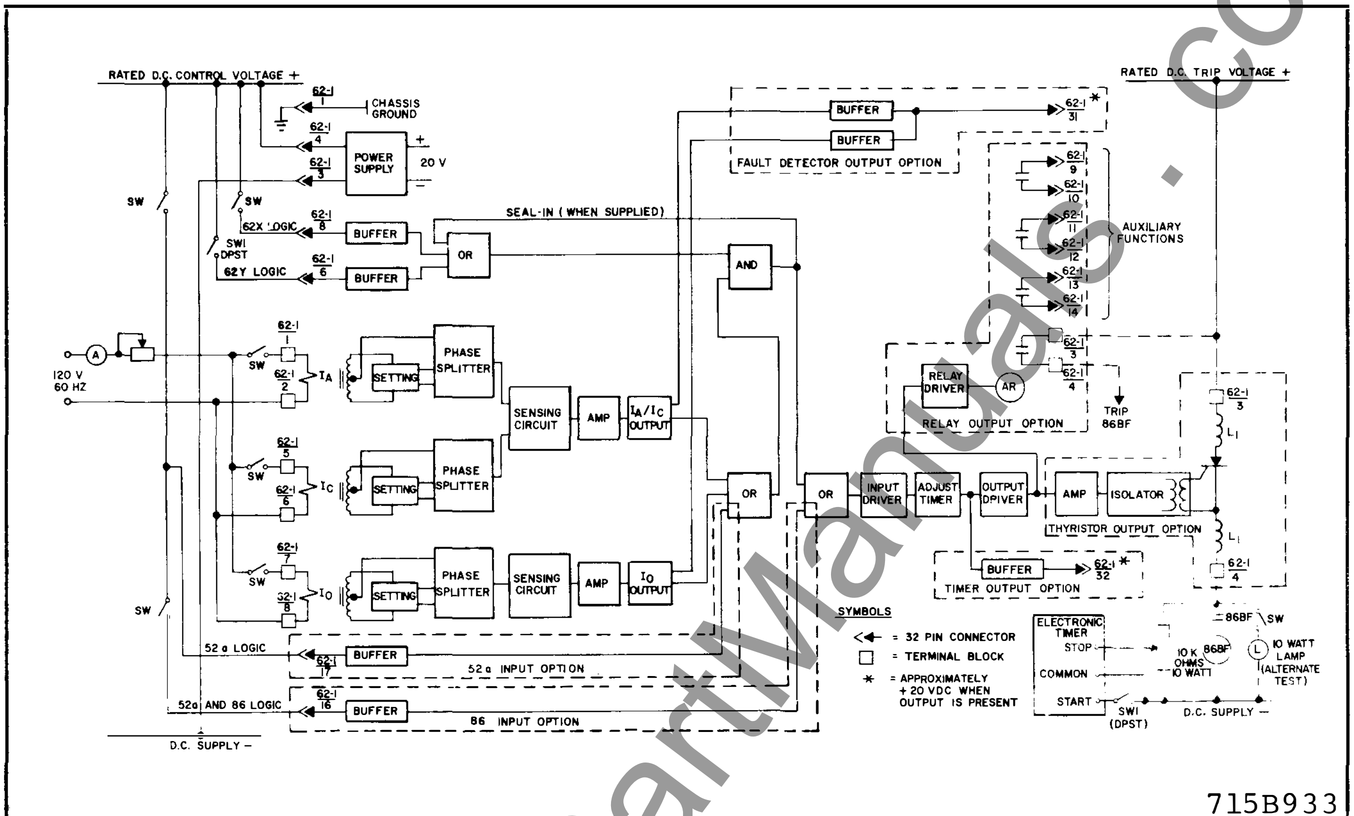


Fig. 43. Test Connection for Type SBFU Relay.

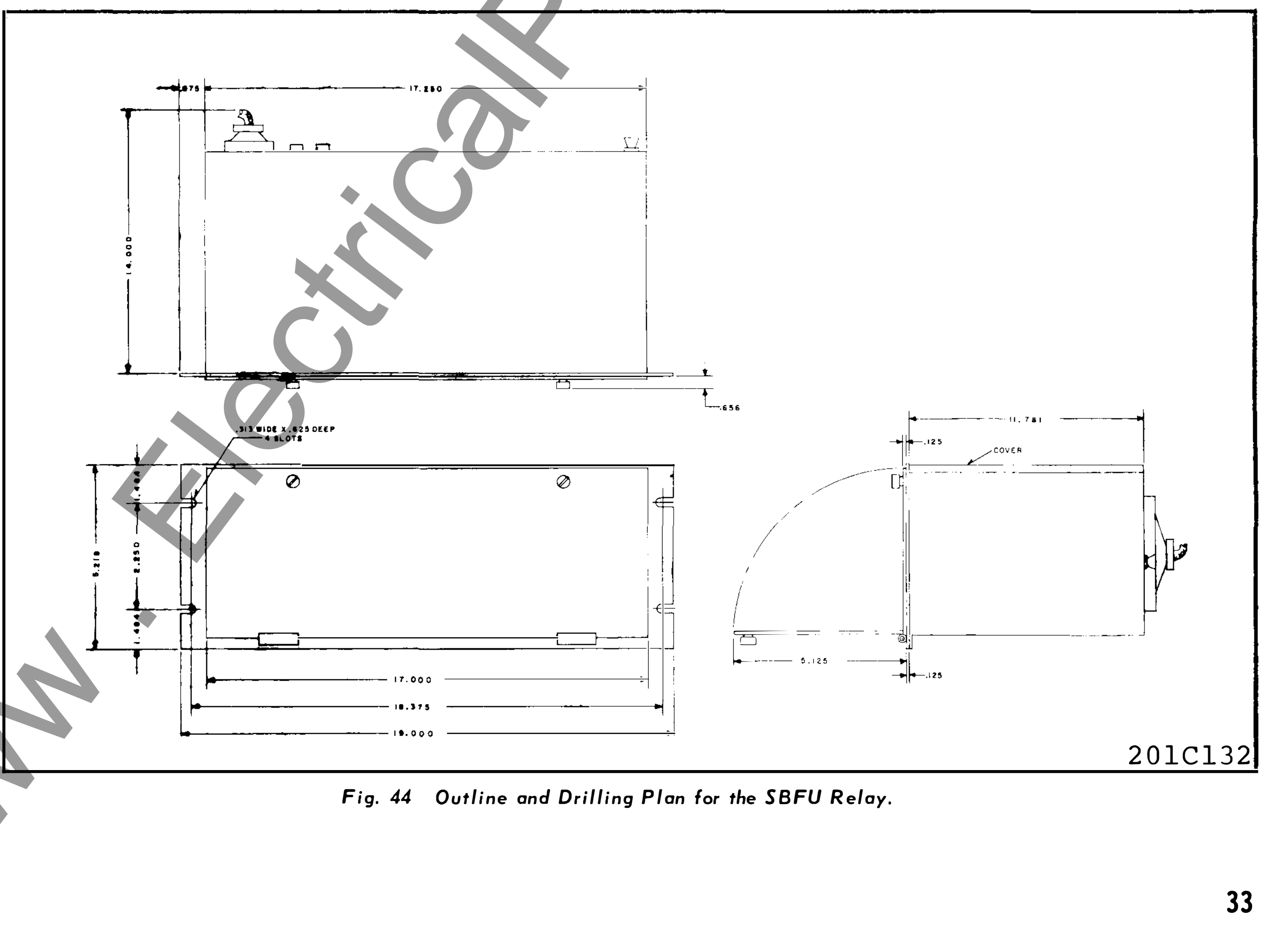


Fig. 44 Outline and Drilling Plan for the SBFU Relay.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBF-1 CIRCUIT BREAKER FAILURE RELAY

CAUTION: It is recommended that the user of this equipment become acquainted with the information in these instructions before energizing the relay. Failure to do so may result in damage to the equipment. Before putting the relay into service, operate the relay to check the electrical connections.

Printed circuit modules should not be removed or inserted while the relay is energized. Failure to observe this precaution may result in an undesired tripping output or cause component damage.

APPLICATION

The SBF-1 is a solid state breaker failure detection relay with contact output. It is used in conjunction with the primary and backup relays. Other logic inputs (such as the 52a contact) may be used where the fault current is insufficient to operate the current detector.

The relay is applicable with any of the bus/breaker schemes in general use.

Provision is included in the relay for "retripping" the breaker without time delay. This may avoid clearing a bus during incorrect maintenance procedure or due to the failure of a trip contact to close.

CONSTRUCTION

The SBF-1 Relay consists of a phase and ground current detector, a breaker failure timer, a control timer, a seal-in (X) relay and an output relay (AR) along with 2 indicating contactor switches (ICS).

Overcurrent Detector

The detector consists of 3 or 4 input transformers and a plug in module. The primary of the transformer is tapped and brought out to a tap block located on the front of the relay. Each transformer has three taps which cover the range of pickup.

The secondary of the transformers are connected to the input of the plug-in detector module where the phase and ground signals are connected to separate pickup level adjustments located on the front of the module. A comparator circuit consists of a plug-in operational amplifer whose output is connected to logic circuitry which controls the AR output relay.

Also located on the module is a reed relay (RR) which is controlled by the breaker failure (BF) timer on the timer module. The normally open contacts of the reed relay are connected in the current detector circuit and controls the operation of the circuit.

BF and Control Timer

These timers are located on the timer plug-in module.

The BF timer can be continuously varied over the range by means of an adjusting knob located at the front of the module. A calibrated scale permits setting the desired time delay. A test jack is also located at the front if it is desired to check the setting with an electronic test timer.

At the bottom of the front plate is an access hole which permits adjusting the control timer

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

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✪DENOTES CHANGED SINCE PREVIOUS ISSUE.

trimpot. A test jack is also supplied to change the control timer delay in conjunction with a tester if other than the factory setting is desired.

✪ A level detector circuit consisting of zener diode Z1 and resistor R3 is connected to terminal 13 of the module for controlling the dc voltage supply to the timer circuit.

✪ A second level detector consisting of zener diode Z2 and resistor R17 is connected to terminal 3 of the module for controlling the turn on voltage level from the 52a input.

Power Supply

Consists of a zener diode (Zs) mounted on an L shaped heat sink. The zener is connected to a 2 inch tubular resistor (RS). A small capacitor (C3) located on the timer module is connected across the zener diode.

Telephone Relay (X)

This is a clapper type auxiliary relay with two normally open contacts.

Output Relay (AR)

This is a 4 pole normally open high speed auxiliary output relay used for tripping duty.

The relay coil is connected in series with a 2 inch tubular resistor (RA).

Indicating Contactor Switch Unit (ICS)

The dc indicating contactor switch is a small 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 front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The operation of the SBF-1 is somewhat different than the conventional breaker failure relay. It may be summarized by saying that the breaker failure relay timer is started by only the BFI (62X) input rather than the BFI and the overcurrent fault detector. The breaker failure timer controls the fault detector so that after it times out, the overcurrent signal (if present) is connected to the level detector. This arrangement keeps the overcurrent input transformer load at a low level. This permits fast reset of the secondary voltage of 3 ms or less, even at very high multiples of pickup current. By use of an additional timer (called the control timer) the breaker failure timer as well as the X seal-in relay is reset after it times out. The circuit operation can be explained by referring to the internal schematic drawing 775B813 (Fig. 2) and detailed internal schematic 1326D19 (Fig. 3).

During stand-by condition the dc input to the relay (terminal 9 positive) is zero since the dc control voltage is connected through the breaker failure initiate contact (see the external schematic) which is normally open.

Upon the closing of the BFI contact and providing the dc voltage is 80% or greater (of rated value) a level detector zener diode Z1 (connected to terminal 9) will permit transistor Q2 and Q1 to turn on. The power supply consisting of a 10 watt zener Zs and 25 watt resistor Rs is also energized which supplies a regulated 24Vdc to the modules and the X relay. When transistor Q2 and Q1 turn on it connects the regulated power supply to the control timer which consists of ½ of IC1, trimpot P2 and timing capacitor C1. Resistor R26 and R27 form a voltage divider which requires approximately one time constant [(P2+R22) x C1)] before the output terminal 12 goes from 24Vdc to less than 2.5Vdc. At the same time the control timer receives power through Q1, the 24Vdc output of the control timer (term. 12 of IC1) is used to turn on transistor Q7 which operates the X relay. One X contact is brought out to relay terminal 15 to permit seal-in of the initiate contact. This is desirable where the BFI contact is only picked up for a short time. The initiate contact must be closed for 8 ms in order for seal-in to take place. While the control timer is timing out, the BF timer will time out first since it is always set for a shorter delay. The output of the BF timer is connected to terminal 9 of the timer module which is wired to terminal 2 of the overcurrent detector module. Since operation of the BF timer is indicated by a voltage drop to less than 2.5V, transistor Q1 turns off and transistor Q2 turns on to pickup the reed relay (RR). In addition, the output of the BF timer also supplies one of the two inputs to transistor Q5 which controls the AR relay switching transistor (Q6). The other input controlling transistor Q5 is either the 52a contact input (if used) connected to relay terminal 18 or operation of the overcurrent unit circuit. This is obtained when the reed relay operates to remove the 100 ohm resistor (R19) from capacitor C1 and to apply the input current signal to terminal 4 of the IC1 on the overcurrent detector module. If this signal voltage is higher than the reference voltage at terminal 5 of IC1 the output voltage at terminal 10 (of IC1) will drop from its high state to less than 2.5 volts. This output change is then applied to the transistor logic circuit consisting of transistor Q3, Q4 and Q5 (on the timer module).

CHARACTERISTICS

Overcurrent Detector

The overcurrent detector has a range of 0.5 to 13.5 amperes. This is obtained by means of three tap settings in conjunction with the tap multiplier to give a continuous adjustment over the range. The pickup point is determined by multiplying the tap value by the tap multiplier setting. The operate speed varies from 3 ms to 8 ms. The reset time is 3 ms maximum and would be measured as the time for the secondary voltage to decay to 10 volts peak (with the reed relay RR contacts open). This reset time applies whether the input current is reduced to zero or up to 95% of pickup current.

Continuous rating is 10 amperes. One second rating is 250 amperes.

The accuracy of the pickup setting is 5% over the full range and 10% from -20 to +55°C. Since the setting is continously adjustable, closer setting accuracy can be obtained by using a current source and a precision ammeter.

CAUTION: Since the tap block connector screw carries operating current, be sure that the screw is turned tight.

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Control Timer

The range of the control timer is 150 to 250 ms. The timer as received should be set for approximately 200 ms. A 150 to 600 ms timer is available and is shipped set at 600 ms.

The timer setting can be changed by means of a screwdriver through the hole on the front plate of the timer module.

The accuracy is 5% over the temperature and voltage range.

BF Timer

The range of the BF timer is 18 to 175 ms. It is set by means of a knob and calibrated scale at the front of the timer module. A 50 to 500 ms timer is also available.

The accuracy of the pickup setting is 5%. Since the setting is continuously adjustable, the timer may be set closer by instrumentation.

The accuracy is 5% over the temperature and voltage range.

Power Supply

Consists of a 10 watt zener diode (Zs), a resistor (Rs) and provides a regulated voltage of 24Vdc $\pm$10% over the voltage and temperature range. A capacitor C3 is connected across the zener diode to decrease the rate of rise and fall of the output voltage to reduce transient effects.

Both modules and the telephone relay (X) are energized by the power supply.

Temperature and Voltage

The relay is operative over a range of 80 to 110% of rated voltage and from -20 to +55°C.

It can be energized continuously at 110% of rated input voltage.

Capacitive Effect

The capacitive surge immunity is as follows (considering the 52a contact input present):

Relay Rating	BF Timer Setting	Capacitance
48 Vdc	18 ms or higher	18 MFD
125 Vdc	18 ms or higher	6 MFD
125 Vdc	35 ms or higher	13 MFD
250 Vdc	18 ms or higher	2.5 MFD
250 Vdc	35 ms or higher	13 MFD

Any value of capacitance effectively in series with the input greater than that shown above might result in an undesired trip operation.

Ordinarily capacitance should not be connected from the lead connecting the 52a contact to the relay and ground. A value of 0.5 MFD could cause the 52a input to stay on for 1.5 ms (48V relay), 4.5 ms (125V relay) and 20 ms (250V relay) after the 52a contact opened.

X RELAY

Coil resistance is 1500 ohms ±5% and rated for 24Vdc operation. The seal-in contact will pickup providing the BFI (62X, 62Y) initiate contacts are closed for a minimum of 8 ms. A second contact is wired to relay terminal 11 and 12 to provide a retrip feature.

AR RELAY

The coil resistance is 630 ohms ±5% and will operate in series with the appropriate resistor from 80% to 110% of rated voltage.

The operate speed is 3 to 5 ms at rated voltage. The dropout time is 30 to 45 ms (diode around the coil). There are 4 normally open contacts available.

INDICATING CONTACTOR SWITCH (ICS)

The coil resistance is approximately 6.5 ohms on the 0.2 amp tap and 0.15 ohms on the 2.0 amp tap.

TRIP CIRCUIT

The main contacts will safely close 30 amperes at 250 Vdc and the seal-in contacts of the ICS will safely carry this current long enough to trip a circuit breaker.

SETTINGS

OVERCURRENT DETECTOR

The pickup of the overcurrent unit is obtained by means of a tap screw and tap block in conjunction with the tap multiplier knob setting located at the front of the overcurrent unit module. This permits a continuous adjustment over the range of 0.5 to 13.5 amperes. Each tap setting permits adjusting the pickup over a 3 to 1 range.

There are 2 or 3 phase inputs depending on the relay style. Each one has its own tap block. Normally all the phase settings should be in the same tap. The operate point for each phase should be within 5% of each other. There are trimpots for each input located on the overcurrent module which are factory adjusted but which may be readjusted if the 5% accuracy must be improved at any one pickup point.

The ground unit pickup is obtained similar to the phase above and is independent of the phase pickup. This permits the ground setting to be lower than the phase setting.

The phase units must be set below the minimum expected fault current and the ground unit set below the minimum expected residual (3I0) current. Settings should be made to assure a multiple of pickup of at least 2 under minimum fault conditions.

CONTROL TIMER

The control timer can be set by use of a screwdriver to adjust the trimpot which is accessible through the hole in the front plate of the timer module. Clockwise rotation will increase the on time. An oscilloscope or electronic timing device can be connected between the bottom red test jack on the timer module front plate and terminal 8 of the relay (common negative).

The control timer should be set for at least 16 milliseconds longer than the BF timer. This allows for pickup time of the reed relay (1 to 3 ms), AR relay pickup (3 to 5 ms) and operate time of the o/c unit (3 to 8 ms).

The range of adjustment is a minimum of 100 ms (150 to 250 ms). The control timer is shipped from the factory set for 200 ms.

A 150 to 600 ms timer is available and is shipped with the timer set for 600 ms.

The control timer acts essentially as a pulse stretcher on the BFI input and then resets. Since the overcurrent unit never picks up on successful clearing, it cannot be used as a cutoff for the breaker failure timer.

BF TIMER

A calibrated scale located on the front of the timer module permits setting the time delay from 18 to 175 milliseconds. The scale is calibrated in 25 ms increments. If more accurate settings are desired an oscilloscope or electronic timer may be connected between the upper red test jack on the timer module and terminal 8 of the relay (Common Negative). Jumpering test point TP6 and TP7 on the timer module prevents the control timer from resetting the BF timer and will help in setting the BF timer. Remember that if the control timer is set shorter than the BF timer, the BF timer will not be able to operate the reed relay (RR).

A 50 to 500 ms BF timer with 50 ms scale increments is also available.

A locking tab is provided to hold the BF timer setting from being accidentally changed.

The timer is shipped set at 175 ms. The 50 to 500 ms timer is shipped set at 500 ms.

The breaker failure timer should be set to exceed the breaker normal clearing time by an appropriate margin. Where the breaker contains a resistor that is inserted on tripping and the overcurrent fault detectors are set below the resistor current, the additional time for this interruption must be included. A secure margin for the SBF-1 is 2 cycles. (33 ms)

INDICATING CONTACTOR SWITCH (ICS)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw.

When the relay energizes a 125 or 250 Vdc type WL relay switch or equivalent use the 0.2 amp tap. For 48 Vdc applications set the unit in the 2 amp tap and use a type WL relay with a S#304C209G01 coil or equivalent.

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 rear mounting stud or studs for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure correct operation of this relay have been made at the factory and should not be disturbed.

Acceptance Test

The following check is recommended to insure that the relay is in proper working order. Refer to Fig. 10 for test connections.

Overcurrent Detector

Check for correct scale marking by placing all the tap settings in the 0.5 Amp. position and rotate the Phase and Ground tap multiplier knob (on the overcurrent unit knob) to the X1 calibration mark.

Jumper test point TP 6 and TP7 on the timer module and apply rated dc voltage. Also apply phase current to phase A input. The voltage at test point TP3 on the overcurrent module should drop from approximately 23.5 volts to less than 2.5 Vdc when the ac current input is between .48 and .52 amperes. The AR output relay will pickup at the same time. When TP6 and TP7 is jumpered the dropout time of the o/c output at TP3 will be slow. Opening switch to terminal 9 momentarily will speed up the dropout time.

Use the same test with applying current to phase C (and also phase B if used). Pickup should be within 5% of the phase A pickup.

Rotate Tap Multiplier Knob to the X3 setting and repeat above. The operate current should be between 1.44 and 1.56 amperes on phase A input and within 5% of phase A pickup for phase C (and phase B if used).

For setting Phase A current operate level, set the tap screw in the proper range location and set the phase tap multiplier at the point at which the voltage at TP3 changes from high to low at the desired input current. The phase C and Phase B (if used) tap screws should be set for the same current range. The AR output relay will also pickup and can be used for an indication.

The Ground overcurrent setting is checked and set exactly like the phase overcurrent circuit.

A locking feature is provided to hold the tap multiplier knob at the desired setting.

Control Timer

Use a low bounce initiate contact in series with relay terminal 9 (positive). Connect an electronic timer to the relay so that the start input is connected to relay terminal 9 (through a voltage divider, if necesary). The stop input should be connected to the bottom test jack on the timer module. The common should be connected to terminal 8. The test timer start input should be adjusted to commence timing on a positive going slope and to stop timing on a negative going slope.

The control timer output should go from a high state to a low state in 190 to 210 milliseconds (or in 570 to 630 ms for the longer range timer).

If some other time interval is desired, the timer setting may be changed by means of a screw driver adjustment through the access hole on the timer module to a multiturn potentiometer. Use the electronic test timer in the manner described to obtain the desired time interval. Remember that the Control Timer should always be set at least 16 milliseconds longer than the BF timer. The adjustment range is 150 to 250 ms (or 150 to 600 ms in the longer range timer).

BREAKER FAILURE (BF) TIMER

This may be checked in the same way as the Control Timer.

First jumper test points TP6 and TP7 on the timer module. Connect the test timer stop lead to the upper test jack on the timer module. Output of the BF timer takes place when it goes from a high state to low state (similar to the Control Timer output). Close switch to terminal 9 and see that the timer output switches in 170 to 180 ms (or 485 to 515 ms for the longer range timer).

Set the timer knob at the desired setting and verify setting by operating the timer several times. The timer should operate within 5% of the setting. The setting may be made closer by means of the electronic test timer.

When the desired setting has been obtained it may be locked in place by means of the locking tab.

Overall operation may be checked by connecting rated dc voltage to relay terminal 18 (52A breaker auxiliary contact input).

Remove jumper from test point TP6 and TP7 on the timer module.

Now when the test switch to terminal 9 is closed, the AR output relay should pickup momentarily and reset even though the test switch is left closed. Remember that the BF timer setting should be 16 ms or more longer than the Control Timer.

Reduce voltage to relay terminal 18 to 60% of rated relay voltage. Close test switch and note that AR relay does not pickup.

Return voltage to normal and reduce voltage to terminal 9 to 60% of rated relay voltage. Close test switch and note that AR relay does not pick up.

✪ Set voltage to terminal 9 and 18 to 80% of rated relay voltage. Close switch to terminal 18 and then 9. See that AR relay picks up momentarily.

Indicating Contactor Switch (ICS)

There are two ICS units used. Each may be checked by placing the ICS tap screw in the desired tap (0.2 or 2 Amps). Adjust the dc current to the tap value.

Test for seal-in by closing switch to terminal 9 and see that each ICS picks up and seals itself in the closed position.

The contact gap should be approximately .047". Both stationary contacts should make with the moving contacts simultaneously. The indicating target should drop just prior to or at the same time the contacts make.

Routine Maintenance

The relay should be inspected periodically. The operation of the overcurrent circuits, timers and indicating contactor switch should be checked similar to procedure described under SETTINGS. In addition inspect the X and AR relay contacts. A contact burnisher S#182A836H01 is recommended for cleaning contacts. The use of abrasive material for cleaning contacts should be avoided because of the danger of embedding small particles in the face of the contact material which might impair the contact operation.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Overcurrent Detector

Refer to Fig. 7 and 8 or 9 when replacing components.

If a new module is inserted, it will require calibration of the dial plate. Other replacement parts such as a transformer or certain components on the module such as the reference zener, operational amplifier, rheostat, etc. might require new scale markings. In that case a new dial plate will be necessary.

To mark the dial, first jumper test point TP6 and TP7 on the timer board. Energize the relay with rated dc voltage and apply 0.48 Amps ac current to phase A. With the tap in the 0.5 position and the phase multiplier dial knob fully counterclockwise, rotate the phase A trimpot slowly CCW (to lower pickup). Operation of the overcurrent unit is indicated when the AR output relay picks up. Verify this adjustment by increasing the ac current until the relay again picks up. This should be between 0.47 and 0.49 amps. Now turn the front panel dial knob fully CW. Check to see that pickup is 1.55 to 1.80 amps. If it is slightly below 1.55 amps, rotate the phase A trimpot slightly clockwise to raise the pickup to 1.55 amps. Go back and check to see that the pickup with the dial knob fully CCW is no higher than .495 amps. Adjust knob on shaft so that the high and low operate point are equidistant from the knob lock. Apply 0.5, 0.7, 0.9, 1.1, 1.3, and 1.5 amps and scribe the scale at the knob pointer setting at which the output relay just operates.

After scribing the scale, set the dial at 0.5 amp (X1) pickup and note what value current the output relay operates. Apply current source to phase C and note at what current value the output relay operates. If the difference is greater than .025 amp from phase A, adjust the phase C trimpot to bring the operate point within .025 amps of phase A. Repeat for phase B if used.

The same procedure should be followed for the ground overcurrent circuit as was used for phase A input.

Remove jumper from TP6 and TP7 on the timer module.

Control Timer

Refer to Fig. 4 and 5 or 6 when replacing components.

If components in the control timer circuit have been replaced or if it is desired to change the control timer setting the same procedure should be used as described under acceptance testing.

Breaker Failure (BF) Timer

If the scale appears to be off calibration due to slippage of the knob pointer on the shaft, this can be corrected by rotating the shaft fully CCW. Now adjust the knob at the pin prick mark. This should return the knob to its original position on the shaft and bring the scale markings back into calibration.

If components in the breaker failure timer circuit have been replaced it may be necessary to change the scale plate and recalibrate. First jumper test points TP6 and TP7. Using a low bounce initiate switch adjust timer knob until a 25 ms time delay has been obtained. Use test procedure described under acceptance testing for measuring time delay. Note the knob position for 25 ms delay. Also note the knob position for 175 ms delay. Loosen the set screw and position the knob on the shaft so that the 25 and 175 ms locations are equidistant about the knob locking tab. Scribe lines at the 25 ms setting and for each 25 ms increment up to 175 ms.

Indicating Contactor Switch (ICS)

Adjust the contact gap for approximately .047" by adjusting the stationary contacts. Both contacts should make simultaneously.

Check to see that the contacts close at rated tap value current. The indicating target should drop at or just prior to the contacts closing. The targer should drop freely.

If the target does not drop or does not reset it may be necessary to remove the cover and bend the tab on the spring that supports the target.

TROUBLE SHOOTING

The components in the SBF-1 relay are operated well within their rating and normally will give long and trouble free service. However, if a relay gives indication of trouble in service or during routine checks the following information will prove helpful. All measurements are approximate and may vary as much as 20%. All voltages are positive with reference to common negative (relay terminal 8) except ac voltages.

Timer Module

1. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at lower test jack=23.5V
   b. Remove jumper. Apply rated voltage. Voltage at lower test jack = 23.5 Vdc.
2. Jumper test points TP6 and TP7
   a. Apply rated relay voltage. Voltage at upper test jack=less than 2.5 Vdc.
   b. Remove jumper. Apply rated voltage. Voltage at upper test jack=less than 2.5 Vdc.
3. Jumper test points TP6 and TP7.
   a. Apply rated voltage. Voltage at terminal 6 of IC1=18.3V.
   b. Remove jumper. Apply rated voltage. Voltage at terminal 6 of IC1 should be approximately 0.1 Vdc less than voltage measured in section a.
4. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 7 of IC1=20.8V with timer knob fully CW.
   b. Voltage at terminal 7 of IC1=23.8V with timer knob fully CCW.
5. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 2 of IC1=16.5V.
   b. Remove jumper and apply voltage. Voltage at terminal 2 of IC1 should be approxi-

mately 0.1V less than voltage measured in section a.

6. Apply twice tap value ac current.
   a. Apply rated relay voltage. Voltage at TP3=12.7V. Voltage at TP4=less than 0.5V.
   b. Interrupt ac current. Voltage at TP3=less than 0.5V. Voltage at TP4=12.7V.

7. Apply rated voltage to relay terminal 18 (52a input).
   a. Apply rated relay voltage to terminal 9. Voltage at TP4=less than 0.5V.
   b. Reduce voltage to terminal 18 to 60% of rated relay voltage. Voltage at TP4=12.7V.

8. Jumper test point TP6 and TP7. Apply twice tap value ac current.
   a. Apply rated relay voltage. Voltage at TP5=6.2V.
   b. Remove jumper. Apply rated voltage. Voltage at TP5=less than 0.5V.

9. Jumper test point TP6 and TP7.
   a. Apply rated relay voltage. Voltage at printed circuit board terminal 10 or 11=less than 0.5V (X and AR relay picked up).
   b. Remove jumper. Apply rated voltage. Voltage at pc terminal 10=24V (X relay not picked up). Voltage at pc terminal 11=rated relay voltage (AR relay not picked up).

Overcurrent Module

1. Jumper test points TP6 and TP7 (timer module). Set tap in 0.5 hole and turn tap multiplier knob to X1 position.
   a. Apply 0.5 amp ac current to the particular input in question. Then apply rated relay voltage. Measure 6.6 Vac at the transformer secondary terminals. The same voltage should be read with the tap in the 1.5 amp tap and 1.5 amps ac applied. Likewise with the 4.5 amp tap.

2. Jumper test points TP6 and TP7. Set tap in 0.5 amp. hole and turn tap multiplier to X1 position.
   a. With 0.4 amp ac current flowing apply rated relay voltage. Measure voltage at terminal 5 of IC1 to be 6.4V. Now increase the current until the output relay operates. The voltage should now read approx. 5.4V. At this point the voltage at terminal 4 should measure 6.4V. The voltage at printed circuit board terminal 3 should measure 23.5Vdc before the output relay operates and less than 2.5V after it operates.

3. Jumper test points TP6 and TP7. Set tap in 0.5 hole and turn tap multiplier knob fully CW.
   a. Apply 0.5 amp ac and apply rated relay voltage. Measure 4.2 volts at the brush terminal of the tap multiplier rheostat.

4. Jumper test points TP6 and TP7 (timer module).
   a. Apply rated relay voltage. Measure 6.2V at TP1 and less than 0.5V at TP2.
   b. Remove jumper. Apply rated relay voltage. Measure less the 0.5V at TP1 and 24V at TP2.

5. Check of Reed relay (RR) contact.
   a. Resistance should be greater than 500 ohms when measured from jumper J1 to common negative.
   b. Jumper test points TP6 and TP7 and apply rated relay voltage. Resistance should drop to less than 5 ohms.

6. Check coil resistance of reed relay (RR) (1000 ohms), AR relay (630 ohms) and X telephone relay (1500 ohms). Attention should be paid to polarity since each of the coils have a diode connected across it.

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 the repair work. When ordering parts, always give the complete nameplate data, and style numbers from the electrical parts list.

TABLE I
ENERGY REQUIREMENTS
60 HZ

TAP	0.5							
TAP MULT.	1 (0.5A PICKUP)				3 (1.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	0.5A	5.0A	0.5A	5.0A	1.5A	1.5A	0.5A	5.0A
VA	.15	2.1	.04	2.2	.53	2.1	.33	2.2
OHMS	.6	.08	.16	.09	.23	.08	.15	.09
P.F. Angle**	75	25	15	27	63	25	20	27

TAP	1.5							
TAP MULT.	1 (1.5A PICKUP)				3 (4.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	1.5A	5.0A	1.5A	5.0A	4.5A	5.0A	4.5A	5.0A
VA	.165	.75	.06	.60	.63	.75	.50	.60
OHMS	.073	.03	.027	.024	.031	.03	.024	.024
P.F. Angle**	45	36	15	15	36	36	15	15

TAP	4.5							
TAP MULT.	1 (4.5A PICKUP)				3 (13.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	4.5A	5.0A	4.5A	5.0A	13.5A	5.0A	13.5A	5.0A
VA	.23	.28	.16	.20	1.6	.28	1.5	.20
OHMS	.011	.011	.008	.008	.008	.011	.008	.008
P.F. Angle**	36	18	5	4	9	18	3	4

* = Saturated Burden
** = Current Lagging Voltage

TABLE 2
BATTERY DRAIN

CONDITION	48Vdc	125Vdc	250Vdc
Standby	0	0	0
During Timing	120mA	95mA	90mA
Trip (AR Relay Picked up)	155	130	125

TABLE 3
CURRENT RATING

CURRENT RANGE (Phase and Ground)		0.5 to 13.5 Amperes
TAP RANGES	**CONTINUOUS**	**1 SECOND**
0.5 to 1.5 Amps	10 Amps	250 Amps
1.5 to 4.5	10	250
4.5 to 13.5	15	300

TABLE 4
AR CONTACT RATINGS

			INTERRUPTING RATING	
CONTACT CIRCUIT RATING	**TRIP RATING**	**CARRY RATING CONTINUOUS**	**RESISTIVE**	**INDUCTIVE L/R=.005**
48Vdc	30 Amps	3 Amps	3.75 Amps	1.75 Amps
125	30	3	.5	.35
250	30	3	.25	.15

✪ TABLE 5
X RELAY CONTACT RATINGS

CONTACT CIRCUIT RATING	TRIP RATING	CARRY RATING CONTINUOUS
48Vdc	30 Amps	3 Amps
125	30	3
250	30	3

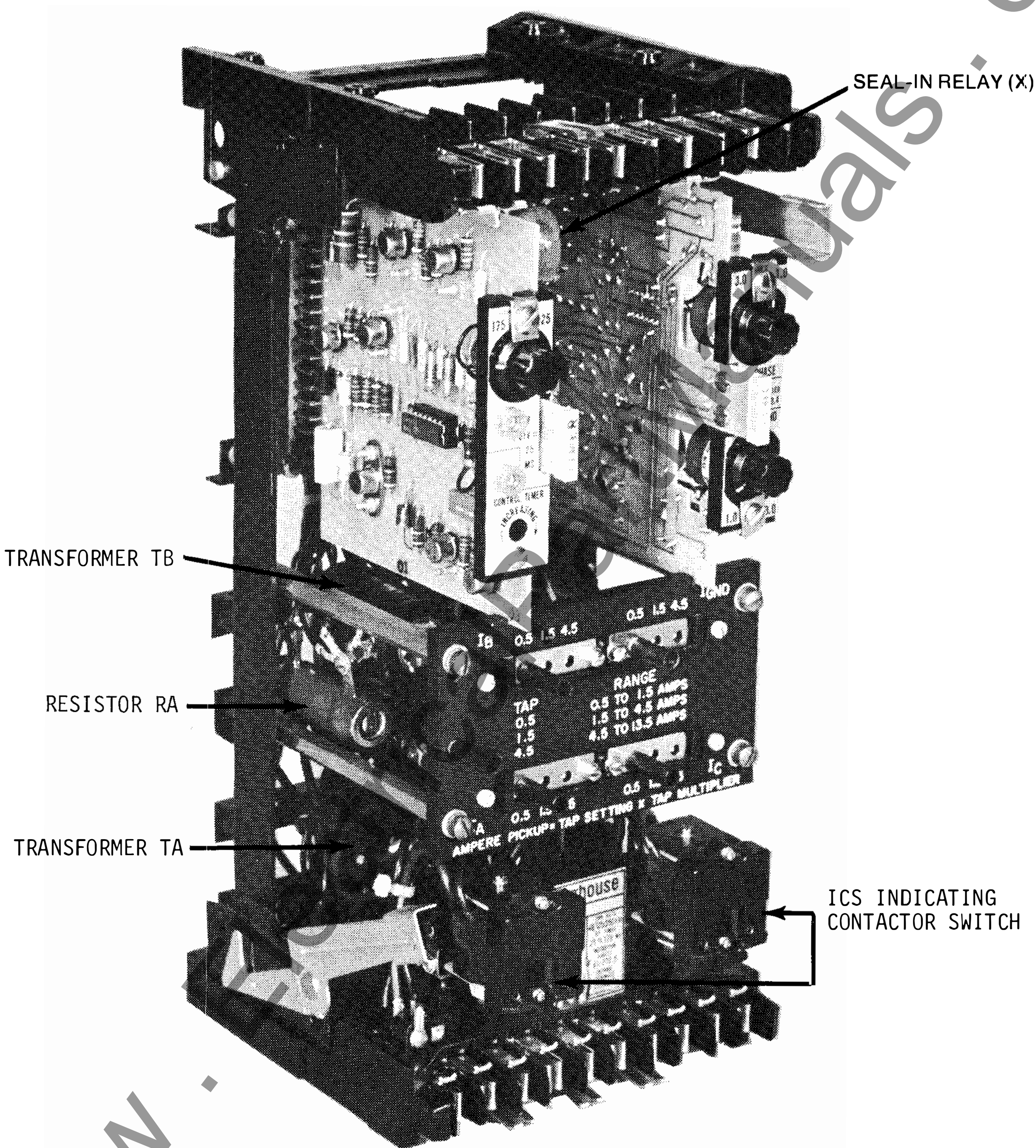
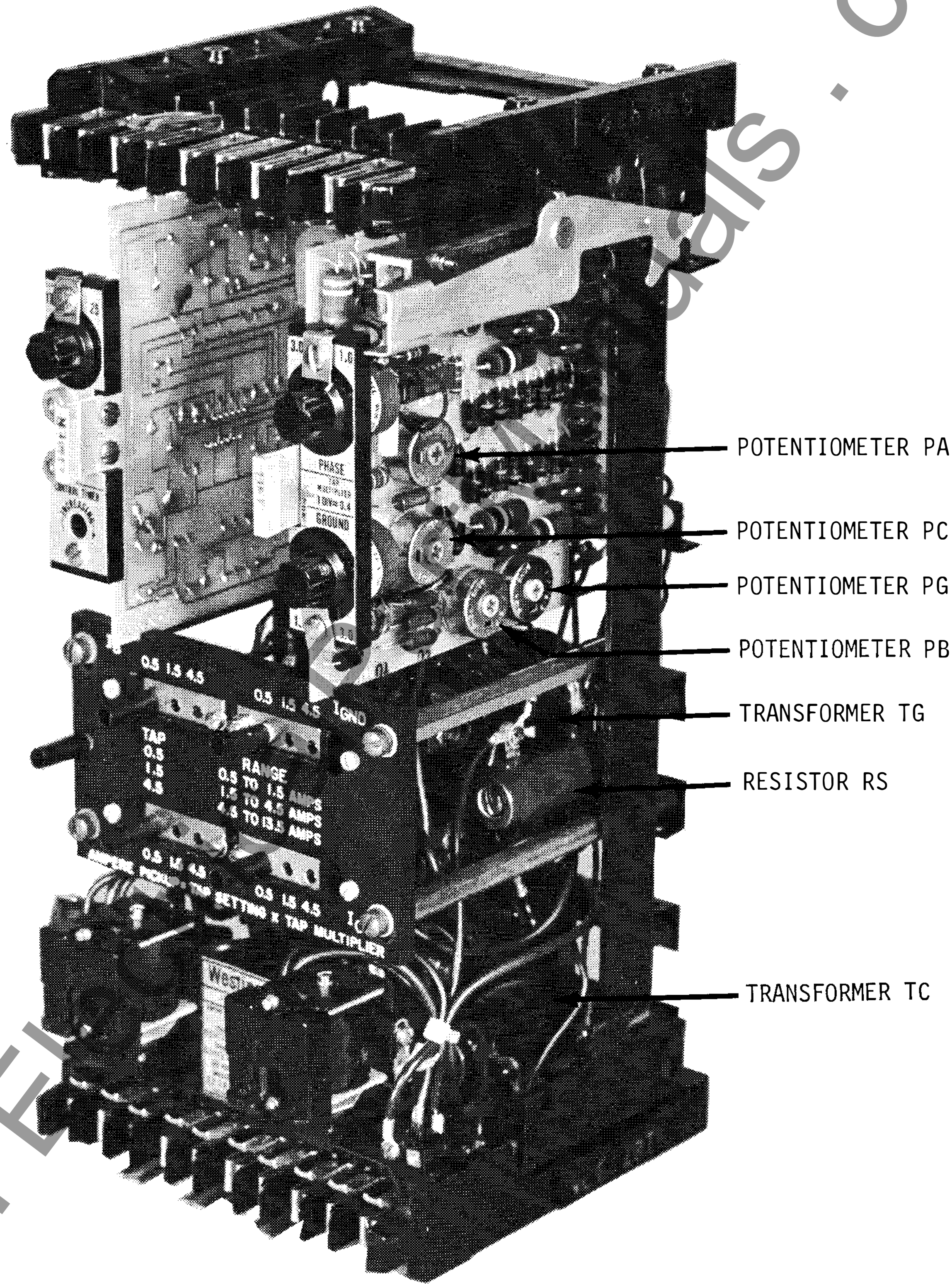
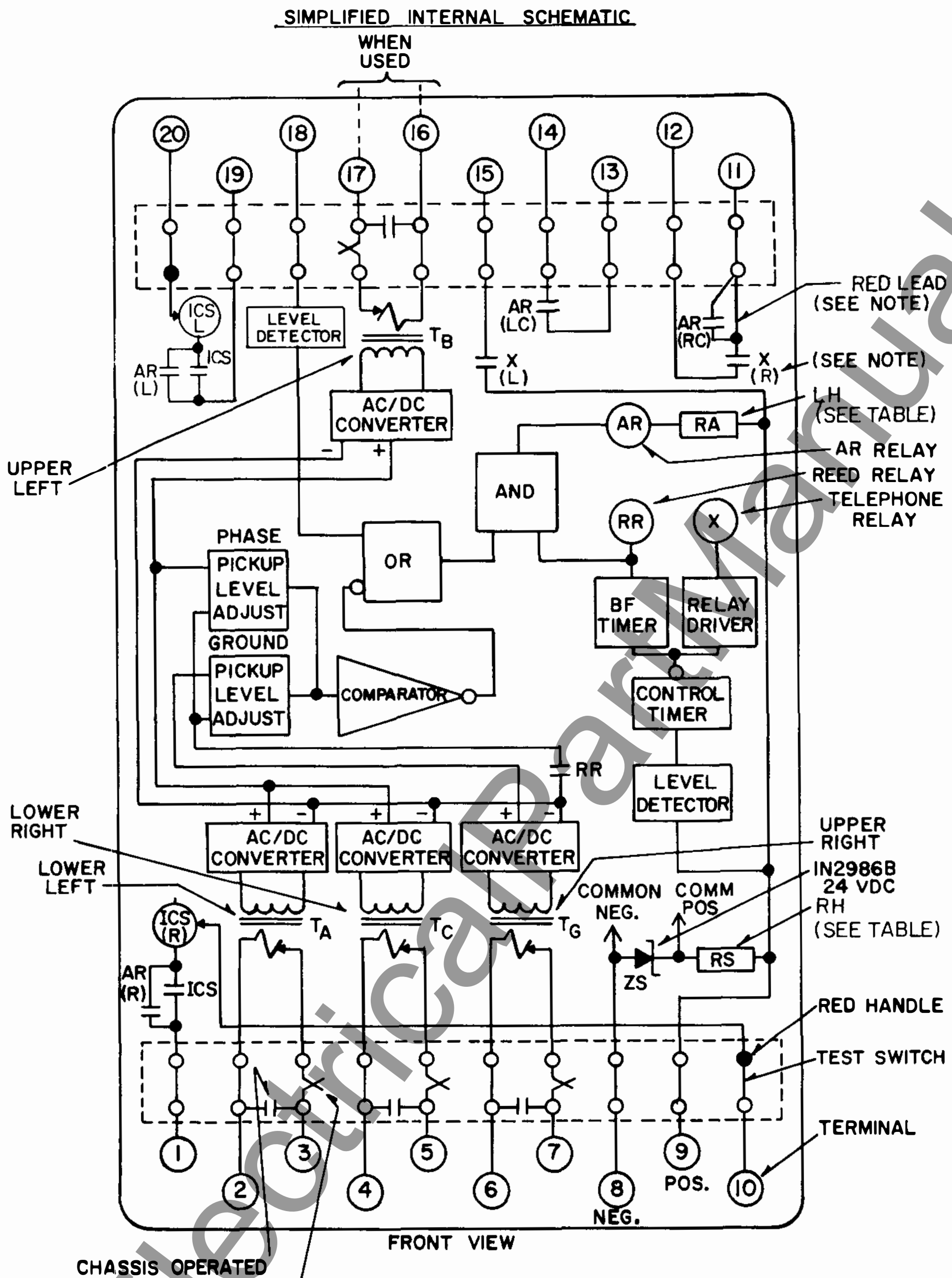


Fig. 1. Photograph of SBF-1 Relay, (without case) with four overcurrent input. Front view



(right oblique).



NOTES:

TO OBTAIN AR CONTACT OUTPUT, MOVE RED LEAD FROM TERMINAL 11 TO TERMINAL 12.

(L),(R),(LC) & (RC) DENOTE LEFT HAND, RIGHT HAND, LEFT CENTER & RIGHT CENTER POSITIONS.

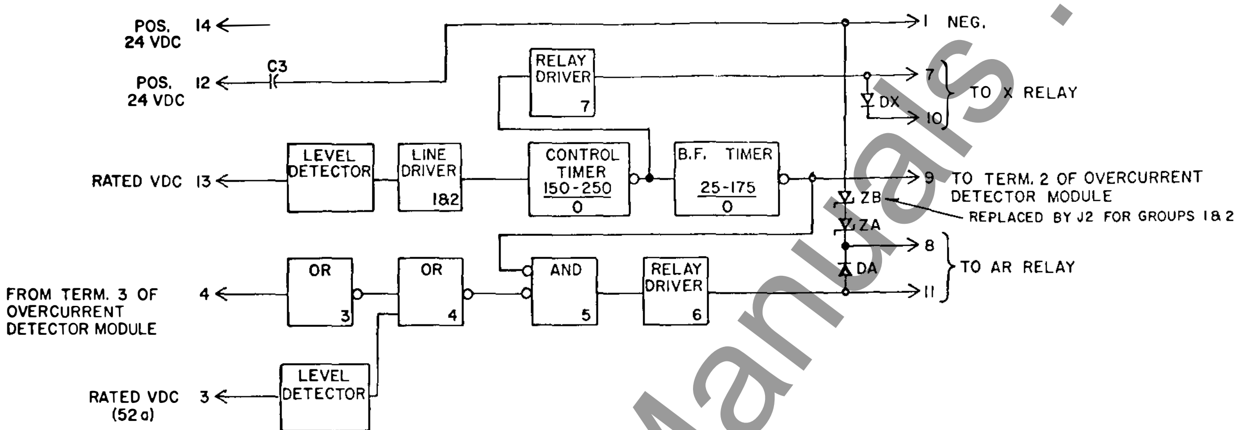
◆ **REF. DWG.**

1326D19 - DETAILED SCHEMATIC
1326D31 - (4 OVERCURRENT UNITS) WIRING
1326D83 - (3 OVERCURRENT UNITS) WIRING

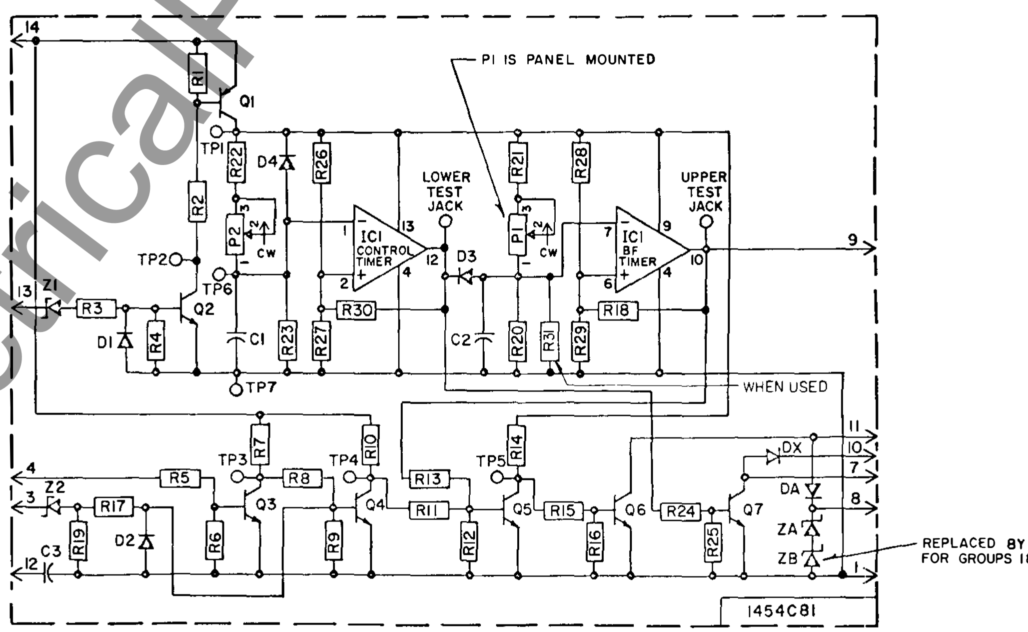
25W RESISTORS		
VOLTS DC	RA	RS
48	900Ω	200Ω
125	3150Ω	1000Ω
250	7100Ω	2500Ω

Sub. 4
Dwg. 775B813

✪ *Fig. 2. Simplified Internal Schematic SBF-1 Relay.*



TIMER AND OUTPUT MODULE



✪ *Fig. 4. Internal Sch*

1454C81G01 (48 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21
DIODE	**DESCRIPTION**	**STYLE NO.**
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12
INT CKT	**DESCRIPTION**	**STYLE NO.**
IC1	747DM	1443C52H01
JUMPER	**DESCRIPTION**	**STYLE NO.**
J1-2	0 OHM RESISTOR	862A473H01
POT	**DESCRIPTION**	**STYLE NO.**
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02
TRANSISTOR	**DESCRIPTION**	**STYLE NO.**
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A535H08
Q6	2N4063	878A432H01
RESISTOR	**DESCRIPTION**	**STYLE NO.**
R4-6-9-12-15 -25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R3-17	20.0K .50W 2%	629A531H63
R5-13-24	27.0K .50W 2%	629A531H66
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39
ZENER	**DESCRIPTION**	**STYLE NO.**
ZA	1R200 200.0V	629A369H01
Z1-2	1N971B 27.0V	862A606H11

1454C81G02 (125 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21
DIODE	**DESCRIPTION**	**STYLE NO.**
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12
INT CKT	**DESCRIPTION**	**STYLE NO.**
IC1	747DM	1443C52H01
JUMPER	**DESCRIPTION**	**STYLE NO.**
J1-2	0 OHM RESISTOR	862A478H01
POT	**DESCRIPTION**	**STYLE NO.**
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02
TRANSISTOR	**DESCRIPTION**	**STYLE NO.**
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01
RESISTOR	**DESCRIPTION**	**STYLE NO.**
R4-6-9-12-15 -25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	47.0K .50W 2%	629A531H72
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39
ZENER	**DESCRIPTION**	**STYLE NO.**
ZA	1R200 200.0V	629A369H01
Z1-2	UZ8870 70.0V	837A693H14

1454C81G03 (250 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21
DIODE	**DESCRIPTION**	**STYLE NO.**
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12
INT CKT	**DESCRIPTION**	**STYLE NO.**
IC1	747DM	1443C52H01
JUMPER	**DESCRIPTION**	**STYLE NO.**
J1	0 OHM RESISTOR	862A478H01
POT	**DESCRIPTION**	**STYLE NO.**
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02
TRANSISTOR	**DESCRIPTION**	**STYLE NO.**
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A535H08
Q6	2N4063	878A432H01
RESISTOR	**DESCRIPTION**	**STYLE NO.**
R6-12-15-25	2000.0 .50W 2%	629A531H39
R4-9	5600.0 .50W 2%	629A531H50
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	100.0K .50W 2%	629A531H80
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R19	36.0K2.00W 5%	185A207H64
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39
ZENER	**DESCRIPTION**	**STYLE NO.**
ZA-B	1N3050B 180.0V	187A936H17
Z1-2	1N3049B 160.0V	187A936H13

1454C81G04 (125 VDC) (50-500 MS BF TIMER / 150-600 MS CONTROL TIMER)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	6.800UF 35V	184A661H21
C1	6.800UF 35V	184A661H21
DIODE	**DESCRIPTION**	**STYLE NO.**
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12
INT CKT	**DESCRIPTION**	**STYLE NO.**
IC1	747DM	1443C52H01
JUMPER	**DESCRIPTION**	**STYLE NO.**
J1-2	0 OHM RESISTOR	862A478H01
POT	**DESCRIPTION**	**STYLE NO.**
P2	500K .75W	3528A37H01
P1	50.0K .50W	880A687H03
TRANSISTOR	**DESCRIPTION**	**STYLE NO.**
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01
RESISTOR	**DESCRIPTION**	**STYLE NO.**
R4-6-9-12-15 -25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	47.0K .50W 2%	629A531H72
R20	255.0K .50W 1%	848A821H21
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	4.99 K .50W 1%	848A820H16
R19	10.0K2.00W 5%	185A207H51
R29	40.2K .50W 1%	848A821H04
R23	226.0K .50W 1%	848A821H76
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39
ZENER	**DESCRIPTION**	**STYLE NO.**
ZA	1R200 200.0V	629A369H01
Z1-2	UZ8870 70.0V	837A693H14

REF. DWG.

COMPONENT LOCATION (48/125 VDC)-- 3517A76
COMPONENT LOCATION (250 VDC)---- 3517A77

Sub. 3
1325D61

ematic of Timer Module.

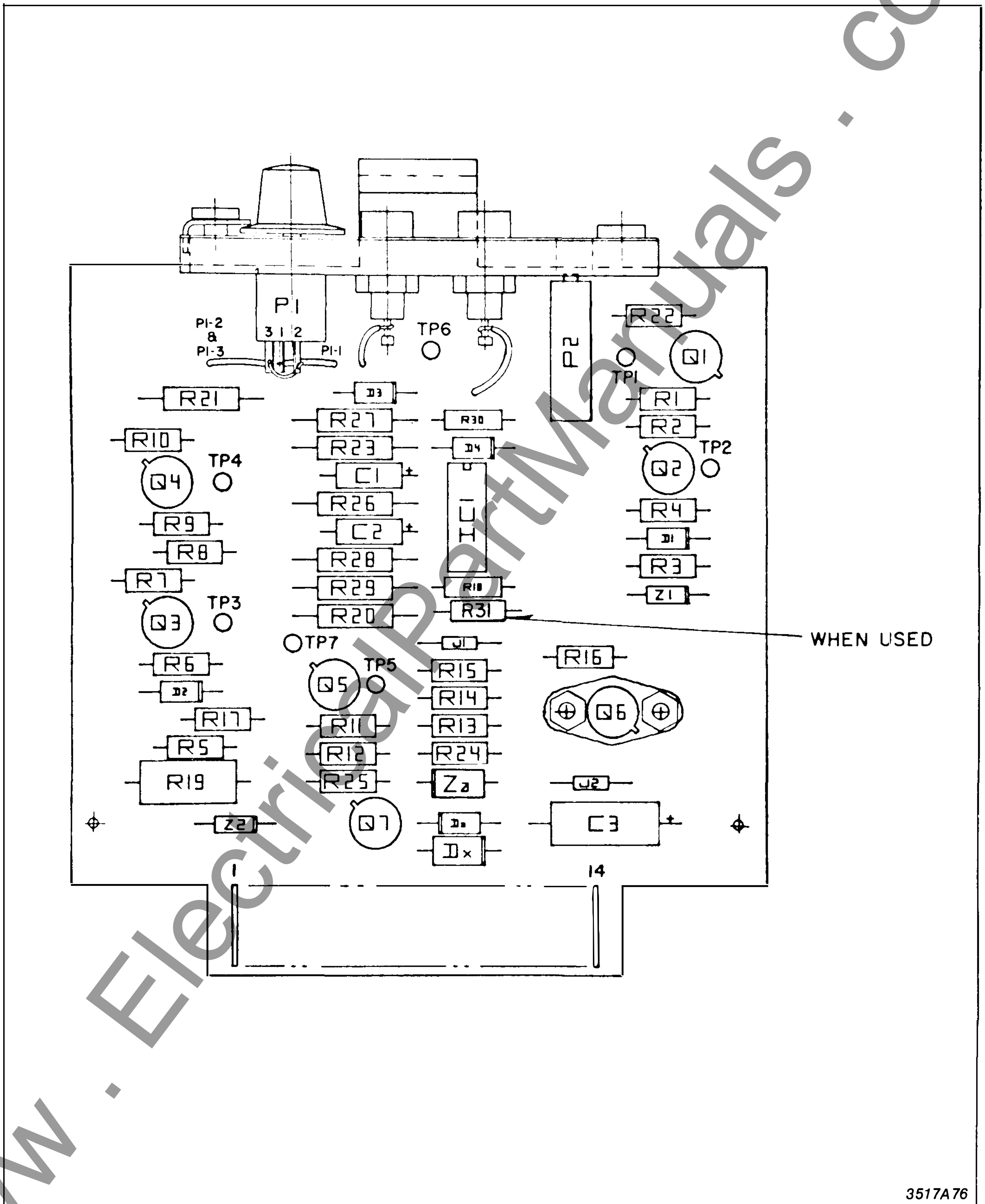


Fig. 5. Component Location for Timer Module 48 or 125Vdc rated relay

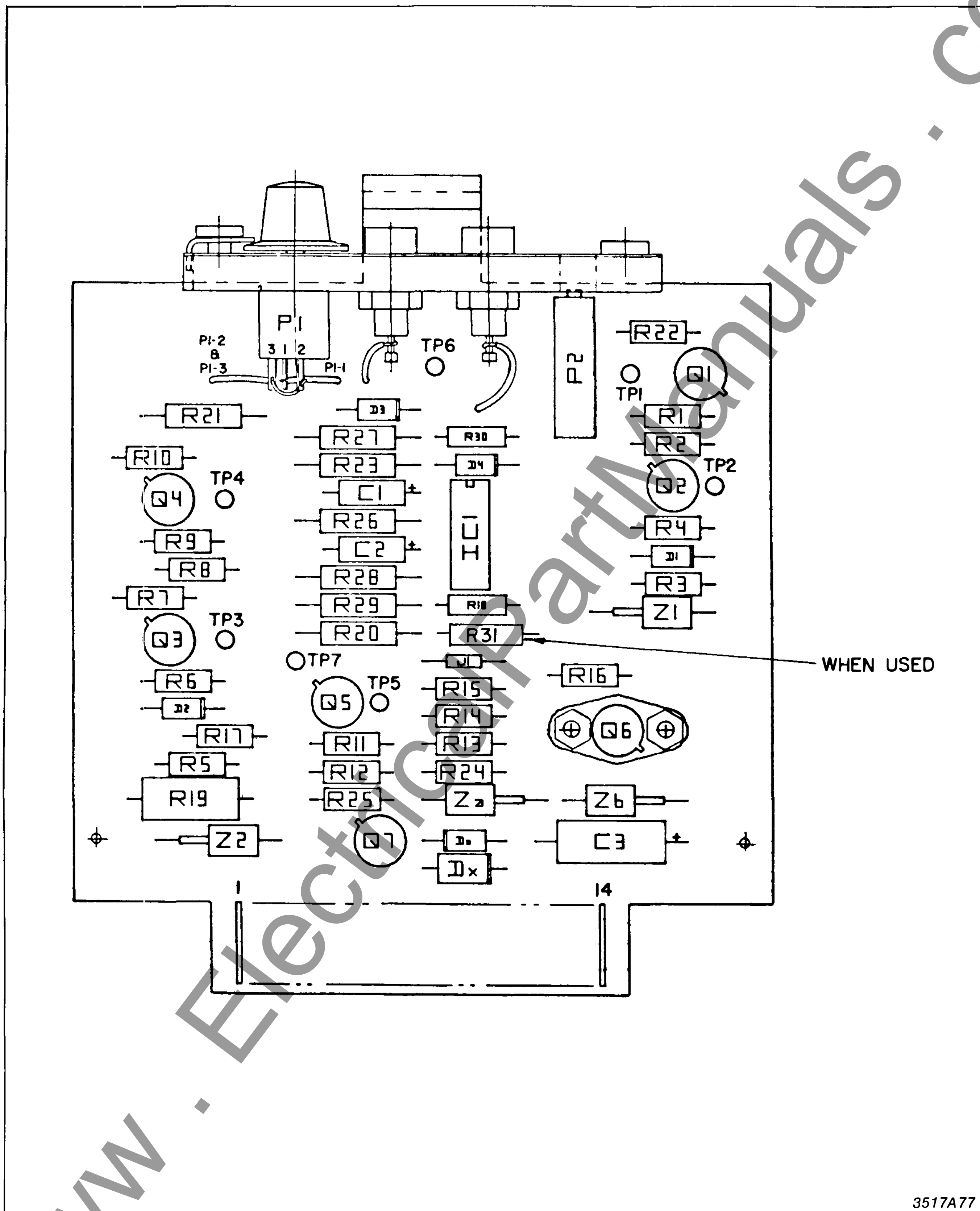
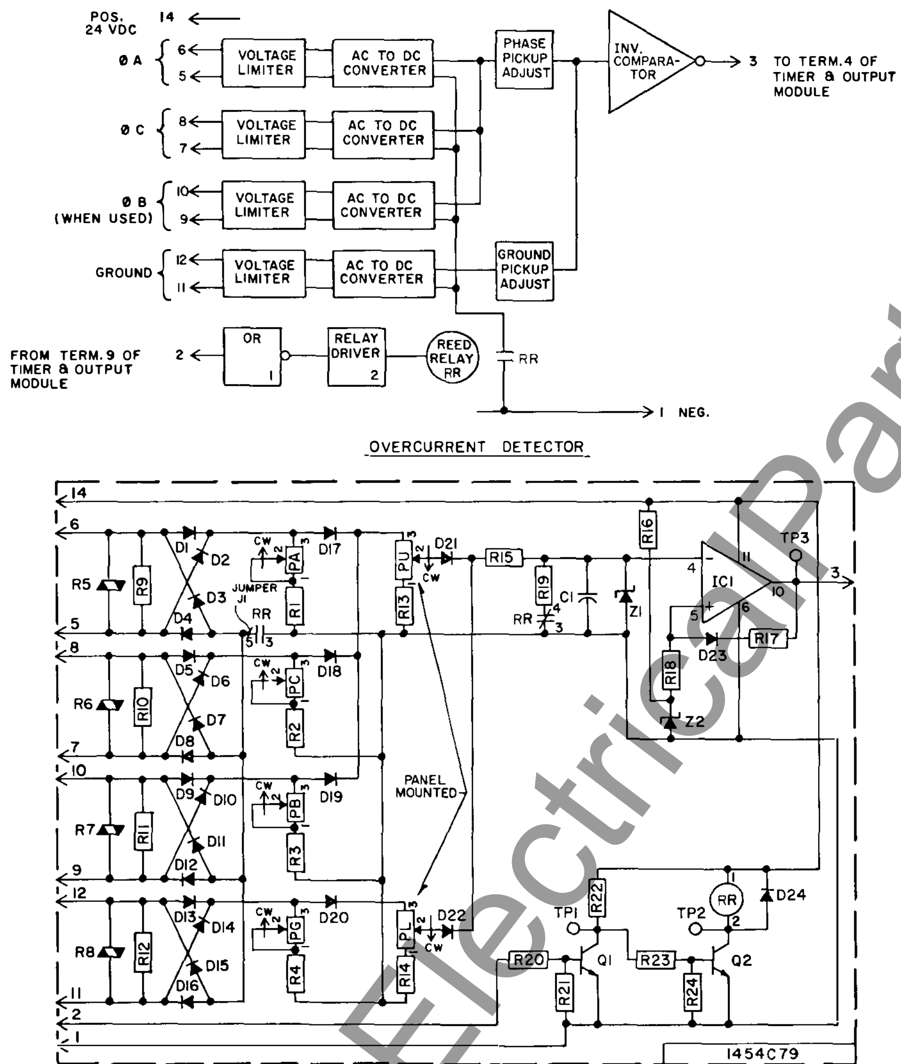


Fig. 6. Component Location for Timer Module 250Vdc rated relay.



1454C79G01 (4 INPUT)

CAPACITOR	DESCRIPTION	STYLE NO.
C1	.270UF 200V	188A669H05
DIØDE	**DESCRIPTIØN**	**STYLE NO.**
D23-24	1N459A	184A855H08
D1-2-3-4-5-6 -7-8-9-10-11 -12-13-14-15 -16-17-18-19 -20-21-22	1N5053	188A342H12
INT CKT	**DESCRIPTION**	**STYLE NO.**
IC1	741C	6677D61H08
JUMPER	**DESCRIPTION**	**STYLE NØ.**
J1	0 OHM RESISTØR	862A478H01
TRANSISTOR	**DESCRIPTION**	**STYLE NO.**
Q1-2	2N1711	762A585H08
RESISTØR	**DESCRIPTIØN**	**STYLE NO.**
R19	100.0 .50W 2%	629A531H03
R21-23	2000.0 .50W 2%	629A531H39
R22	6800.0 .50W 2%	629A531H52
R18-24	10.0K .50W 2%	629A531H56
R20	27.0K .50W 2%	629A531H66
R17	30.0K .50W 2%	629A531H67
R15	10.0K1.00W 5%	137A643H51
R1-2-3-4	1.0K3.00W 5%	763A127H02
R16	1.5K1.00W 5%	187A643H31
R13-14	3.9K2.00W 5%	185A207H41
R9-10-11-12	100.0K2.00W 5%	185A207H75
ZENER	**DESCRIPTION**	**STYLE NO.**
Z2	1N753A 6.2V	862A606H01
Z1	1N4752A 33.0V	849A515H02
PØT	**DESCRIPTIØN**	**STYLE NØ.**
PA-PB-PC-PG	500.0 2.00W 10%	848A778H04
PU-PL	10.0K 12.5W 10%	836A635H14
REED RELAY	**DESCRIPTIØN**	**STYLE NØ.**
MR	1000 OHM COIL	204C556H05
VARISTØR	**DESCRIPTIØN**	**STYLE NØ.**
R5-R6-R7-R8	ZNR K431	3509A31H03

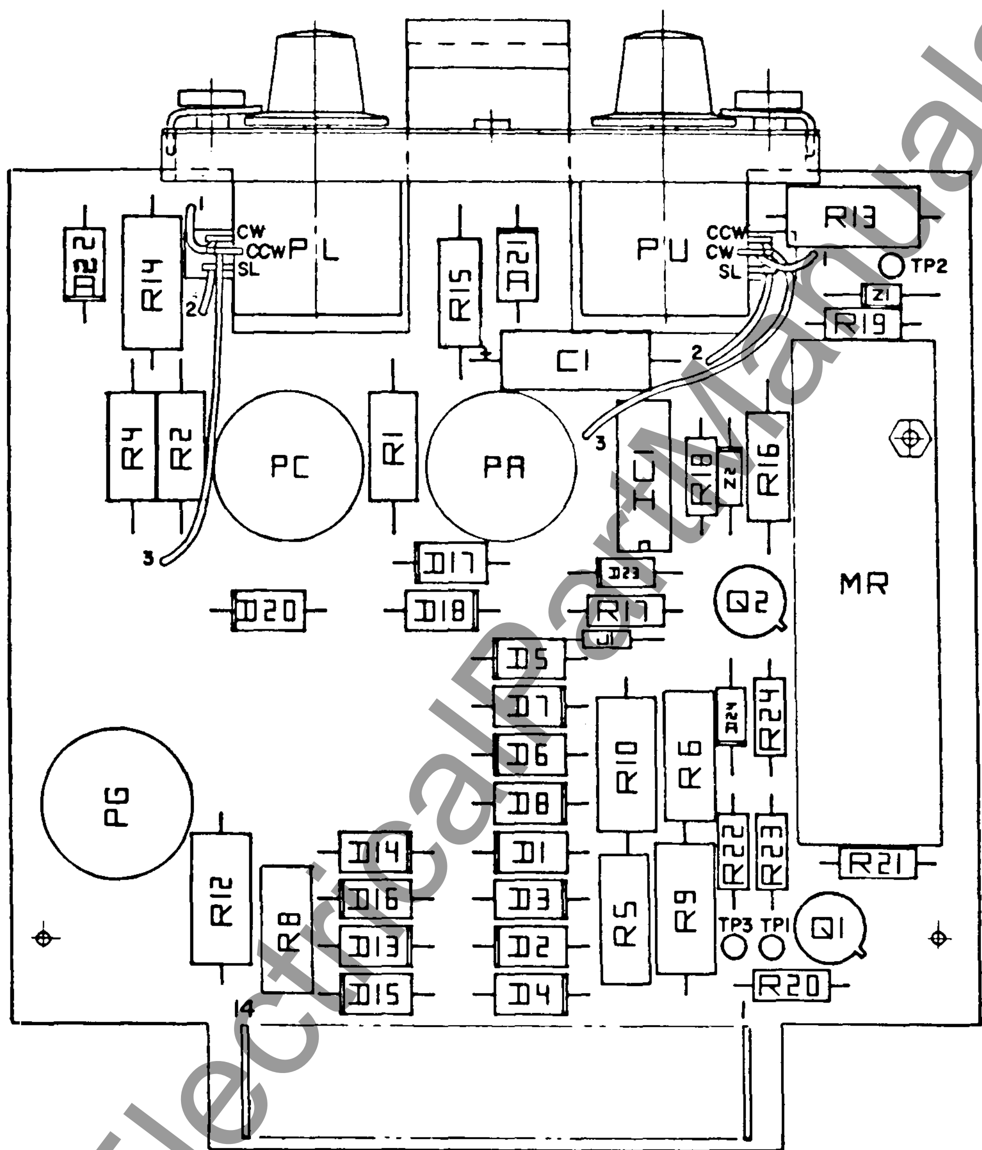
1454C79G02 (3 INPUT)

CAPACITØR	DESCRIPTIØN	STYLE NØ.
C1	.270UF 200V	188A669H05
DIØDE	**DESCRIPTIØN**	**STYLE NØ.**
D23-24	1N459A	184A855H08
D1-2-3-4-5-6 -7-8-13-14-15 -16-17-18-20 -21-22	1N5053	188A342H12
INT CKT	**DESCRIPTIØN**	**STYLE NØ.**
IC1	741C	6677D61H08
JUMPER	**DESCRIPTIØN**	**STYLE NØ.**
J1	0 ØHM RESISTOR	862A478H01
TRANSISTOR	**DESCRIPTIØN**	**STYLE NØ.**
Q1-2	2N1711	762A585H08
RESISTØR	**DESCRIPTIØN**	**STYLE NØ.**
R19	100.0 .50W 2%	629A531H03
R21-23	2000.0 .50W 2%	629A531H39
R22	6800.0 .50W 2%	629A531H52
R18-24	10.0K .50W 2%	629A531H56
R20	27.0K .50W 2%	629A531H66
R17	30.0K .50W 2%	629A531H67
R15	10.0K1.00W 5%	137A643H51
R1-2-4	1.0K3.00W 5%	763A127H02
R16	1.5K1.00W 5%	187A643H31
R13-14	3.9K2.00W 5%	185A207H41
R9-10-12	100.0K2.00W 5%	185A207H75
ZENER	**DESCRIPTIØN**	**STYLE NO.**
Z2	1N753A 6.2V	862A606H01
Z1	1N4752A 33.0V	849A515H02
PØT	**DESCRIPTIØN**	**STYLE Ɨ**
PA-PC-PG	500.0 2.00W 10%	848A778H04
PU-PL	10.0K 12.5W 10%	836A635H14
REED RELAY	**DESCRIPTIØN**	**STYLE NØ.**
MR	1000 OHM COIL	204C556H05
VARISTØR	**DESCRIPTIØN**	**STYLE NØ.**
R5-R6-R8	ZNR K431	3509A31H03

REF. DWG.
4 INPUT COMPONENT LOCATION-3517A79
3 INPUT COMPONENT LOCATION-3517A78

✪ *Fig. 7. Internal Schematic of Overcurrent Detector Module.*

Sub. 3
1455C09



3517A78

Fig. 8. Component Location for 3 Current Input Overcurrent Detector Module.

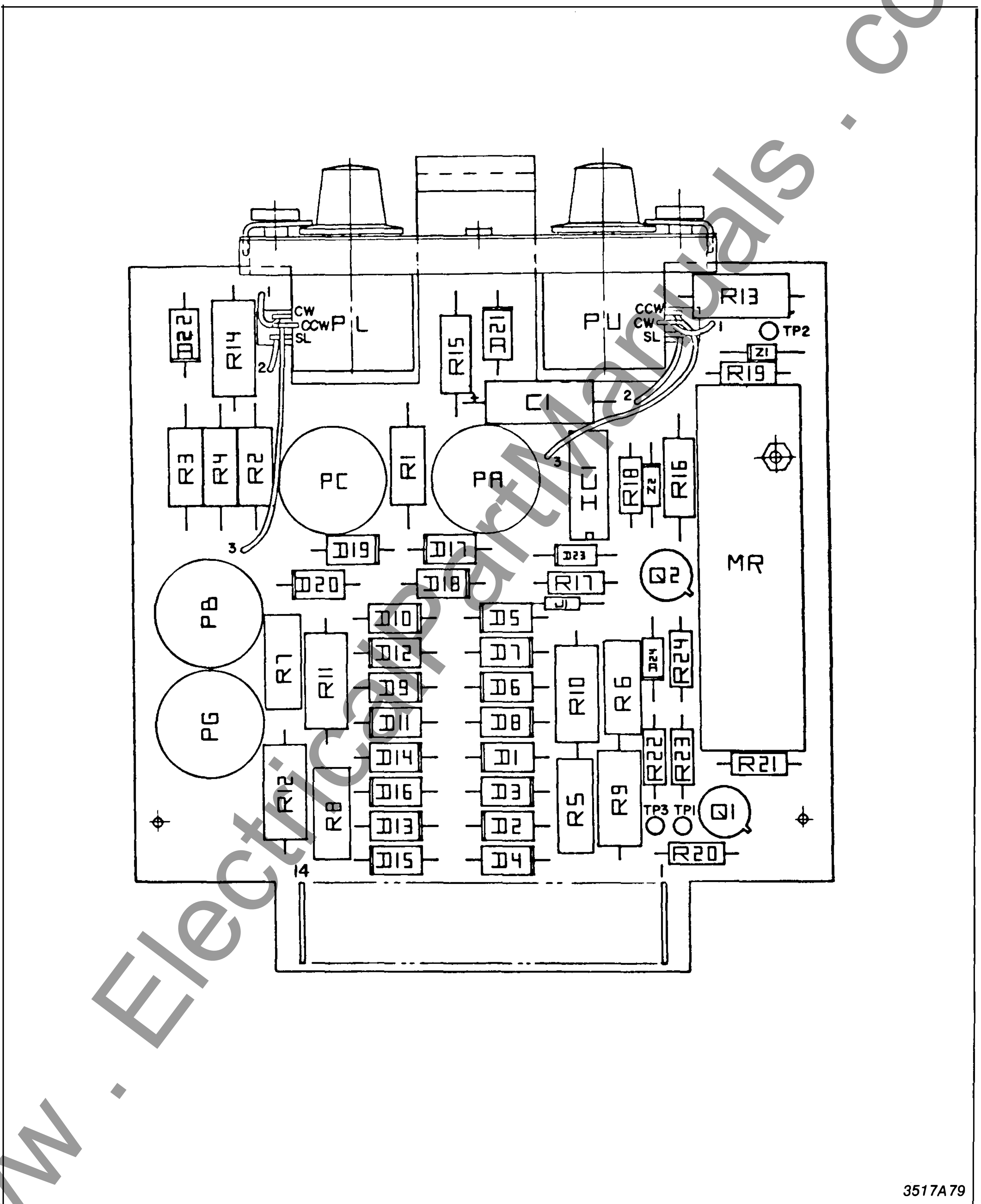


Fig. 9. Component Location for 4 Current Input Overcurrent Detector Module.

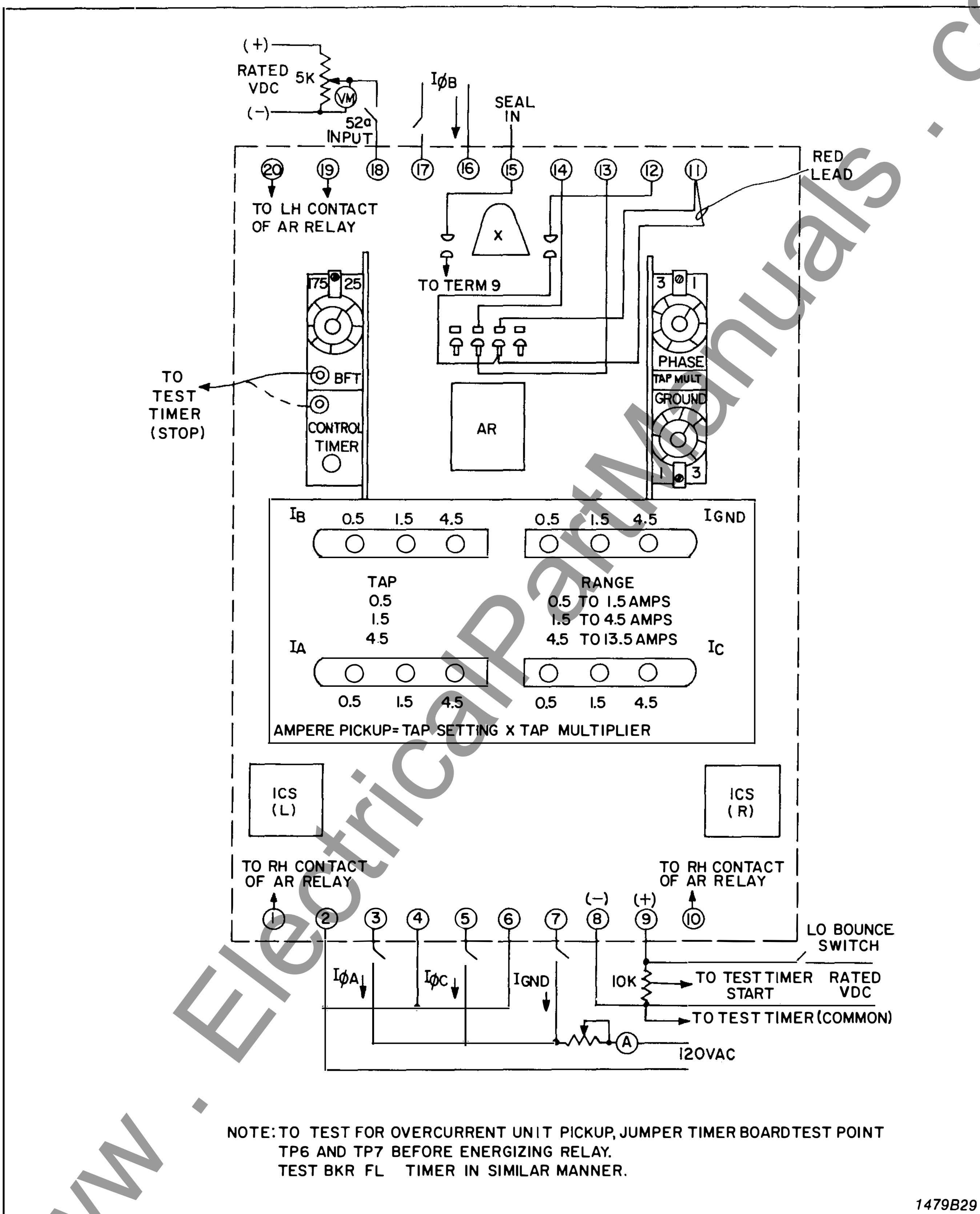
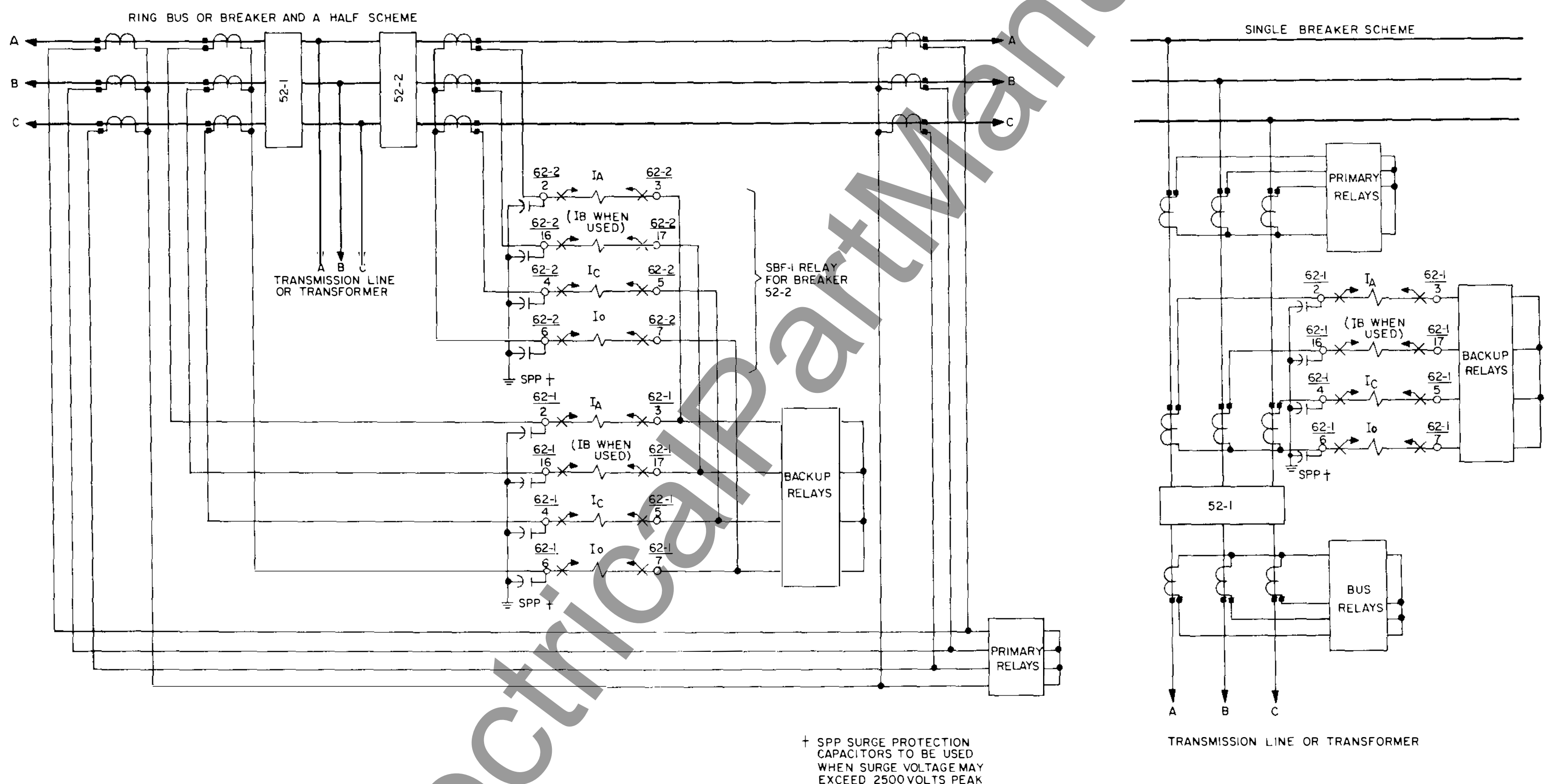
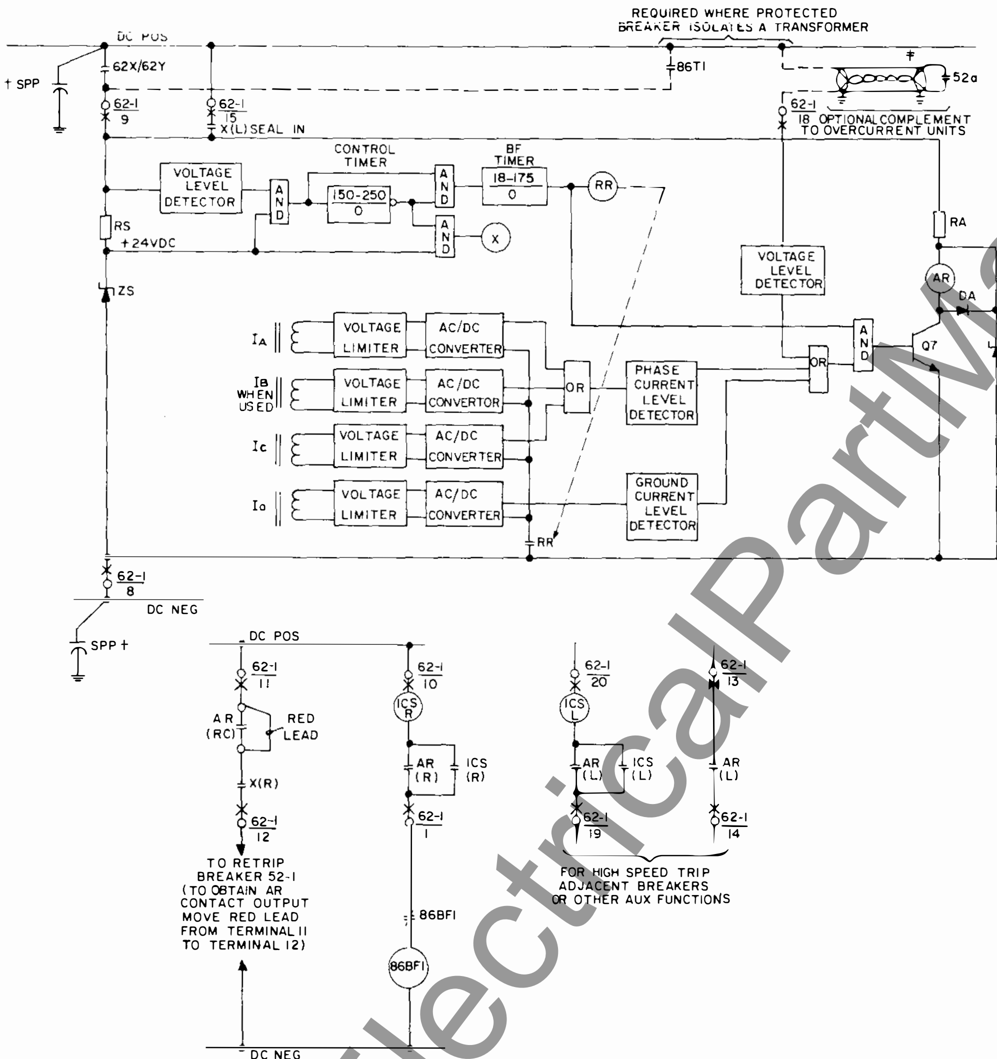


Fig. 10. Test Diagram for SBF-1 Relay.



LEGEND	
DEV	DESCRIPTION
52	CIRCUIT BREAKER
62	SBF-1 BREAKER FAILURE RELAY (775B813, 1326D19)

Fig. 11. External AC Schematic for SBF-1 Relay.



LEGEND	
DEV	DESCRIPTION
52	CIRCUIT BREAKER
62	SBF-I BREAKER FAILURE RELAY (775B813, 1326019)
62X, 62Y	BREAKER FAILURE INITIATE CONTACTS
86BF	BREAKER FAILURE LOCKOUT RELAY
86TI	TRANSFORMER LOCKOUT RELAY

TYPICAL 86BF AND/OR RELAY AUX FUNCTIONS

1. TRIP BREAKERS CONNECTED TO SAME BUS SECTION.
2. BLOCK ALL AUTOMATIC RECLOSING.
3. BLOCK MANUAL CLOSING.
4. KEY TRANSFER TRIP TRANSMITTERS TO TRIP REMOTE BREAKERS AND BLOCK RECLOSING.
5. STOP "BLOCKING" CARRIER.

† SPP SURGE PROTECTION CAPACITOR TO BE USED WHEN SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK

‡ WHEN SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK USE SHIELDED CONTROL CABLE & GROUND BOTH ENDS PER SWITCHYARD RUNS WHERE SURGE VOLTAGE MAY EXCEED 2500 VOLTS REAR

AC SCHEMATIC 1464C77

1464C78

Fig. 12. External DC Schematic for SBF-1 Relay.

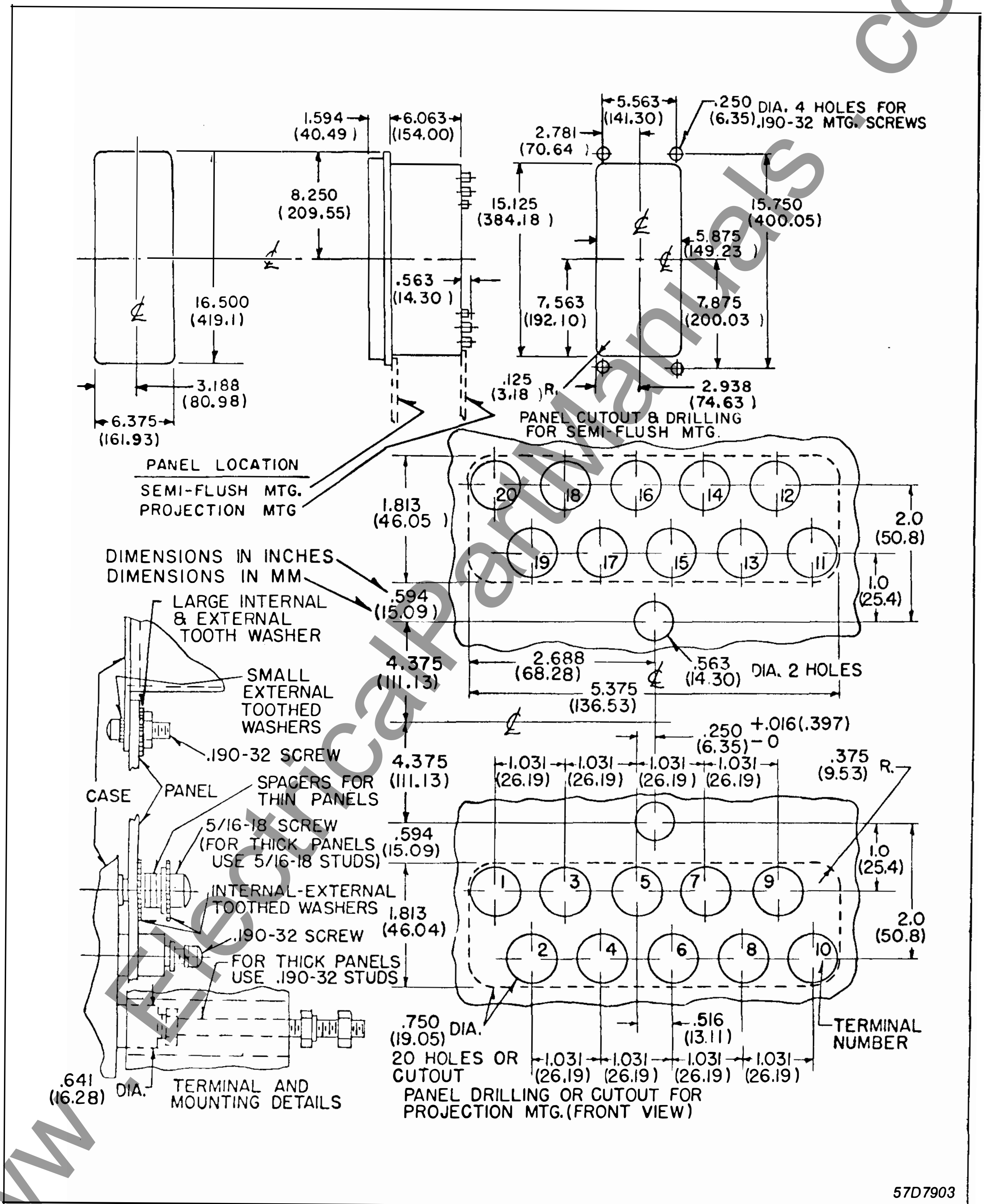


Fig. 13. Outline and Drilling Plan for SBF-1 relay in the Type FT-32 Case. Dwg.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION

CORAL SPRINGS, FL.

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