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, 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.

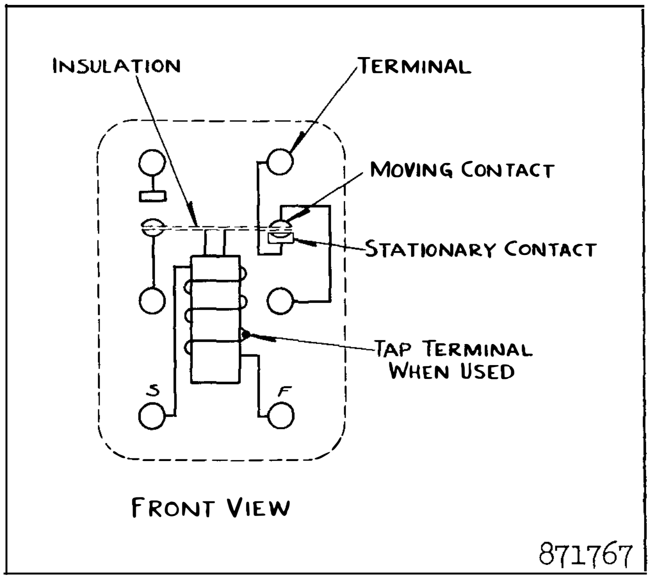


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

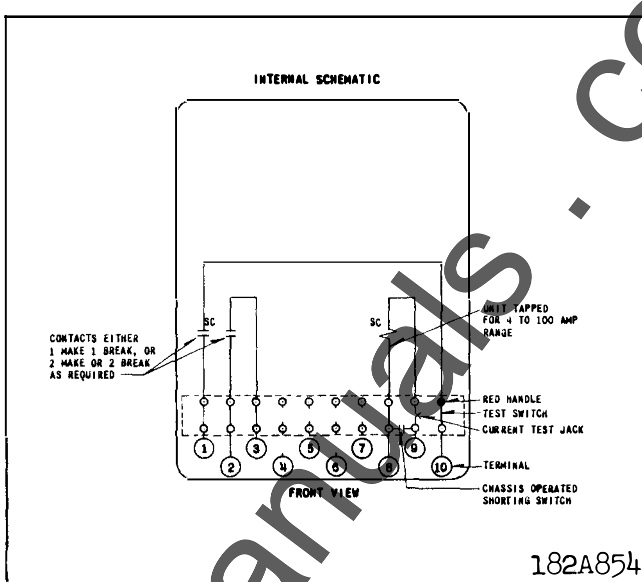


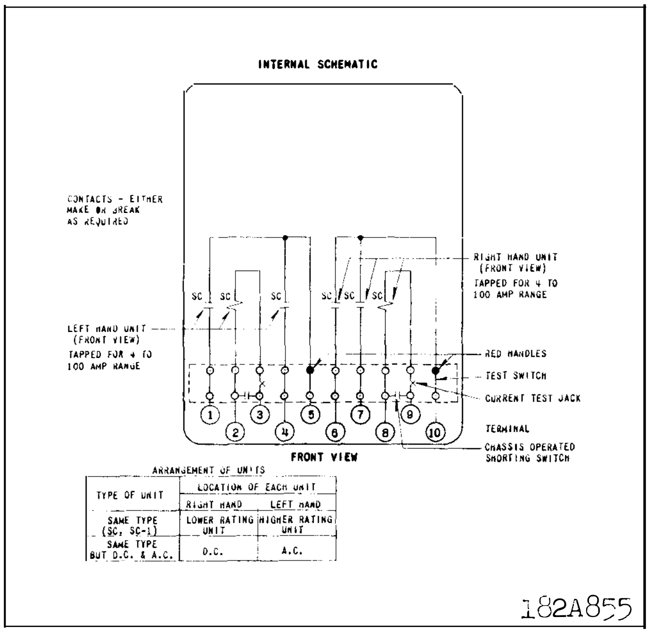
Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay In The Type FT21 Case.

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 pick-up 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 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



TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SC, SC-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

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

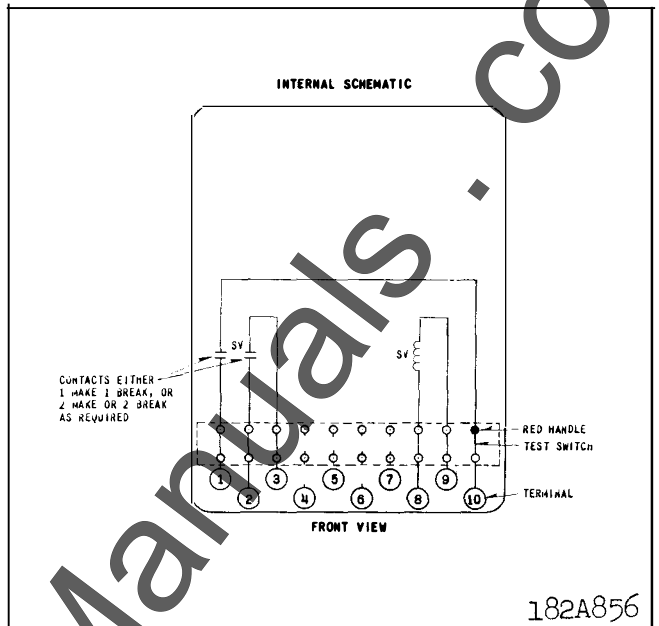


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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 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

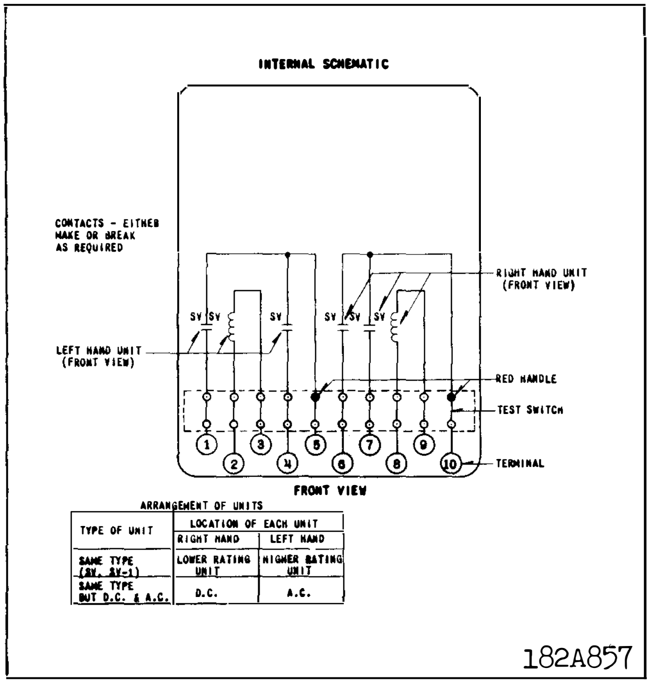


Fig. 5. Internal Schematic of the Double Unit Type SV or SV-1 Relay in the Type FT21 Case.

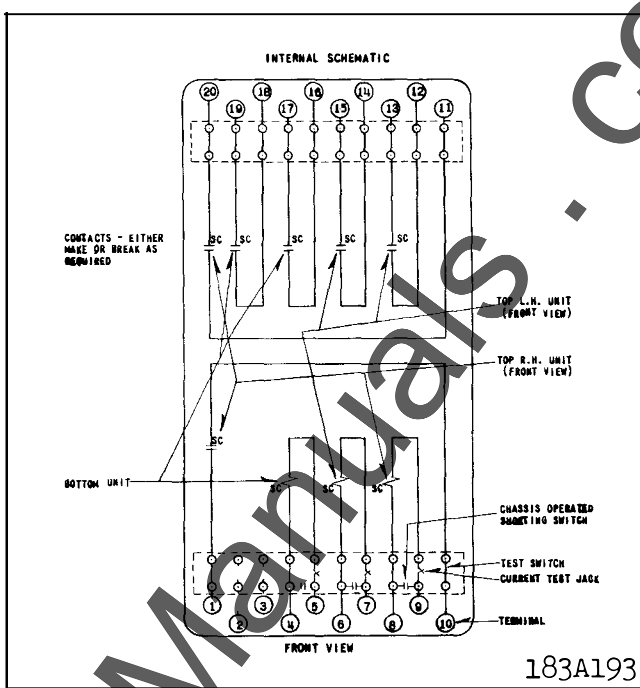


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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 so 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 sand 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-

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	70-160	160	3.4	7.3	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-1	60	70-160	160	4.1	8.5	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%

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 on the 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%.

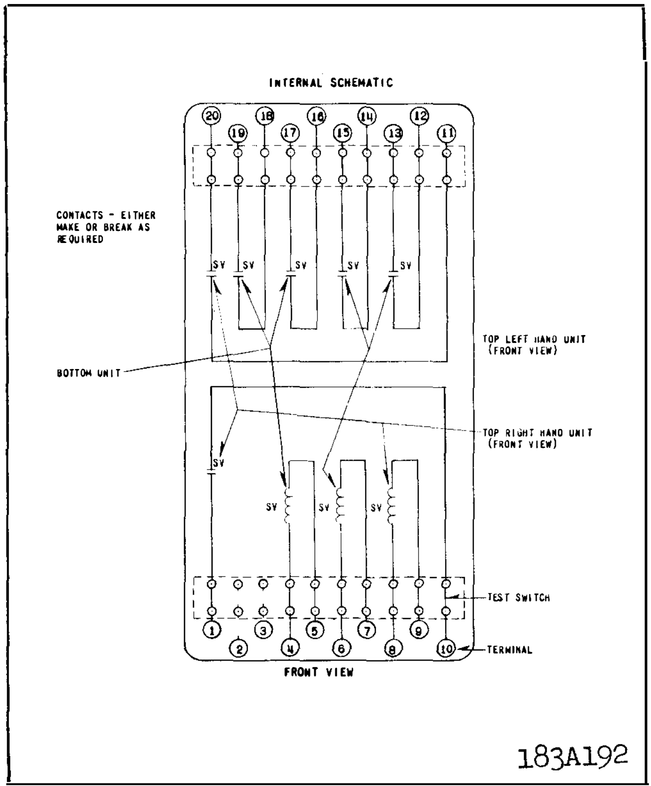


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

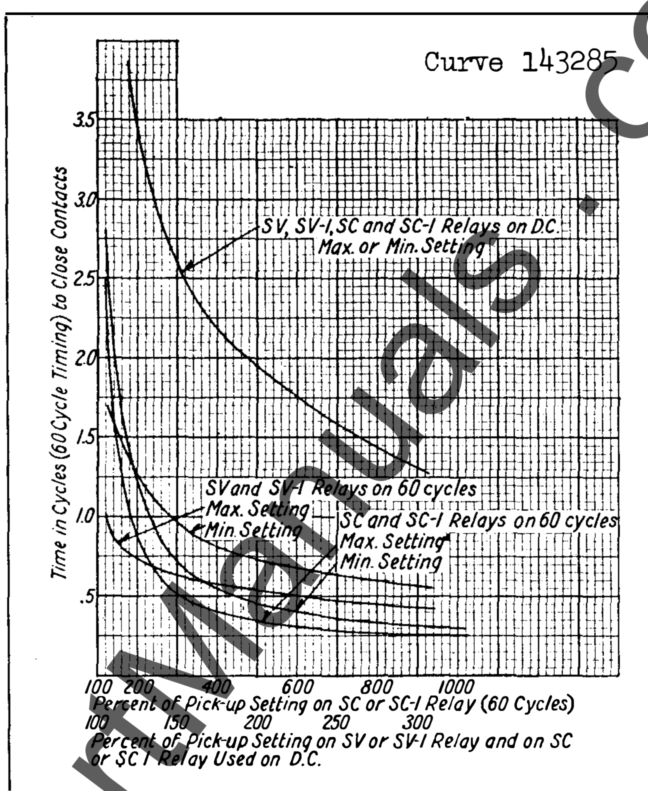


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

shaped bushing assembled on the upper end of the plunger shaft has a portion of 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 longnose 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 set screw, 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, lintless cloth. This may be moistened with benzene or some other cleaning solvent if necessary. Use no lubricant on the plunger shaft or bearings when reassembling 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

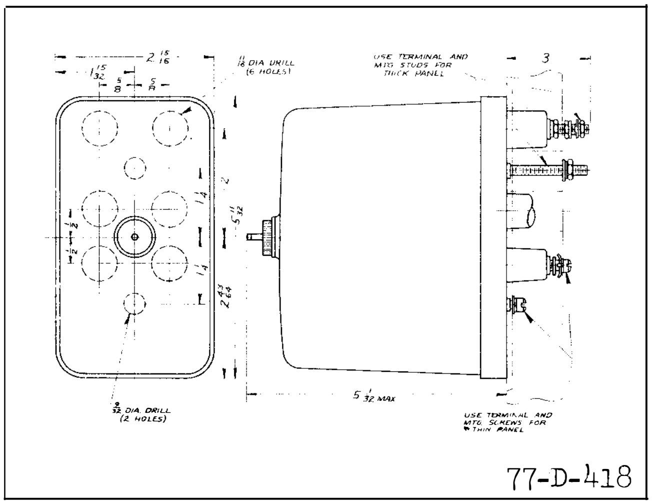


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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 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.

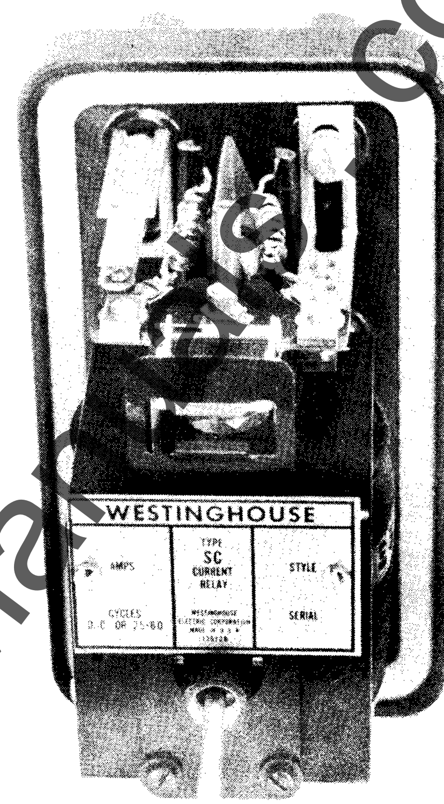


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Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

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 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

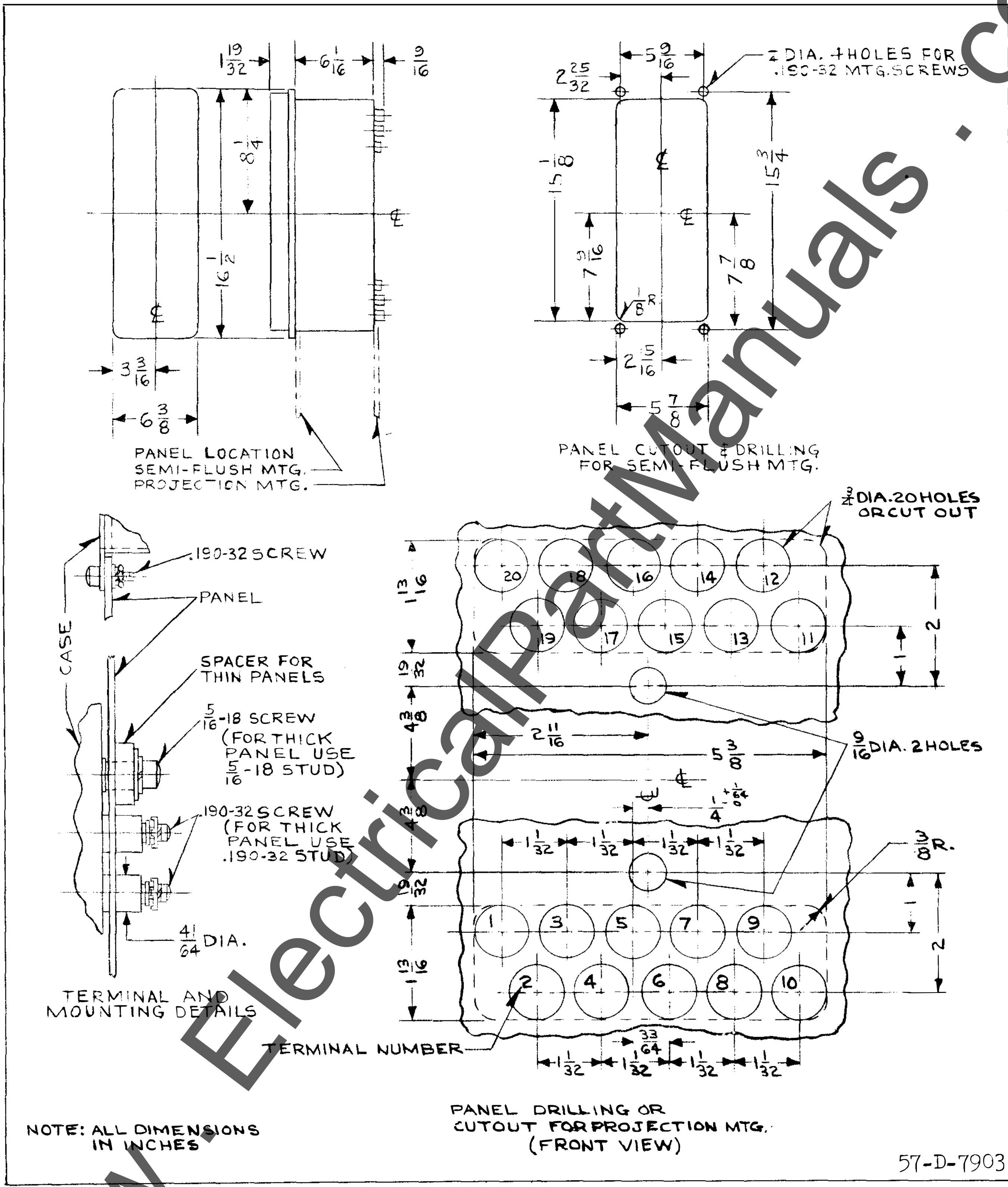

Fig. 12. Outline & Drilling Plan for Three Unit Relays in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION • NEWARK, N.J.
Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

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APPLICATION

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CONSTRUCTION

The types SC, SC-1, 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.

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SUPERSEDES I. L. 41-766.1

EFFECTIVE JANUARY 1958

*Denotes changed from superseded issue.

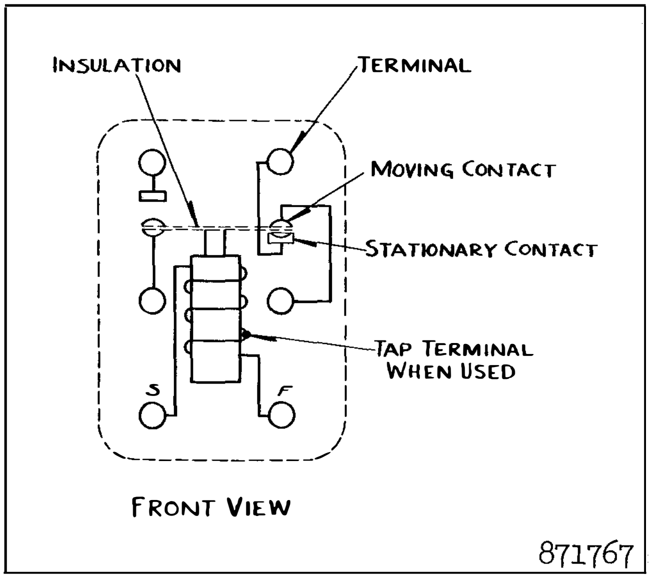
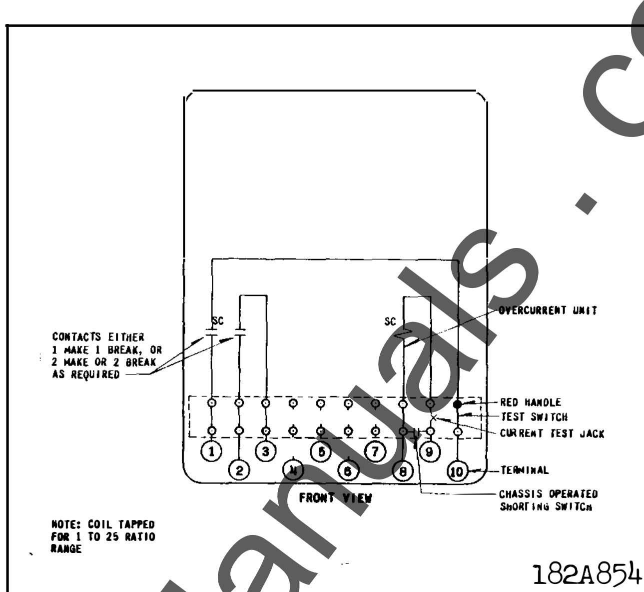


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.



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

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.

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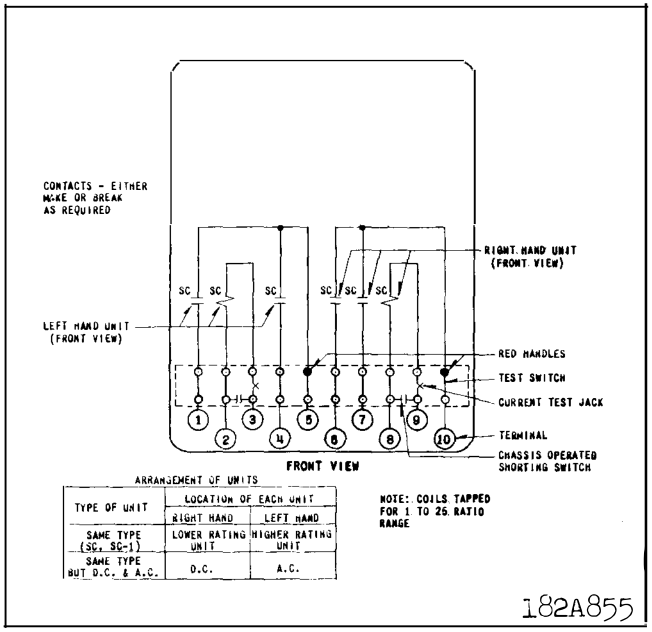
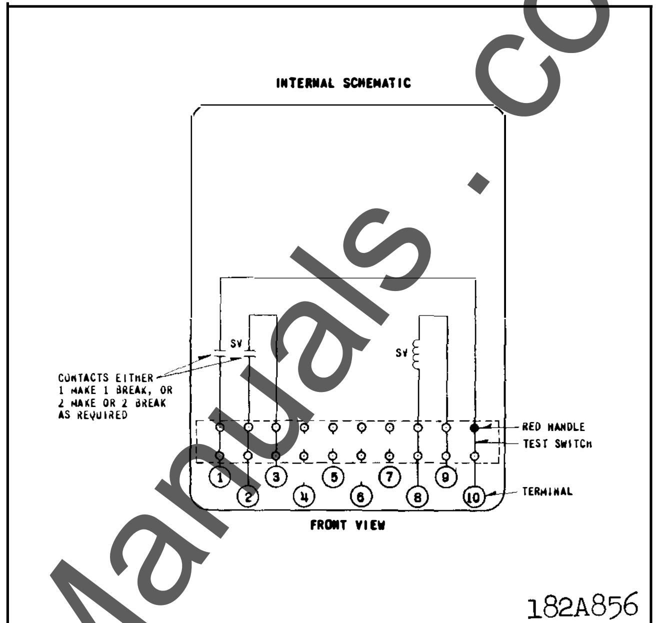


* *Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.*



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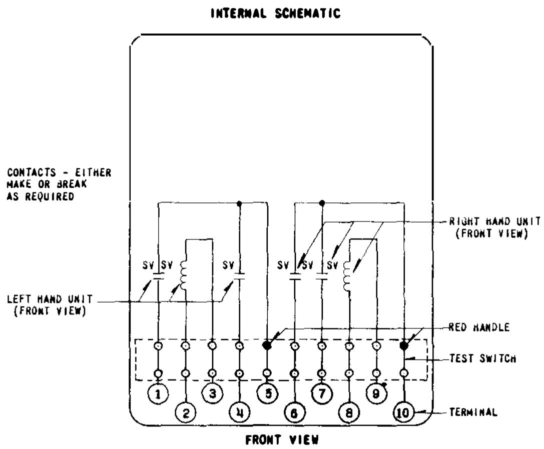
INSTALLATION

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

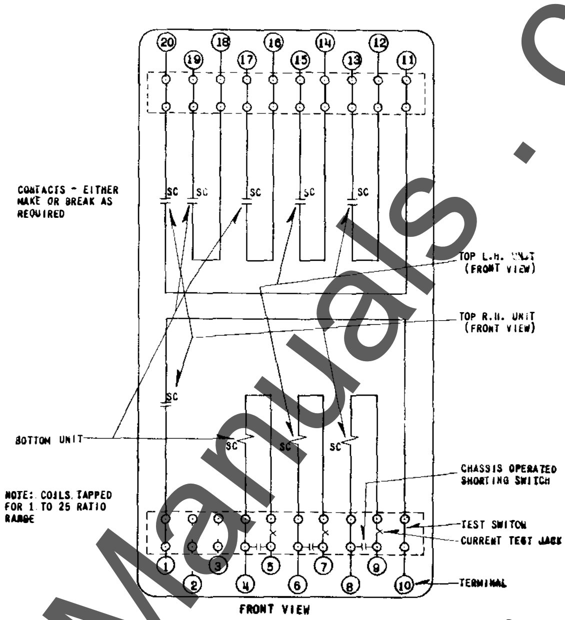


ARRANGEMENT OF UNITS

TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SV, SV-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

182A857

Fig. 5. Internal Schematic of the Double Unit Type SV or SV-1 Relay in the Type FT21 Case.



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

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 so 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 sand 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-

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	70-160	160	3.4	7.3	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-1	60	70-160	160	4.1	8.5	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%

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 on the 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%.

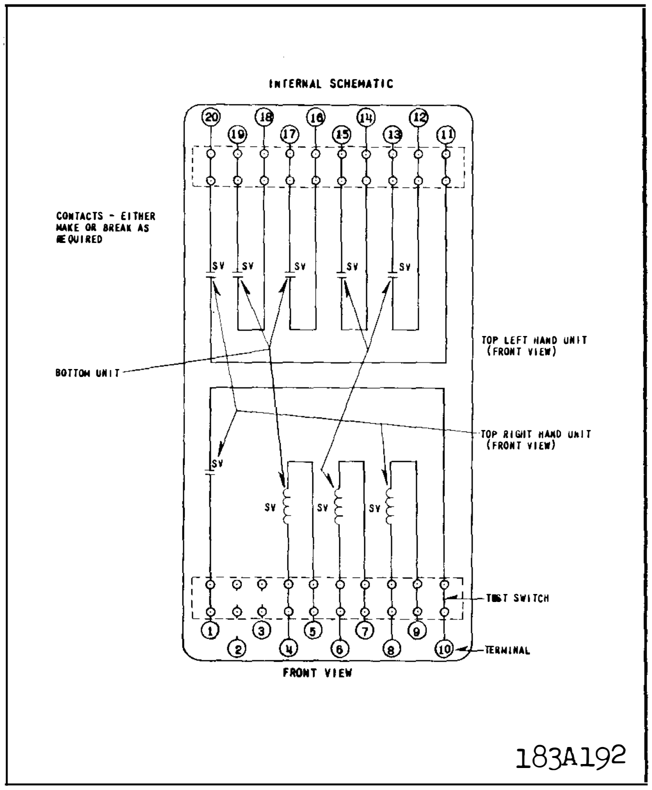


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

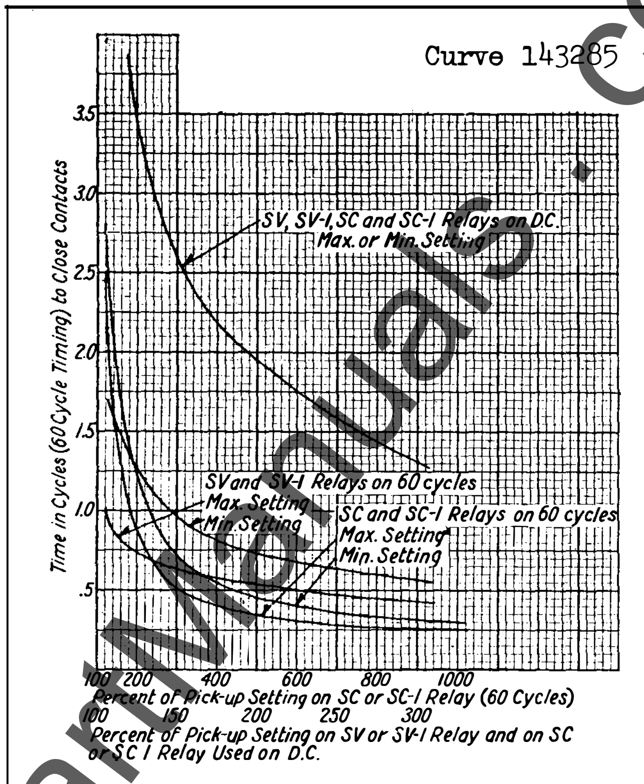


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

shaped bushing assembled on the upper end of the plunger shaft has a portion of 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 longnose 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 set screw, 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, lintless cloth. This may be moistened with benzene or some other cleaning solvent if necessary. Use no lubricant on the plunger shaft or bearings when reassembling 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

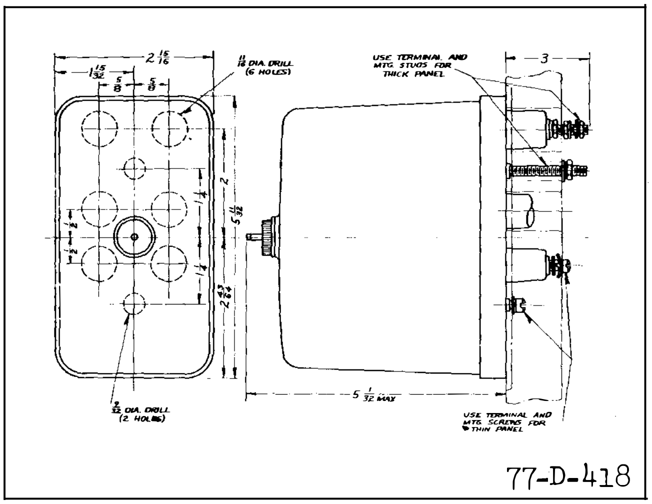


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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 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.

Fig. 10. View of Type SC Relay Showing Correct Shaping of 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 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 convenient 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 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 plunger 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.

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.

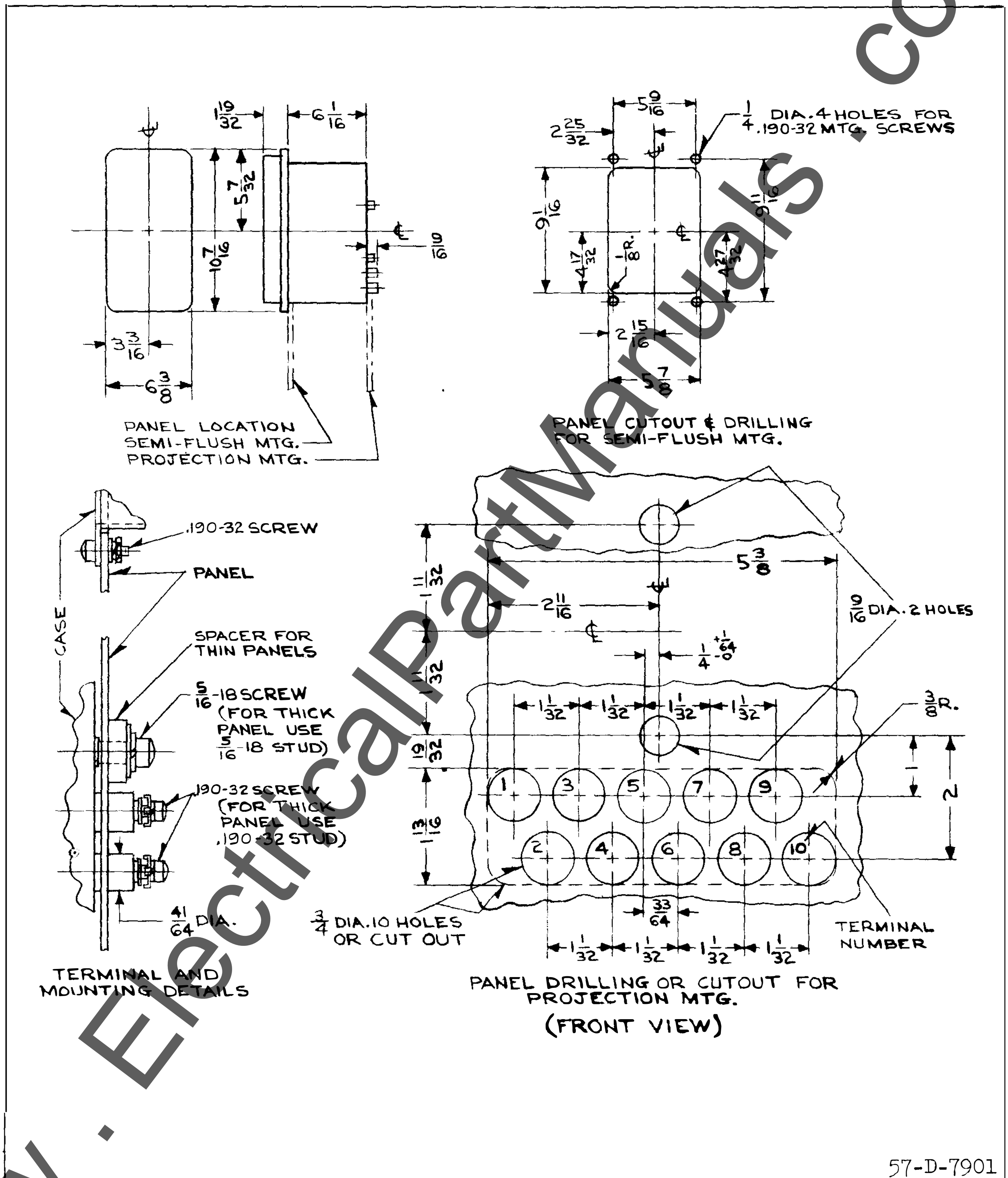


Fig. 11. Outline & Drilling Plan for Single & Double Unit Relays in the Type FT21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

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
* Denotes changed from superseded issue.

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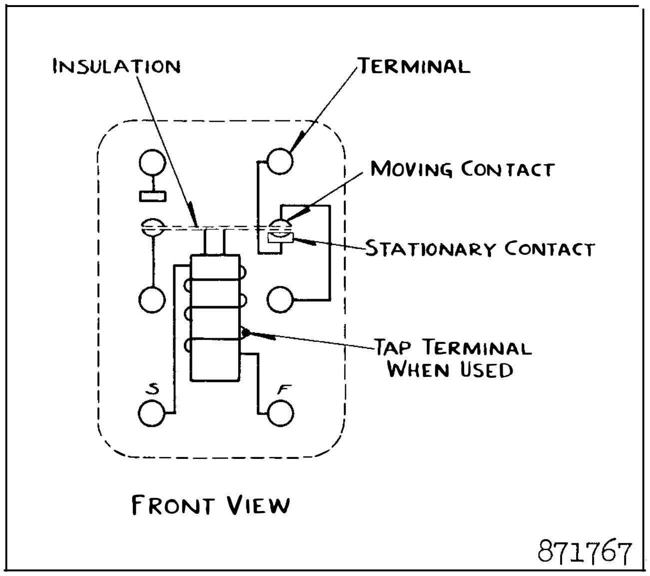


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

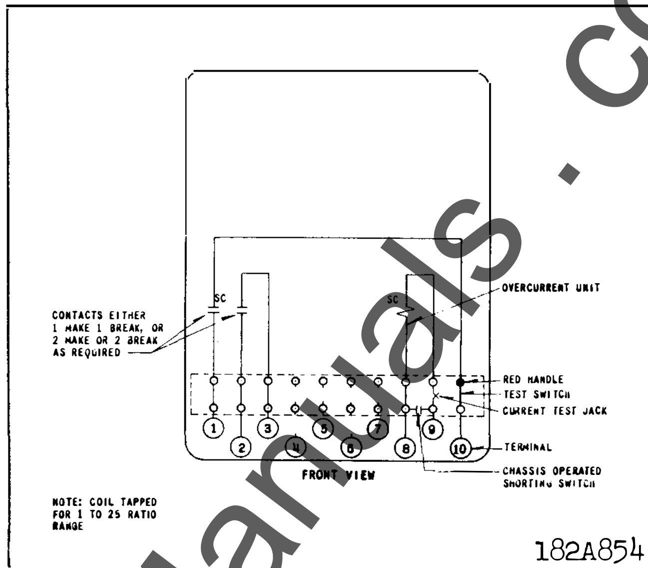


Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

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

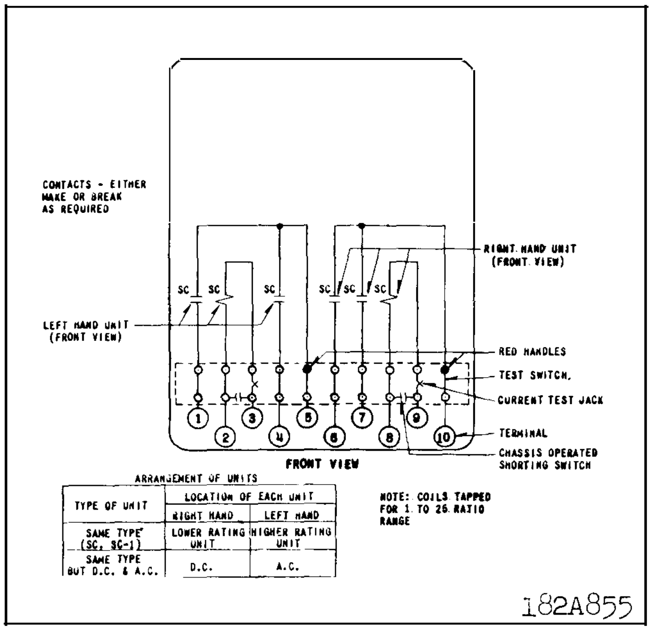


Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

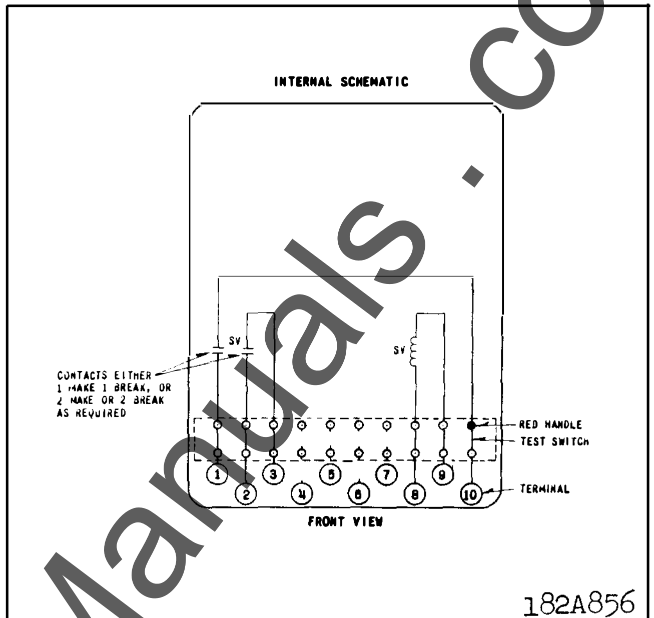


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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.

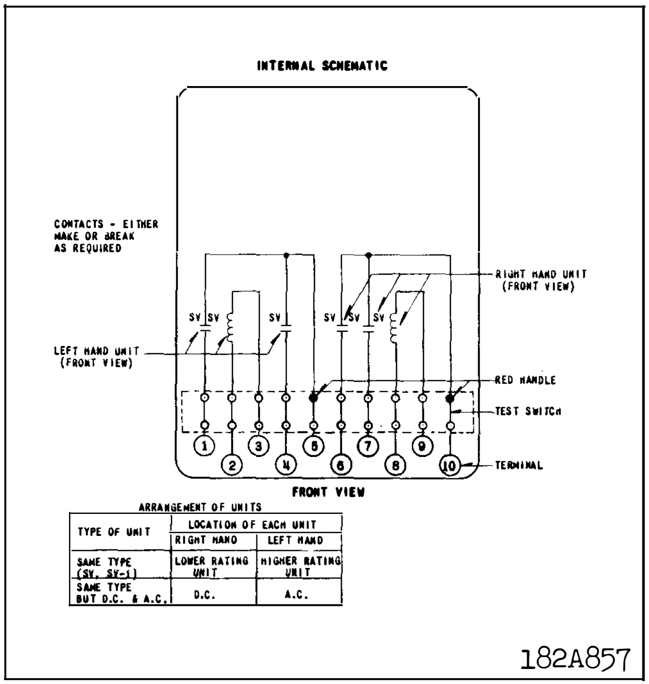
ADJUSTMENTS AND MAINTENANCE

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



ARRANGEMENT OF UNITS

TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SV, SV-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

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

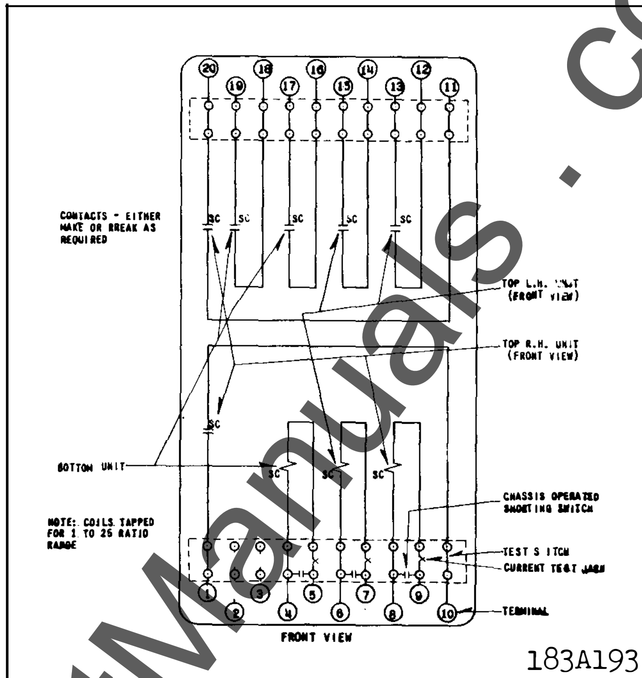


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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%.

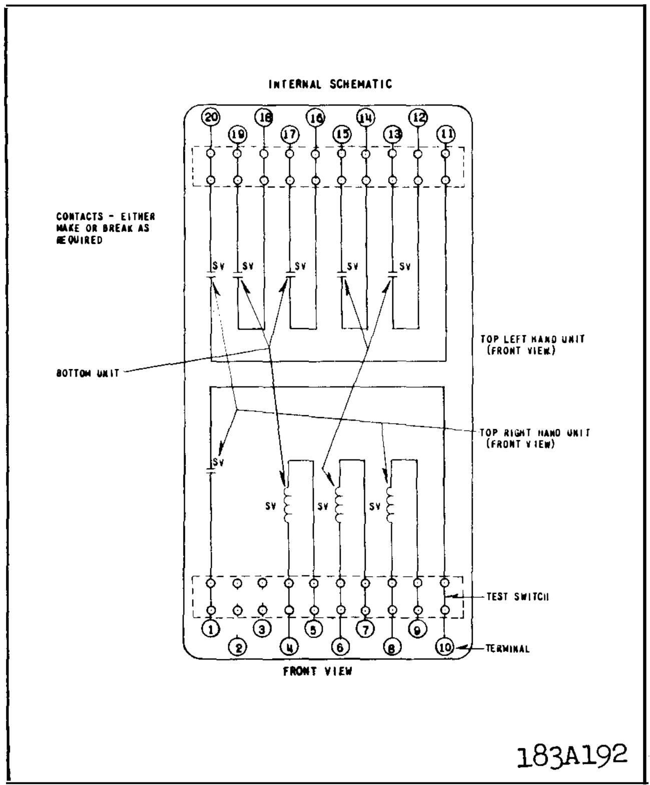


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

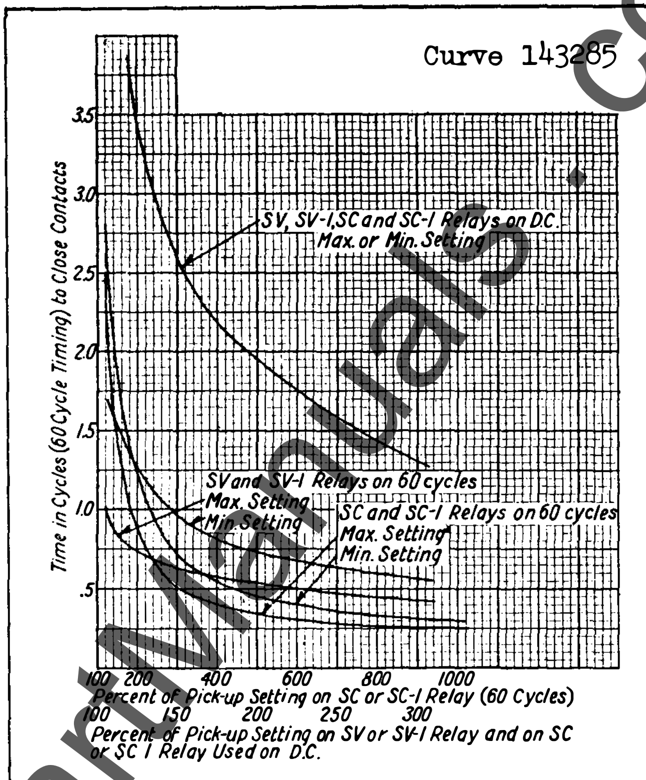


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

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

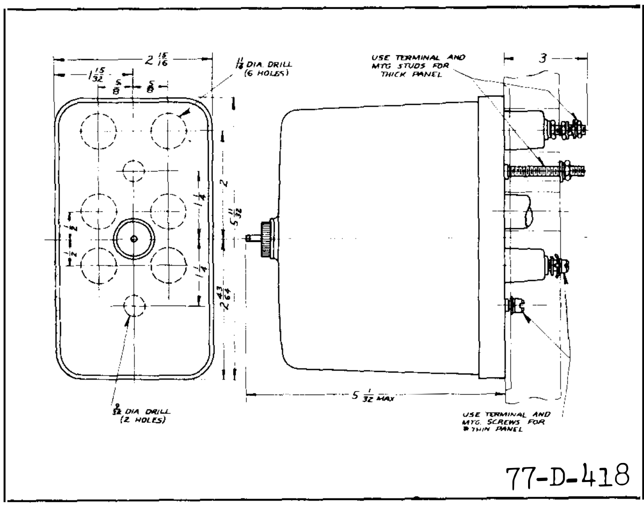


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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.

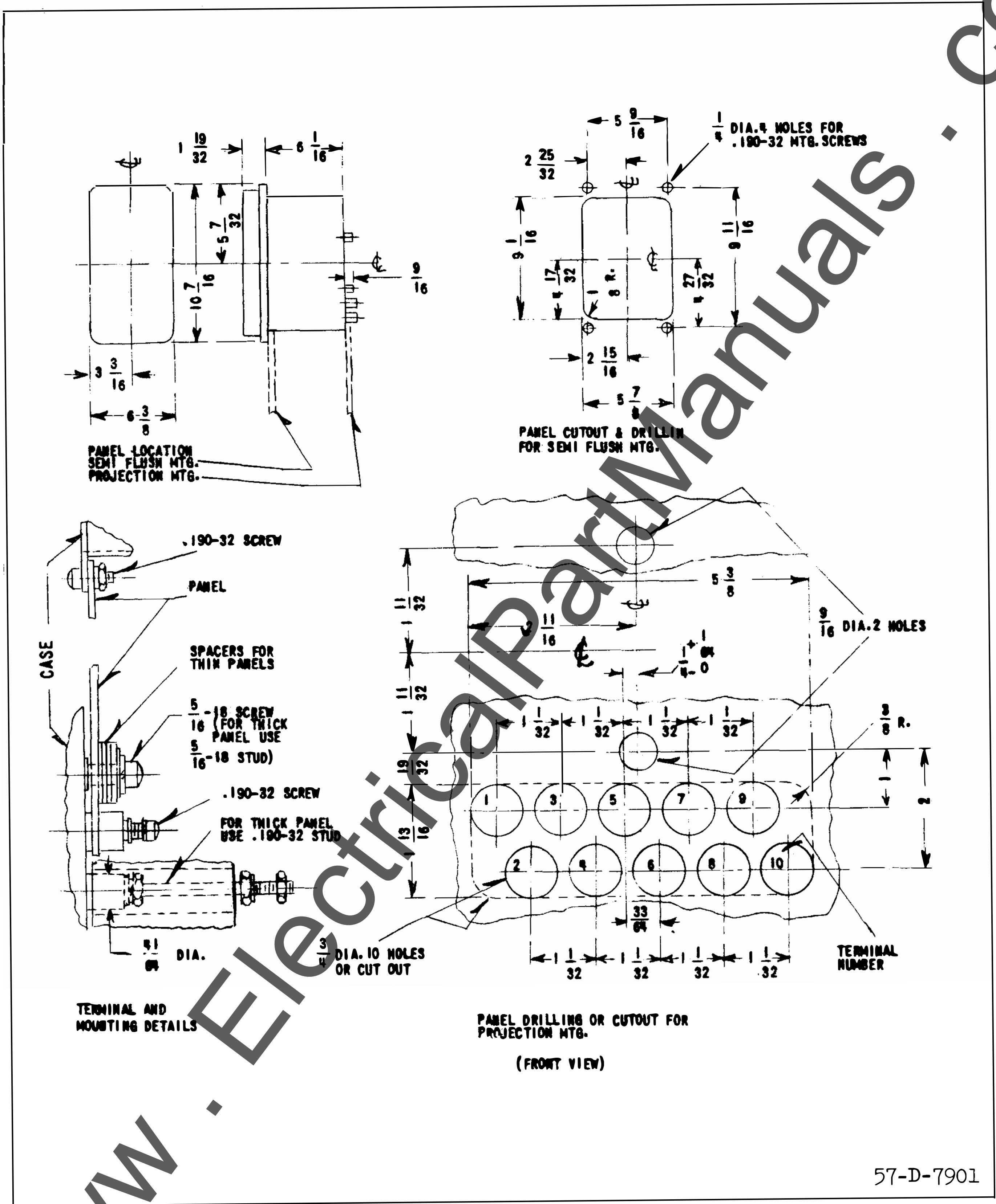


Fig. 11. Outline & Drilling Plan for Single & Double Unit Relays in the Type FT21 Case.

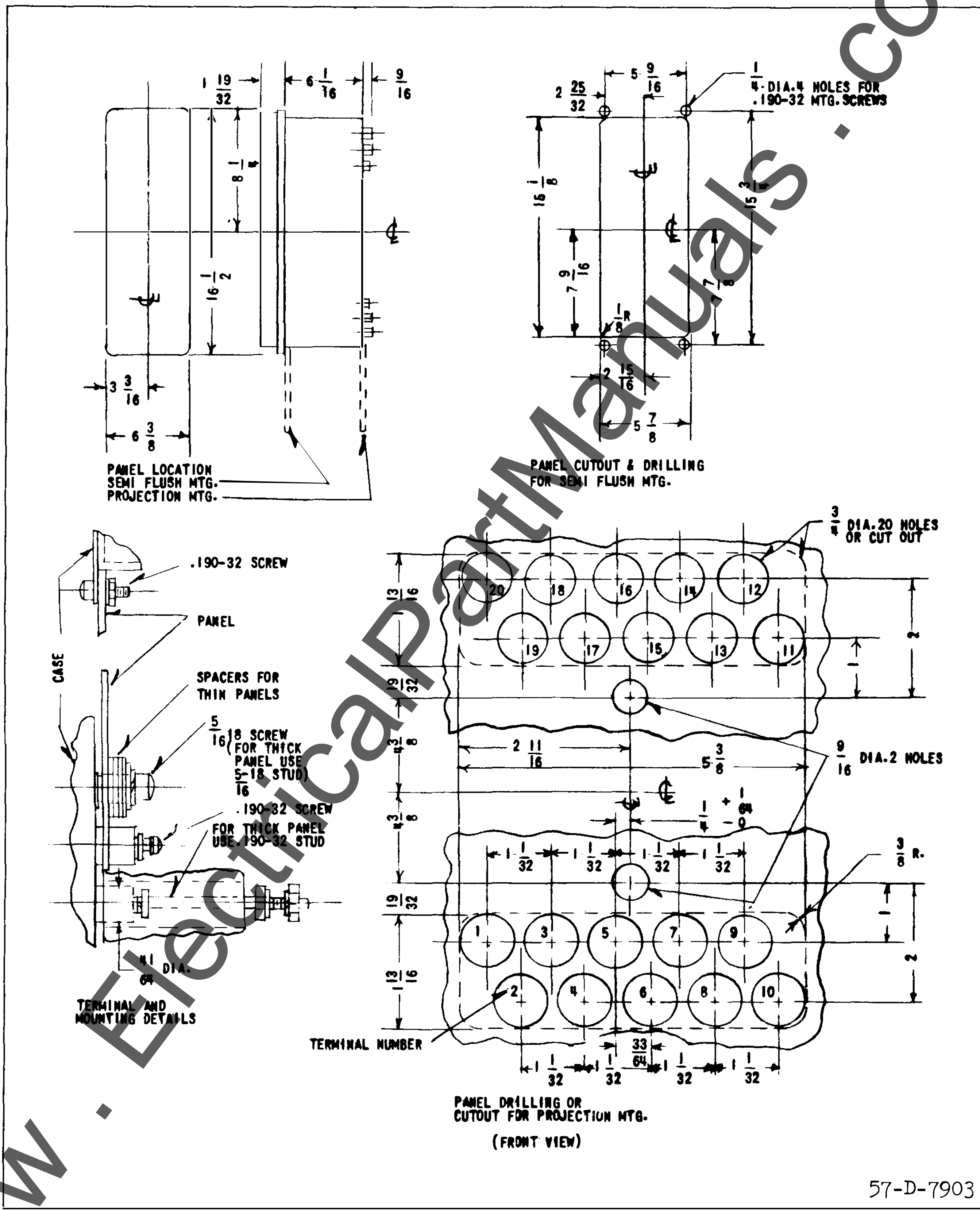


Fig. 12. Outline & Drilling Plan for Three Unit Relays in the Type FT32 Case.

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

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

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. 41-766.1B
*Denotes change from superseded issue.

EFFECTIVE FEBRUARY 1966

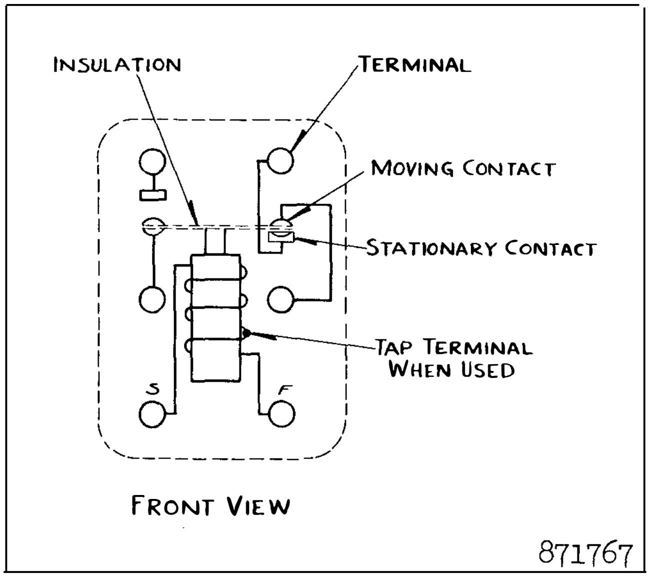


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

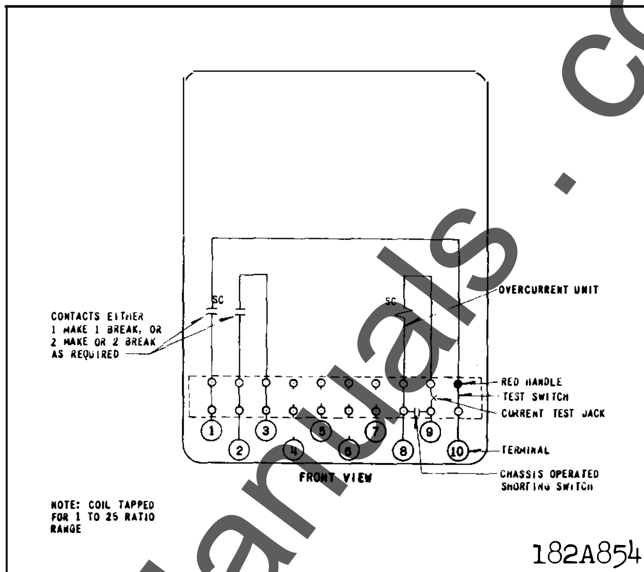


Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

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

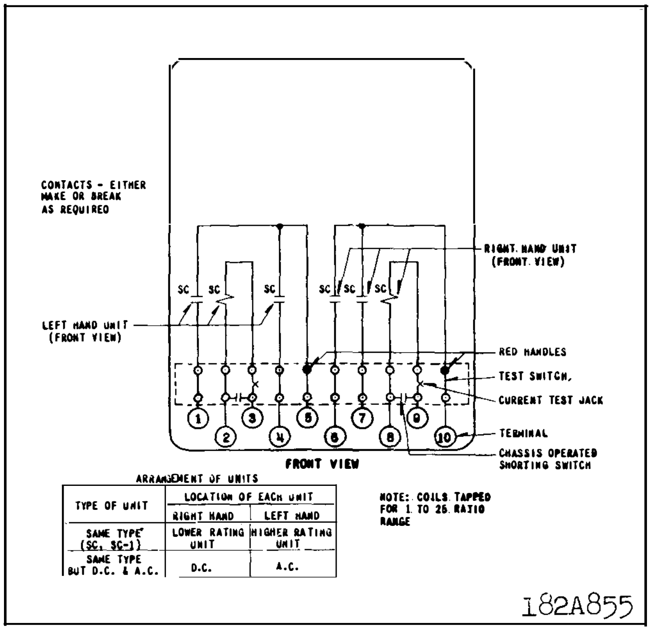


Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

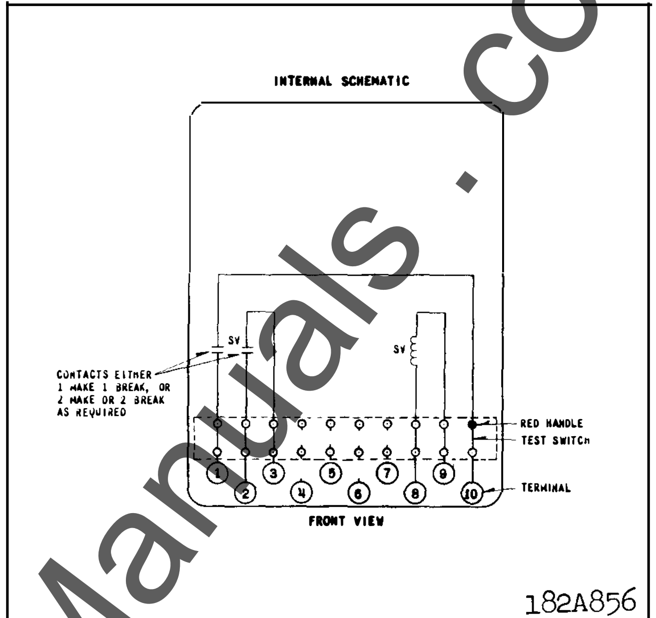


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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.

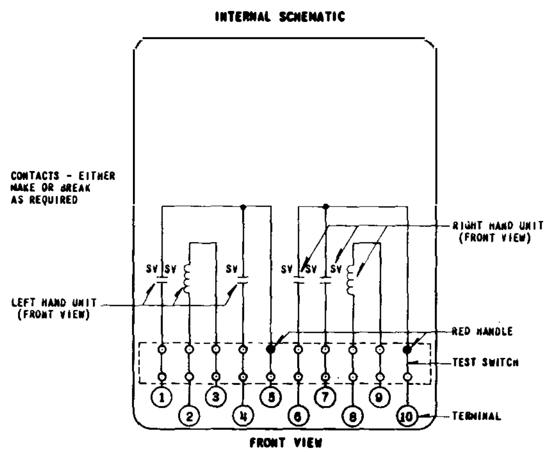
ADJUSTMENTS AND MAINTENANCE

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



ARRANGEMENT OF UNITS

TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SV, SV-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

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

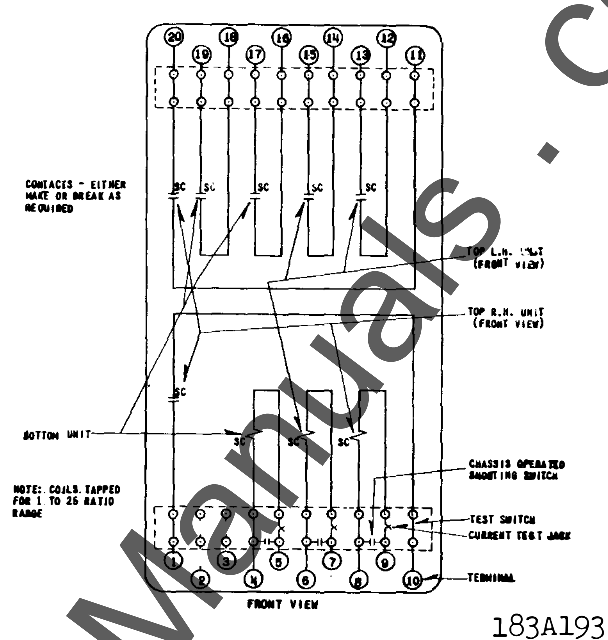


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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%.

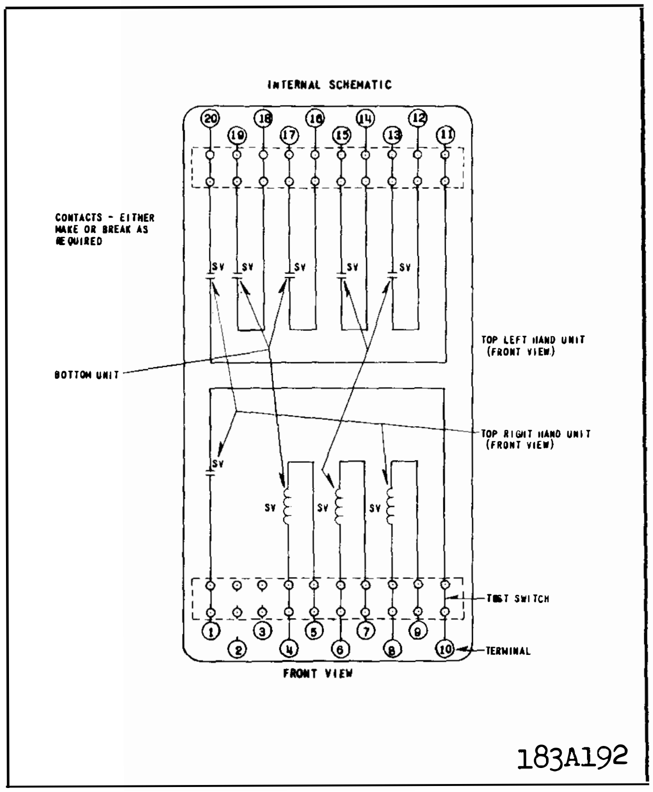


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

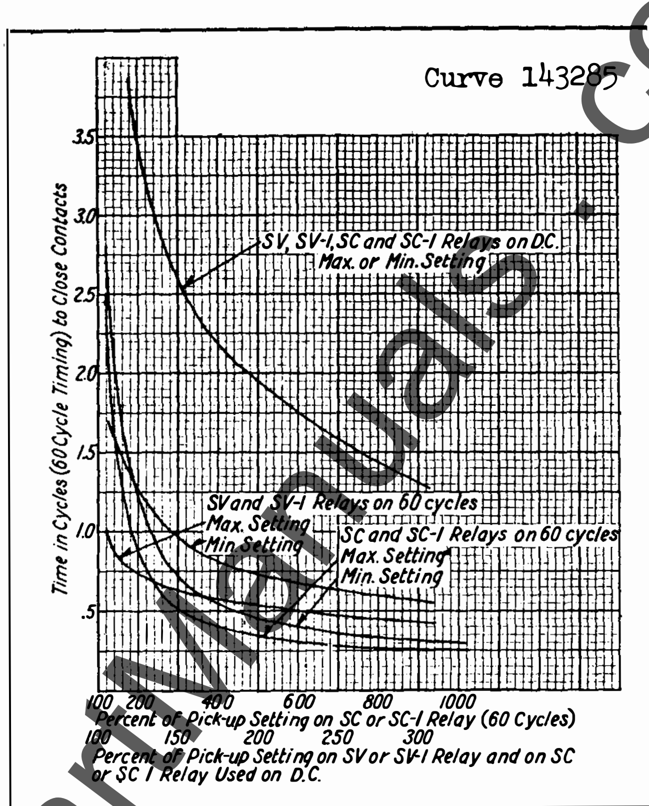


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

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

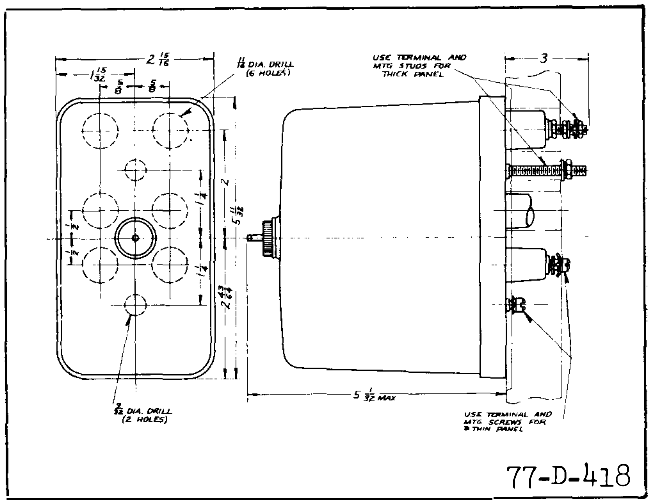


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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.

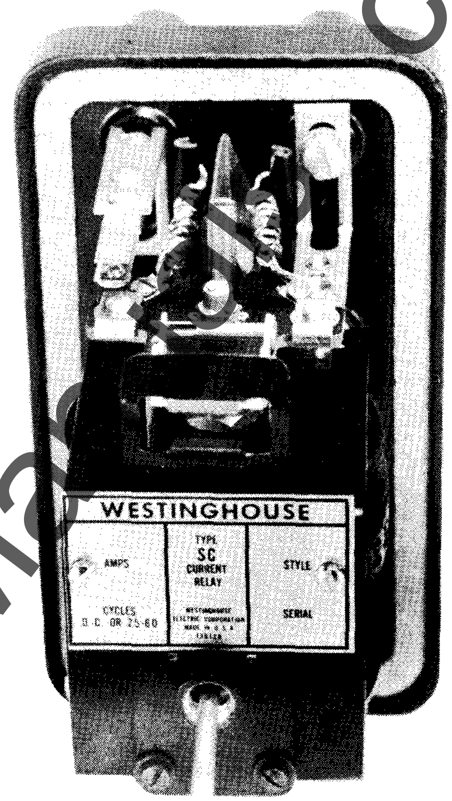
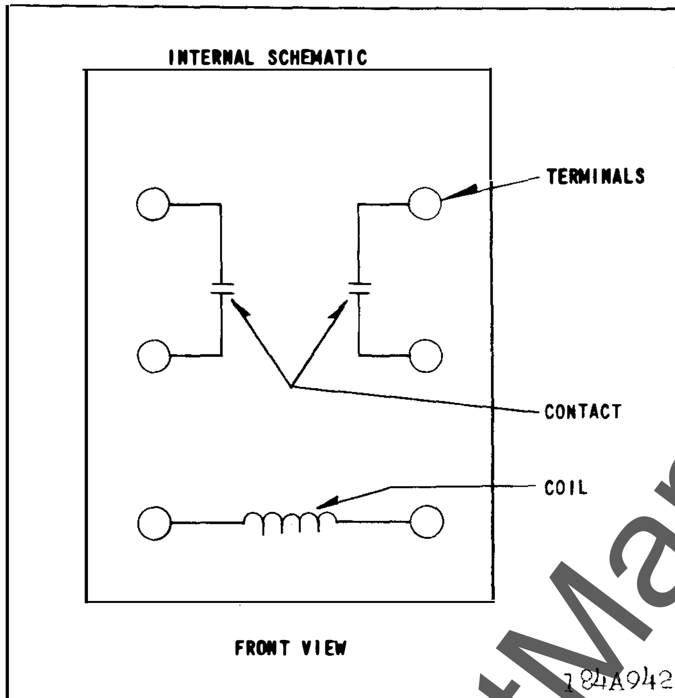


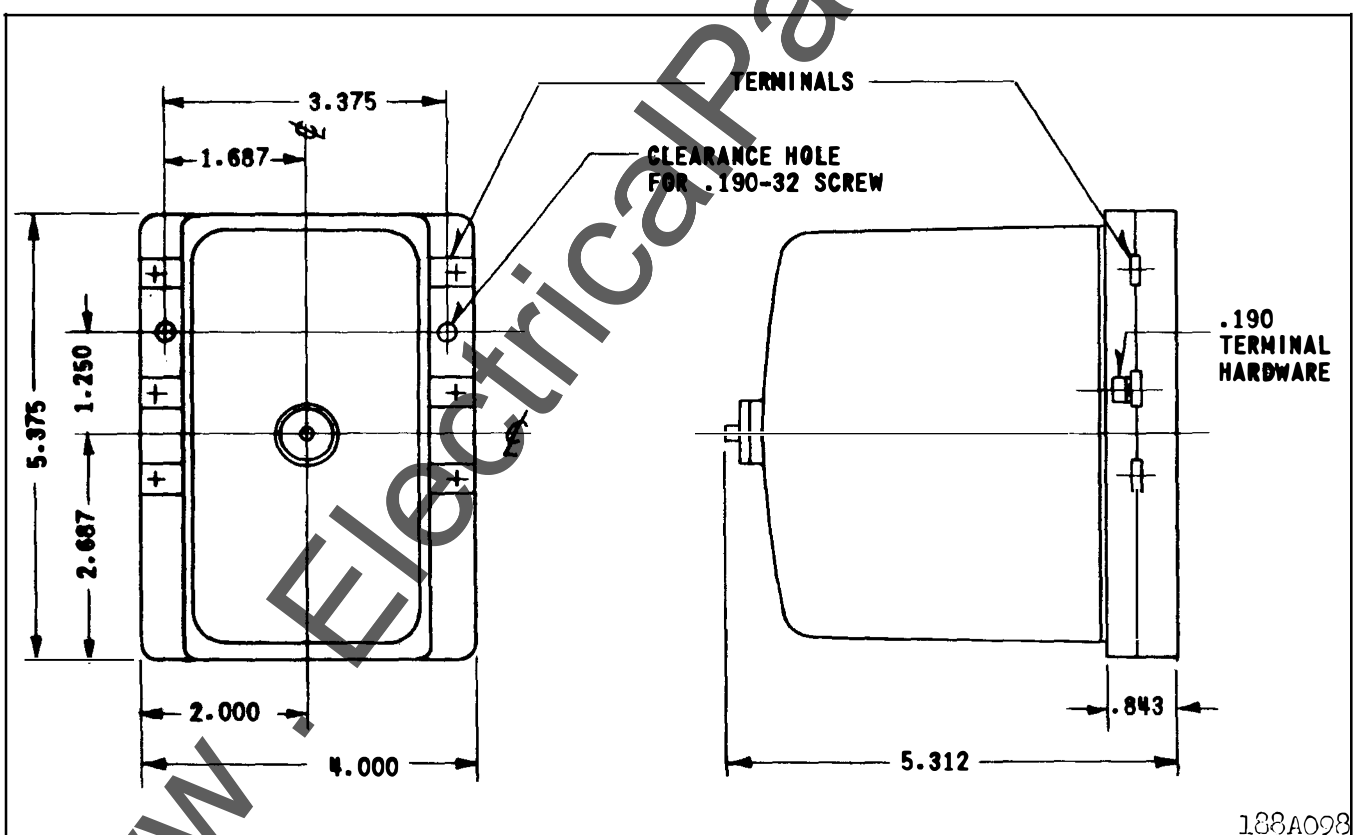
Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

RENEWAL PARTS

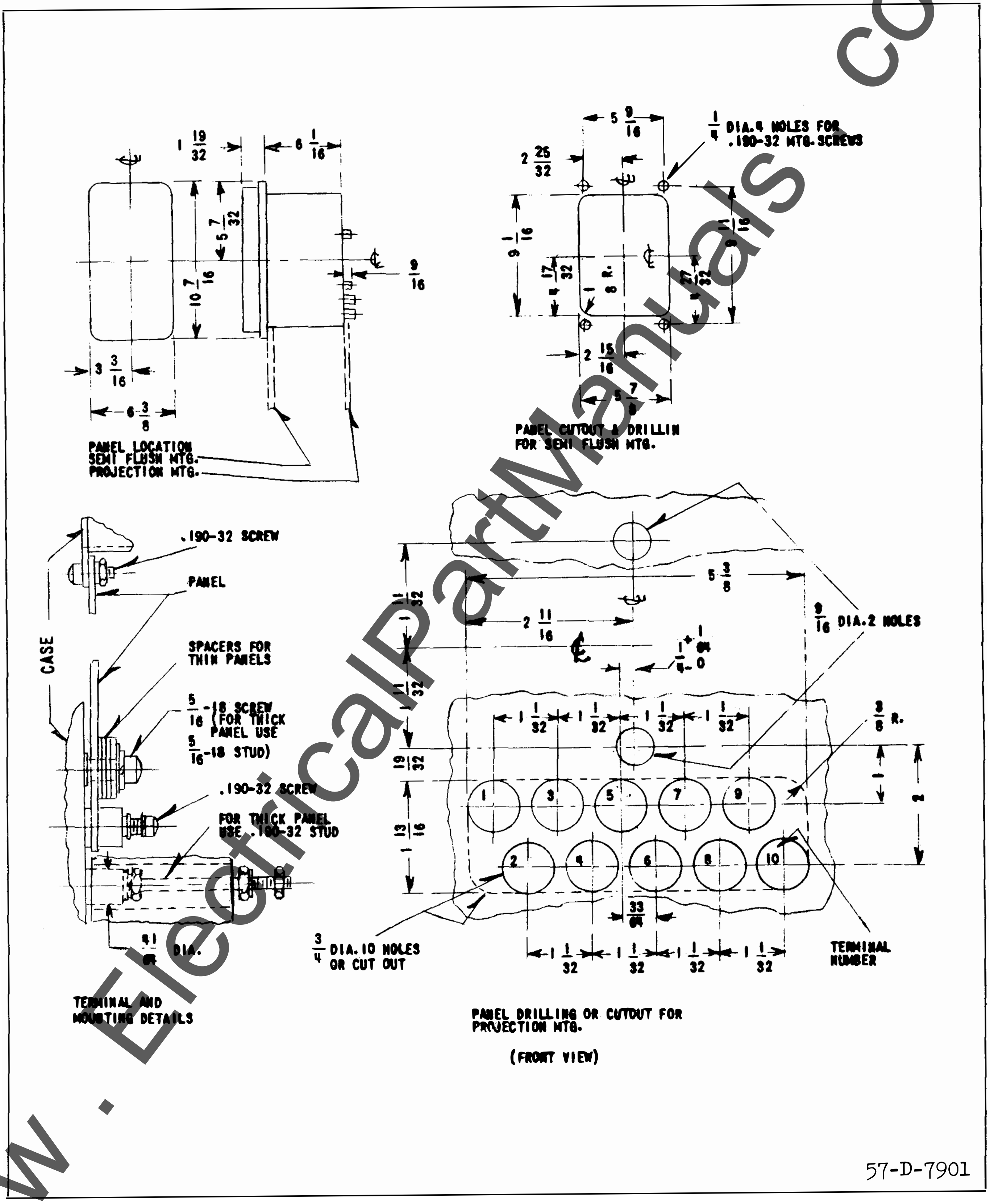
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



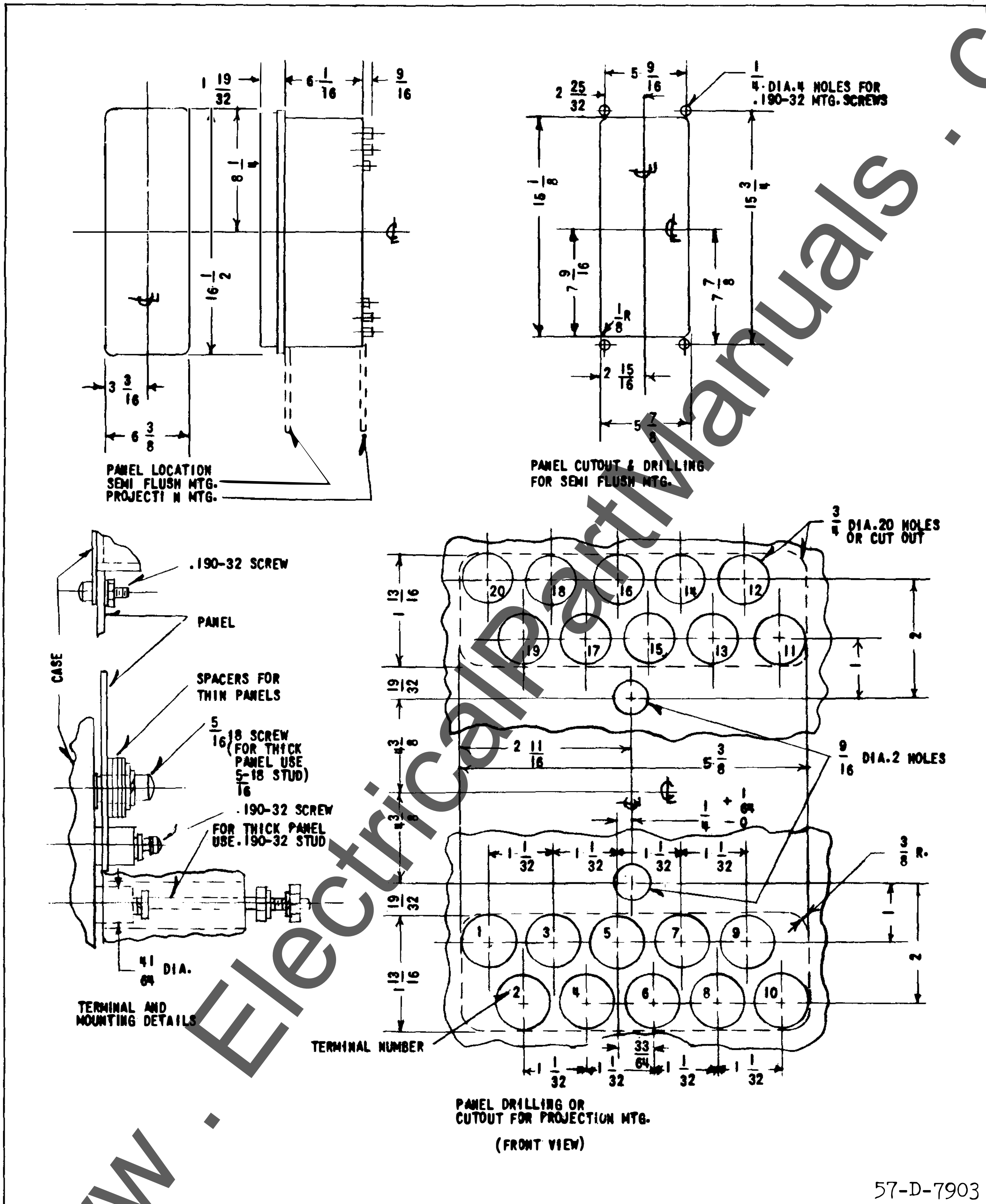
* *Fig. 11. Internal Schematic for Relays in Front Connected Case.*



* *Fig. 12. Outline and Drilling Plan for Relays in Front Connected Case.*



* *Fig. 13 Outline and Drilling Plan for Single and Double Unit Relays in the Type FT21 Case.*



* *Fig. 14. Outline and 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

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. 41-766.1C
*Denotes change from superseded issue.

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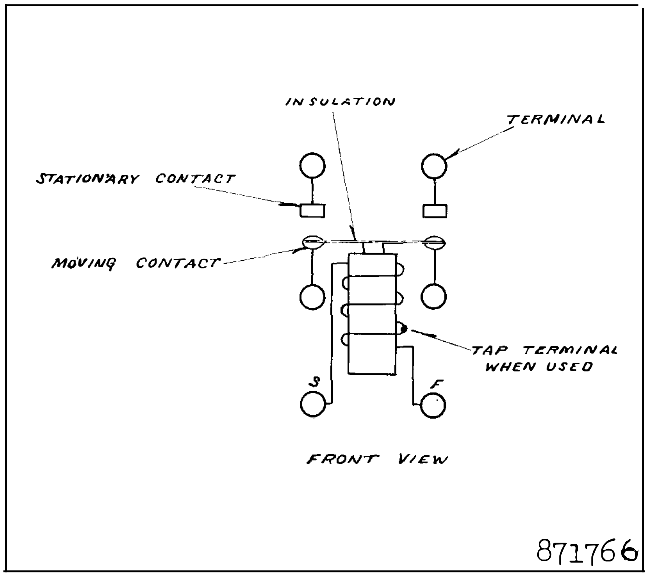


* *Fig. 1. Internal Wiring of the Relays In The Small Glass Case.*

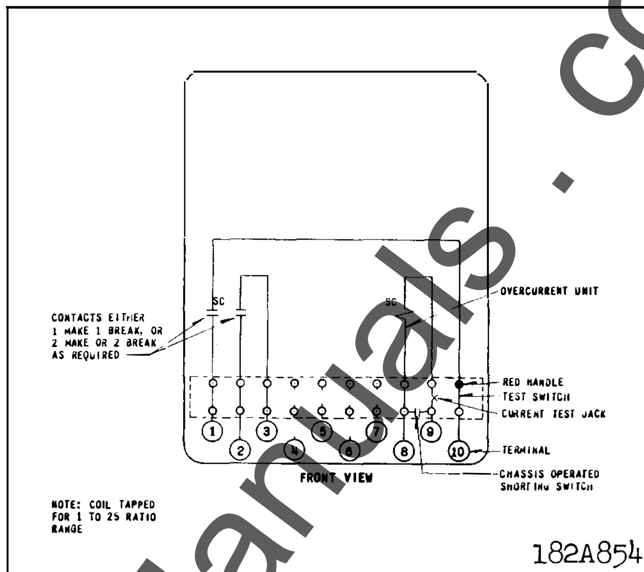


Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

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

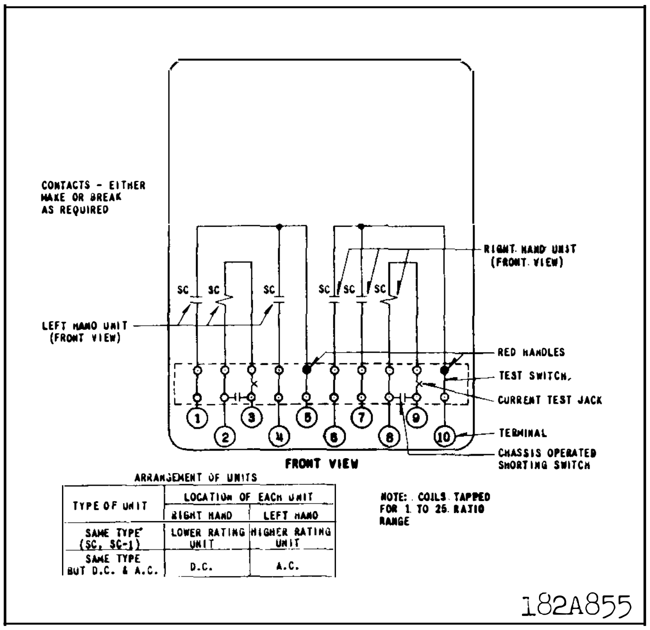


Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

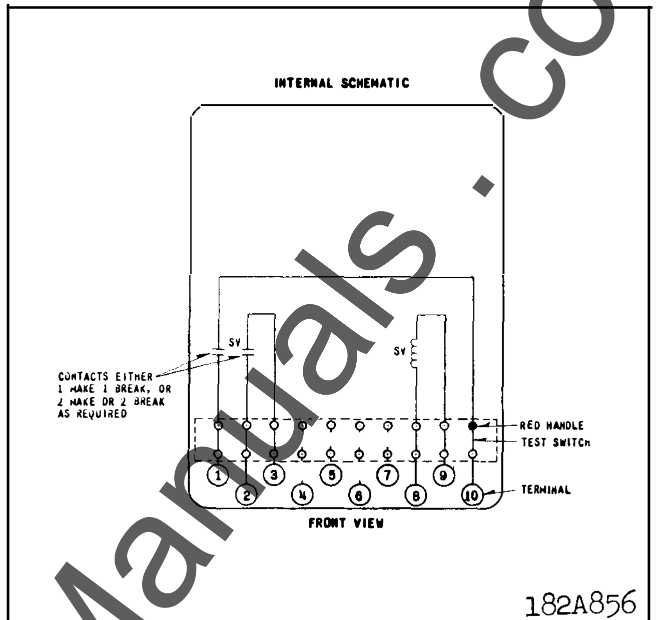


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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.

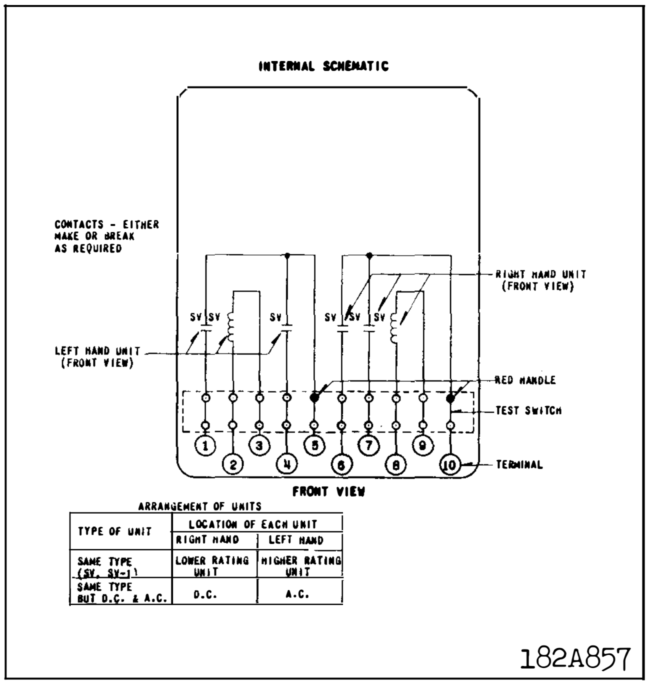
ADJUSTMENTS AND MAINTENANCE

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



TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SV, SV-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

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

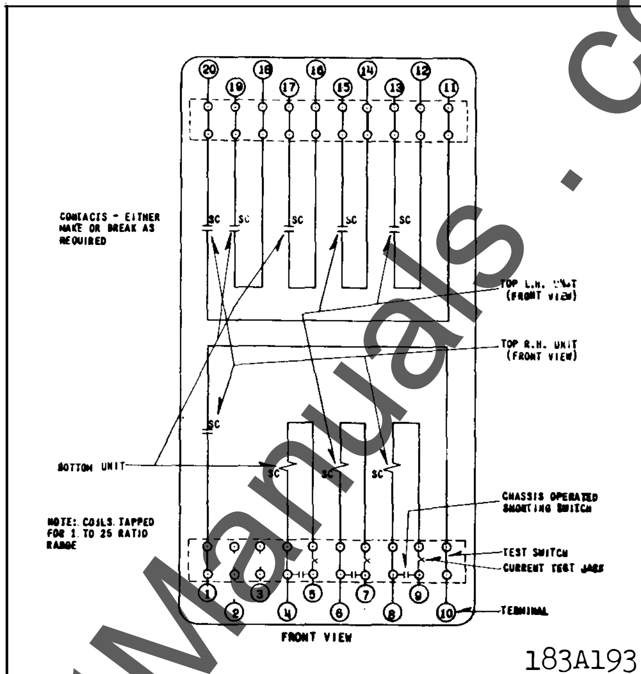


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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%.

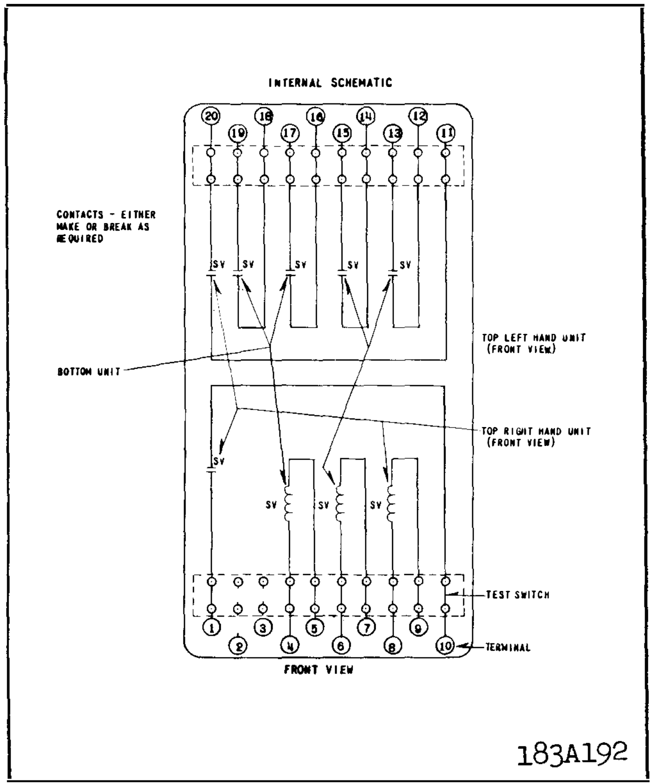


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

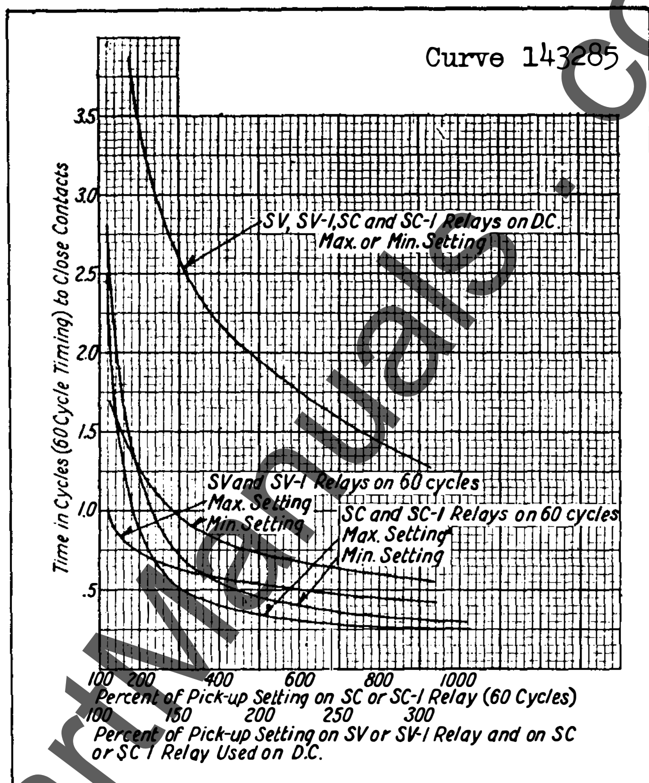


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

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

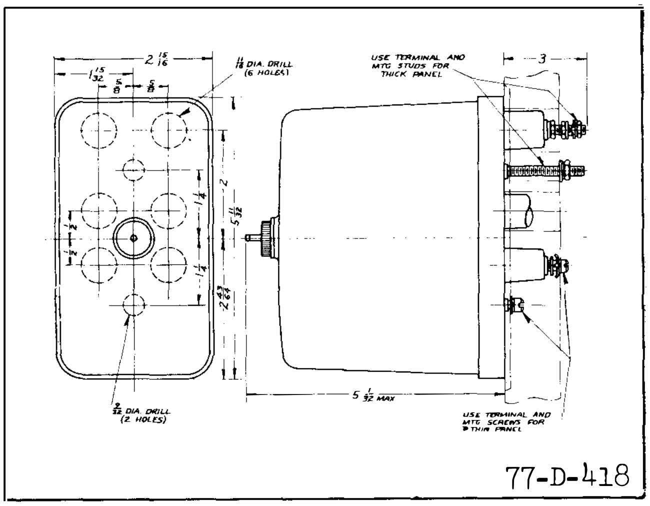


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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

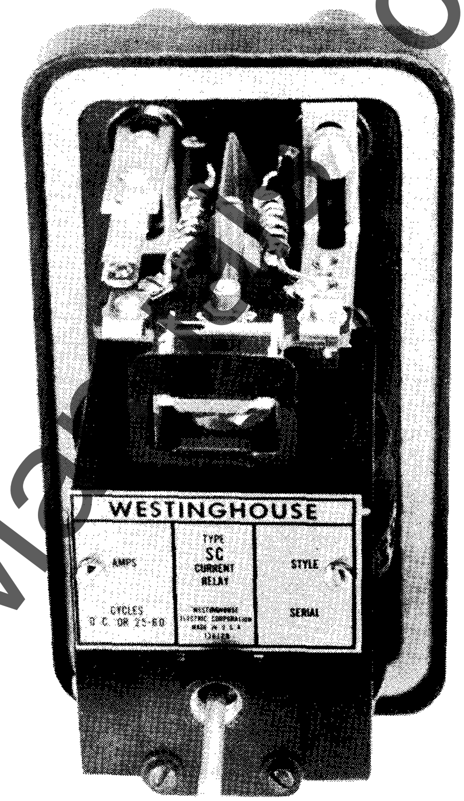
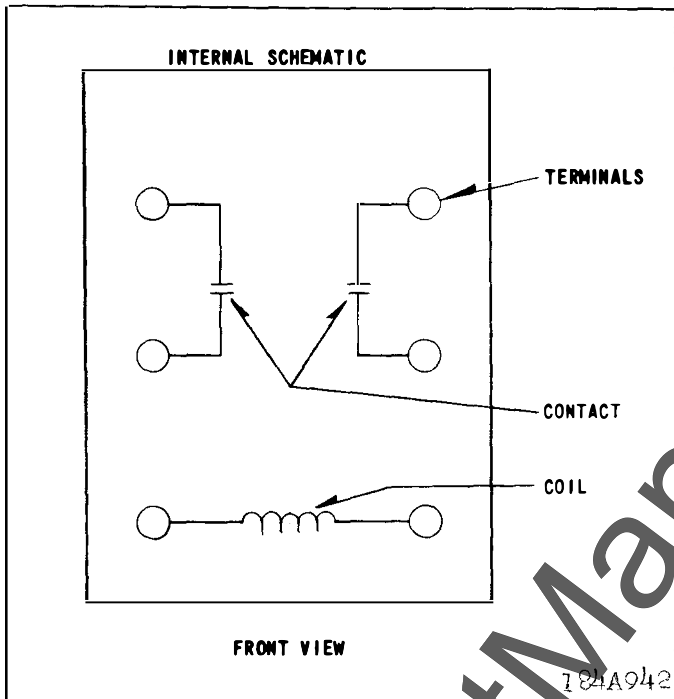


Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

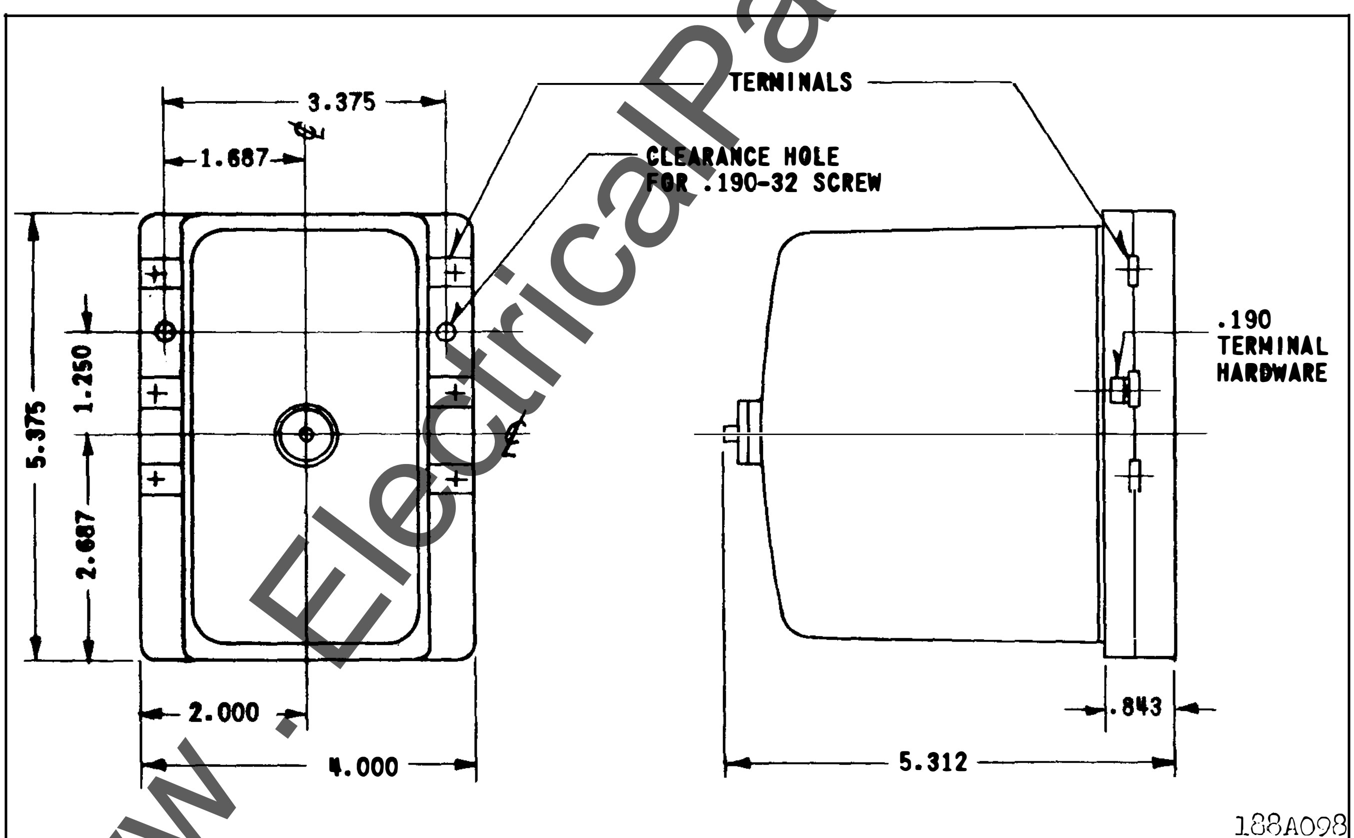
means of altering the ratio of dropout to pickup.

RENEWAL PARTS

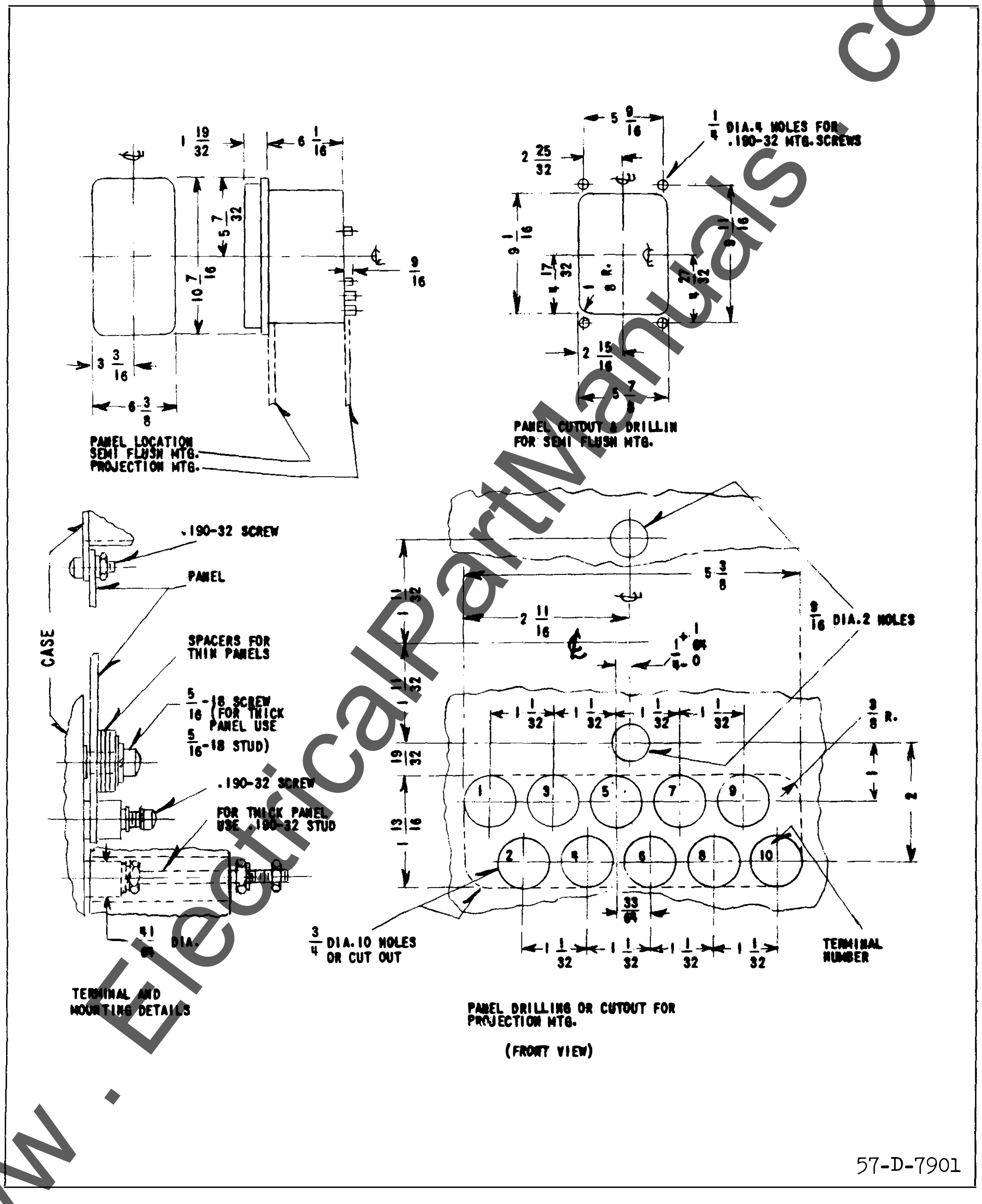
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



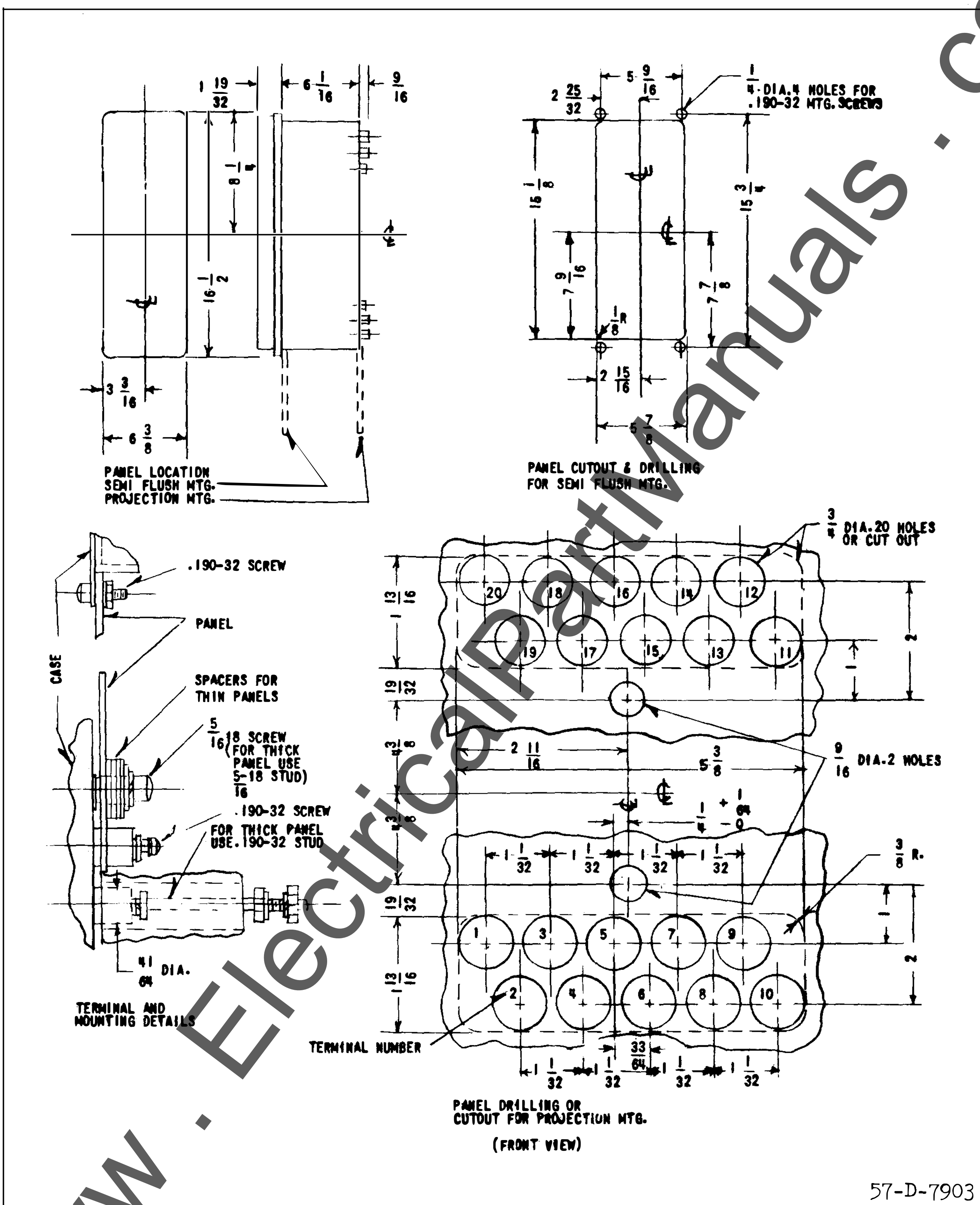
* *Fig. 11. Internal Schematic for Relays in Front Connected Case.*



* *Fig. 12. Outline and Drilling Plan for Relays in Front Connected Case.*



** Fig. 13 Outline and Drilling Plan for Single and Double Unit Relays in the Type FT21 Case.*



* *Fig. 14. Outline and Drilling Plan for Three Unit Relays in the Type FT32 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION NEWARK, N. J.

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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 fluorosint 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. 41-766.1D
*Denotes change from superseded issue.

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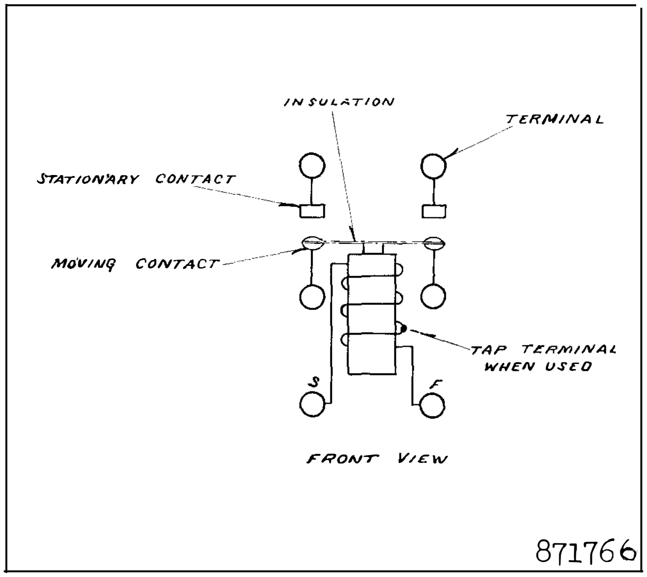


Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

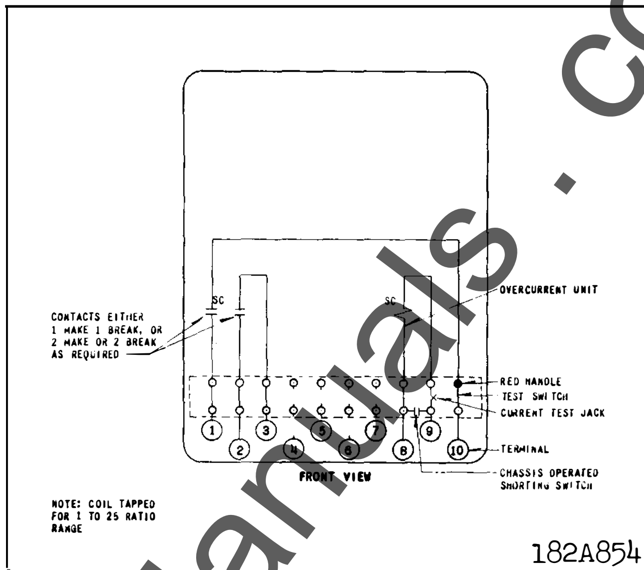


Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

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

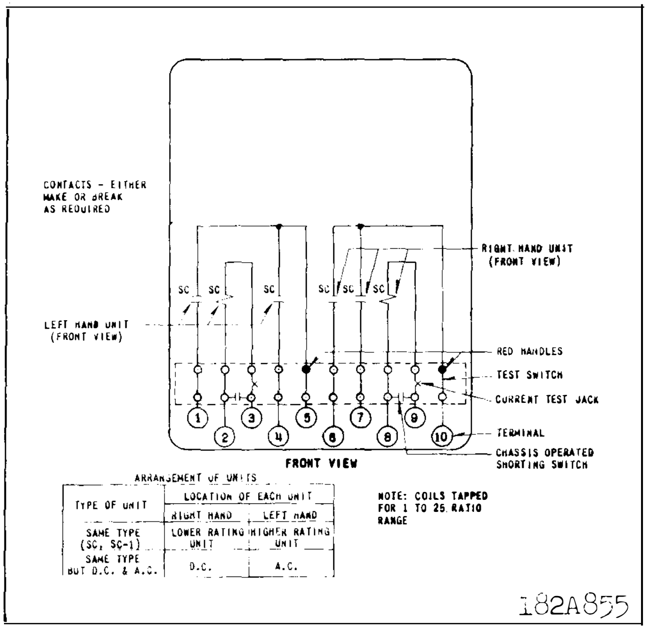


Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

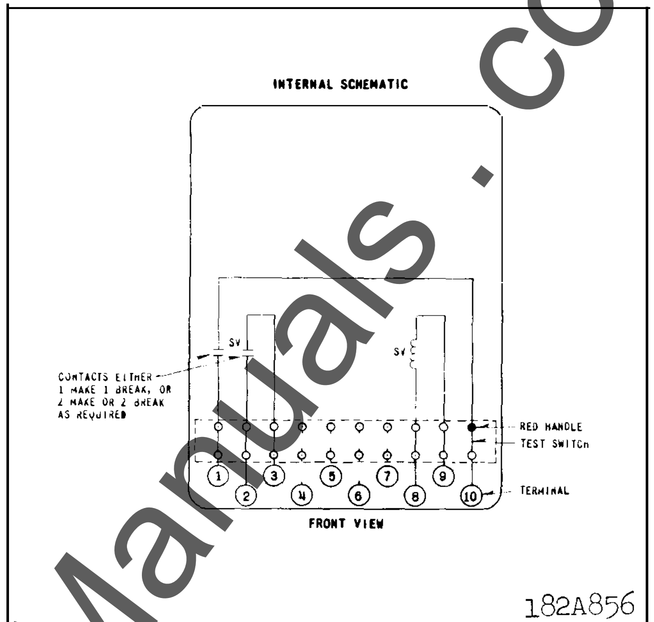


Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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.

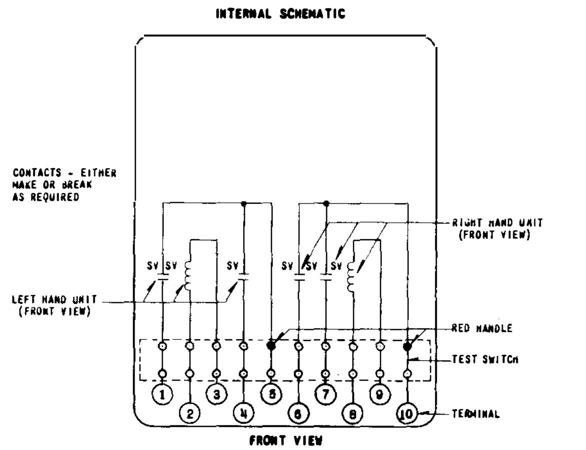
ADJUSTMENTS AND MAINTENANCE

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 so 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



ARRANGEMENT OF UNITS

TYPE OF UNIT	LOCATION OF EACH UNIT	
	RIGHT HAND	LEFT HAND
SAME TYPE (SV, SV-1)	LOWER RATING UNIT	HIGHER RATING UNIT
SAME TYPE BUT D.C. & A.C.	D.C.	A.C.

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

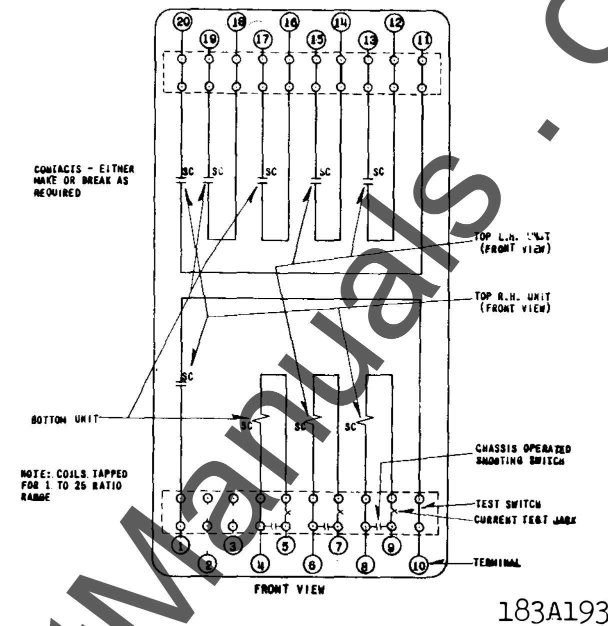


Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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%.

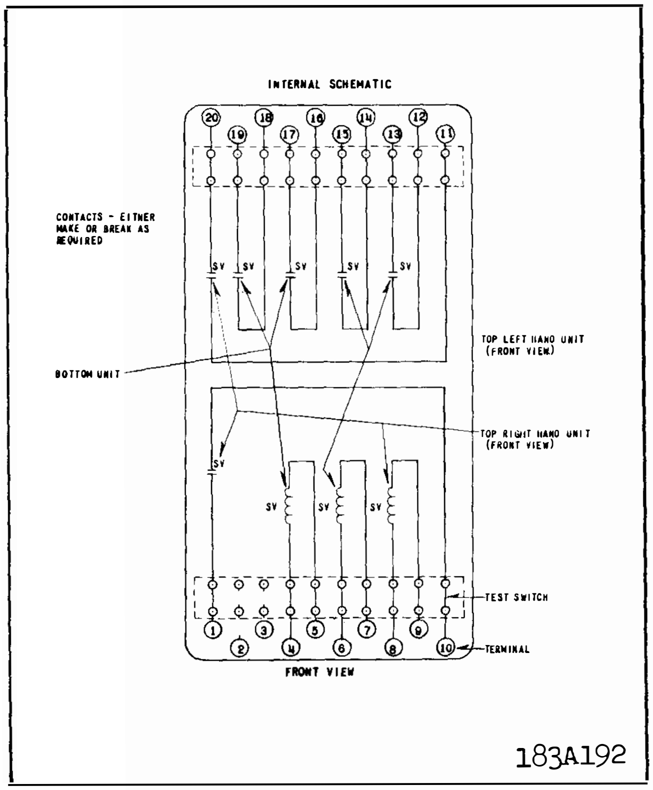


Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

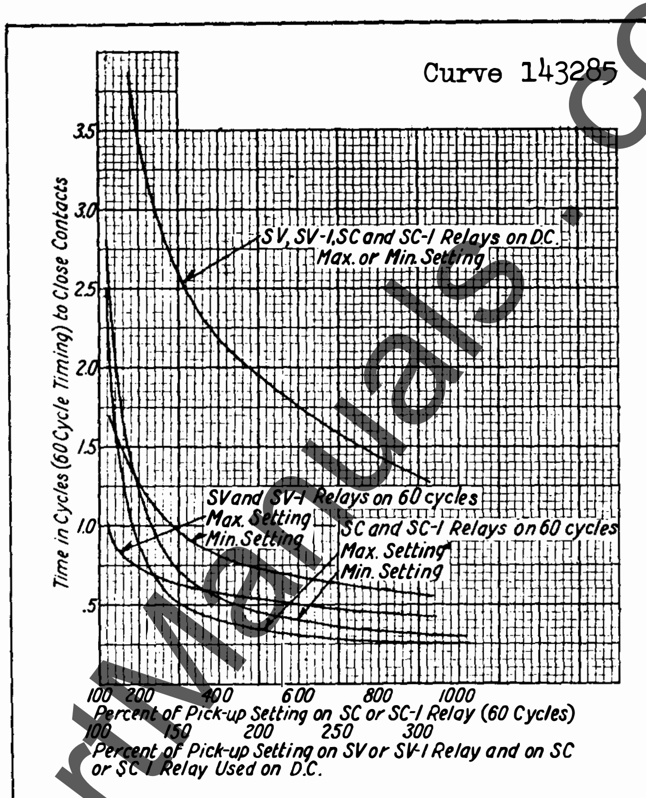


Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

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

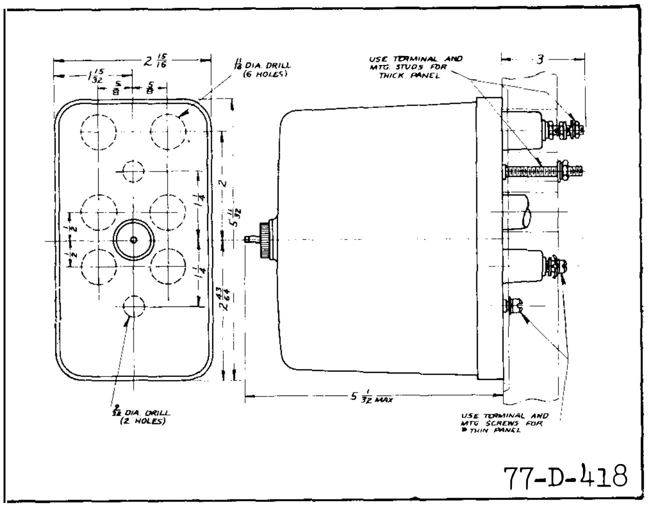


Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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.

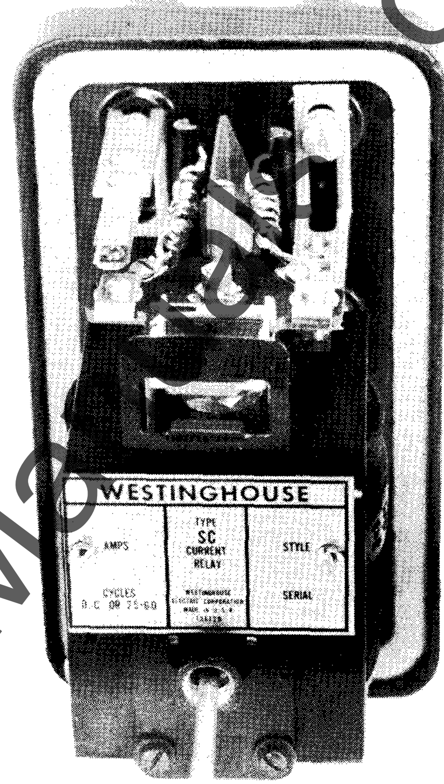


Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

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.

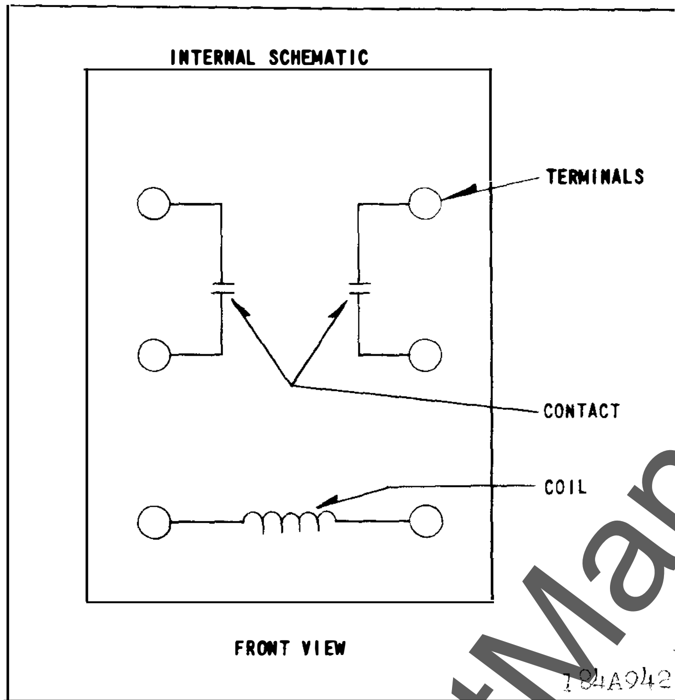
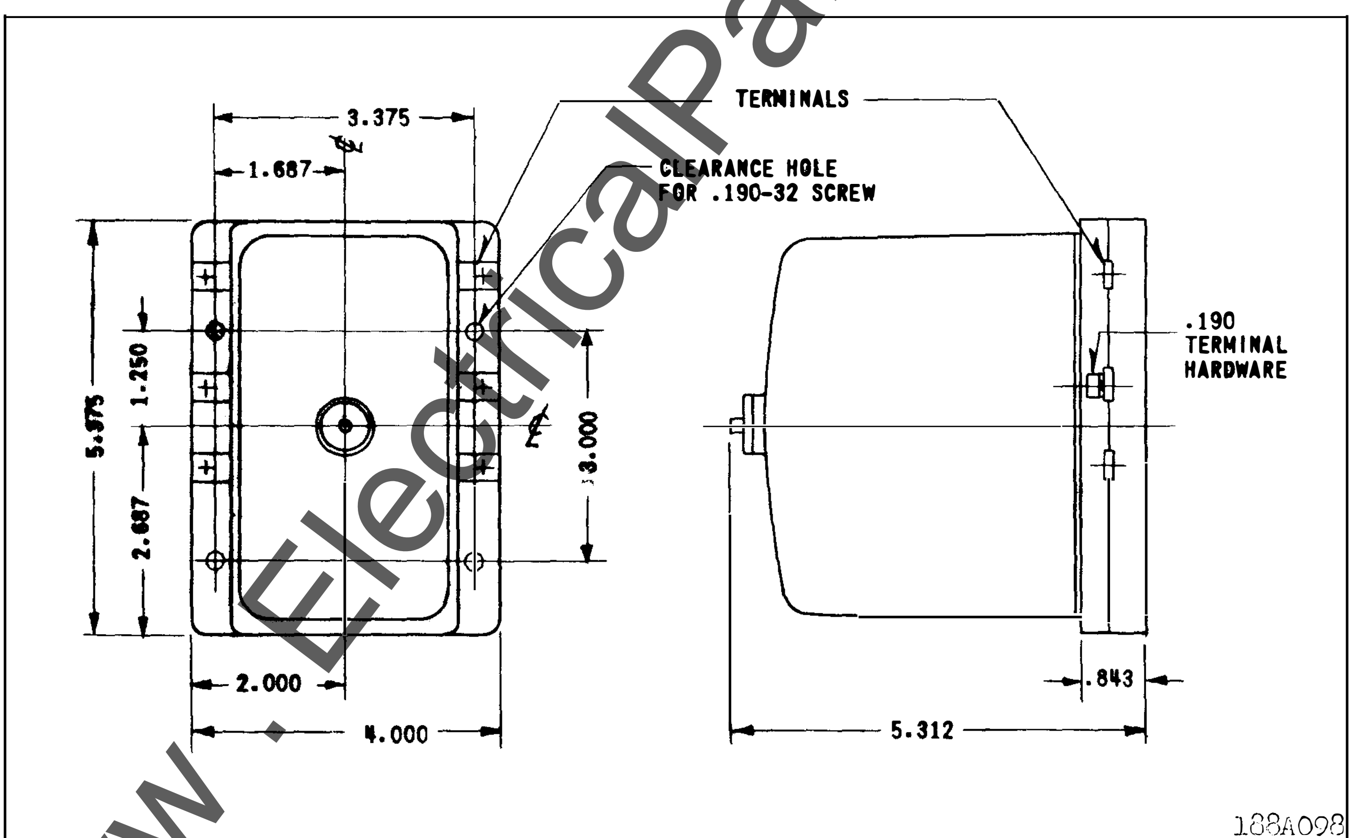


Fig. 11. Internal Schematic for Relays in Front Connected Case.



* *Fig. 12. Outline and Drilling Plan for Relays in Front Connected Case.*

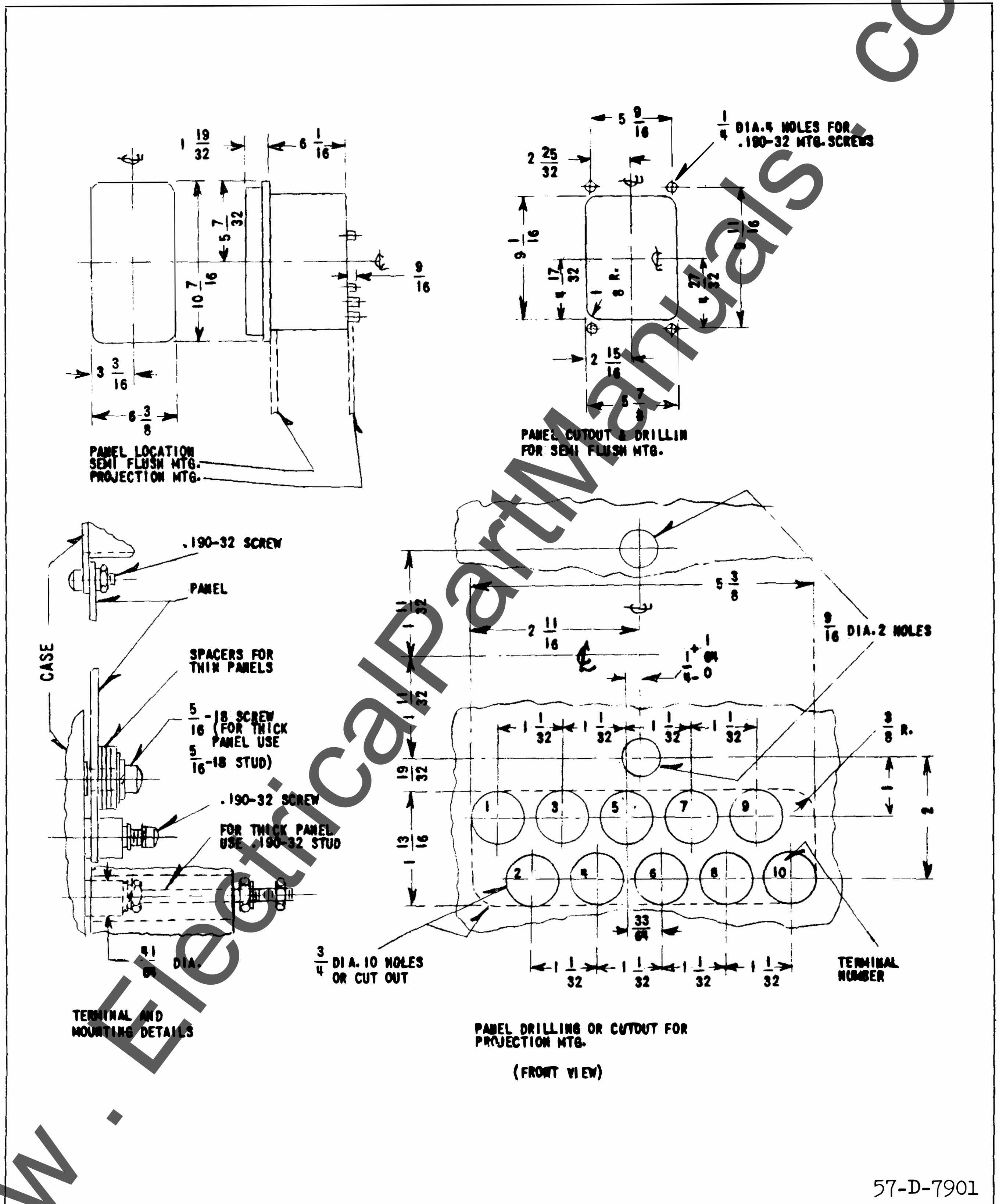


Fig. 13 Outline and Drilling Plan for Single and Double Unit Relays in the Type FT21 Case.

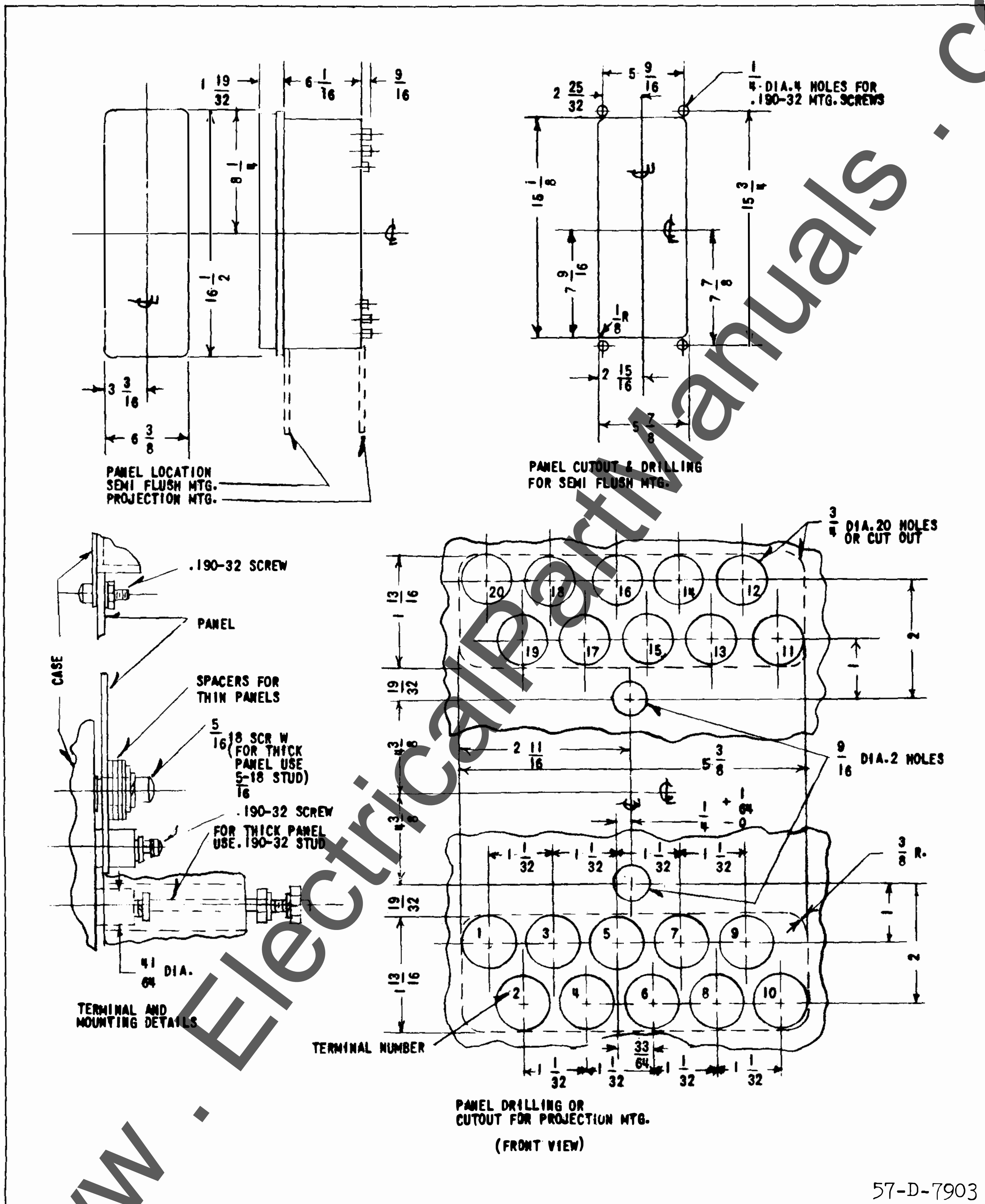


Fig. 14. Outline and Drilling Plan for Three Unit Relays in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-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, 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.

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. 41-776.1E
*Denotes changes from superseded issue.

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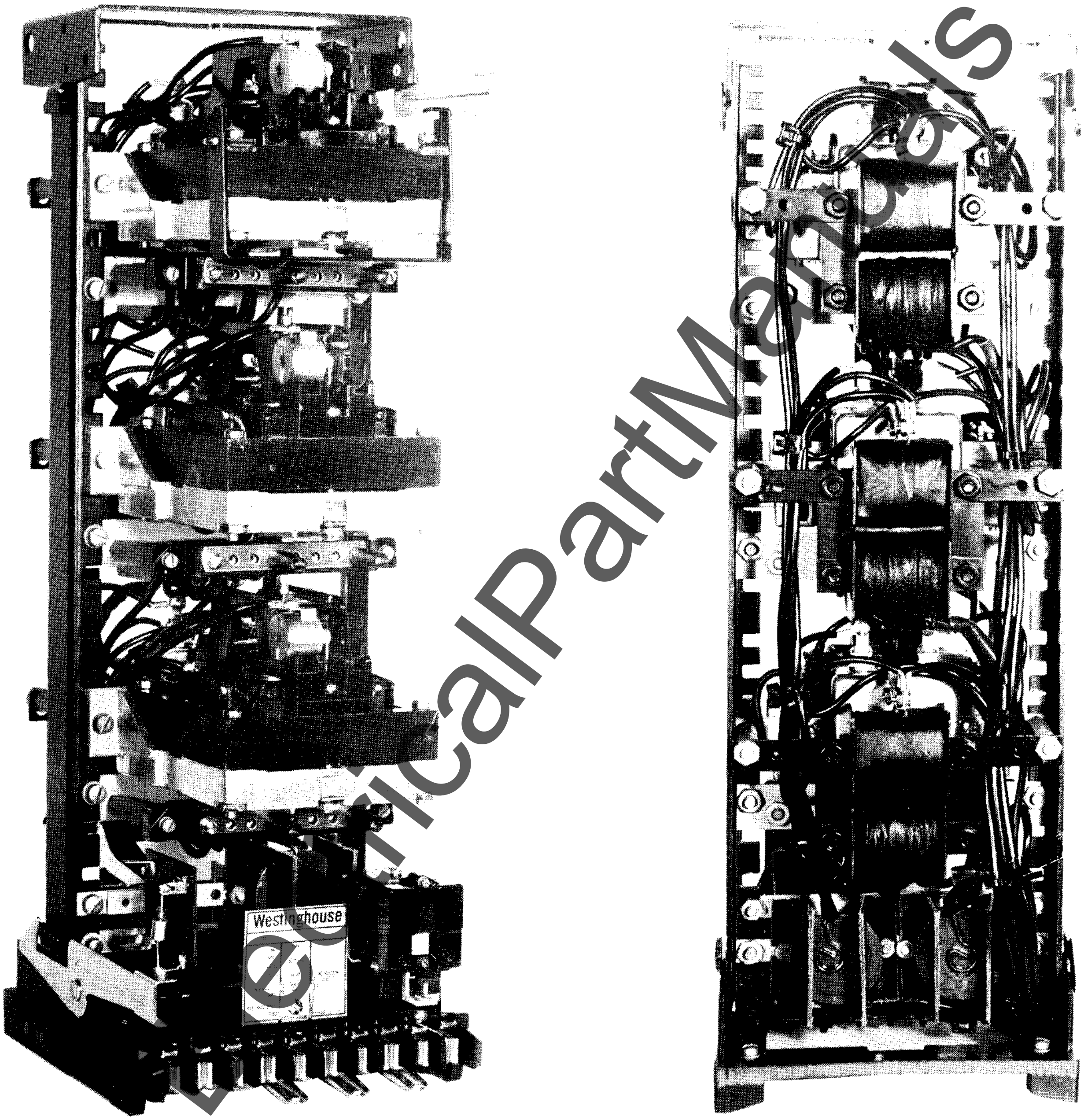


Fig. 1. Type KC-4 Relay Without Case.

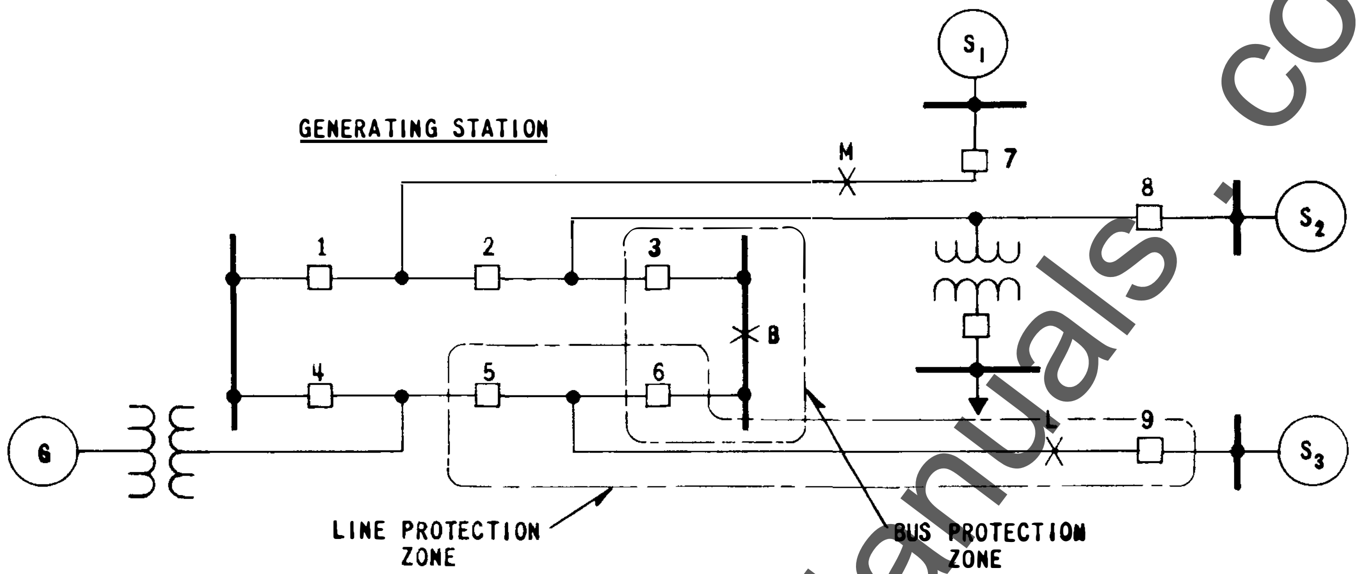


Fig. 2. Sample System to Show Advantages of Breaker-Failure Protection.

CONSTRUCTION

* The type KC-4 relay 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 the breaker-failure timing circuit. In addition, where the line relays trip two breakers such as on a ring

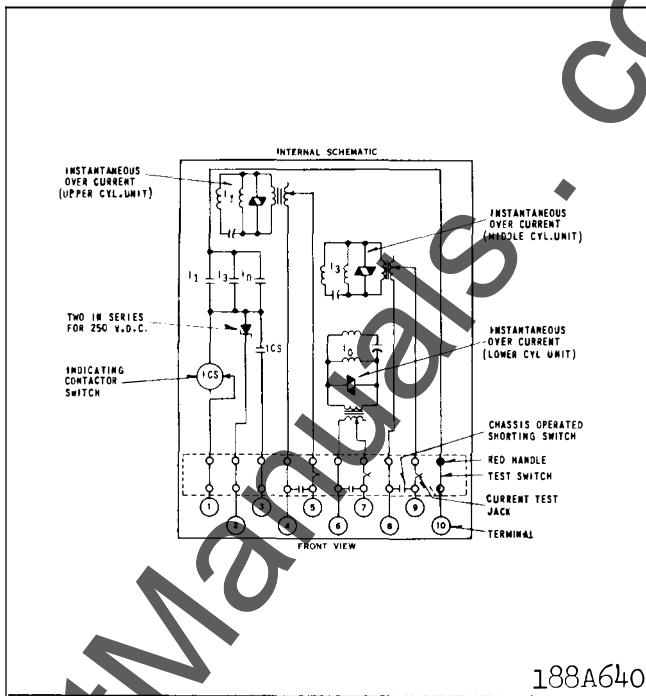
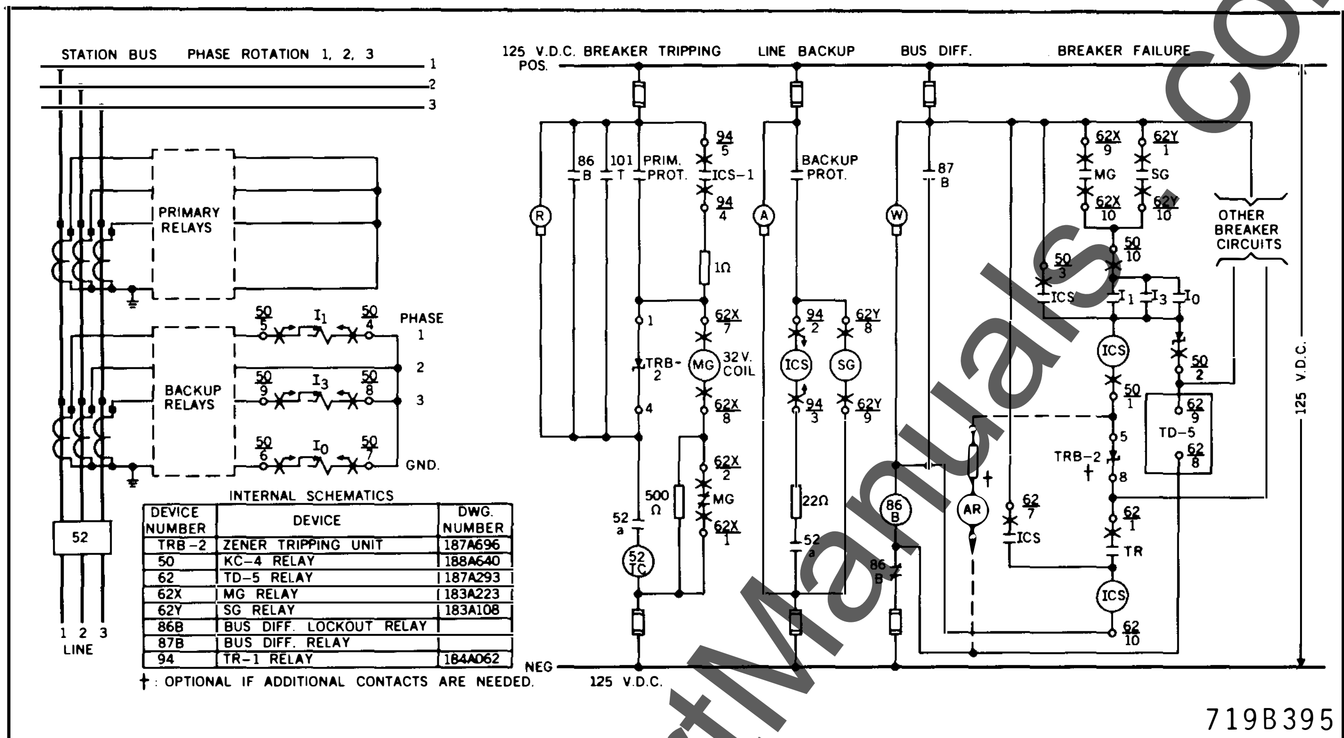


Fig. 3. Internal Schematic of the KC-4 Relay in the FT-41 Case.

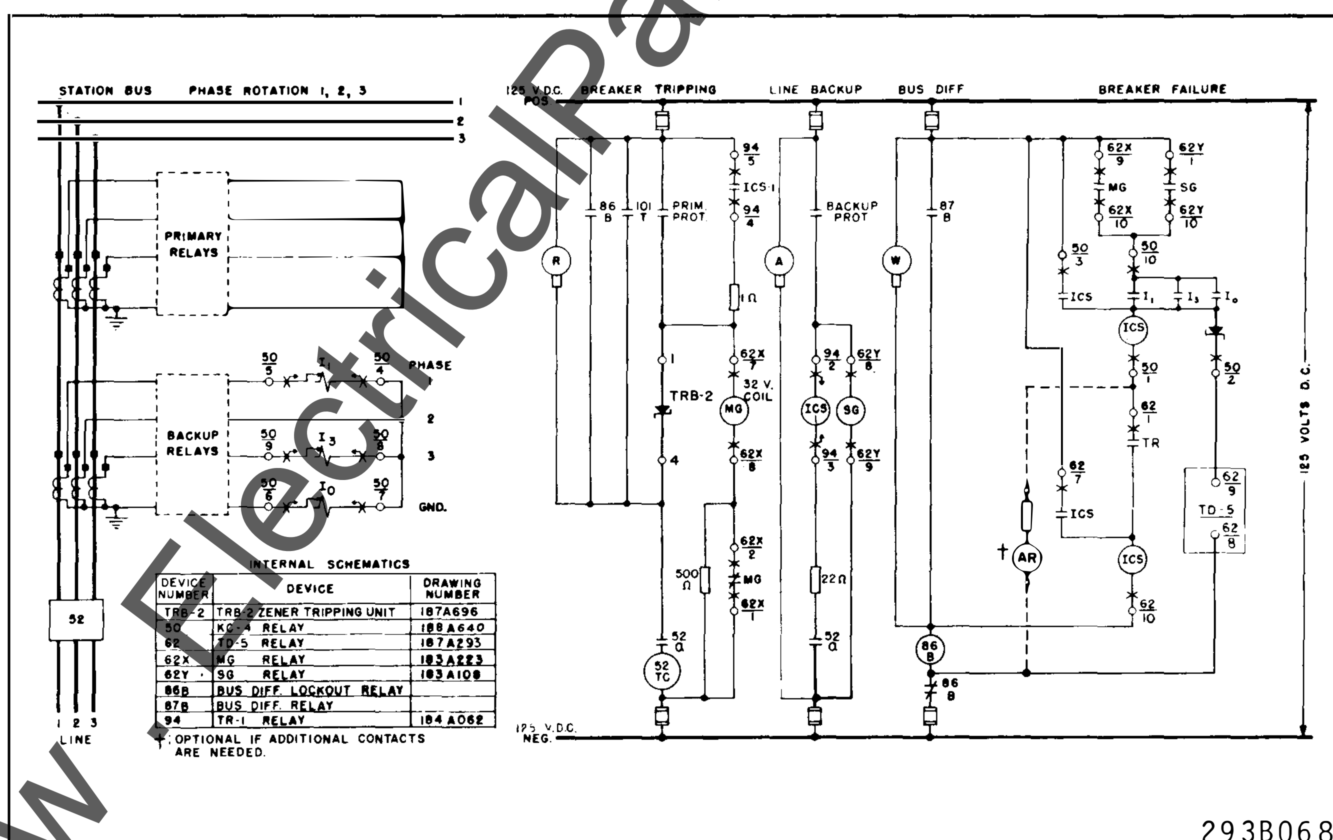
bus, the KC-4 selects which of the two breakers has failed. When the phase overcurrent units I_1 and I_3 are set above load-current level, the KC-4 also functions as a fault detector to prevent undesired tripping by test personnel. The following paragraphs describe KC-4 operation in more detail for different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

* For the single bus/single breaker and breaker-and-a-half configurations, external schematics are shown for breaker-failure schemes using either one timer per bus (Figs. 4 and 6), or one timer per breaker (Figs. 5 and 7). Although using one timer per bus requires fewer timers, the individual breaker timer scheme has the following advantages.

1. For a sequential, spreading fault, a common bus timer may be held on and may clear the bus unnecessarily. Separate timers eliminate this hazard.
2. For breakers of different rated interrupting times, each timer may be set for optimum clearing speed; i.e., the scheme will not be limited by the slowest breaker.
3. For a bus fault with a breaker failure, separate timers can selectively transfer-trip transmission lines without additional control circuitry.
4. When the bus configuration is changed, separate timers require minimal rewiring of dc control circuitry.



* *Fig. 4 External Schematic of the KC-4 Relay for Breaker Failure Protection of a Single Bus/Single Breaker Arrangement — One Timer Per Bus*



* *Fig. 5 External Schematic of the KC-4 Relay for Breaker Failure Protection of a Single Bus/Single Breaker Arrangement — One Timer Per Breaker*

* 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. Figs. 4 and 5 show 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-4 contacts. If the line breaker fails to clear the fault, KC-4 contacts remain 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-2 rectifier in the primary – protection circuits of Figs. 4 and 5 blocks the flow of red-light supervision current through the 62X coil.

An MG-6 relay performs the 62X function in Figs. 4 and 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 Figs. 6 & 7. The trip circuits for line A and bus L are shown. Similar circuits 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.

* Refer to Fig. 6. 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. 6 is the same as that used with the single bus/single breaker arrangement in Figs. 4 and 5.

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.

* In Fig. 7, a separate timer is associated with each breaker and the need for multiple control paths is eliminated. 62ZL initiates breaker failure operation directly along with 62X and 62Y.

Note that, for bus faults with a failed breaker, the bus lockout aux. 86BL is re-tripped by the 86Z contact; this is unnecessary but not detremental and permits simplest circuitry. Similarly, a line A fault with breaker 1 failure will initiate redundant tripping of breaker 2 and transfer-tripping of line A.

Ring Bus Arrangement

The circuits for the ring bus are shown in Fig. 8 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 86BF-Relay 86BF 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 86BF 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 tripping. Otherwise, line A continues to feed the fault through breaker 2 until a back-up relay operates or until the fault burns clear.

* Additional Contacts

Figs. 4 through 8 show how an AR auxiliary relay may be connected to provide additional contacts. In each case, the AR will operate when both the KC-4 contacts and the 62X, Y, or Z contacts close. The 10-watt AR coil (80 ma @125 Vdc) will not pick up the ICS unit in the KC-4, but may hold the ICS picked up unless its coil current is interrupted by the 86B contact as shown.

Note that one of the TRB-2 zener diodes in Figs. 4 and 6 is designated as necessary only if the AR relay is used.

Fig. 9 illustrates how Figs. 4 through 8 may be modified so that the AR relay will be operated by the KC-4 overcurrent unit contacts directly. If this is done, it is essential that the KC-4 relay be set well above load current; otherwise, the overcurrent unit contacts may be damaged by repeated keying of the AR relay coil current.

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. 10.

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

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.*

* 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
.5-2	.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

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
4-16	10	200

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.

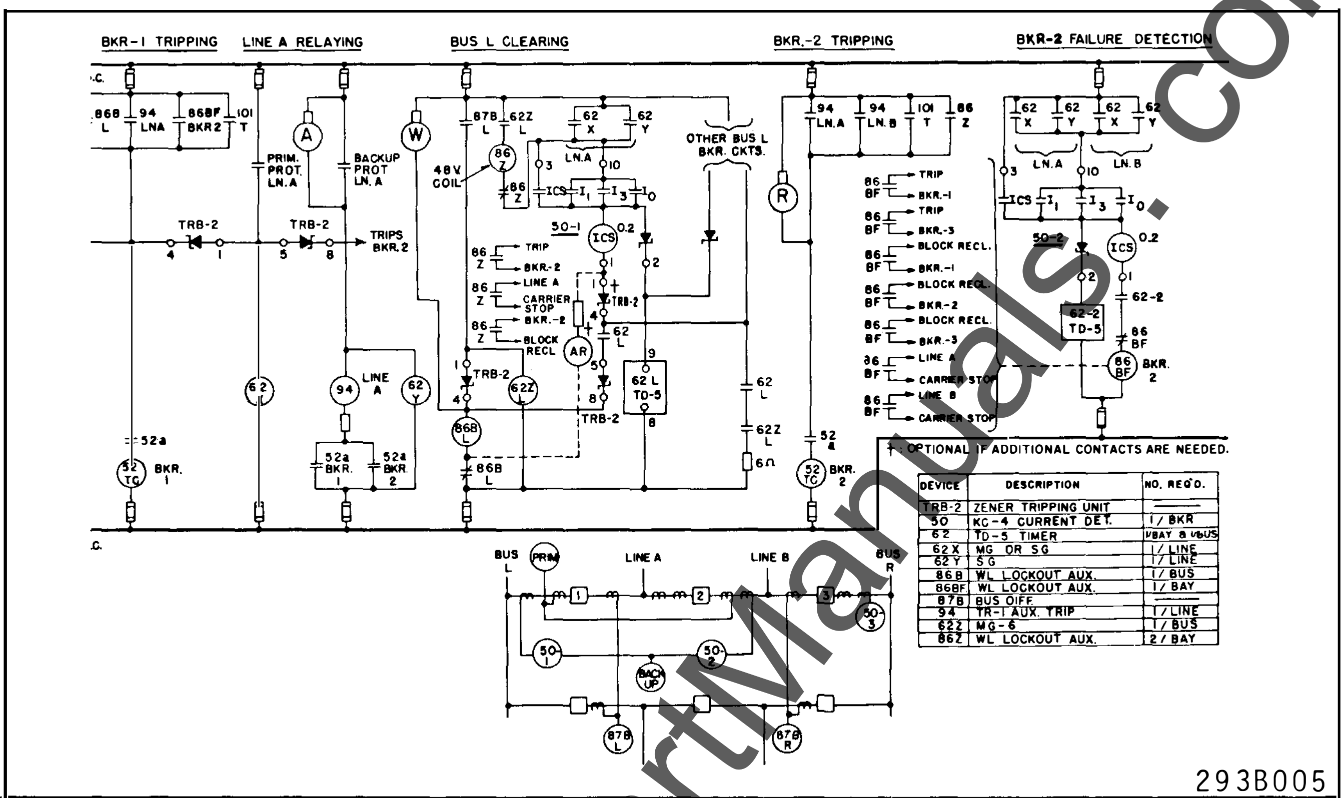
Indicating Contactor Switch (ICS.)

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

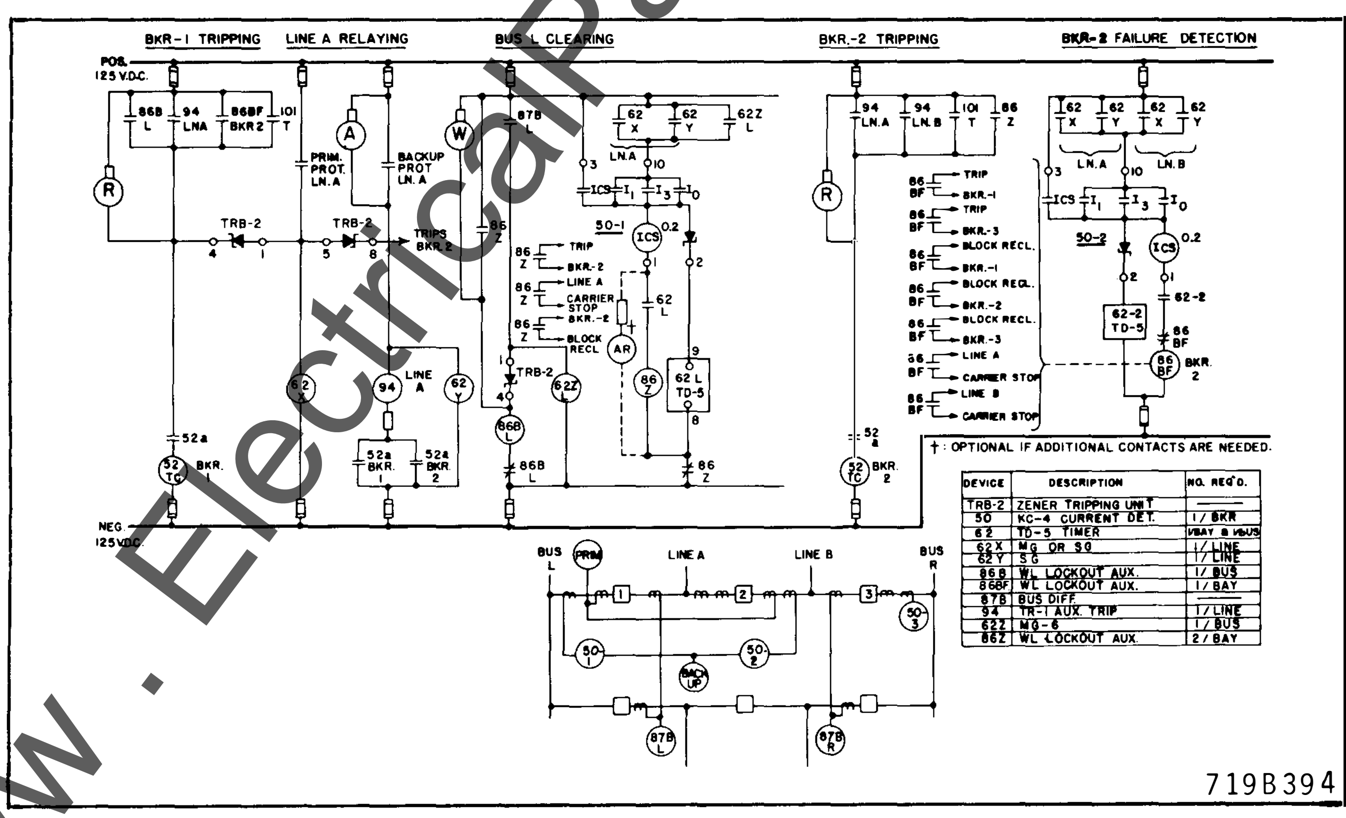
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection 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.



DEVICE	DESCRIPTION	NO. REQ'D.
TRB-2	ZENER TRIPPING UNIT	——
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
86BF	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. 6 Simplified External Schematic of the KC-4 Relay for Breaker Failure Protection of a Breaker-and-a-Half Bus — One Timer Per Bus*



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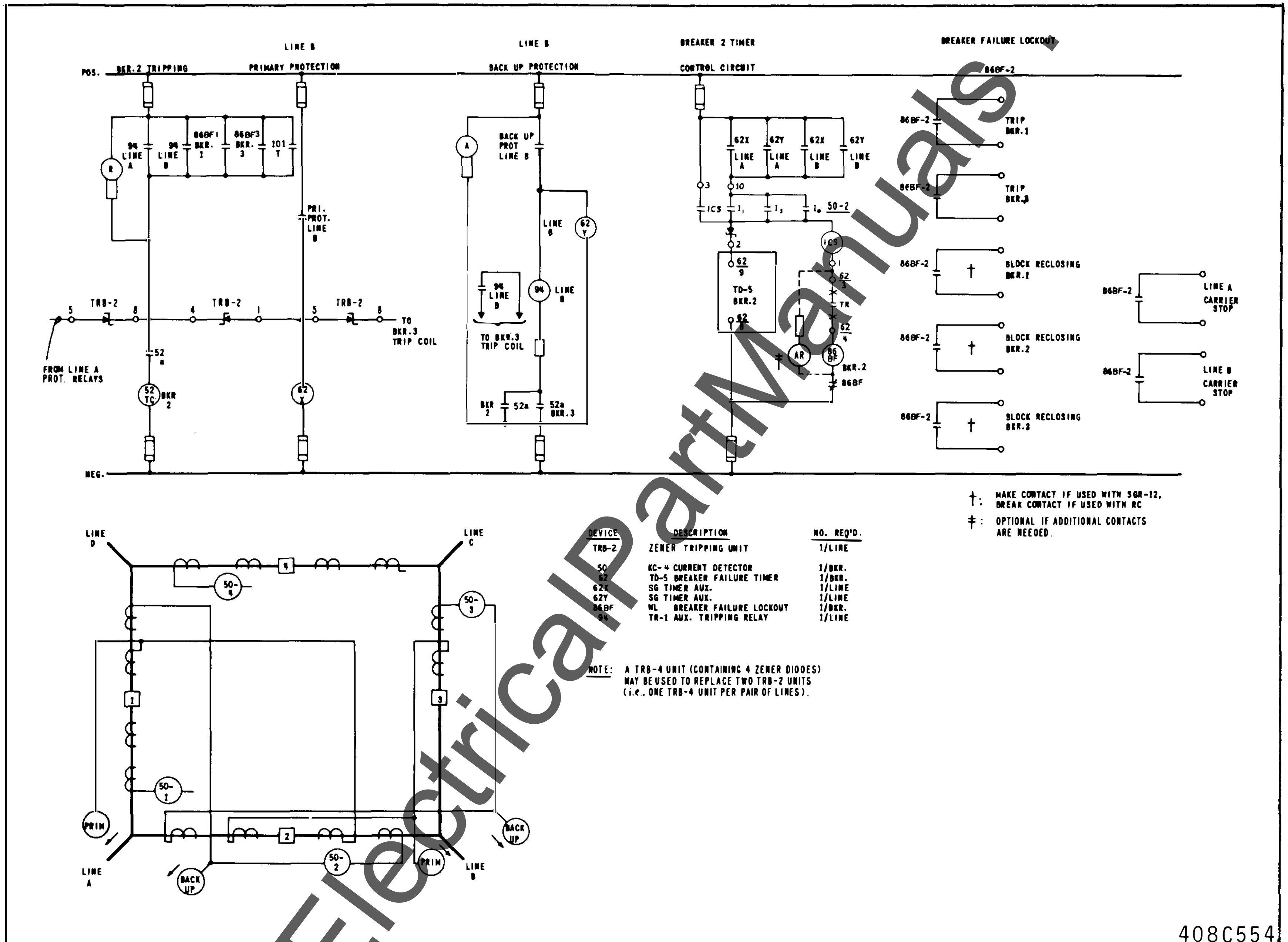
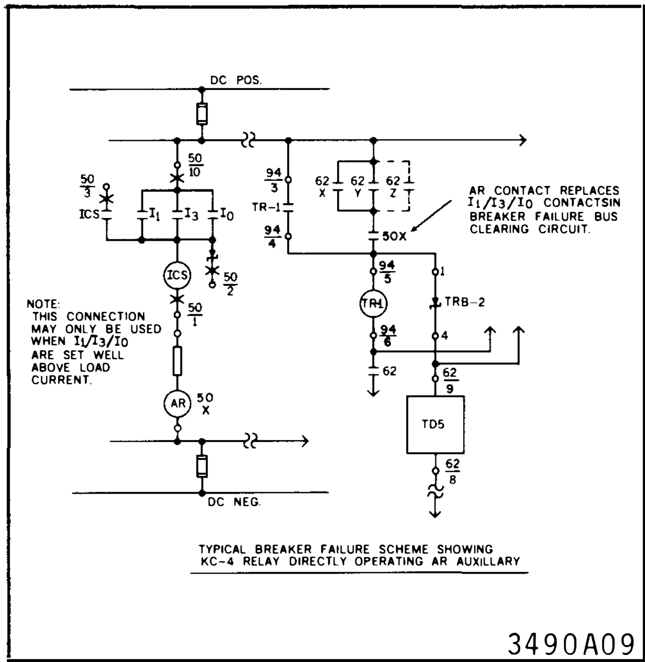
62X	MG OR SG	1/LINE
62Y	SG	1/LINE
86B	WL LOCKOUT AUX.	1/BUS
86BF	WL LOCKOUT AUX.	1/BAY
87B	BUS DIFF.	
94	TR-1 AUX. TRIP	1/LINE
62Z	MG-6	1/BUS
86Z	WL LOCKOUT AUX.	2/BAY

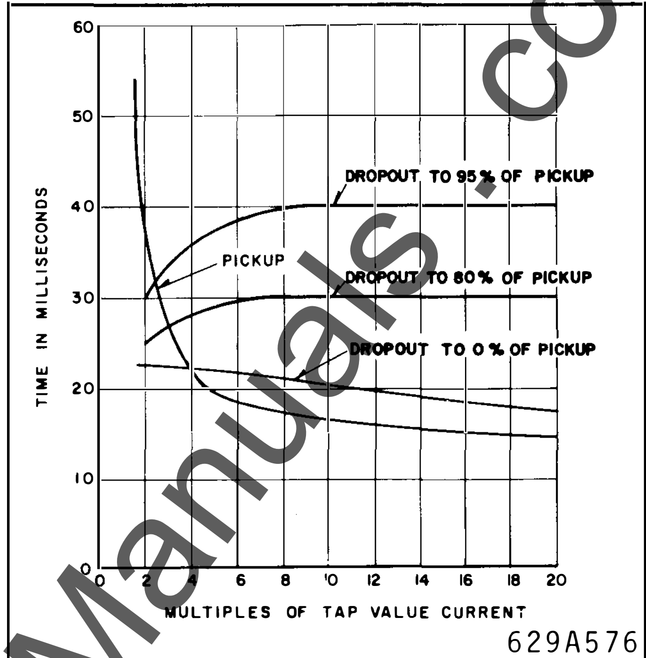
* *Fig. 7 Simplified External Schematic of the KC-4 Relay for Breaker Failure Protection of a Breaker-and-a-Half Bus — One Timer Per Breaker*



* *Fig. 8 Simplified External Schematic of the KC-4 Relay for Breaker Failure Protection of a Ring Bus*



* *Fig. 9 Direct Operation of AR Relay by KC-4 Overcurrent Contacts*



* *Fig. 10. Maximum Pick-Up and Drop-Out Time Curves for the Phase and Ground Overcurrent Units*

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.

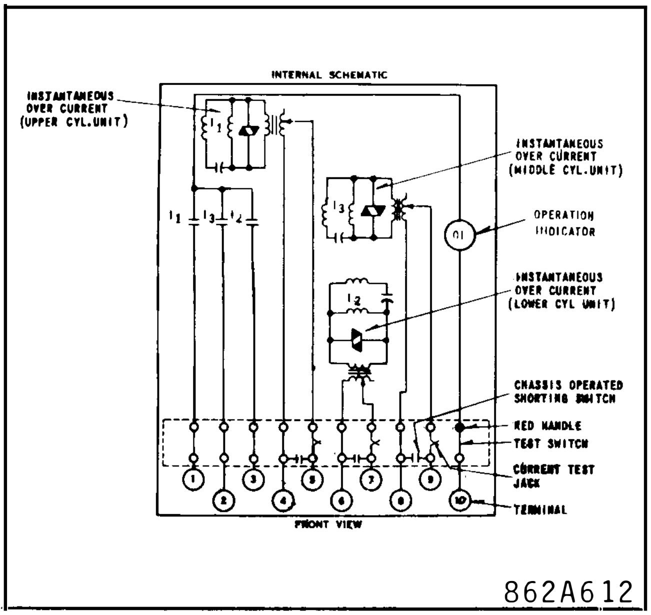
Routine Maintenance

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.

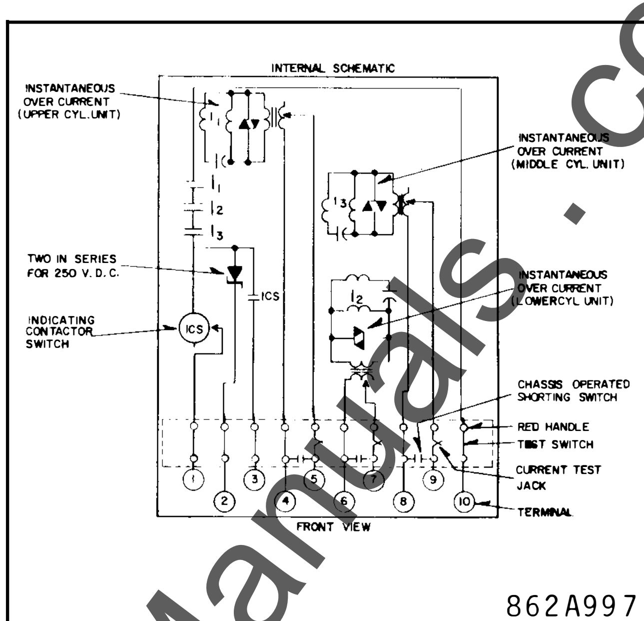
All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

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").



* *Fig. 11 KC-4 Relay Instantaneous-Overcurrent Contacts to Separate Terminals in FT-41 Case.*



* *Fig. 12 KC-Relay Instantaneous-Overcurrent Series make Contacts in FT-41 Case.*

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.

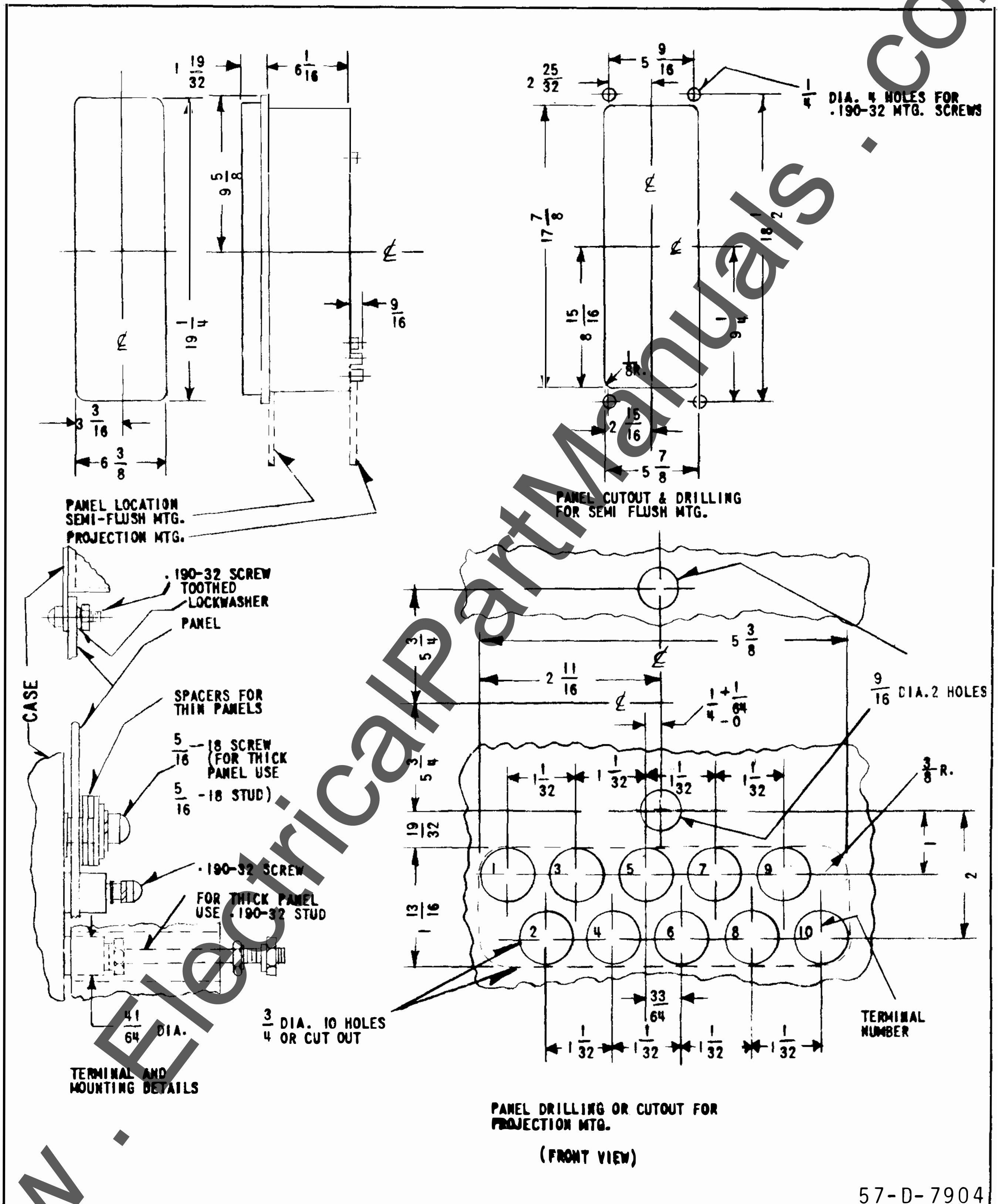
Indicating Contactor Switch (ICS.)

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. 13. KC-4 Relay in FT-41 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

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 Fluorosint® 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 Fluorosint® 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

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*Denotes change from superseded issue.

EFFECTIVE FEBRUARY 1973

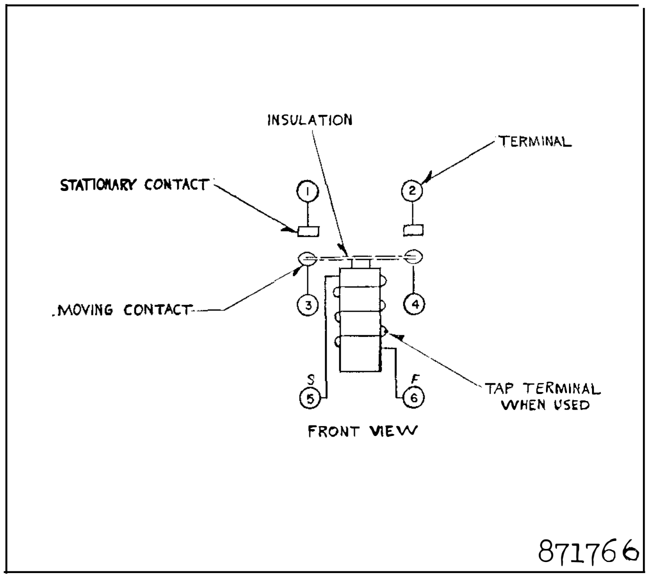

Fig. 1. Internal Wiring of the Relays In The Small Glass Case.

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.

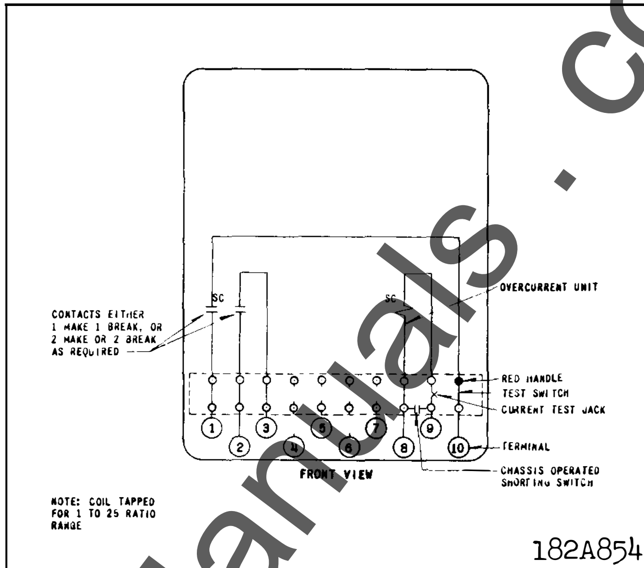

Fig. 2. Internal Schematic of the Single Unit Type SC or SC-1 Relay in The Type FT21 Case.

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

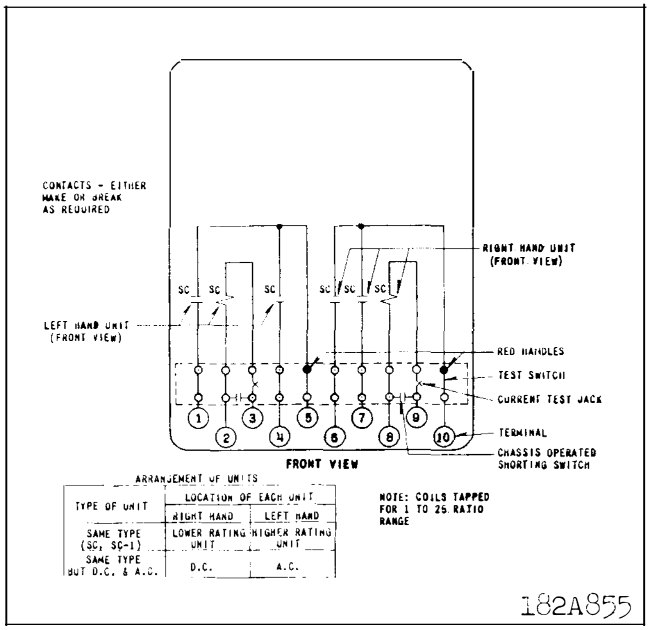

Fig. 3. Internal Schematic of the Double Unit Type SC or SC-1 Relay in the Type FT21 Case.

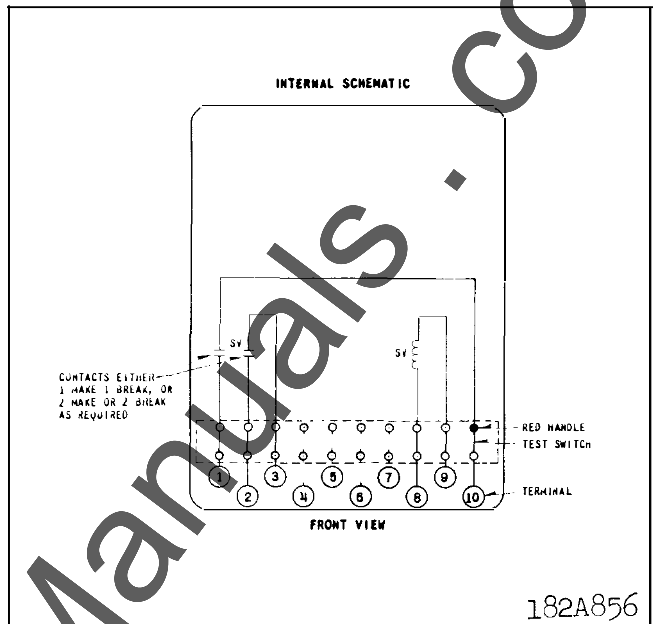

Fig. 4. Internal Schematic of the Single Unit Type SV or SV-1 Relay in the Type FT21 Case.

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 so 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

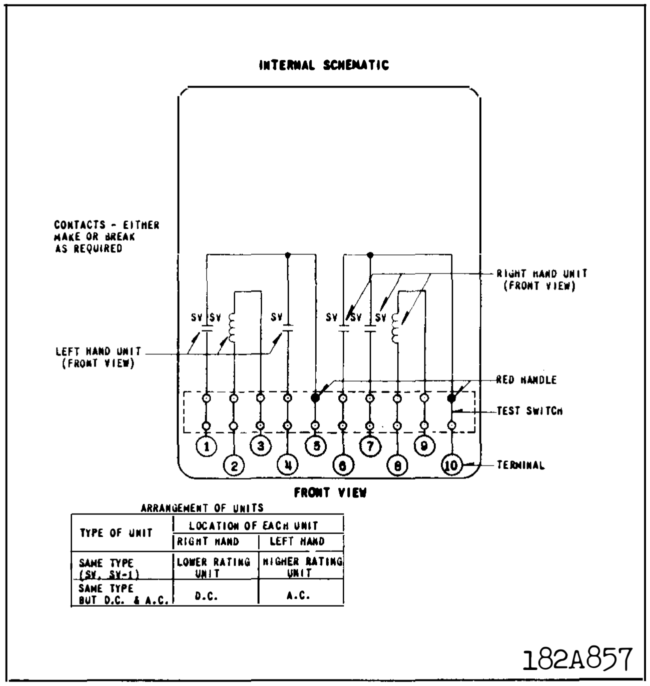

Fig. 5. Internal Schematic of the Double Unit Type SV or SV-1 Relay in the Type FT32 Case.

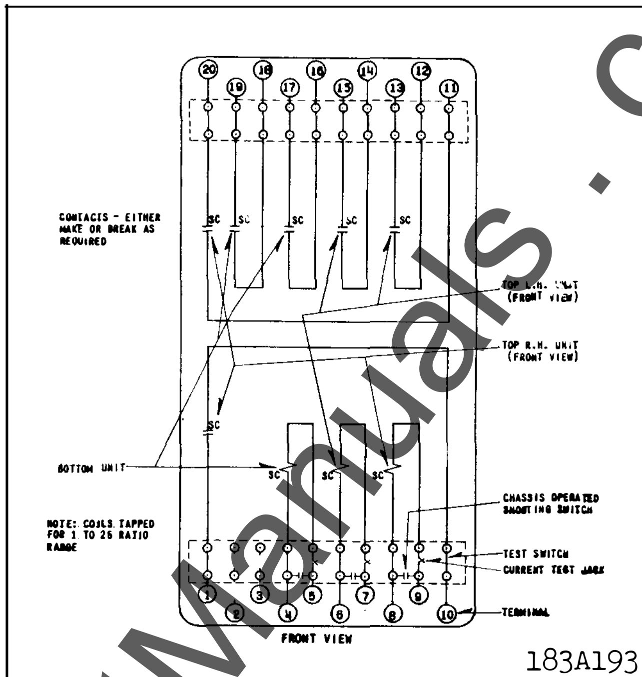

Fig. 6. Internal Schematic of the Three Unit Type SC or SC-1 Relay in the Type FT32 Case.

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 hz.	.5-2	1.5	99	225	90-98%	65-80%
SC	DC, 25 to 60 hz.	1-4	3	28	65	90-98%	65-80%
SC	DC, 25 to 60 hz.	2-8	6	6.9	19	90-98%	65-80%
SC	DC, 25 to 60 hz.	4-16	12	1.5	5	90-98%	65-80%
SC	DC, 25 to 60 hz.	10-40	25	.24	.7	90-98%	65-80%
SC	DC, 25 to 60 hz.	20-80	40	.07	.16	90-98%	65-80%
SC	DC, 25 to 60 hz.	40-160	40	.03	.05	90-98%	65-80%
SC	DC, 25 to 60 hz.	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 hz.	.5-2	1.5	100	210	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	1-4	3	24	60	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	2-8	6	6	16	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	4-16	12	1.5	5	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	10-40	25	.25	.65	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	20-80	40	.07	.16	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	40-160	40	.03	.05	35-60%	25-40%
SC-1	DC, 25 to 60 hz.	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%.

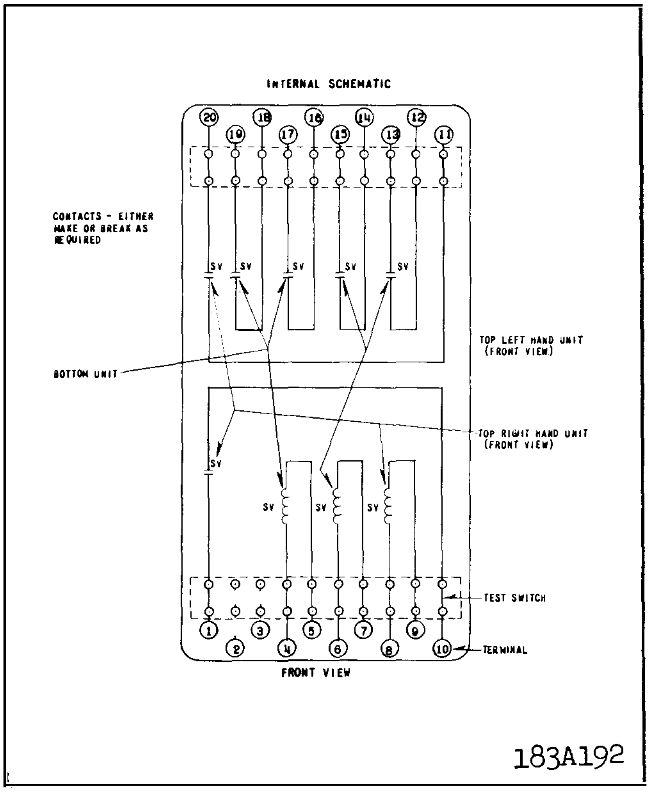

Fig. 7. Internal Schematic of the Three Unit Type SV or SV-1 Relay in the Type FT32 Case.

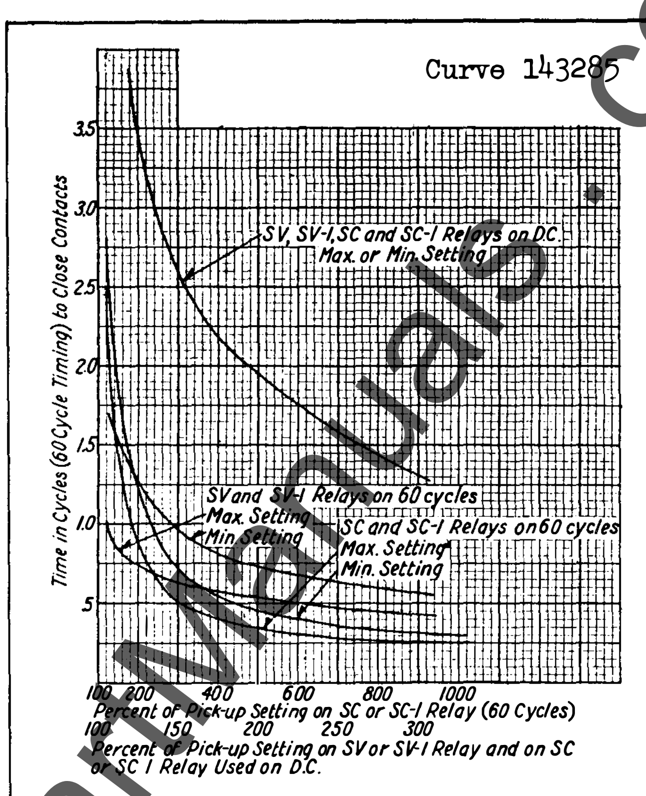

Fig. 8. Typical Time Curves for the Types SC and SV Relays (Using Flux Shunt for Pick-up Adjustment.)

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

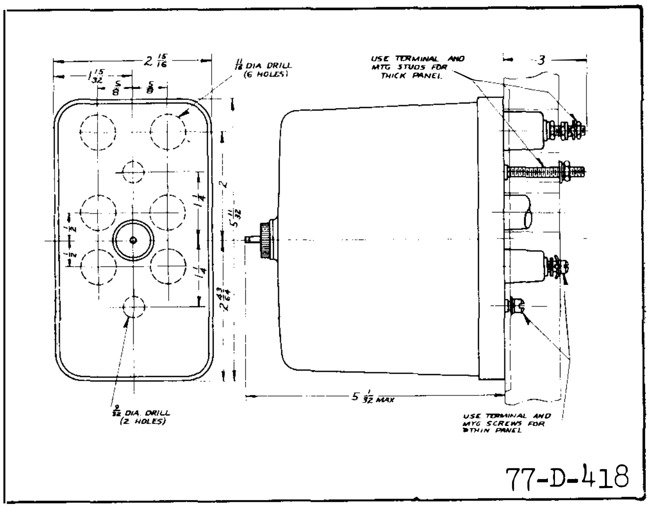

Fig. 9. Outline & Drilling Plan for Single Unit Relays in Small Glass Projection Case.

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.

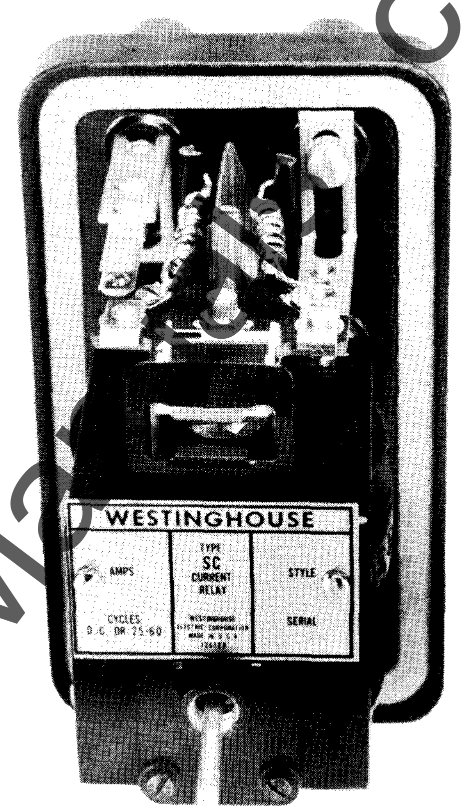

Fig. 10. View of Type SC Relay Showing Correct Shaping of Moving Contact Leads.

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.

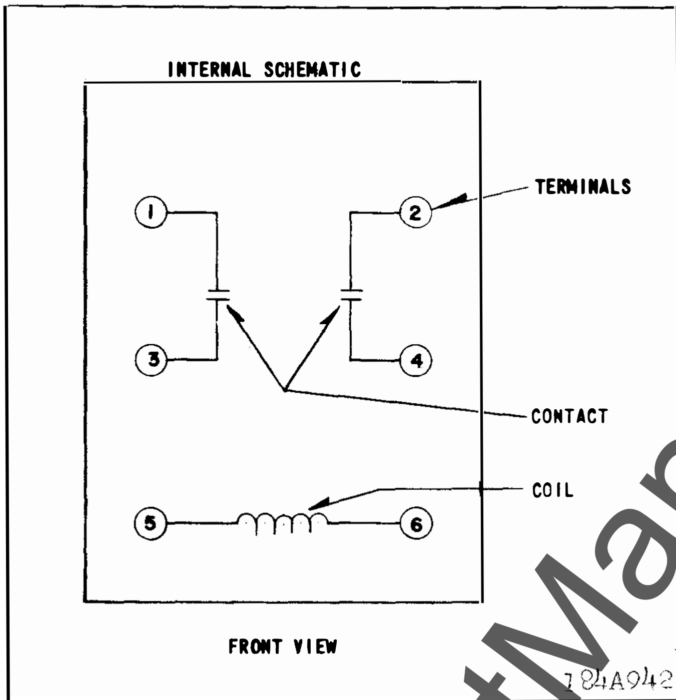

Fig. 11. Internal Schematic for Relays in Front Connected Case.

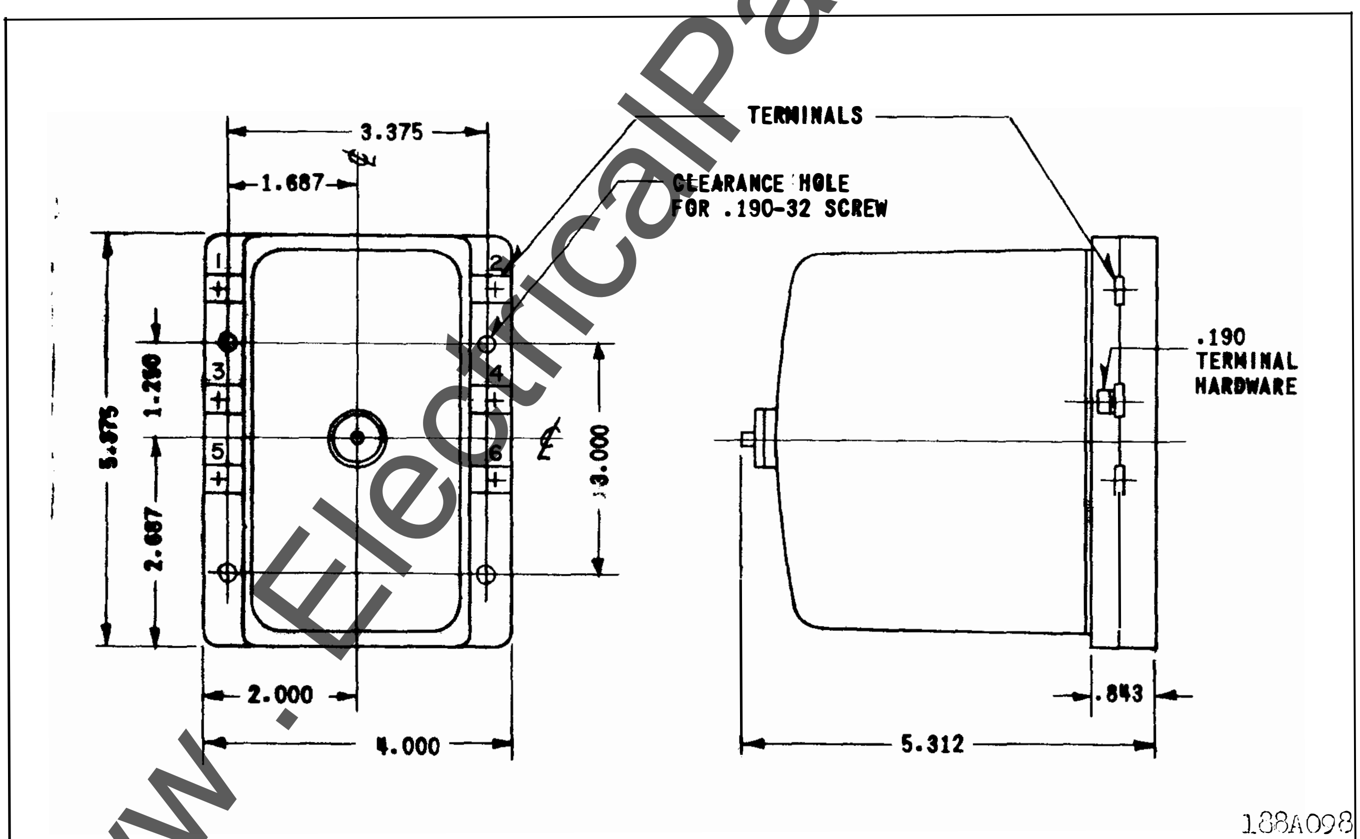

Fig. 12. Outline and Drilling Plan for Relays in Front Connected Case.

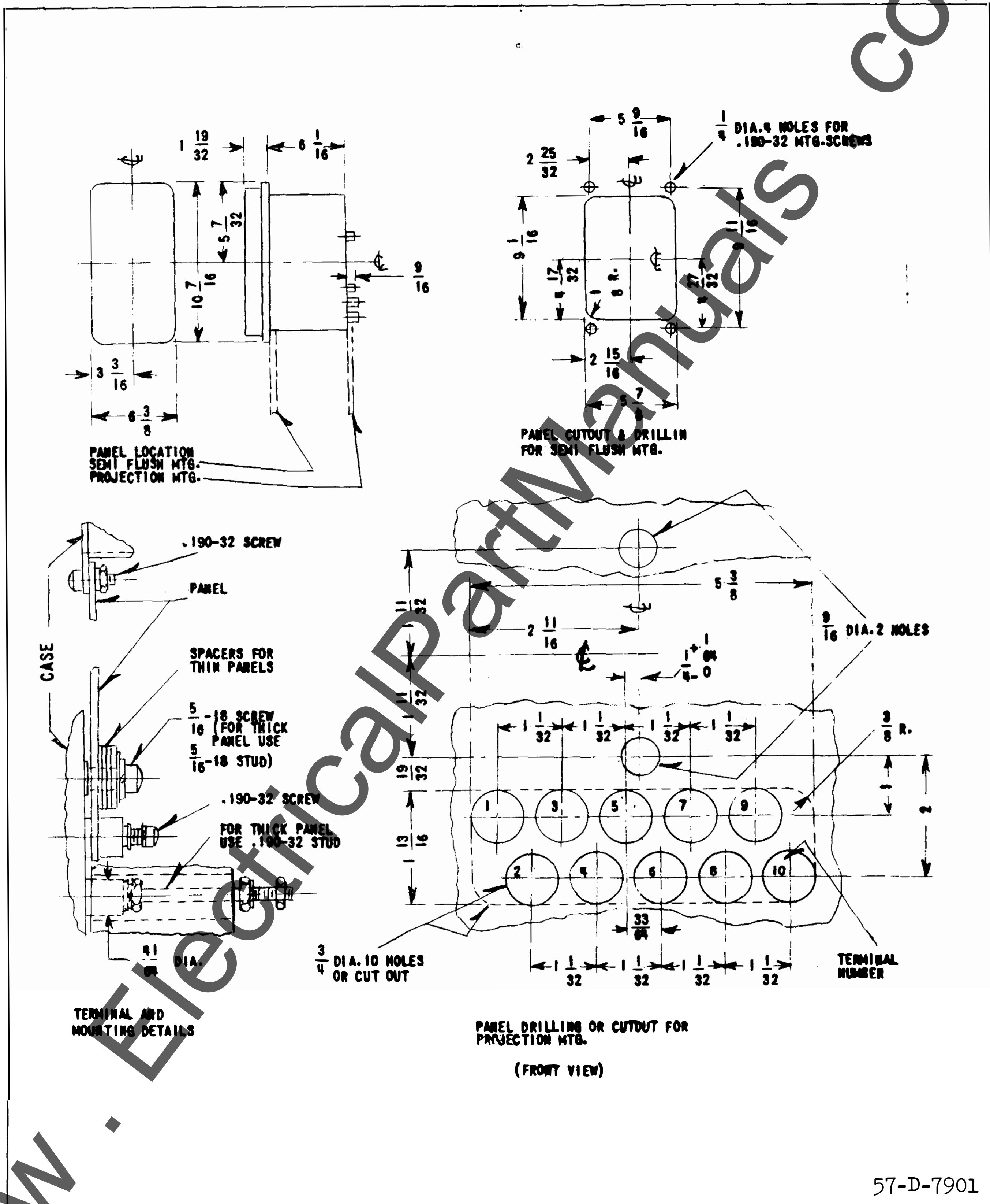

Fig. 13 Outline and Drilling Plan for Single and Double Unit Relays in the Type FT21 Case.

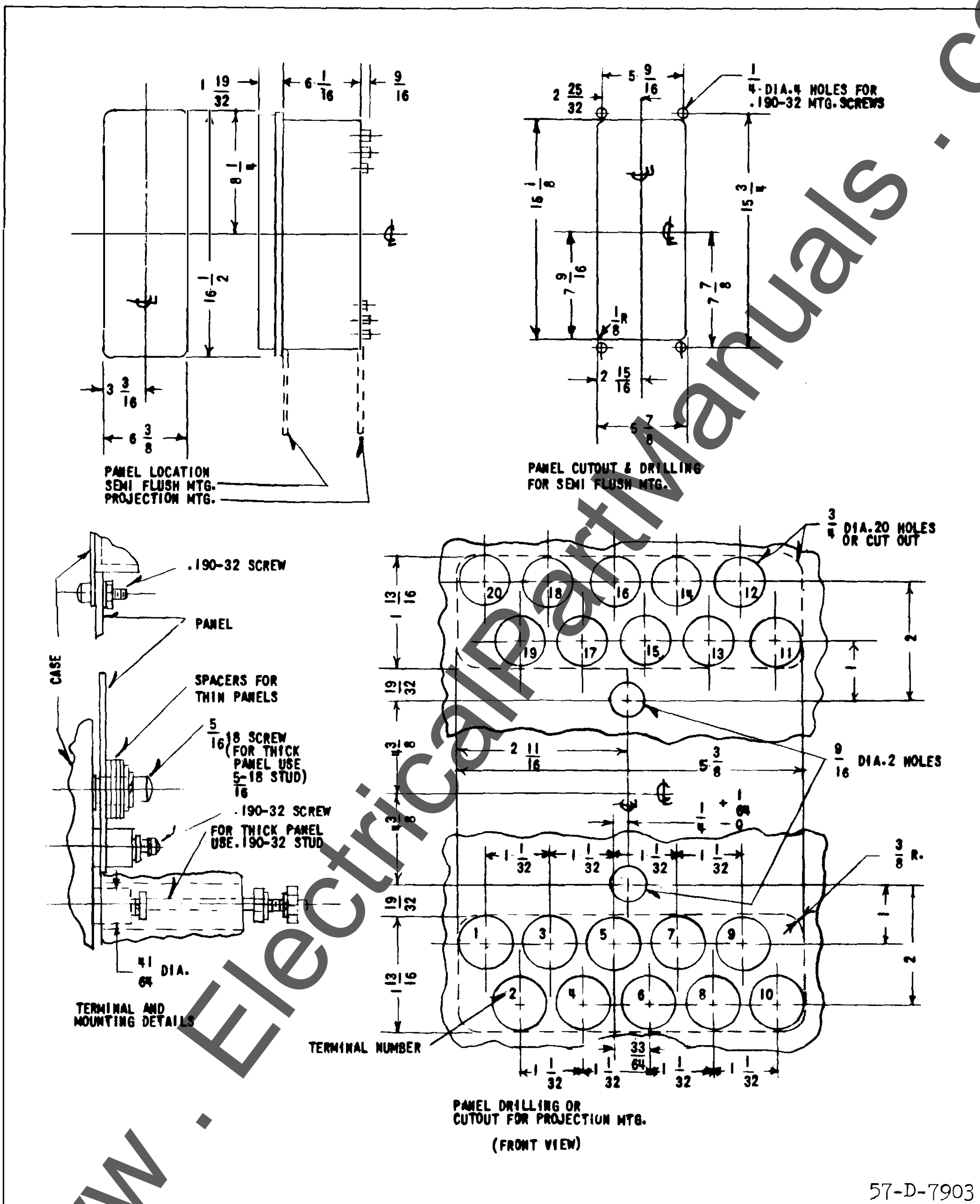

Fig. 14. Outline and Drilling Plan for Three Unit Relays in the Type FT32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KC-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.

EFFECTIVE SEPTEMBER 1980

SUPERSEDES I.L. 41-776.1J, dated December 1977
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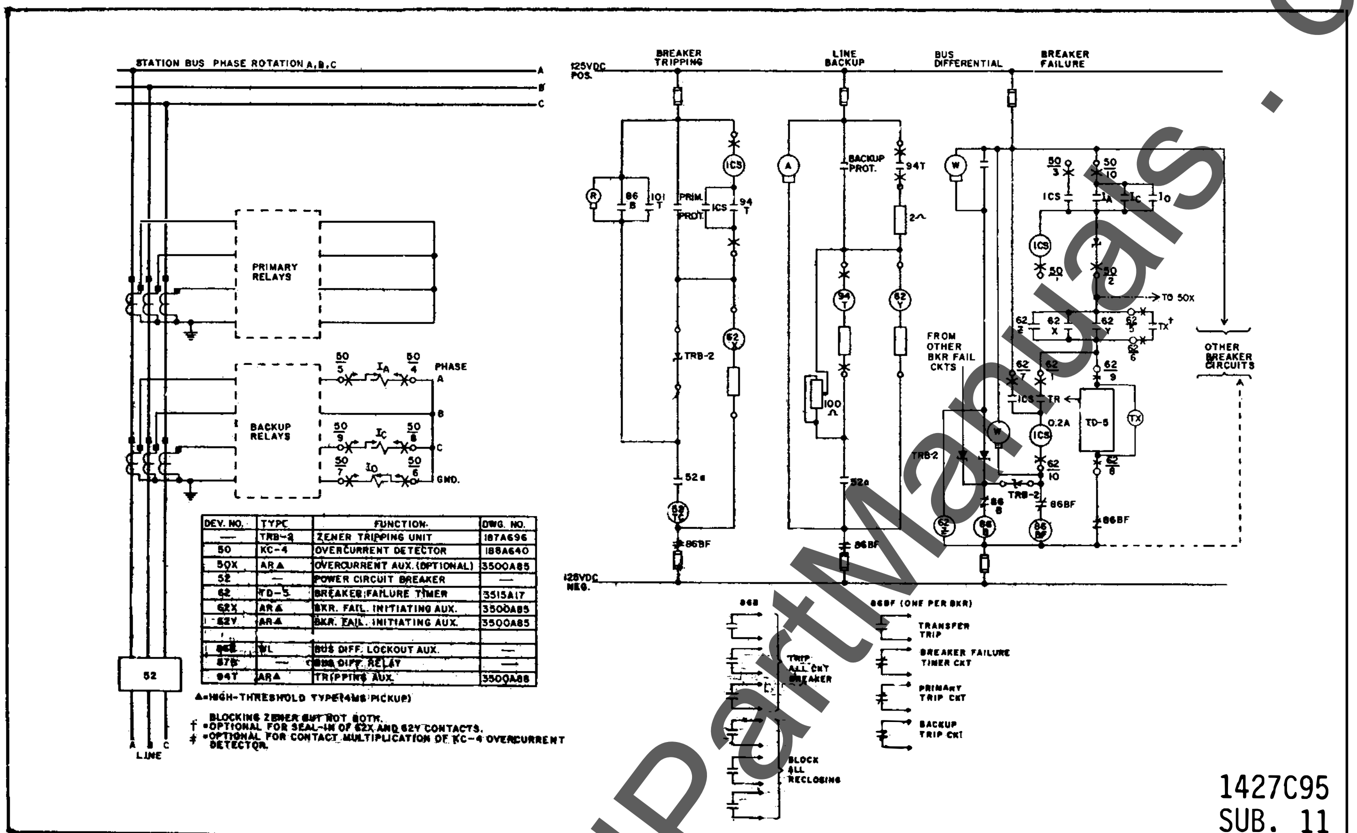


Fig. 3. External Connections for the KC-4 Relay – Breaker Failure Protection of a Single Bus/Single Breaker Arrangement with One Timer per Breaker.

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

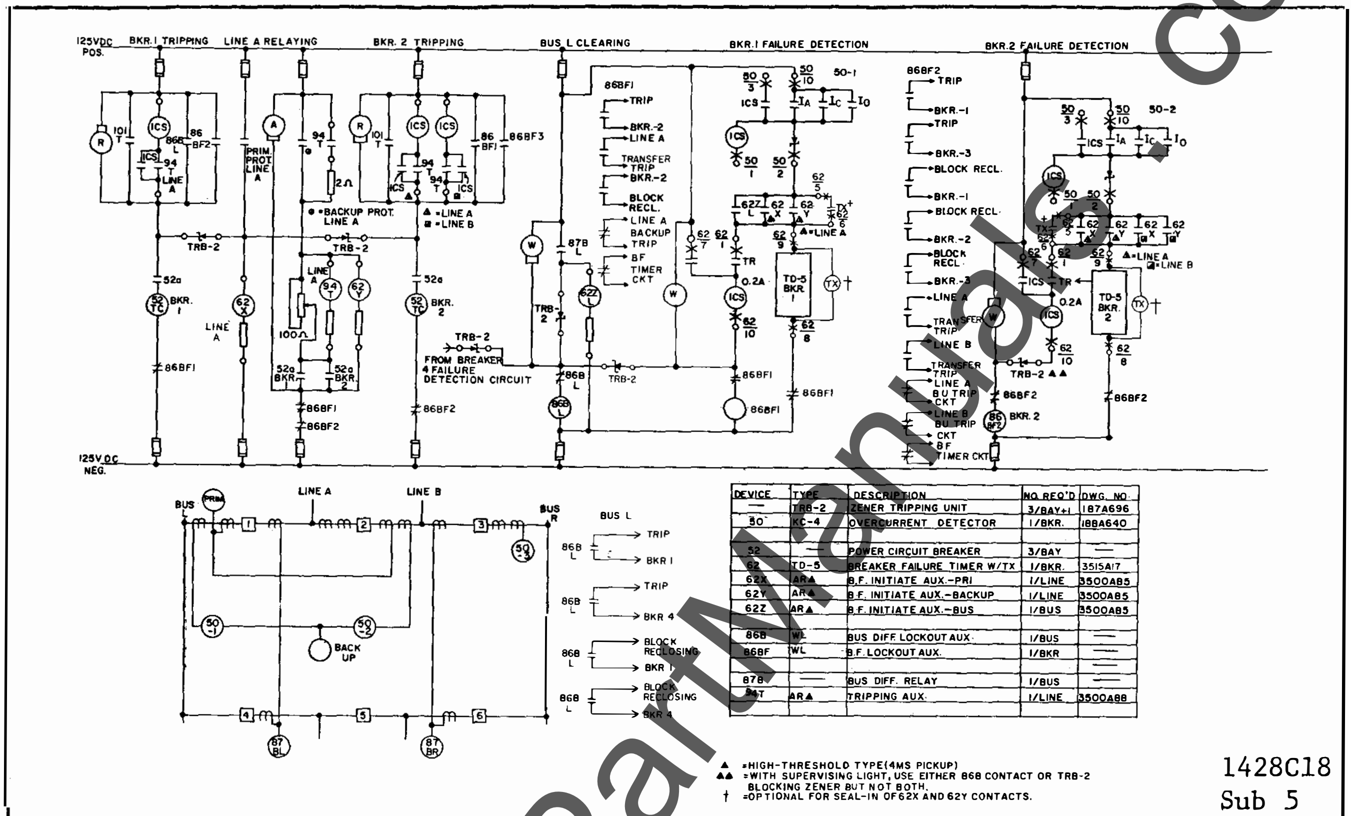
Figure 4 show breaker-failure protection circuits for a breaker-and-a-half bus arrangement, with one timer for each breaker.

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.

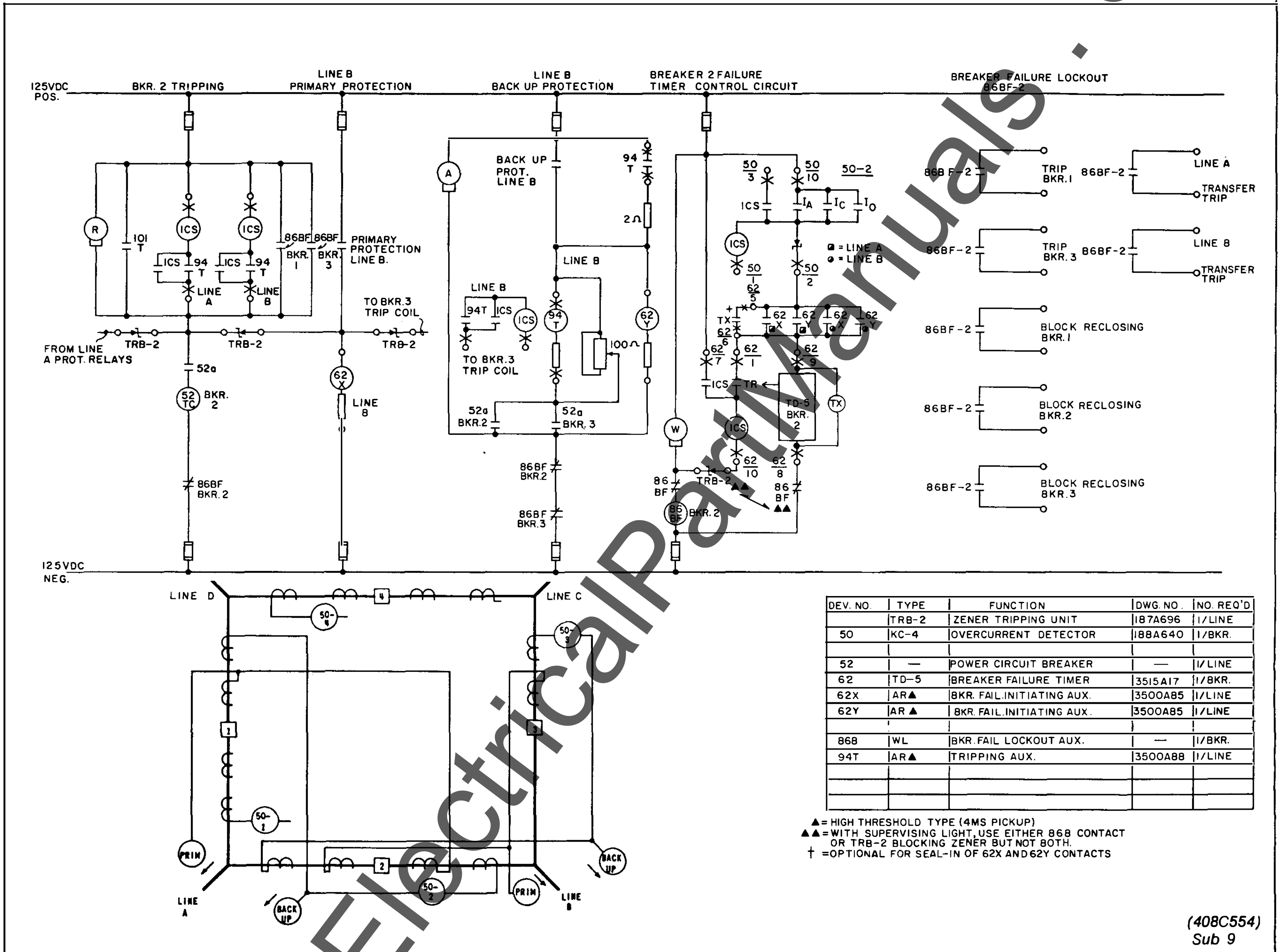
Indicating Contactor Switch (ICS)

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

(408C554)
Sub 9

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.

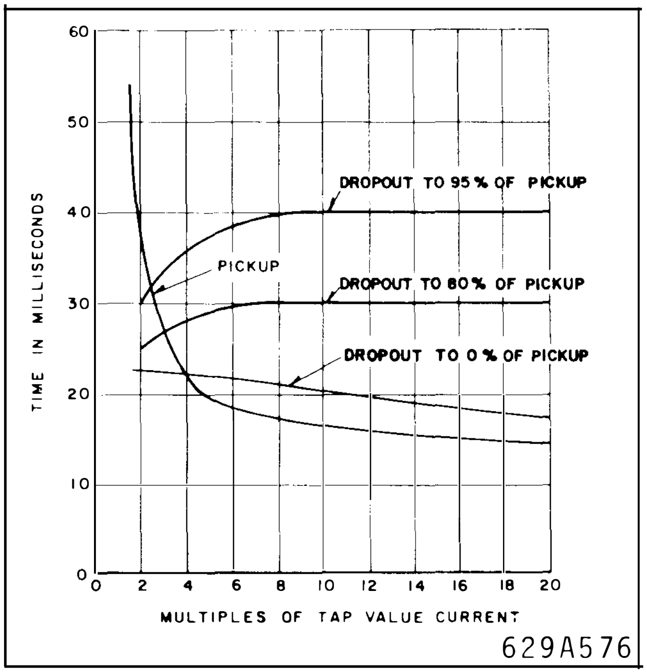


Fig. 6. Maximum Pick-Up and Drop-Out Time Curves for the Phase and Ground Overcurrent Units

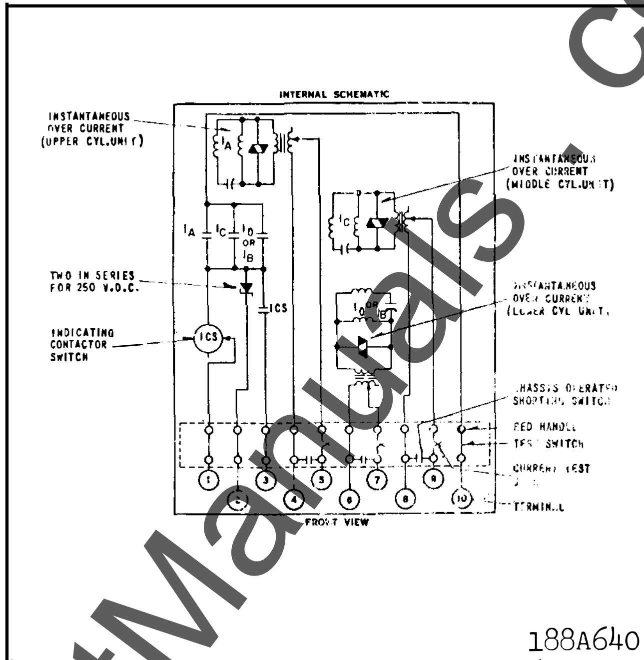


Fig. 7. Internal Schematic of the KC-4 Relay in the FT-41 Case.

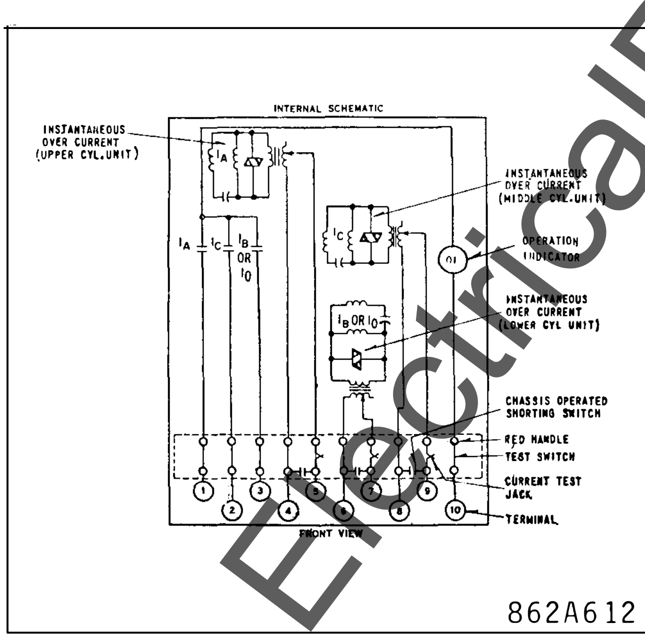


Fig. 8. Internal Schematic of the KC-4 Relay with Operation Indicator and Contacts to separate terminals in FT-41 case.

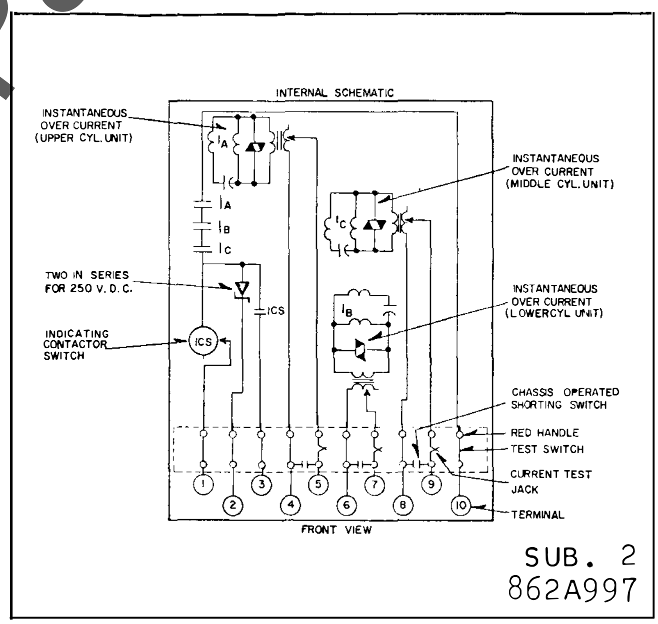


Fig. 9. Internal Schematic of the KC-4 Relay with Series Make Contacts in FT-41 Case.

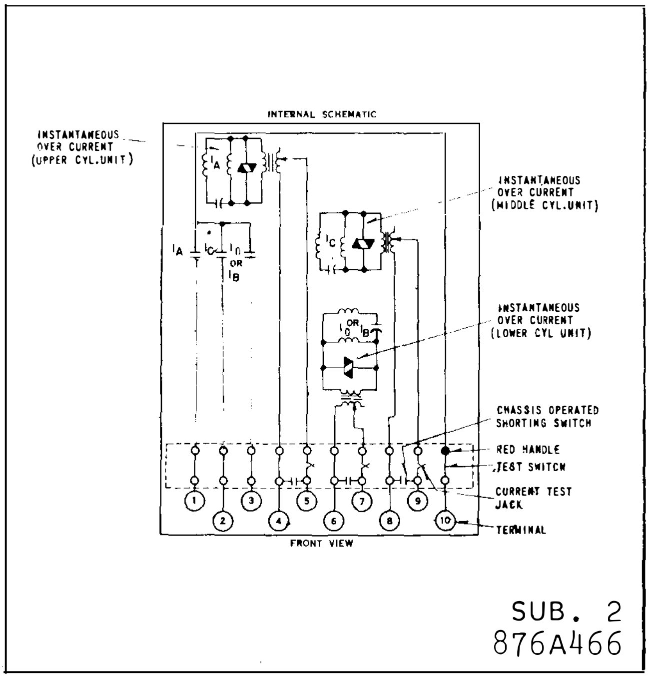


Fig. 10. *Internal Schematic of the KC-4 Relay with one side of Contacts to Separate Terminals in FT-41 Case.*

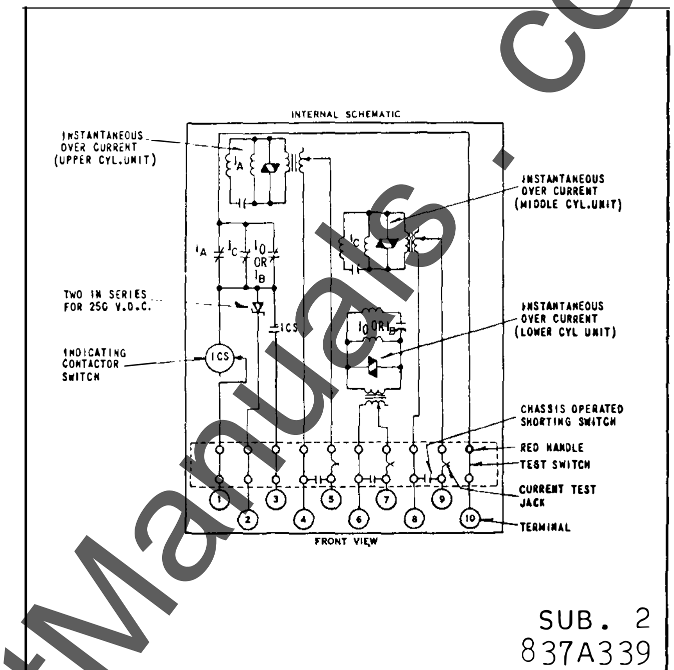


Fig. 11. *Internal Schematic of the KC-4 Relay with Normally Closed Contacts in FT-41 Case.*

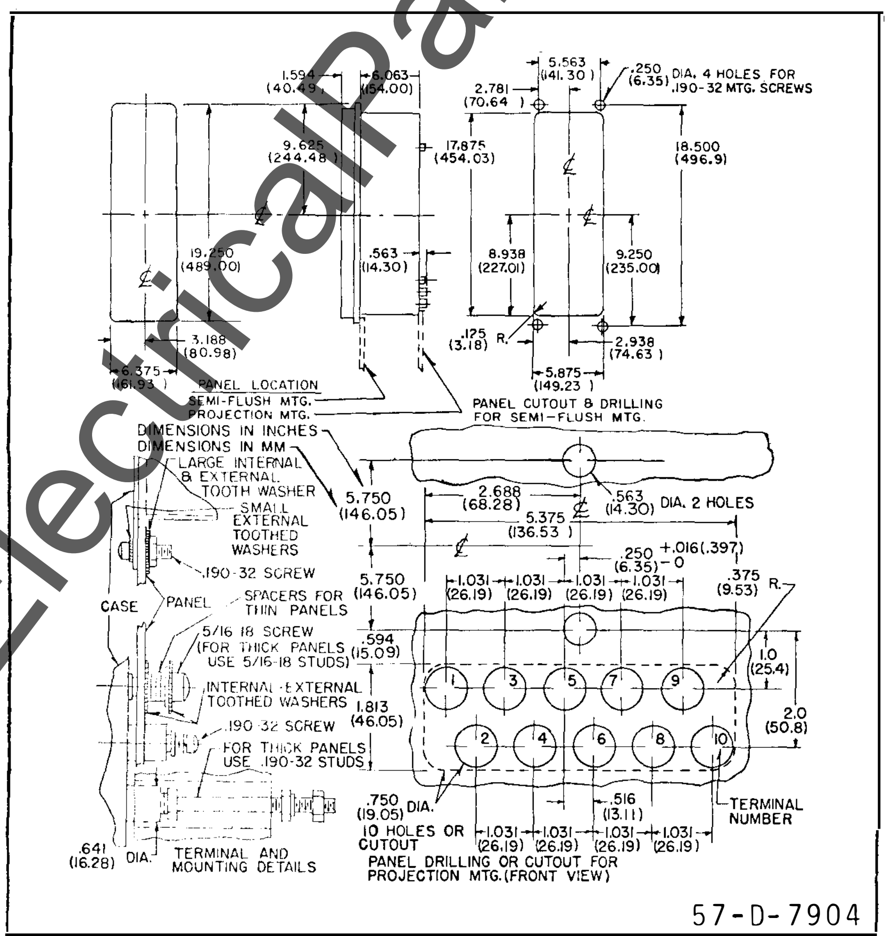


Fig. 12. *Outline and Drilling Plan for the KC-4 Relay in FT-41 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

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

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