INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBR STATIC CONTROL

APPLICATION

The type SBR Static Control is a breaker tripping and reclosing device suitable for use on distribution breakers where non-directional overcurrent relaying including instantaneous trip, is used and where automatic reclosing, including instantaneous and/or time-delay multi-shots, is desired. This device is intended for use primarily where a station battery is available; however, provision can be made for use with a-c supply.

The static time overcurrent characteristics of the type SBR static control, coordinate with existing electromechanical characteristics and fuse time characteristics. The use of static circuitry also provides major advantages in both relaying and reclosing. These include fast reset for the overcurrent units and a flexible reset characteristic for the reclosing control. Unlike other reclosing units which must cycle through a complete sequence, the SBR reclosing circuit may be programmed to return to "home "position after a present time delay following breaker reclosing.

The type SBR static control is entirely self-contained on a one-eighth-inch thick steel panel, 19 inches wide and approximately 25 inches high. The panel may be semi-flush mounted on a breaker, relay board or control switchboard, or may be mounted on a 19-inch rack or cabinet. This self-contained and coordinated package, containing all protective, reclosing and manual control functions required, is a major advantage of the type SBR static control.

CONSTRUCTION AND OPERATION

The type SBR static control consists of a type SBR-1 relay, type SBR-2 relay, and a 101 switch, 43 switch, Cold Load Pickup switch, located on the SBR static control panel. The SBR-1 relay is a three-phase and ground static overcurrent relay and is composed of (1) eight current to voltage transformers, (2) a phase time-delay printed circuit board, (3) a ground time-delay printed circuit board, (4) phase and ground instantaneous printed circuit board, (5) a phase time-delay and instantaneous amplifier printed circuit board, (6) a ground time delay and instantaneous amplifier printed circuit board, (7) two tripping thyristors and (8) indication for phase and ground tripping. The SBR-2 relay is a semi-static reclosing relay and is composed of (1) an integrator, (2) a reclose timer printed circuit board, (3) a reset timer printed circuit board, (4) alarm relay, (5) close relay, (6) lockout indication and (7) push-to-test sequencing switch. All timing functions are accomplished through the use of semiconductor components. The principal identification of all components and their locations are shown in Figure 12.

TYPE SBR-1 RELAY

Phase Time Delay Board

The secondary voltages from the three-phase time delay transformers are applied to three full-wave bridges. The output of all the bridges are connected in parallel. This parallel connection of the bridges is a maximum voltage network. Hence, the rectifier voltage applied to the phase timer is proportional to the phase with the largest magnitude of fault current. The filtered d-c activates the trip circuit, curve shaping and time delay circuits simultaneously, and at a predetermined level, a signal is applied to the input of the phase time-delay amplifier. See Figure 4 for component location and board layout.

Ground Time Delay Board

The secondary voltage from the ground time delay transformer is applied to a full-wave bridge, rectified and filtered. The filtered d-c activates the minimum trip circuit, curve shaping and time delay circuits simultaneously, and at a predetermined level, an output signal is applied to the input of the ground time-delay amplifier. See Figure 5 for component location and board layout.

Phase and Ground Instantaneous Board

The secondary voltage from the ground transformer is applied to a full-wave bridge, rectified, and filtered. The filtered d-c activates the minimum trip circuit, curve shaping and instantaneous circuits simultaneously, and at a predetermined level, an output signal is applied to the input of the instantaneous amplifier.

The secondary voltages from the three-phase transformers are applied to three full-wave bridges. The output of all the bridges are connected in parallel. This parallel connection of the bridges is a maximum voltage network. Hence, the rectified voltage applied to the phase timer is proportional to the phase with the largest magnitude of fault current. The filtered d-c activates the minimum trip circuit, curve shaping and instantaneous circuits simultaneously and, at a predetermined level, a signal is applied to the input of the instantaneous amplifier. See Figure 6 for component location and board layout.

Phase Time Delay and Instantaneous Amplifier

This amplifier receives low-level signals from the phase time-delay and instantaneous boards. These signals are amplified to a value that is of sufficient magnitude to operate the trip circuit of the control. The time delay inputs are further modified by circuitry on this board to obtain desired curve shapes. The output signal is also applied to the indication circuitry to indicate that a phase fault has taken place. See Figure 8 for component location and board layout.

Ground Time Delay and Instantaneous Amplifier

This amplifier receives low-level signals from the ground time delay and instantaneous boards. These signals are amplified to a value that is of sufficient magnitude to operate the trip circuit of the control. The output signal is also applied to the indication circuitry to indicate that a ground fault has taken place. See Figure 7 for component location and board layout.

Trip Circuits

The phase and ground amplifiers feed separate trip circuits. Each trip circuit consists of a thyristor, (hereafter referred to as SCR). Both SCR's are connected in parallel and are protected by a zener diode. The SCR has an anode, cathode, and gate. The anode of the SCR is connected to the positive side of the station battery. The cathode of the SCR is connected to the negative side of the battery through the trip coil and a normally closed contact of the breaker. The gate of the SCR is connected to the output of the phase and ground amplifiers. With no output from the various amplifiers, the SCR acts on an open circuit to the breaker's trip coil. When an output from an amplifier is fed to the gate of the SCR, the SCR turns on and connects the breaker trip coil across the station battery opening the breaker and the trip circuit.

SBR-1 Indication Lights

Phase and ground indication lights are located on the front panel of the SBR-1 relay, and they will indicate when a phase or ground fault has taken place.

TYPE SBR-2 RELAY

Reset Timer Board

Reset timer: the reset timer is controlled by the integrator, the auxiliary switches on the breaker, and the phase and ground circuitry (SBR-1). The front panel settings allow a choice of 5 different times for the resetting interval. The time delay circuits is of the quick-reset type. This enables the reset times to always be consistent with times indicated on the front panel. See Figure 9 for component location and board layout.

Reclose Timer Board

The reclose timer is controlled by the integrator. The front panel allows a choice of 5 different times for each interval of reclosing. The time-delay circuit is of the quick reset type which allows a specific timing circuit to be used for all reclosing intervals. See Figure 10 for component location and board layout.

Push to Test Sequence Switch

This switch is used to check the operation of the control and the breaker. It checks the operation of the phase instantaneous amplifier and the phase trip circuit by injecting a low-level d-c signal into the phase instantaneous circuitry which will open the breaker. The control will sequence in accordance with the front panel settings of the SBR-2 relay until lockout is reached as long as the button is held in. If the button is released before the control sequences to lockout, the reset timer will be

activated and the control will be reset to its home position. In order to insure that this switch is not pushed accidently, a circular button guard is supplied.

Lockout Alarm and Indicator

The lockout alarm and indicator are controlled by the operation of the integrator. They will be energized when the integrator is on the lockout position.

Close Relay

The operation of the close relay is controlled by the operation of a breaker auxiliary switch, the reclose timer and the automatic reclosing switch.

Integrator — See Table 1 and Table 2 for complete description.

SBR STATIC CONTROL PANEL

101 Switch

This switch, when switched to the trip position, will automatically trip the breaker open and step the integrator to the lockout position. When switched to the closed position, this switch initiates closing of the breaker. If a fault exists, the breaker will trip open and remain at the lockout position.

Cold-Load Pickup Switch

The cold-load pickup switch will desensitize the phase instantaneous circuitry by a factor of 3 when in the "ON" position, ie.. if the phase instantaneous connector screws are in the 7-ampere tap, it would take 21 amperes to trip open the breaker, For normal operation, the switch should be in the "OFF" position.

Ground Cutout Switch

The ground cutout switch will short out the ground circuitry to battery negative and remove it from operation. For normal operation, the switch should be in the "OFF" opsition.

Automatic Reclosing Switch

The automatic reclosing switch will set up the control to automatically reclose when in the "ON" position. In the "OFF" position, the switch will de-energize terminals 5 and 13 (SBR-2) to keep the relay from reclosing.

TABLE I
INTEGRATOR LEVEL AND STEP FUNCTIONS PLUS TAP BLOCK SETTINGS

Integrator	Step 10 Home Position	Step 1	Step 2	Step 3	Step 4
Level 1 and RESET TIMER TAP BLOCK SETTING	No Connection	No connection	Energize reset timer time delay circuit †	No connection	Energize reset timer time delay circuit †
Level 2	Pulses integrator to step 1 when SCR-6 or SCR-8 energizes trip coil	No connection	Pulses integrator to step 3 when SCR-6 or SCR-8 energizes trip coil	No connection	Pulses integrator to step 5 when SCR-6 or SCR-8 energizes trip coil
Level 3 and OPERATIONS TO LOCKOUT TAP BLOCK SETTING	Supplies base drive for T2 to keep reset timer inoperative	Pulses integrator to step 2 when set for one operation to lockout	No connection	Pulses integrator to step 4 when set for 1 or 2 operations to lockout	No connection
Level 4 and RECLOSE TIMER TAP BLOCK SETTING	No connection	Energizes reclose timer time delay circuit through interval one	No connection	Energizes reclose timer time delay circuit through interval two	No connection
Level 5 and GROUND INST. TAP BLOCK SETTING	Determine instantaneous	No connection	Same as step 10	No connection	Same as step 10
Level 6 and PHASE INST. TAP BLOCK SETTING	Determine instantaneous operations	No connection	Same as step 10	No connection	Same as step 10
Level 7	Short Circuits reclose timer time delay capacitors	No connection	Same as step 10	No connection	Same as step 10

† If fault is cleared, reset timer will time out and energize the integrator coil directly.

TABLE II
INTEGRATOR LEVEL AND STEP FUNCTIONS PLUS TAP BLOCK SETTINGS

Integrator	Step 5	Step 6	Step 7	Step 8 Lockout Pos.	Step 9
Level 1 and RESET TIMER TAP BLOCK SETTING	No connection	Energizes reset timer time delay circuit †	No connection	Energizes reset timer time delay circuit †	Energizes reset timer time delay circuit †
Level 2	No connection	Pulses integrator to step 7 when SCR-6 or SCR-8 energizes trip coil	No connection	No connection	No connection
Level 3 OPERATIONS TO LOCKOUT TAP BLOCK SETTING	Pulses integrator to step 6 when set for 1, 2, or 3 operations to lockout	No connection	Pulses integrator to step 8	Energizes lockout indicator, alarm relay, and terminal 7	No connection
Level 4 RECLOSE TIMER TAP BLOCK SETTING	Energizes reclose timer time delay circuit through interval three	No connection	No connection	No connection	No connection
Level 5 GROUND INST. TAP BLOCK SETTING	No connection	Same as step 10	No connection	Same as step 10	No connection
Level 6 and PHASE INST. TAP BLOCK SETTING	No connection	Same as step 10	No connection	Same as step 10	No connection
Level 7	No connection	Same as step 10	Same as step 10	Same as step 10	Same as step 10

† If fault is cleared, reset timer will time out and energize coil directly.

SBR Indicating Lights

The red and green lights located at the center of the front panel indicate the condition of the breaker at all times. The red light is lit when the breaker is closed and the green light is lit when the breaker is open. These lights are energized from the same source used for the closing of the breaker.

Characteristics

The control is available with the following current ranges:

Phase Time Delay	Taps
Range	
4.0 to 12.0 amp.	4.0, 5.0, 6.0, 7.5, 8.5, 10.0, 12.0
Phase Instantaneous	
Range	
7.0 to 30.0 amp	7.0, 8.0, 10.0, 12.0, 15.0, 20.0, 30.0
Ground Time Delay	
Range	
2.0 to 6.0 amp.	2.0, 2.5, 3.0, 4.0, 5.0, 6.0
Ground Instantaneous	
Range	
4.0 to 15.0 amp.	4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 15.0

The time versus current characteristics are shown in Figures 13 through 17. These characteristics give the control operating time for the minimum and maximum settings of the phase and ground adjuster, when the indicated multiples of tap value current are applied to the control. Three different time-current characteristics are available for phase time-delay protection along with one instantaneous curve. For ground fault protection, a single time-current characteristic for delayed tripping and a single time-current characteristic for instantaneous tripping. When reclosing after lockout, the control will be set up for a time-delayed operation (unless a tap screw is placed in position 5 of the phase and ground instantaneous selector) until the integrator resets to its home position, where the effective settings then apply.

Tripping Sequences

The tripping sequences can be all instantaneous, all time delayed or any combination of instantaneous and time delayed.

Reset Time

The reset timer can be set for 10, 15, 20, 40 and 60 seconds resetting time.

Reclose Time

The reclose timer can be set for instantaneous, 2, 15, 30 and 45 seconds reclosing time for each reclosing interval or any combination of the aforementioned times.

Operation to Lockout

The control can be set to lockout the breaker after 1, 2, 3 or 4 operations.

THEORY OF OPERATION

Operation of the control will be described with the aid of Figure 12. We will assume that the SBR control is set for two instantaneous and two time-delayed operations and that a permanent fault occurs on the line being protected. Current transformers feed the alternating current signal to the primary of the three time-delayed phase transformers (T_1, T_2, T_3) and to the primary of the three instantaneous phase transformers (T_4, T_5, T_6). The secondary voltages from transformers (T_5 to T_6) are fed to two sets of three full-wave bridges. This parallel connection of the bridges is a maximum voltage network. That is to say that the voltage applied to filter capacitor C25 or C5 is proportional to the phase with the largest magnitude of fault current.

The filtered d-c is now applied to the minimum trip circuits. When the breakdown voltage of Zener diode Z6 is exceeded (measured at pin 10, board 293B294), current flows into the gate of silicon-controlled rectifier, SCR-2. This turns SCR-2 on and the voltage at the anode of SCR-2 drops to a low value. This deprives transistor Q4 of its base drive and it no longer conducts, removing the short circuit from capacitor C16. The identical action is taking place on board 202C736 with Zener diode Z_1, SCR-1 and Transistors Q1, Q3, Q14, Q16 and Q17. This removes the short circuit from capacitors C2, C3 and C27. With transistor Q3 and Transistor Q4 in the non-conducting state, the phase amplifier is set to receive signals from the instantaneous or time-delayed circuitry. We will follow an instantaneous signal through the tripping operation.

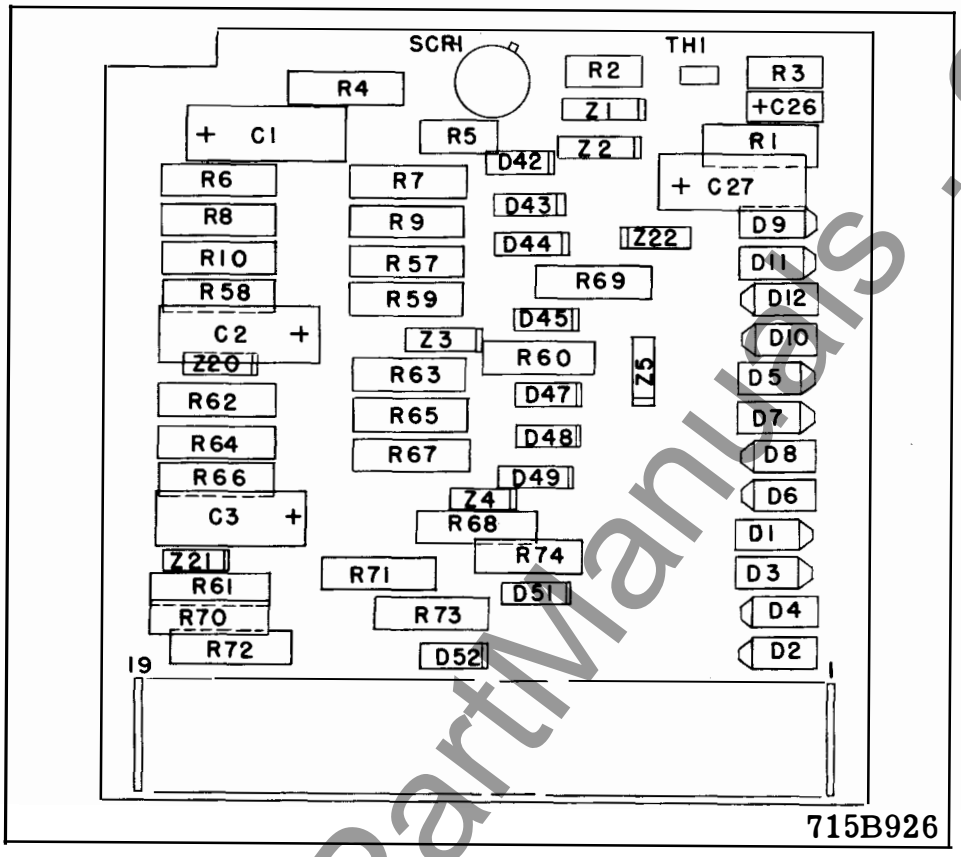


Fig. 1. Component Location on Phase Time Delay Board.

A positive signal is applied to terminal 12 of the SBR-1 relay. This signal also appears on terminal 10 of the SBR-2 relay and on the moving contact arm of the integrator on level 6. Due to the fact that we are set for an instantaneous operation, the signal is coupled to contact 10 of level 6, terminal 1 of the phase instantaneous selector tap block and then back to the SBR-1 relay by way of terminal 7 (SBR-2 relay) and terminal 13 (SBR-1 relay). When this signal, fed to a time-delay circuit consisting of resistor R32 and capacitor C16, exceeds the breakdown voltage of Zener diode Z15, a signal is applied to the base of transistor Q5, making it conduct removing the base drive from transistor Q6, and supplying base drive to transistor Q7, Capacitor C18 starts to charge through resistor R89 until it reaches a predetermined level, at this point capacitor C18 discharges through unijunction switch Q18 and Transformer T9. Transformer action takes place, and a positive pulse is applied to the gates of thyristor SCR-5 and thyristor SCR-6. SCR-6 turns on and connects the station battery across the trip coil opening the breaker contacts and removing the fault input to the phase circuitry. At the same time, thyristor SCR-5 turns on and the phase indicator indicating a phase fault comes on and will stay on until manually reset.

The 52a contact in series with terminal 10 (SBR-1 relay) opens and this stops SCR-6 from conducting as there is no longer a complete path for current to flow. With no input to the phase transformers, the voltage applied to Zener diode Z6 falls to zero. SCR-2 no longer has any current flow into its gate and because of circuit values associated with SCR-2, it turns off. The anode voltage on SCR-2 rises to a magnitude sufficiently high to breakdown Zener diode Z7 and allows current to flow into the base of transistor Q4. Transistor Q4 starts to conduct and capacitor C16 discharges. With capacitor C16 discharged, transistors Q5 and QU cease conduction, and transistor Q6 starts to conduct shorting capacitor C18. At this point, no positive pulses are fed to the output SCR.

When the 52b contact in series with terminal 5, (SBR-2 relay) closes, battery positive is placed across the integrator coil through the 52b contact, the normally closed AR relay contacts, the normally

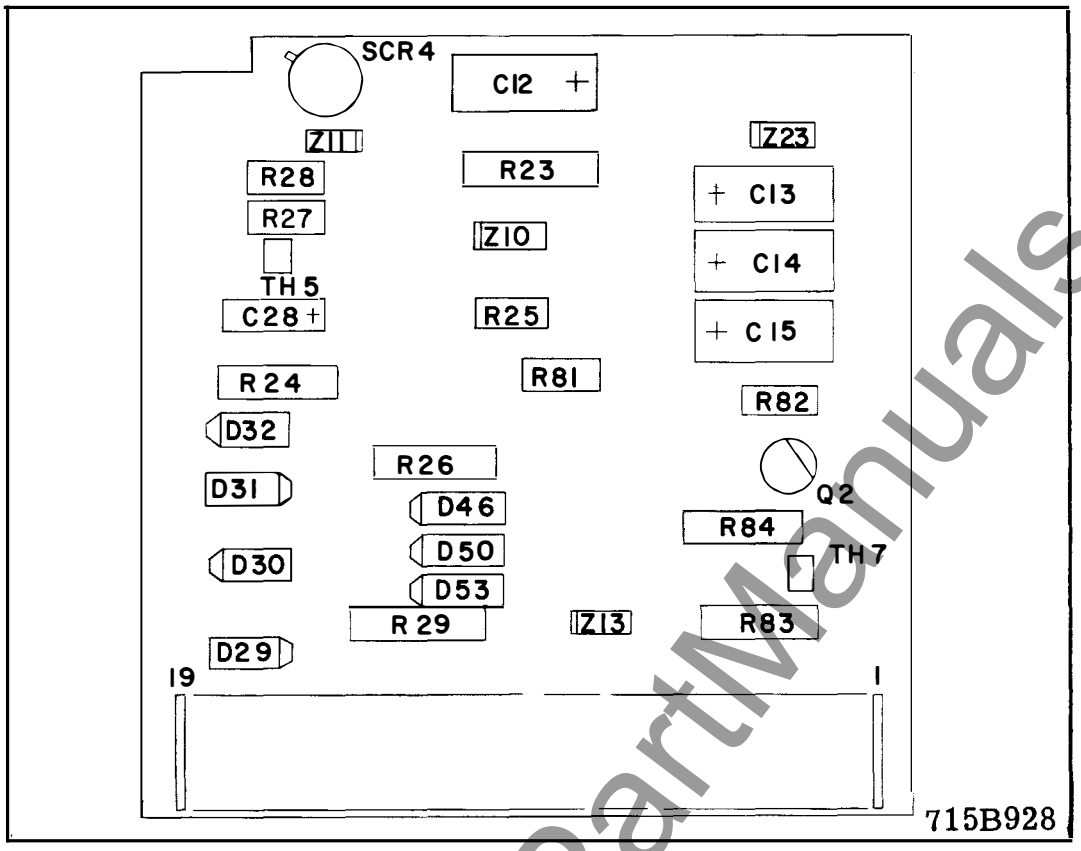


Fig. 2. Component Location on Ground Time Delay Board.

closed integrator contacts (SS-1) and level 2, step 10 of the integrator. As the armature of the integrator picks up, the normally closed contacts of the integrator (SS-1) open, stopping current flow. The integrator armature compresses a spring when the coil is energized.

When the SS-1 contacts open and the coil is de-energized, the spring moves the take-off arm to step 1.

The reclose timer is now energized through the take-off arm level 4, step 1, and interval one of the reclose timer tap block. With the input removed from the base of transistor T5 because of the closing of the 52b contacts between battery positive and terminals 5 and 20 (SBR-2), the resistor-capacitor timing circuit commences to charge to a voltage that will be sufficient to allow current to flow into the base of transistor T6 through Zener diode Z2. This signal is amplified by transistor T6 and applied to the gate of SCR-2, turning SCR-2 on and placing the close relay across the battery voltage through the 52b contact (terminals 4, 5, and 20 of the SBR-2 relay). The CR contacts energize the closing circuit, which closes the main contacts to the breaker and prepares the breaker for another tripping operation. When terminal 20 (SBR-2 relay) loses its positive voltage, due to the opening of the 52b, the close relay drops out. The CR contacts also energized the stepping switch coil which compresses a spring. When the 52b contact opens, the coil is de-energized and the spring moves the take-off arm to step 2.

When the breaker has closed, terminal 20 (SBR-2) goes to zero voltage and base current is applied to transistor T5 discharging the time delay capacitors (C8, C9, and C 10) on the reclose timer (board 670B115) thus setting it up for the next reclosing interval.

The reset timer (board 670B113) was energized through step 2, the take-off arm of level 1 and the RESET TIMER tap block. The reset time delay capacitors (C1 to C3) were kept inoperative by being short-circuited to battery negative by either transistor T2, or Q13 (SBR-1 relay). Transistor T2 shorts these capacitors when the breaker is open by the positive potential on terminal 5 (SBR-2)

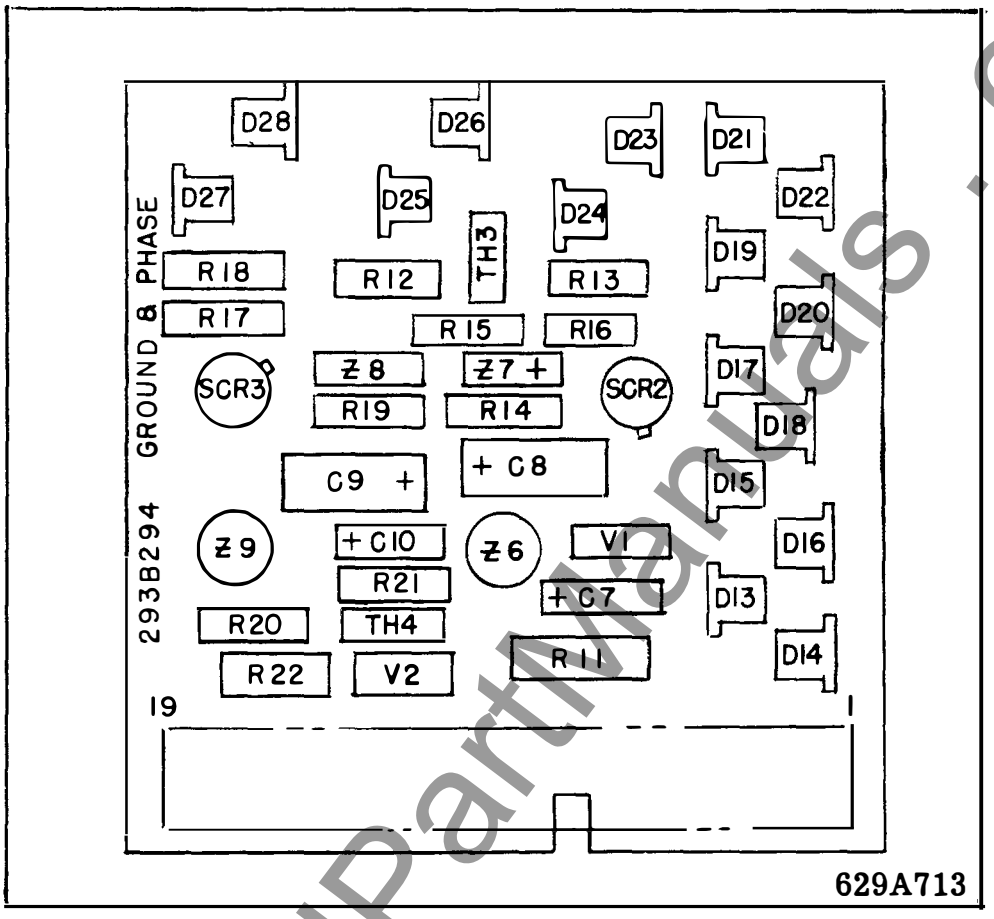


Fig. 3 Component Location on Ground Time Delay Board

supplying base drive to transistor T2 turning it on. Transistor Q13 provides a shorting path as long as there is a fault present and SCR-1, or SCR-4, is in the ON state. The turning on of SCR-1, or SCR-4, provides a shorting path for the base drive of Q14, or Q15, respectively, causing them to switch off, turning Q13 on. With capacitors C1 to C3 shorted, SCR-1 (SBR-2) cannot turn on to reset the integrator to its home position (step 10).

Since the control was set for instantaneous faults, another instantaneous fault takes place in a similar manner to that which was described for the previous operation. The 52b contact in series with terminal 5 closes, battery positive is placed across the integrator coil through the 52b contact, the normally closed AR contacts, the normally closed integrator contacts (SS-1) and level 2, step 2, of the integrator. As the armature of the integrator picks up, the normally closed contacts of the integrator (SS-1) open, stopping current flow. The integrator armature compresses a spring when the coil is energized. When the SS contacts open and the coil is de-energized, the spring moves the take-off arm to step 3.

To insure consistent reclose times when set for more than one instantaneous reclosure, the positive side of the reclose timer's time delay capacitors is short-circuited by the integrator take-off arm of level 7 on the previous steps 10 and 2, and subsequent steps 4 and 6.

The reclose timer's resistor-capacitor time-delay circuit, is now energized through the moving arm of level 4, step 3, and the setting on the RECLOSE TIMER tap block interval 2 and will operate in accordance with that setting. After a predetermined time delay, SCR-2 turns on and the close relay is energized. The close relay contacts energize the close circuit and the stepping switch coil. This prepares the stepping switch for its move to step 4 by compressing its spring. Energizing the close circuit closes the breaker. The 52b contact opens removing the voltage from terminal 5 (SBR-2). This allows the close relay to dropout and de-energize the stepping switch coil allowing it to move to step 4.

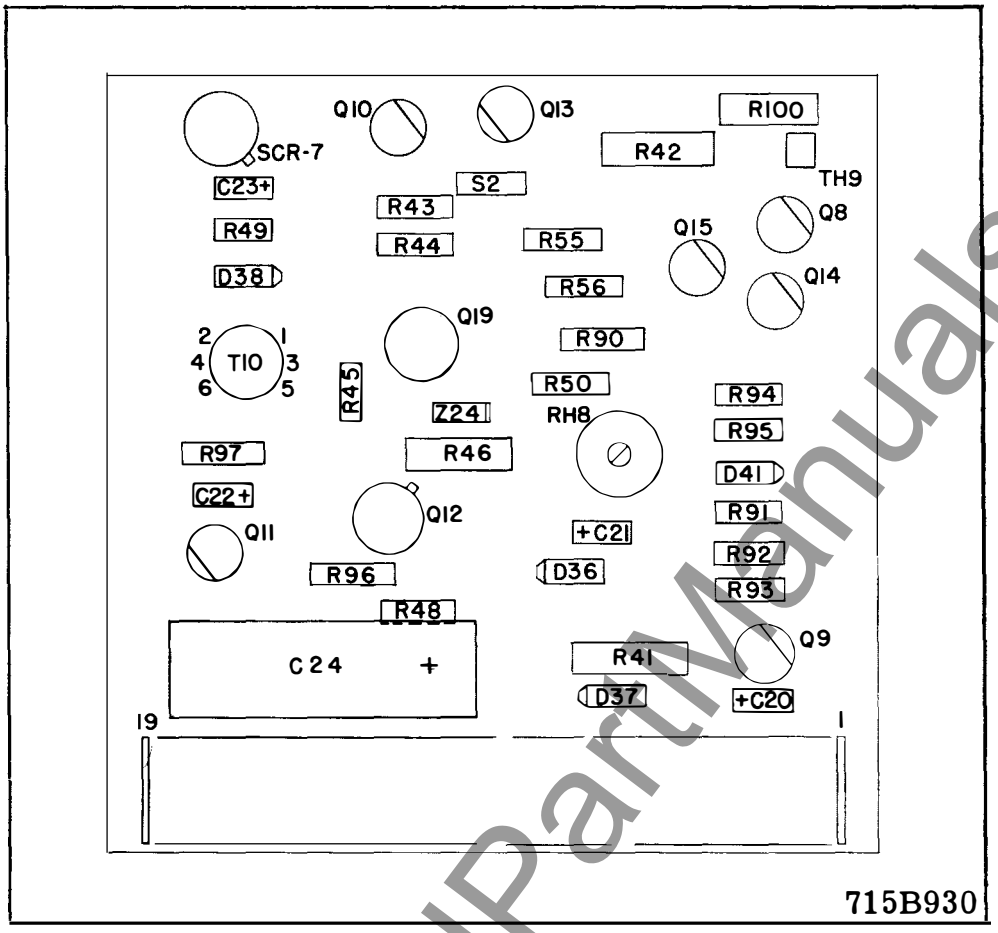


Fig. 4. Component Location on Phase and Ground Instantaneous Board.

During the time that the reclose timer was operating, the reset timer was held inoperative by either transistor T2 or Q13 shorting the reset timer capacitors. Upon reclose, the phase transformers again sense the fault and the minimum trip circuitry reacts in the same way as previously described. The instantaneous signal gets as far as the PHASE INSTANTANEOUS selector tap block and reaches a dead end as the control was not set for an instantaneous operation on the third and fourth operations.

Depending upon the setting in the "PHASE CURVE SELECTOR" tap block, one of the three biased-diode curve shaping and timing circuits on phase board 202C736 apply a signal at a predetermined level to the time delay input of the amplifier through amplifier board terminal 9.

This signal is fed to the base of transistor Q5 making transistors Q5 and Q6 conduct, removing the base drive for transistor Q6. Transistor Q6 reverts to its non-conducting state, and capacitor C18 starts to charge through resistor R89. At a predetermined level unijunction switch Q18 fires, discharging capacitor C18 through transformer T9 feeding a positive pulse to the gate of SCR-6, turning SCR-6 on. This again places the station battery across the trip coil opening the breaker. Again, the operation of the 52b contact in conjunction with the wiring of level 2 moves the stepping switch to step 5.

The reclose timer is energized through the moving arm of level 4, step 5 and interval three of the RECLOSE TIME tap block. After the predetermined time delay, SCR-2 turns on picking up the closing circuit which closes the breaker main contacts, and prepares the stepping switch to move to step 6. When the 52b contact opens, the potential at terminal 5 drops to zero and de-energizes the close relay. The stepping switch moves to step 6. The reset timer is energized through the moving arm of level 1, and step 6, and it will attempt to reset the integrator to its home position (Step 10) if the fault has disappeared.

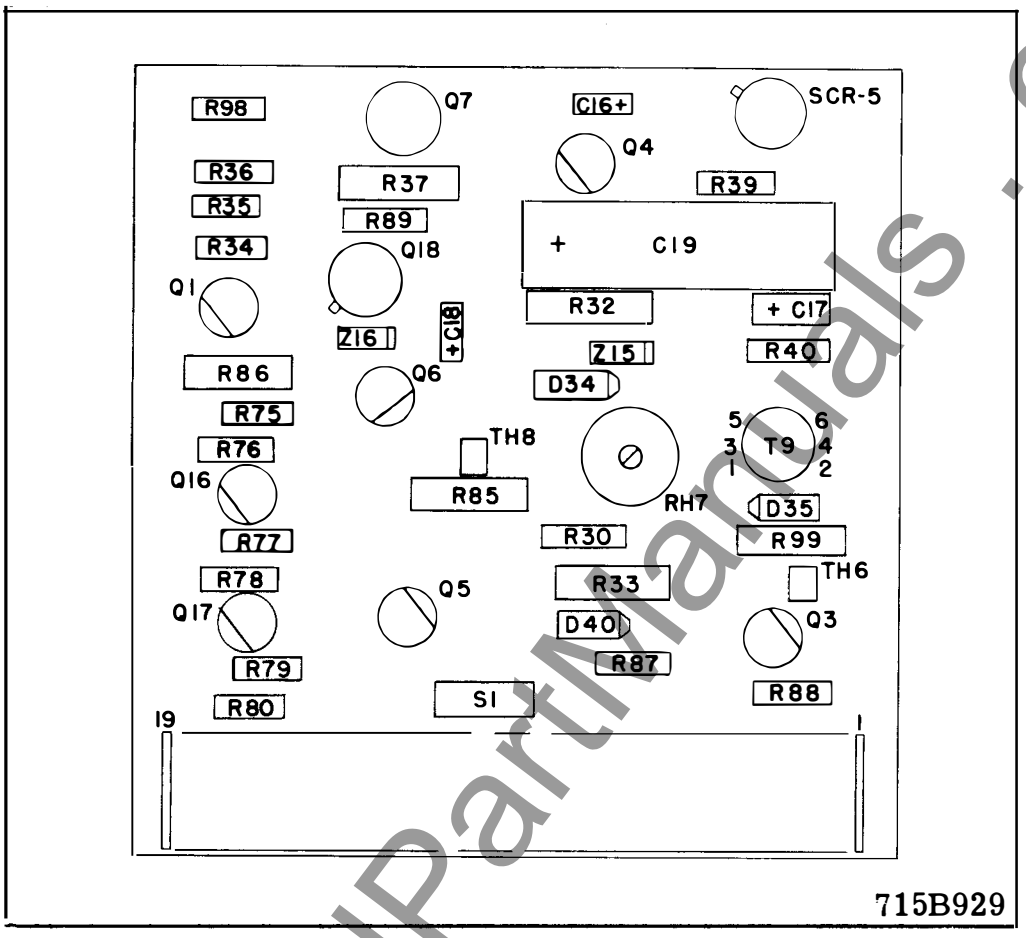


Fig. 5. Component Location on ground Amplifier board.

The fault reappears and the relay goes through another time-delayed operation as no instantaneous operation was preset on the PHASE INSTANTANEOUS SELECTOR tap block. The breaker opens and the 52b contact again energizes the stepping switch coil through level 2, step 6, and the normally close SS-1 contacts. This moves the stepping switch to step 7. The internal wiring of level 3, step 7, moves the stepping switch to step 8. This is the ''lockout'' step. The reclose timer is kept inoperative by the action of level 7. This level places a short circuit across capacitors C8, C9 and C10.

The reset timer is energized through the moving arm of level 1, step 8, and the RESET TIMER tap block setting. The time-delay capacitors are short circuited due to the base drive applied to transistor T2 by the positive voltage on terminal 5 (SBR-2 relay). The relay will remain in this condition until the breaker is manually or electrically closed.

Close the breaker utilizing the 101 switch. Assuming the fault still exists, the voltage will activate the minimum trip circuitry of the time delay and instantaneous circuits. The relay will trip out time-delayed unless a tap screw has been placed in the number 5 position of the PHASE INSTANTANEOUS SELECTOR tap block (under this condition, an instantaneous operation will take place). The operation of the SBR-1 relay will be in accordance with the description already described. When the 52b goes positive again, terminal 5 will go positive, but no signal reaches the stepping switch coil as terminal 5 is connected to the AR relay normally closed contacts. At this point, the AR relay is energized and its normally closed contacts are open. Therefore, the stepping switch remains at lockout.

Since the relay was at step 8 after the last operation, the relay will remain at ''lockout'' until it is manually or electrically closed. If we now assume that the fault has been cleared and the

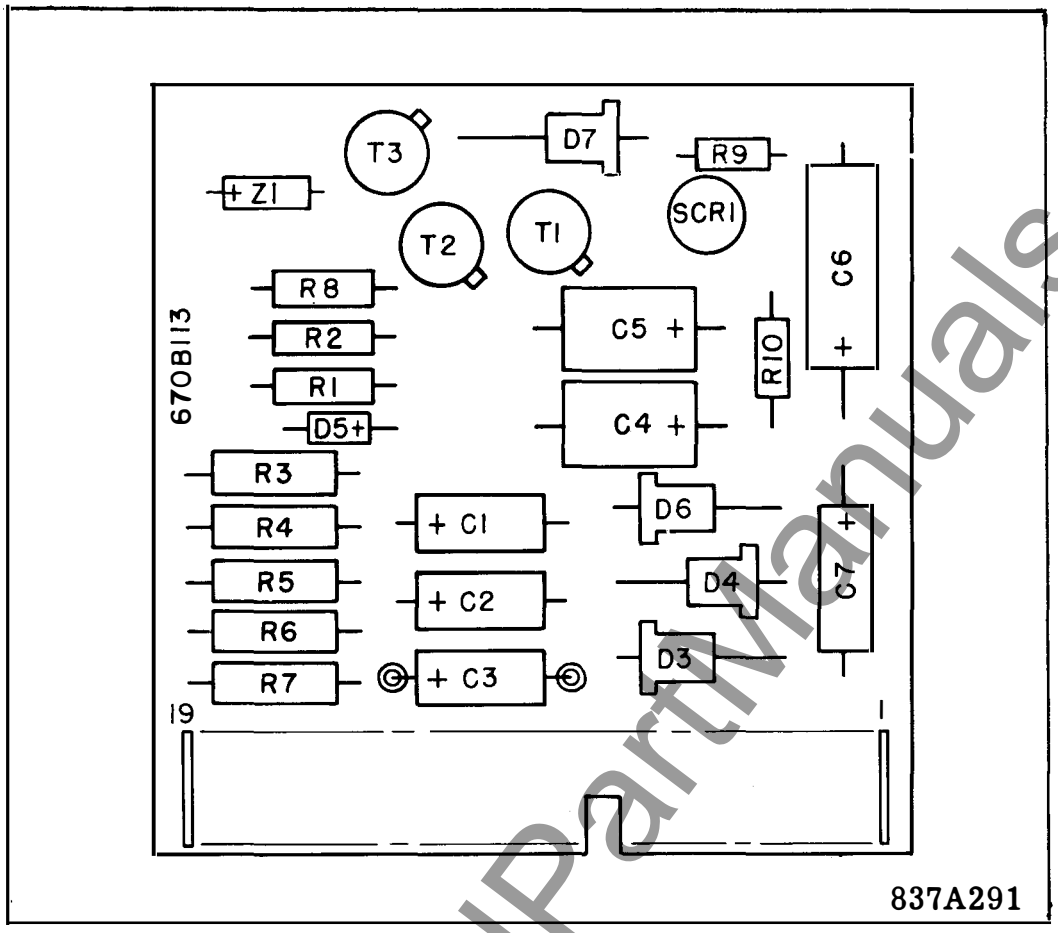


Fig. 6. Component Location on Phase Amplifier Board

breaker is closed in, terminal 9 (SBR-2 relay) becomes positive and energizes the reset timer through the moving arm of level 1, step 8, and the "Reset Timer" tap block setting. With no base drive into transistor T2, transistor T2 will not conduct allowing the time delay capacitors C1 to C3 to charge up to a voltage of sufficient magnitude to make Z1 conduct current into the base of transistor T3. Transistor T3 amplified the signal which is applied to the gate of SCR-1. SCR-1 turns on placing the integrator coil across the regulated voltage through the integrator contacts (SS-2) and the homing contact (HC). As the armature pulls in, the integrator contact (SS) opens, allowing the integrator to move to step 9. SCR-1 fires again which moves the stepping switch to step 10. All circuits are de-energized except for step 10. level 3, which feeds a positive voltage to the base of transistor T2 through resistor R1 in the reset timer. This positive voltage makes transistor T2 conduct, discharging the reset timer's time delay capacitors (C1 to C3) and keeps the capacitors discharged when the integrator is at its home position (step 10). The homing contact (HC), a cam-operated switch, is open at step 10 and keeps the integrator coil from being energized when at the integrator's home position. The lockout indicator and alarm relay were energized by level 3 step 8 and will remain energized until the integrator is returned to its home position (Step 10). The SBR-2 relay is now reset and ready to go through a full sequence in line with the settings made at the beginning of this description.

Ground fault sensing and tripping occur exactly the same as described except zero sequence current is sensed instead of phase current. Ground fault sensing can be traced from transformers T7 and T8 to circuit boards 293B294 (ground instantaneous) and 202C738 (ground time delay) where the fault is sensed, and then to the 202C788 (ground amplifier). All circuits on the aforementioned board operate in a manner similar to that described for a phase fault.

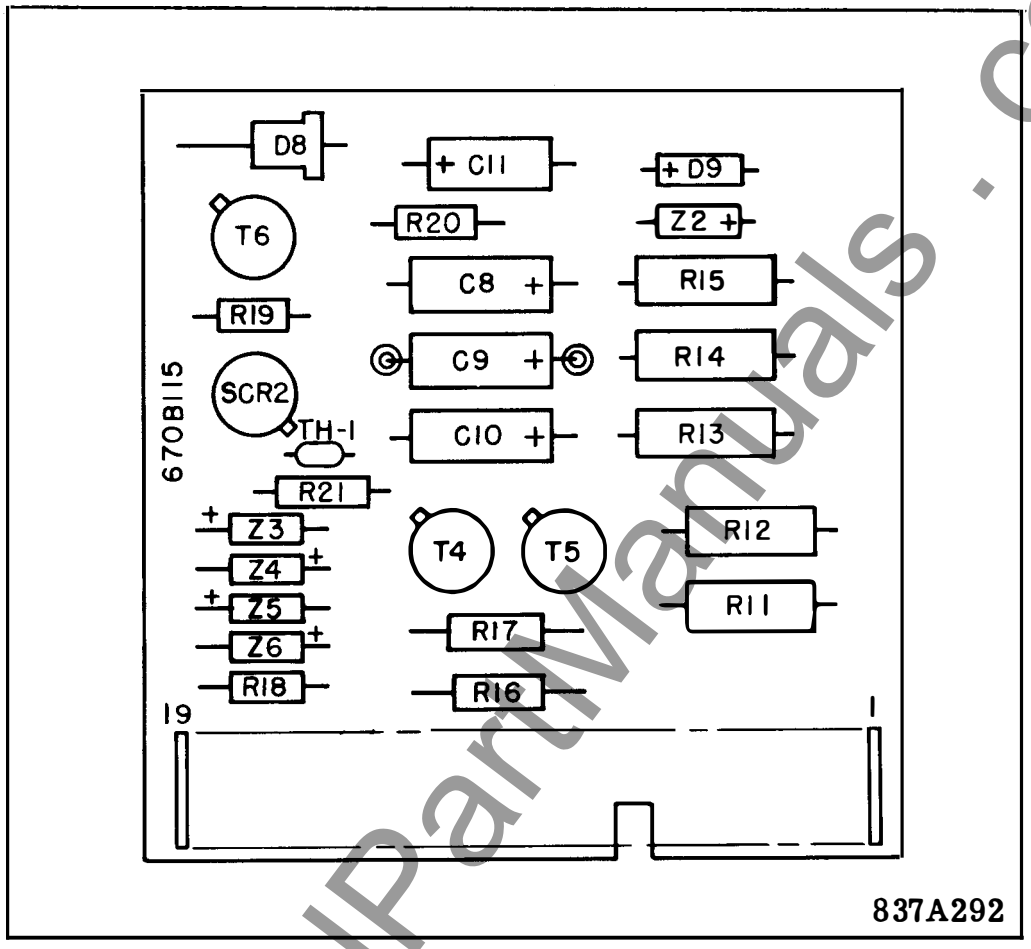


Fig. 7 Component Location on Reset Timer Board.

SETTINGS

1. Phase and Ground Minimum Trip

The connector screw on the tap plate of the phase and ground timers makes connection to various turns on the primary coil of the current to voltage transformer. By placing this screw in the various tap plate holes, the control will respond to multiples of tap value currents in accordance with the various typical time curves. Since the tap block connector carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare screw (located in the phase instantaneous tap block) in the desired tap position before removing the other tap screw from its original position.

2. Phase Curve Selector

Place tap screw in proper tap to obtain desired time current characteristics for time-delayed operations.

3. Phase Curve Adjuster

Set this adjuster for the desired time on the phase curve selected in step 2. Lock in place. Curves can be adjusted between minimum and maximum values shown on typical time curves, Figure 13 through 16. For accurate settings between minimum and maximum values, an electronic timer should be used.

4. Ground Curves Adjuster

Set this adjuster for desired curve on ground time delay tripping. Lock in place. Curve can be adjusted between minimum and maximum values shown on typical time curve in figure 17. For accurate settings between minimum and maximum values, an electronic timer should be used.

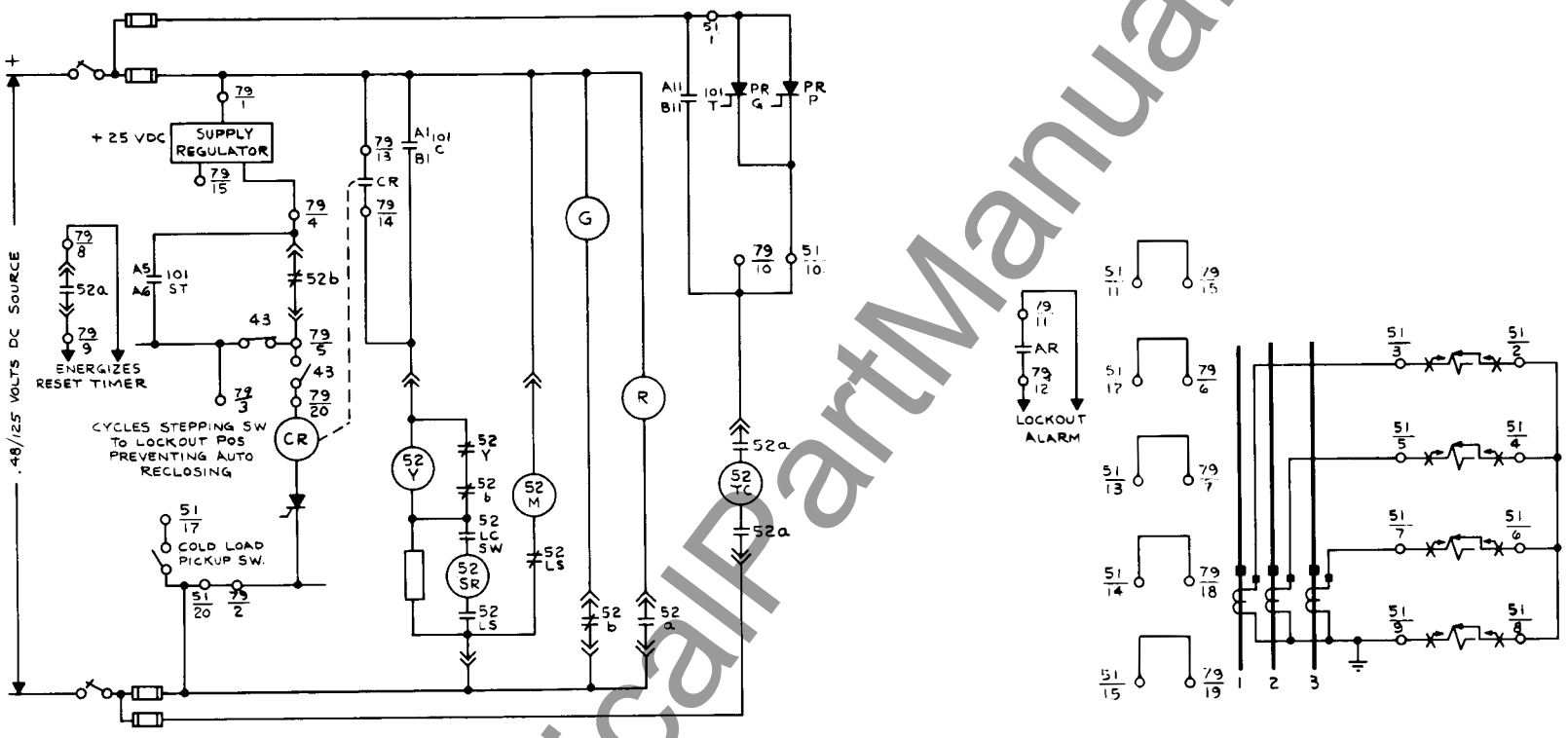


Fig. 8. External Schematic of SBR System.

TYPE SBR-2 RELAY

1. Reclosing Timer

Tap screws may be placed in different numbered reclosing times taps for all three intervals or in the same number for all intervals. A tap screw must be in each interval, otherwise the breaker will not close on that interval. When operating on less than 4 operations to lockout, the reclosing intervals will be dropped starting with the third interval first, i.e. for 3 operations to lockout, the control will reclose in accordance with the tap screws in intervals one and two, and then the control will proceed to lockout. The number above the tap indicates the time duration of the reclosing interval.

2. Reset Timer

Place tap screw in proper tap to obtain the desired reset time. The number above the tap indicates the time duration of the reset interval.

3. Operation to Lockout

Place tap screw in desired tap for obtaining 1 to 4 operations to lockout. The number above tap indicates the number of operations that will occur before lockout is reached.

4. Phase and Ground Instantaneous

Place tap screws in the desired taps for obtaining instantaneous operation. The numbers above the taps indicate which of the sequence of trips that would be instantaneous. For instantaneous operations on the first two trips, tap screws should be placed in the taps numbered 1 and 2. Time delayed trips will occur on all positions that do not have a trip screw.

A tap screw must be placed in position 5 when instantaneous tripping is desired during normal closing of the breaker.

Main Panel

1. Automatic reclosing switch: This switch should be in the "ON" position for normal use.
2. Cold Load Pickup: This switch should be in the "OFF" position for normal use.
3. Ground Cutout Switch: This switch should be in the "OFF" position for normal use.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

The following check is recommedned to insure that the control is in proper working order. Before proceeding, connect control to breaker or to a test relay:

A. Check settings, they should be as follows:

1. Type SBR-1 Relay
   a. Minimum trip current
      Phase and ground time delay — 4 amp tap
      Phase and ground time instantaneous — 7 amp tap
   b. Phase curve and ground curve adjusters set on O.
   c. Phase curve selector in position T3.
2. Type SBR-2 Relay
   a. Phase and ground instantaneous selector tap screws in positions 1 and 2.
   b. Operation to lockout tap screw in position 4.
   c. Reset timer tap screw in 10-second position.
   d. Reclosing timer intervals, all tap screws in the 2-second position.
3. Type SBR Static Control Front Panel
   a. Automatic reclosing switch in the "OFF" position
   b. Cold Load Pickup switch in the "OFF" position.
   c. Ground Cutout switch in the "OFF" position.

CAUTION: No tests should be made until both a-c and c-d connections have been made to control. Check nameplate

ENERGY REQUIREMENTS

Ampere Range	Taps	At Tap Value Current	Volt Amperes †		20X Tap Value Current
			At 3X Tap Value Current	At 10X Tap Value Current	
4/12	4	.840	7.8	76	232
	5	.875	8.0	81	275
	6	.900	8.5	88	312
	7.5	1.05	9.8	105	374
	8.5	1.15	10.7	115	400
	10	1.35	12.5	135	400
	12	1.70	15.2	174	620
7/30	7	2.08			
	8	2.15			
	10	2.43			
	12	2.90			
	15	3.48			
	20	5.3			
	30	10.5			
2/6	2	.45	3.8	28.6	87.2
	2.5	.45	3.9	31.5	101.0
	3	.47	4.1	35.2	120.0
	3.5	.49	4.2	37.1	142.0
	4	.55	6.2	42.8	160.0
	5	.69	9.6	57.0	230.0
	6	.83	14.4	75.0	300.0
4/15	4	1.61			
	6	1.76			
	7	1.79			
	8	1.94			
	10	2.30			
	12	2.80			
	15	3.72			

† Voltage taken with Rectox type voltmeter Station Battery -- 48/125 V.D.C.

made to control. Check nameplate for proper voltage.

1. 101 Switch

Trip breaker utilizing the 101 switch on the front panel. Control should lockout, and the green indicating light should remain lit. The lockout indicator in the SBR-2 case should remain lit.

2. 101 Switch

Close breaker utilizing the 101 switch on the front panel. The control should close the breaker instantaneously and the red light should light. After approximately 10 seconds, the integrator should step to its home position, and the lockout indicator should go out.

3. Automatic Reclosing Switch

Energize terminals 8 and 9 of the SBR-1 relay with 2X tap value current. The breaker should trip and remain open. De-energize terminals 8 and 9. Move the Automatic Reclosing Switch to the "ON" position, and the breaker will automatically reclose.

4. Ground Time Delay Minimum Trip Current

Energize terminals 8 and 9 of the SBR-1 relay with approximately tap value current, place VTVM (5-volt scale) from test point 2 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Raise current until a slowly increasing voltage can be seen on the voltmeter. Check value of current, this value should be equal to the tap value setting on the ground minimum trip block plus or minus 5%.

5. Ground Instantaneous Minimum Trip Current

Place a short circuit from test point 2 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Energize terminals 8 and 9 of the SBR-1 relay with approximately tap value current of the ground instantaneous tap block. Raise current until the breaker trips open. Note this value of current should be equal to the tap value setting of the ground instantaneous tap block plus or minus 5%. Remove short circuit from test point 2 and battery negative.

6. Phase Time Delay Minimum Trip Current

Place VTVM across test point 1 (SBR-1 Front Panel) and test point common (SBR-1 Front Panel). Energize terminals 2 and 3 of SBR-1 relay with approximately tap value current, raise current until a slowly increasing voltage can be seen on the voltmeter. Check value of current, this value should be equal to the tap value setting on the top phase tap block plus or minus 5%. Repeat the above procedure energizing terminals 5 and 2 and terminals 7 and 2. This will check all three phases for the correct minimum trip setting.

7. Phase Instantaneous Minimum Trip Current

Place a short circuit from test point 1 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Energize terminals 3 and 2 of the SBR-1 relay with approximately tap value current of the phase instantaneous tap block. Raise current until the breaker trip opens, and note this value of current. This value of current should be equal to the tap value setting of the phase instantaneous tap block plus or minus 5%. Repeat the above procedure energizing terminals 5 and 2 and terminals 7 and 2. This will check all three phases for the correct minimum trip settings.

8. Operations to Lockout - Phase and Ground Instantaneous

a. Observe if the control locks the recloser open in the correct number of operations, and note if the correct number of fast and time-delayed operations occur in line with the settings that were made when terminals 7 and 2 of SBR-1 relay are energized with 2 times tap value current.

b. Repeat 8a except energize terminals 9 and 2 of SBR-1 relay with 2 times tap value current.

9. Ground Time Delay Curve Calibration

Remove tap screws from the ground instantaneous tap block in the SBR-2 relay. Repeat step 8b and check the time required for tripping the breaker open. Repeat step 8b using different value as fault current. The times obtained minus the breaker operating times should equal the times shown under typical time curve Figure 17 plus or minus 5%.

10. Ground Instantaneous Time Curve Calibration

Replace the tap screws in the ground instantaneous tap block in the SBR-2 relay. Energize terminal 9 and 2 of the SBR-1 relay with 2X the instantaneous tap block setting, and time the opening of the breaker. Repeat using different values of current. These times minus the breaker opening time should equal the times of the instantaneous curve Figure 17 plus or minus 5%.

11. Phase Time Delay Curve Calibration

Remove tap screws from the phase instantaneous tap block in the SBR-2 relay. Repeat steps 8a and check the time required for tripping the breaker open. Repeat 8a using different multiples of minimum pickup. The times obtained at minus the breaker opening time should equal the times shown under typical time curve Figure 13 plus or minus 5%.

12. Phase Instantaneous Time Curve Calibration

Replace the tap screw in the phase instantaneous tap block in the SBR-2 relay. Energize terminals 7 and 2 of the SBR-1 relay with 2X instantaneous tap block setting, and time the opening of the breaker. Repeat the above procedure using different multiples of minimum pickup. The times obtained minus the breaker opening time should equal the time shown under typical time curve Figure 16 plus or minus 5%.

13. Reset Timer

With the control at lockout position, close the breaker utilizing the 101 switch and simultaneously start a stop watch, time the interval that elapses before the integrator resets. The integrator will be resetting when the lockout light in the SBR-2 relay goes out. This time should equal the front panel RESET TIMER setting plus or minus 5%.

14. Reclose Timer

Connect a VTVM to terminals 5 and 2 of SBR-2 relay (positive lead to terminal 5). Energize terminal 9 and 2 of SBR-1 relay with 2X tap value current. When the breaker opens, terminal 5 will become positive with respect to terminal 2. Start stop watch when terminal 5 becomes positive, and time interval until the voltage falls to zero. This time should equal the first interval of the RECLOSER TIMER SETTINGS on the front panel plus or minus 10%. Repeat timing procedure to check the second and third reclosing intervals. For instantaneous reclosing, an electronic timer will have to be utilized.

ROUTINE MAINTENANCE

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

CALIBRATION

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

SBR-1 RELAY

1. Ground Time Delay Minimum Trip Current

Place VTVM (5-volt scale) across test point 2 (SBR-1 Front Panel) and test point common. Test point 2 is positive with respect to common. Energize terminals 9 and 2 with tap value current, adjust control RH-5 (rear sub base) so that a slowly increasing voltage can be seen on the voltmeter at the value current plus 1%, and the aforementioned voltage should fall to zero at tap value current minus 1%. With tap value current plus 1%, the ground timer should trip open the breaker.

2. Ground Instantaneous Minimum Trip Current

Place a short circuit from test point 2 to test point common. Energize terminals 9 and 2 with ground instantaneous tap value current. Adjust control RH-4 (rear sub base) so that the control trips open the breaker with tap value current plus or minus 1%. Remove short circuit from test point 2.

3. Phase Time Delay Minimum Trip Current

Place VTVM (1.5-volt scale) across test point 1 (SBR-1 Front Panel) and test point common. Test point 1 is positive with respect to test point common. Energize terminals 3 and 2 with phase time delay tap value current, adjust control RH-1 (rear sub base) so that a slowly increasing voltage can be seen on the voltmeter at tap value current plus 1%, and the aforementioned voltage should fall to zero at tap value current minus 1%. With tap value current plus 1%, the phase timer should trip the breaker open. Place a short circuit across test point 1 and test point common. Place VTVM (50-volt scale) across terminal 18 and battery negative. Voltage at this point should read 27.7 to 28.3 volts d-c when terminals 3, 5, or 7, and terminal 2 are energized with tap value current.

4. Phase Instantaneous Minimum Trip Current

Place a short circuit from test point 1 to test point common. Energize terminals 3 and 2 with

phase instantaneous tap value current and adjust control RH-3 (rear sub base) so that the control trips open the breaker with tap value current plus or minus 1%. Energize terminals 5 and 2, and 7 and 2; control should trip open the breaker at tap value current plus or minus 1%. Remove short circuit from test point 1.

5. Time Curve Calibration - Phase Time Delay

Remove tap screws from PHASE INSTANTANEOUS TAP BLOCK. Set phase curve adjuster to maximum (fully clockwise). Place VTVM (1.5-volt scale) across test point 1 (SBR-1 front panel) and test point common. Energize terminals 7 and 2 with 1.1 times tap value current. Adjust RH-7 (phase amplifier board 202C755 so that the control trips open the breaker when .88 to .90 volts are seen on the VTVM. De-energize circuit. Set phase curve adjuster to zero. Energize circuit with 2 times tap value current. Check to see that the control will trip open the breaker in .655 seconds plus or minus 5%. When presetting current, place a short circuit across test point 1 and battery negative. Do not leave high currents on for long periods when the short circuit is across test point 1 and test point common. This will cause overheating and could cause destruction of some of the components. Apply currents as multiples of tap value setting and measure operating time of the breaker. The operating times obtained minus the breaker opening time should equal those listed in typical time curves Figure 13 plus or minus 5%. Replace tap screws in the phase instantaneous tap block.

6. Time Curve Calibration - Phase Instantaneous

No adjustments necessary.

7. Time Curve Calibration - Ground Time Delay

Remove tap screws from ground instantaneous tap block. Set ground curve adjuster to maximum (fully clockwise). Place VTVM (5-volt scale) across test point 2 (SBR-2 Front Panel) and test point common. Energize terminals 9 and 2 with 1.1 times tap value current. Adjust RH-8 (ground amplifier board 202C788 so that the control trips open the breaker when 1.24 to 1.26 volts are seen on the VTVM. De-energize circuit. Set ground curve adjuster to zero. Energize circuit with 2 times tap value current. The control will trip open the breaker in 14.5 seconds plus or minus 5%. When presetting current, place a short circuit across test point 2 and battery negative. Do not leave high currents on for long periods when the short circuit is across test point 2 and battery negative. This will cause overheating and could cause destruction of some of the components. Apply currents as multiples of tap value setting and measure operating time of the breaker. The operating times minus the opening time of the breaker should equal those listed in typical time curve Figure 18 plus or minus 5%.

8. Time Curve Calibration - Ground Instantaneous

No adjustments necessary.

SBR-2 RELAY

RH-1 Calibration

1. Place VTVM from terminal 8 to common test point. Adjust RH-1 (rear sub base) so that 18 volts d-c can be seen on the VTVM when terminals 1 and 2 are energized with rated voltage.
2. No other calibration necessary.

RENEWAL PARTS

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

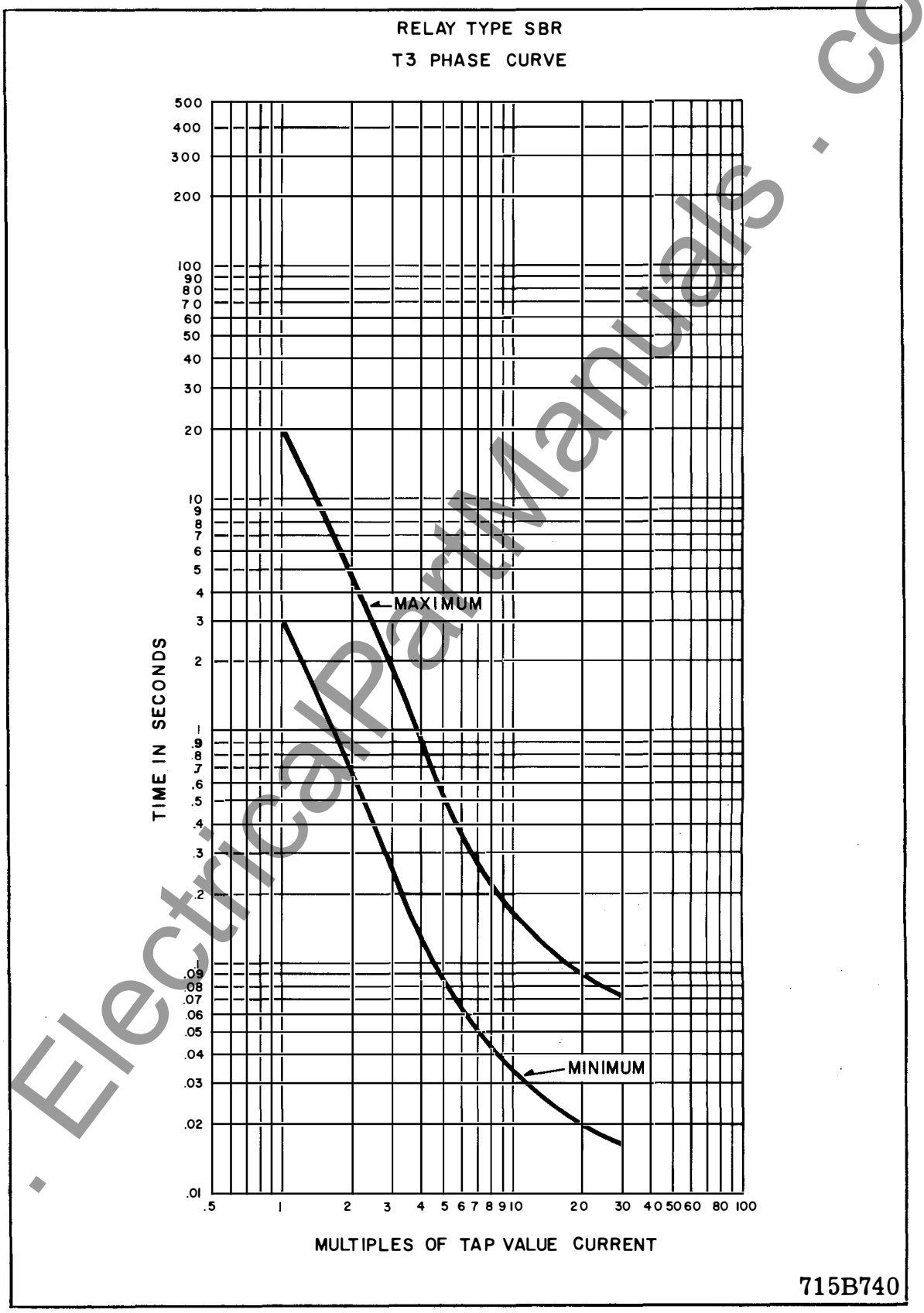


Fig. 10. Time Curves for Phase Time Delay T3 Curve Selector.

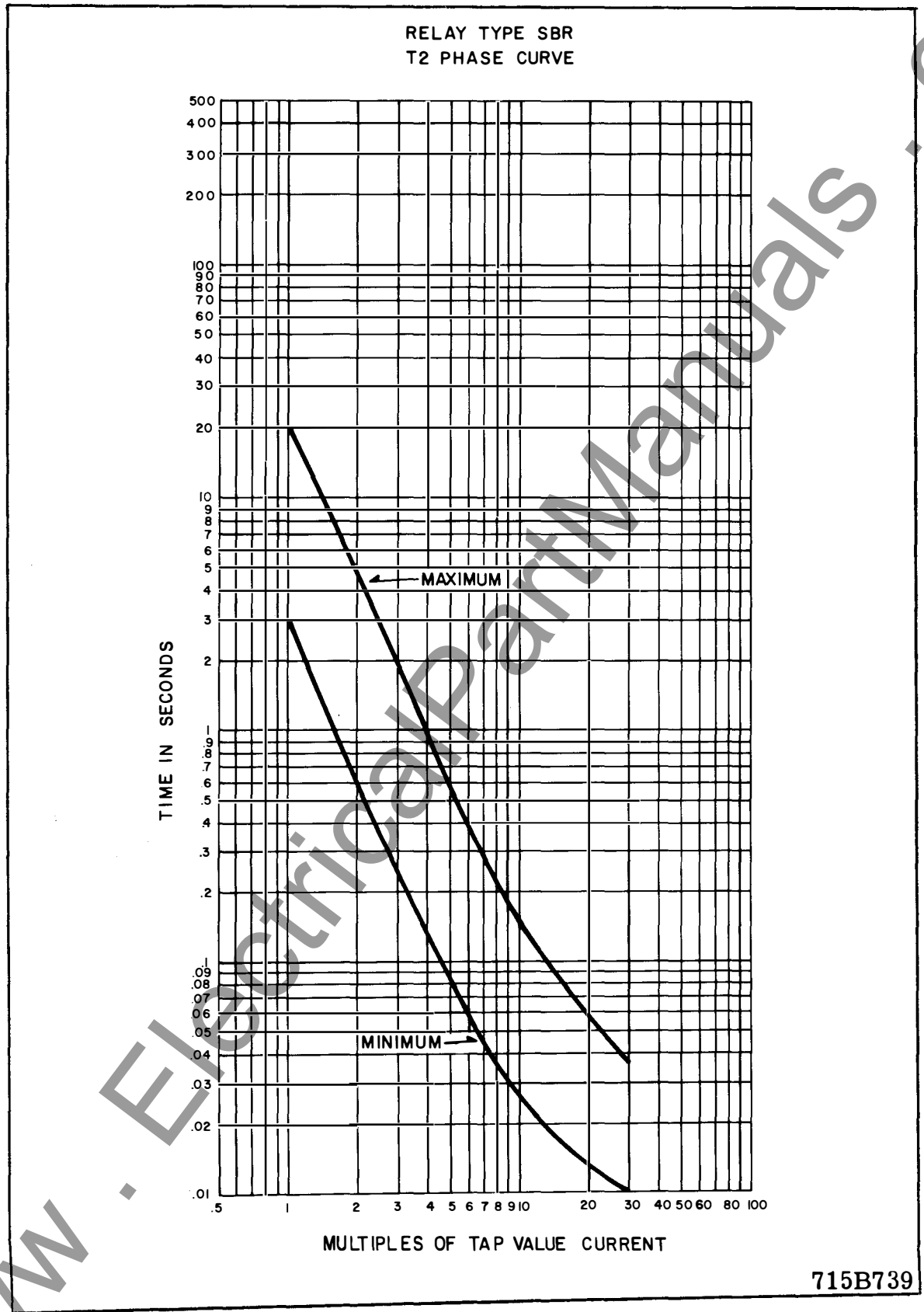


Fig. 11. Times Curves for Phase Time Delay T2 Curve Selector.

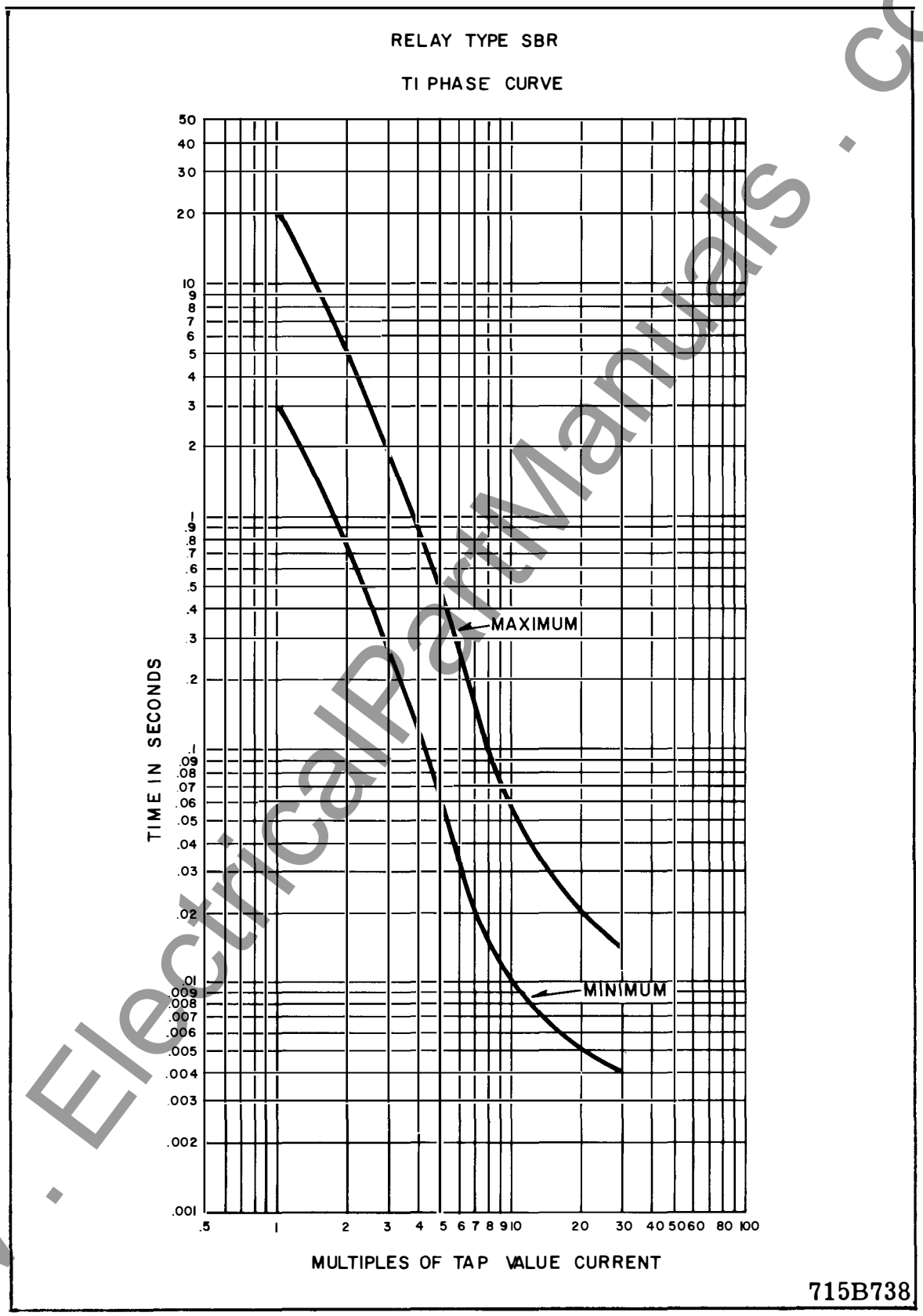


Fig. 12. Time Curves for Phase Time Delay T1 Curve Selector.

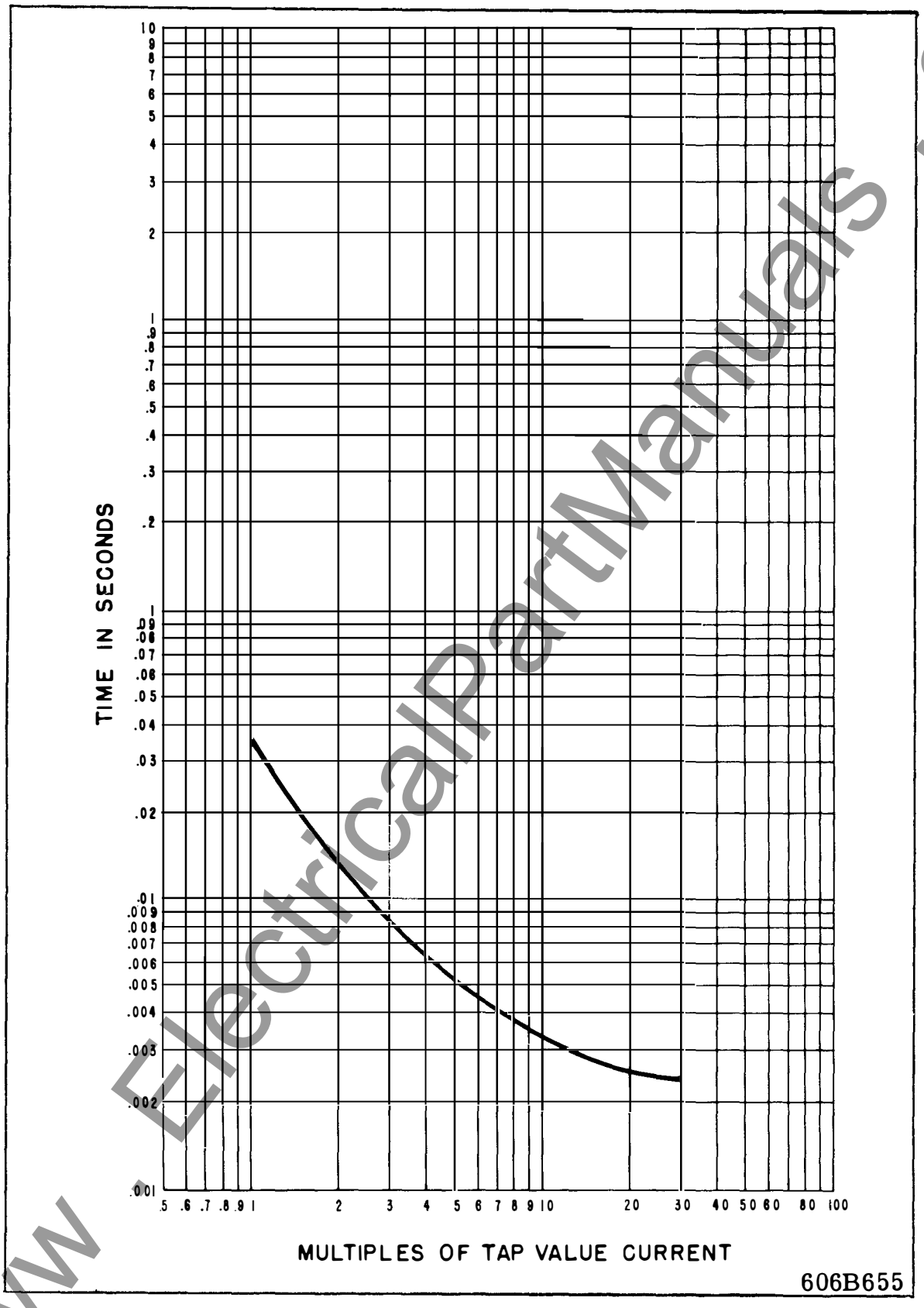


Fig. 13. Time Curves for Phase Instantaneous Relay.

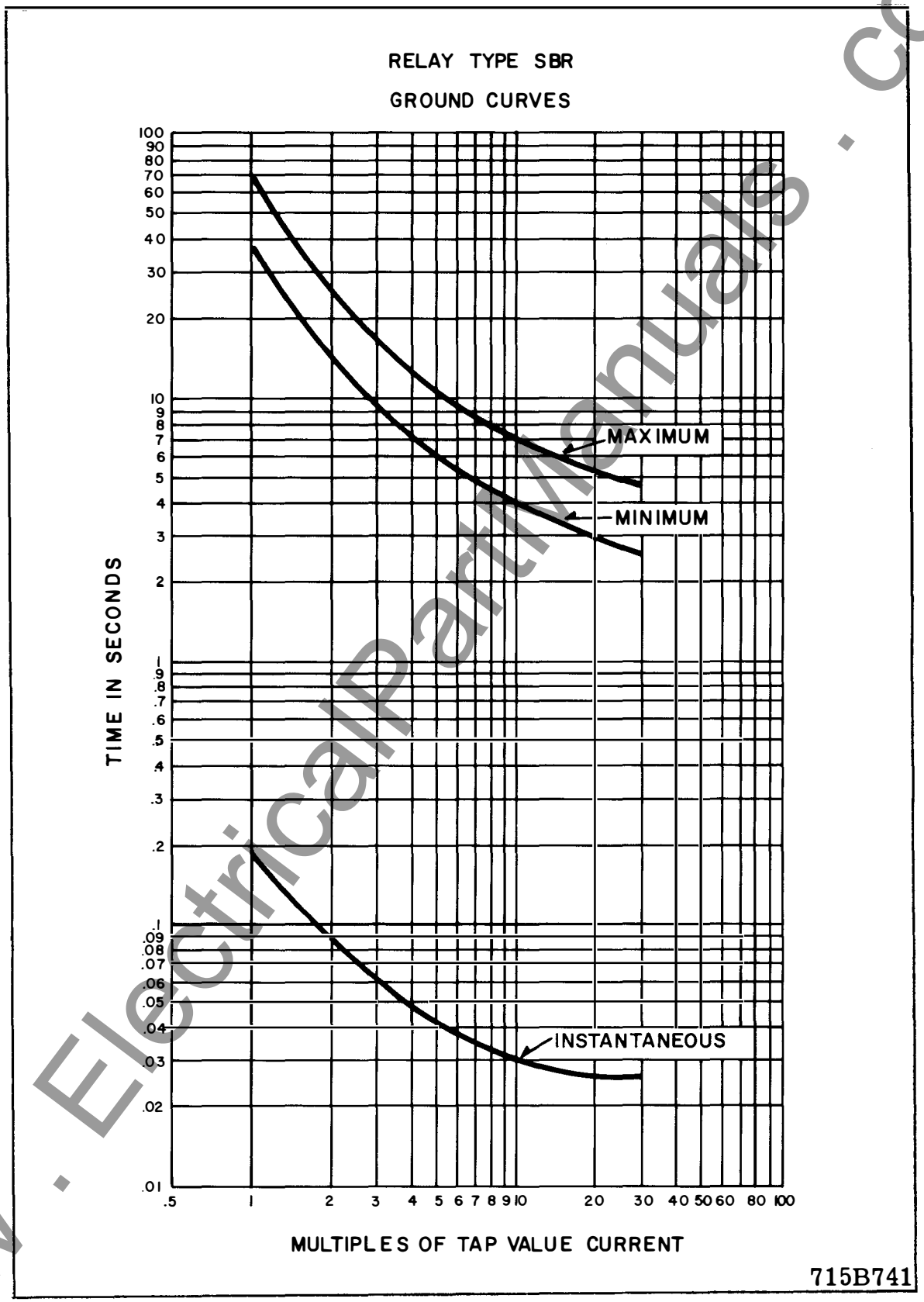


Fig. 14. Time Curves for Ground Instantaneous and Time Delay Relay.

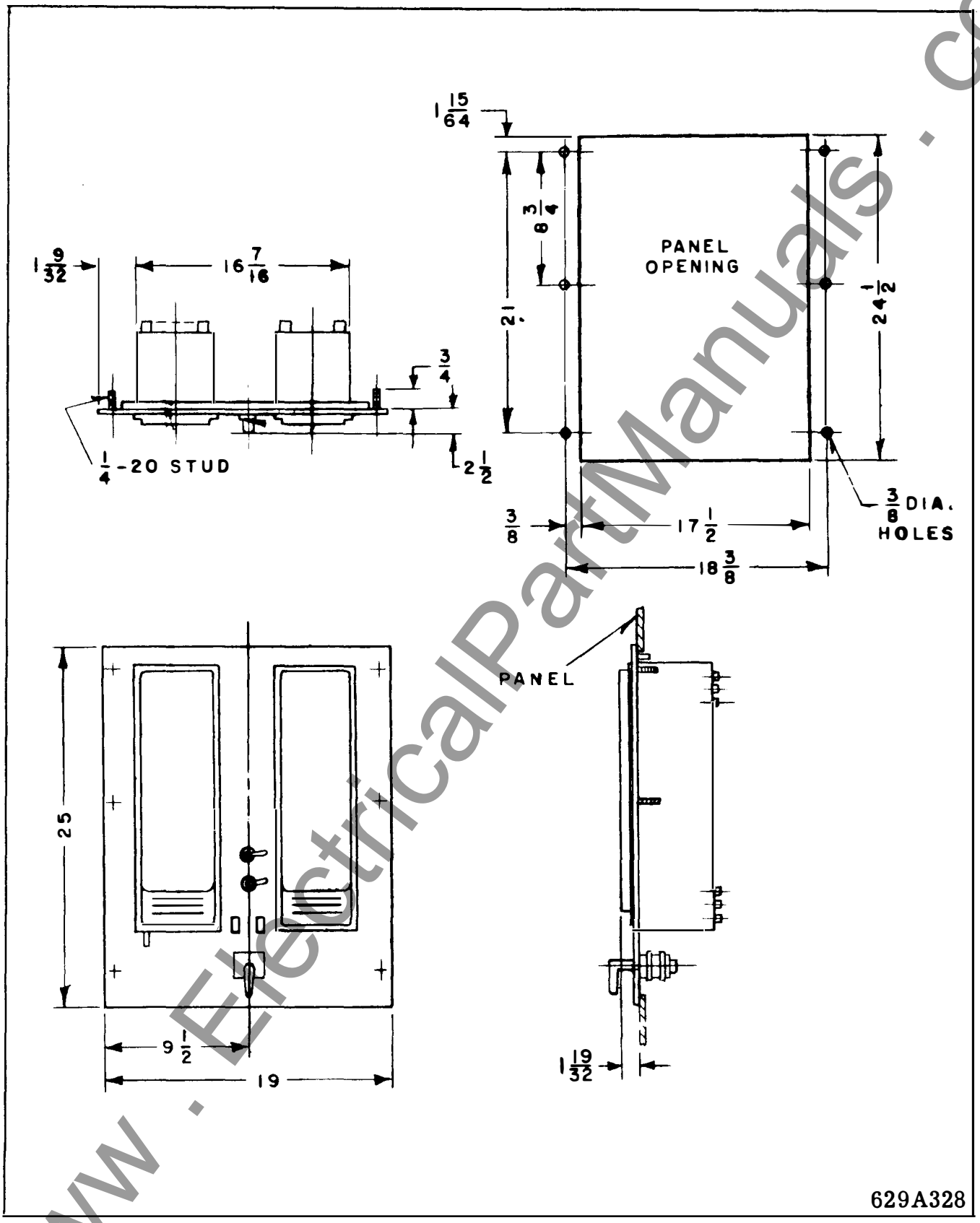


Fig. 15. Outline and Drilling for SBR Panel.

ELECTRICAL PARTS LIST – SBR-1

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RESISTORS		
R1	27,500 3 W 1%	763A126H45
R2	560 ½W 5%	184A763H21
R3	680 ½W 5%	184A763H23
R4	30.100 ½W 1%	862A377H47
R5	4,700 ½W 5%	184A763H43
R6	2,000 ½W 1%	862A376H30
R7	33,200 ½W 1%	862A377H51
R8	2,490 ½W 1%	862A376H39
R9	49,900 ½W 1%	862A377H68
R10	10,000 ½W 1%	862A377H01
R11	7,500 3 W 5%	184A636H01
R12	560 ½W 5%	184A763H21
R13	680 ½W 5%	184A763H23
R14	27,000 ½W 5%	184A763H61
R15	6,800 ½W 5%	184A763H47
R16	10,000 ½W 5%	184A763H51
R17	6,800 ½W 5%	184A763H47
R18	10,000 ½W 5%	184A763H51
R19	27,000 ½W 5%	184A763H61
R20	560 ½W 5%	184A763H21
R21	680 ½W 5%	184A763H23
R22	7,000 3 W 5%	184A636H01
R23	30,100 ½W 1%	862A377H47
R24	10,000 3 W 1%	763A126H20
R25	4,700 ½W 5%	184A763H43
R26	7,000 3 W 5%	184A636H01
R27	680 ½W 5%	184A763H23
R28	560 ½W 5%	184A763H21
R29	715,000 ½W 1%	862A378H83
R30	47,000 ½W 5%	184A763H67
R32	68,100 ½W 1%	862A377H81
R33	47,500 ½W 1%	862A377H66
R34	100,000 ½W 5%	184A763H75
R35	10,000 ½W 5%	184A763H51
R36	100,000 ½W 5%	184A763H75
R37	100 1 W 5%	187A643H03
R39	180 ½W 5%	184A763H09
R40	1,500 ½W 5%	184A763H31
R41	332,000 ½W 1%	862A378H51
R42	47,500 ½W 1%	862A377H66
R43	100,000 ½W 5%	184A763H75
R44	10,000 ½W 5%	184A763H51
R45	100,000 ½W 5%	184A763H75
R46	100 1 W 5%	187A643H03
R48	180 ½W 5%	184A763H09
R49	1,500 ½W 5%	184A763H31
R50	47,000 ½W 5%	184A763H67
R52	1,120 – 48 V.D.C.	1955252
	4,750 – 125 V.D.C.	1955274
R53	200	1202586
R54	475 – 48 V.D.C.	1955289
	2,000 – 125 V.D.C.	1267296
R55	68,000 ½W 5%	184A763H71
R56	27,000 ½W 5%	184A763H61

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RESISTORS (Continued)		
R57	110,000 ½W 1%	862A378H05
R58	56,200 ½W 1%	862A377H73
R59	274,000 ½W 1%	862A378H43
R60	845,000 ½W 1%	862A378H90
R61	24,900 ½W 1%	862A377H39
R62	33,200 ½W 1%	862A377H51
R63	82,500 ½W 1%	862A377H89
R64	11,000 ½W 1%	862A377H05
R65	100,000 ½W 1%	862A378H01
R66	100,000 ½W 1%	862A378H01
R67	332,000 ½W 1%	862A378H51
R68	619,000 ½W 1%	862A378H77
R69	20,000 ½W 1%	862A377H30
R70	12,100 ½W 1%	862A377H09
R71	110,000 ½W 1%	862A378H05
R72	90,900 ½W 1%	862A377H93
R73	324,000 ½W 1%	862A378H50
R74	619,000 ½W 1%	862A378H77
R75	10,000 ½W 5%	184A763H51
R76	470 ½W 5%	184A763H19
R77	10,000 ½W 5%	184A763H51
R78	470 ½W 5%	184A763H19
R79	10,000 ½W 5%	184A763H51
R80	470 ½W 5%	184A763H19
R81	470 ½W 5%	184A763H19
R82	10,000 ½W 5%	184A763H51
R83	221,000 ½W 1%	862A378H34
R84	1,000,000 ½W 1%	862A379H01
R85	3,090,000 ½W 1%	862A379H48
R86	768,000 ½W 1%	862A378H86
R87	470 ½W 5%	184A763H19
R88	10,000 ½W 5%	184A763H51
R89	2,200 ½W 5%	184A763H35
R90	470 ½W 5%	184A763H19
R91	470 ½W 5%	184A763H19
R92	470 ½W 5%	184A763H19
R93	10,000 ½W 5%	184A763H51
R94	10,000 ½W 5%	184A763H51
R95	10,000 ½W 5%	184A763H51
R96	2,200 ½W 5%	184A763H51
R97	10,000 ½W 5%	184A763H51
R98	10,000 ½W 5%	184A763H51
R99	243,000 ½W 1%	862A378H38
R100	243,000 ½W 1%	862A378H38
POTENTIOMETERS		
RH-1	25,000	185A067H03
RH-2	1,500,000	185A086H14
RH-3	10,000	185A067H02
RH-4	10,000	185A067H02
RH-5	10,000	185A067H02
RH-6	200,000	185A086H27
RH-7	100,000	629A430H04
RH-8	100,000	629A430H04

ELECTRICAL PARTS LIST – SBR-1 (Continued)

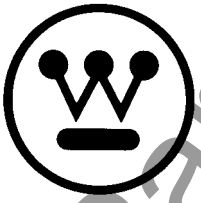
CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
CAPACITORS		
C1	47 MFD. 10% 35V.	187A508H12
C2	47 MFD. 5% 50V.	862A177H06
C3	68 MFD. 5% 60V.	862A177H03
C5	1 MFD. 10% 330V.	1876999
C6	1 MFD 10% 330V.	1876999
C7	6.8 MFD. 20% 35V.	184A661H10
C8	47 MFD. 20% 35V.	184A661H03
C9	47 MFD. 20% 35V.	184A661H03
C10	6.8 MFD. 20% 35V.	184A661H10
C11	1 MFD. 10% 330V.	1876999
C12	47 MFD. 10% 35V.	187A508H12
C13	150 MFD. 5% 30V.	862A177H05
C14	150 MFD. 5% 30V.	862A177H05
C15	150 MFD. 5% 30V.	862A177H05
C16	1.5 MFD. 5% 20V.	184A661H22
C17	6.8 MFD. 5% 35V.	184A661H21
C18	.47 MFD. 5% 35V.	837A241H21
C19	2 MFD. 10% 100V.	764A278H13
C20	6.8 MFD. 5% 35V.	184A661H21
C21	1.5 MFD. 5% 20V.	184A661H22
C22	.47 MFD. 5% 35V.	837A241H21
C23	6.8 MFD. 5% 35V.	184A661H21
C24	2 MFD. 10% 200V.	764A278H13
C25	1 MFD. 10% 300V.	1876999
C26	2.2 MFD. 5% 35V.	837A241H16
C27	68 MFD. 5% 60V.	862A177H03
C28	2.8 MFD. 5% 35V.	837A241H16
TRANSISTORS		
Q1 to Q6	ZN3417	848A851H02
Q7	ZN4249	849A441H03
Q8 to Q11	ZN3417	848A851H02
Q12	ZN2647	629A435H01
Q13 to Q17	ZN3417	848A851H02
Q18	ZN2647	629A435H01
Q19	ZN4249	849A441H03
SCR'S		
SCR-1	K1149-13	184A640H13
SCR-2	K1149-14	184A640H14
SCR-3	K1149-14	184A640H14
SCR-4	K1149-13	184A640H13
SCR-5	K1149-13	184A640H13
SCR-6	48 V.D.C. – ZN1846	184A614H06
	125 V.D.C. – ZN1850	184A614H05
SCR-7	K1149-13	184A640H13
SCR-8	48 V.D.C. – ZN1846	184A614H06
	125 V.D.C. – ZN1850	184A614H05
ZENER DIODES		
Z1	IN748A	186A797H13
Z2	IN748A	186A797H13
Z3	IN957B	186A797H06
Z4	IN957B	186A797H06
Z5	IN957B	186A797H06
Z6	IN705	837A693H06
Z7	IN748A	186A797H13
Z8	IN748A	186A797H13
Z9	IN705	837A693H06
Z10	IN705	186A797H13
Z11	IN748A	186A797H13
Z13	IN753A	186A797H03

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
ZENER DIODES (Continued)		
Z14	IN3051	187A936H01
Z15	IN705	837A693H06
Z16	HW22B	185A212H16
Z18	IN3350A	762A631H05
Z19	IN3029B	188A302H11
Z20	IN960B	186A797H10
Z21	IN960B	186A797H10
Z22	IN960B	186A797H10
Z23	IN960B	186A797H10
Z24	HW22B	185A212H16
DIODES		
D1 to D12	IN5053	188A342H12
D13 to D28	IN4822	188A342H11
D29 to D32	IN5053	188A342H12
D34 to D38	IN4816	188A342H10
D40	IN4816	188A342H10
D41	IN4816	188A342H10
D42 to D45	TI-55	183A790H09
D46	IN4816	188A342H10
D47 to D49	TI-55	183A790H09
D50	IN4816	188A342H10
D51	TI-55	183A790H09
D52	TI-55	183A790H09
D53	IN4816	188A342H10
THERMISTORS		
TH-1	ID203	185A211H02
TH-3	ID203	185A211H02
TH-4	ID203	185A211H02
TH-5	ID203	185A211H02
TH-6	RL23S1	185A211H01
TH-7	RL23S1	185A211H01
TH-8	55TM1	187A375H03
TH-9	RL23S1	185A211H01
VARISTORS		
V1	68D5010	183A640H03
V2	68D5010	183A640H03
SENSISTORS		
S1	1.2K 10%	187A685H03
S2	1.2K 10%	187A685H03
TRANSFORMERS		
T1	Phase	408C374G06
T2	Phase	408C374G06
T3	Phase	408C374G07
T4	Phase Inst.	408C374G05
T5	Phase Inst.	408C374G05
T6	Phase Inst.	408C374G08
T7	Ground Inst.	408C374G02
T8	Ground	408C374G03
T9	UTC-H62	629A372H02
T10	UTC-H62	629A372H02
MISCELLANEOUS		
I1	Ground Indicator	183A825G05
I2	Phase Indicator	183A825G05

ELECTRICAL PARTS LIST – SBR-2

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RESISTORS		
R1	82,000 ½W 5%	184A763H73
R2	220,000 ½W 5%	184A763H83
R3	118,000 ½W 1%	837A131H05
R4	174,000 ½W 1%	837A131H04
R5	232,000 ½W 1%	837A131H07
R6	453,000 ½W 1%	836A503H87
R7	665,000 ½W 1%	837A131H06
R8	2,700 ½W 5%	184A763H37
R9	2,200 ½W 5%	184A763H35
R10	200 ½W 5%	184A763H11
R11	649,000 ½W 1%	837A131H01
R12	442,000 ½W 1%	837A131H03
R13	221,000 ½W 1%	836A503H80
R14	28,700 ½W 1%	837A131H02
R15	2,670 ½W 1%	836A503H36
R16	12,000 ½W 5%	184A763H53
R17	220,000 ½W 5%	184A763H83
R18	33,000 ½W 5%	184A763H63
R19	2,700 ½W 5%	184A763H37
R20	2,200 ½W 5%	184A763H35
R21	200 ½W 5%	184A763H11
R22	5,000 125 V.D.C. 5%	1205214
R22	1,400 48 V.D.C. 5%	1267292
R23	2,500 125 V.D.C. 5%	1267299
R23	560 48 V.D.C. 5%	1267282
R24	6,800 125 V.D.C.	187A643H47
R24	1,000 48 V.D.C.	187A643H27
POTENTIOMETERS		
RH-1		762A790H04
CAPACITORS		
C1	100MFD. 6V 5%	184A661H06
C2	100MFD. 6V 5%	184A661H06
C3	To be determined in test.	
C4	.25MFD. 200 V.D.C. 10%	187A624H02
C5	.25MFD. 200 V.D.C. 10%	187A624H02
C6	10MFD. 150 V.D.C. 20%	27D5476H09
C7	.05MFD. 200 V.D.C.	187A624H05
C8	150MFD. 6 V.D.C. 5%	184A661H08
C9	To be determined in test.	
C10	100MFD. 6 V 5%	184A661H06
C11	33MFD. 20 V 20%	184A661H11
C12	1MFD. 20%	184A662H04
C13	1MFD. 20%	184A662H04

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
TRANSISTORS		
T1	2N3417	848A851H02
T2	2N3417	848A851H02
T3	2N3417	848A851H02
T4	2N3417	848A851H02
T5	2N3417	848A851H02
T6	2N3417	848A851H02
ZENER DIODES		
Z1 to Z6	1N748A	186A797H13
Z7 to Z10	1R200 (1N3051)	629A369H01
THERMISTOR		
TH-1	2D504	185A211H07
CONTROLLED RECTIFIERS		
SCR-1	K1149-13	189A640H13
SCR-2	125 V – K1149-13	189A640H13
SCR-2	250 V – K1149-12	184A640H12
RECTIFIERS		
D3	1N4822	188A342H11
D4	1N4822	188A342H11
D5	T1-55	183A790H09
D6	1N4822	188A342H11
D7	1N4822	188A342H11
D8	1N4822	188A342H11
D9	T1-55	183A790H09
MISCELLANEOUS		
SS	Stepping Switch 125 V.D.C.	411C693G01
SS	Stepping Switch 48 V.D.C.	411C693G02
AR	Alarm Relay 125 V.D.C.	541D514H06
AR	Alarm Relay 48 V.D.C.	541D514H08
CR	Close Relay 125 V.D.C.	541D514H05
CR	Close Relay 48 V.D.C.	541D514H07
I1	Lockout Indicator – 52410-993	183A825G05



WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBR STATIC CONTROL

APPLICATION

The type SBR Static Control is a breaker tripping and reclosing device suitable for use on distribution breakers where non-directional overcurrent relaying including instantaneous trip, is used and where automatic reclosing, including instantaneous and/or time-delay multi-shots, is desired. This device is intended for use primarily where a station battery is available; however, provision can be made for use with a-c supply.

The static time overcurrent characteristics of the type SBR static control, coordinate with existing electromechanical characteristics and fuse time characteristics. The use of static circuitry also provides major advantages in both relaying and reclosing. These include fast reset for the overcurrent units and a flexible reset characteristic for the reclosing control. Unlike other reclosing units which must cycle through a complete sequence, the SBR reclosing circuit may be programmed to return to "home "position after a present time delay following breaker reclosing.

The type SBR static control is entirely self-contained on a one-eighth-inch thick steel panel, 19 inches wide and approximately 25 inches high. The panel may be semi-flush mounted on a breaker, relay board or control switchboard, or may be mounted on a 19-inch rack or cabinet. This self-contained and coordinated package, containing all protective, reclosing and manual control functions required, is a major advantage of the type SBR static control.

CONSTRUCTION AND OPERATION

The type SBR static control consists of a type * SBR-1 relay, type SBR-2 relay, a 101 switch, 43 switch and a Cold Load Pickup switch, located on the SBR static control panel. The SBR-1 relay is a three-phase and ground static overcurrent relay and is composed of (1) eight current to voltage transformers, (2) a phase time-delay printed circuit board, (3) a ground time-delay printed circuit board, (4) phase and ground instantaneous printed circuit board, (5) a phase time-delay and instantaneous amplifier printed circuit board, (6) a ground time delay and instantaneous amplifier printed circuit board, (7) two tripping thyristors and (8) indication for phase and ground tripping. The SBR-2 relay is a semi-static reclosing relay and is composed of (1) an integrator, (2) a reclose timer printed circuit board, (3) a reset timer printed circuit board, (4) alarm relay, (5) close relay, (6) lockout indication and (7) push-to-test sequencing switch. All timing functions are accomplished through the use of semiconductor components. The principal identification of all components and their locations are shown in * Figure 9.

TYPE SBR-1 RELAY

Phase Time Delay Board

The secondary voltages from the three-phase time delay transformers are applied to three full-wave bridges. The output of all the bridges are connected in parallel. This parallel connection of the bridges is a maximum voltage network. Hence, the rectifier voltage applied to the phase timer is proportional to the phase with the largest magnitude of fault current. The filtered d-c activates the trip circuit, curve shaping and time delay circuits simultaneously, and at a predetermined level, a signal is applied to the input of the phase time-delay * amplifier. See Figure 1 for component location and board layout.

Ground Time Delay Board

The secondary voltage from the ground time delay transformer is applied to a full-wave bridge, rectified and filtered. The filtered d-c activates the minimum trip circuit, curve shaping and time delay circuits simultaneously, and at a predetermined level, an output signal is applied to the input of the ground time-delay amplifier. See Figure * 2 for component location and board layout.

SUPERSEDES I.L. 41-881.2
*Denotes change from superseded issue.

EFFECTIVE OCTOBER 1969

Phase and Ground Instantaneous Board

The secondary voltage from the ground transformer is applied to a full-wave bridge, rectified, and filtered. The filtered d-c activates the minimum trip circuit, curve shaping and instantaneous circuits simultaneously, and at a predetermined level, an output signal is applied to the input of the instantaneous amplifier.

The secondary voltages from the three-phase transformers are applied to three full-wave bridges. The output of all the bridges are connected in parallel. This parallel connection of the bridges is a maximum voltage network. Hence, the rectified voltage applied to the phase timer is proportional to the phase with the largest magnitude of fault current. The filtered d-c activates the minimum trip circuit, curve shaping and instantaneous circuits simultaneously and, at a predetermined level, a signal is applied to the input of the instantaneous amplifier. * See Figure 3 for component location and board layout.

Phase Time Delay and Instantaneous Amplifier

This amplifier receives low-level signals from the phase time-delay and instantaneous boards. These signals are amplified to a value that is of sufficient magnitude to operate the trip circuit of the control. The time delay inputs are further modified by circuitry on this board to obtain desired curve shapes. The output signal is also applied to the indication circuitry to indicate that a phase * fault has taken place. See Figure 5 for component location and board layout.

Ground Time Delay and Instantaneous Amplifier

This amplifier receives low-level signals from the ground time delay and instantaneous boards. These signals are amplified to a value that is of sufficient magnitude to operate the trip circuit of the control. The output signal is also applied to the indication circuitry to indicate that a ground fault * has taken place. See Figure 4 for component location and board layout.

Trip Circuits

The phase and ground amplifiers feed separate trip circuits. Each trip circuit consists of a thyristor, (hereafter referred to as SCR). Both SCR's are connected in parallel and are protected by a zener diode. The SCR has an anode, cathode, and gate. The anode of the SCR is connected to the positive side of the station battery. The cathode of the SCR is connected to the negative side of the battery through the trip coil and a normally closed contact of the breaker. The gate of the SCR is connected to the output of the phase and ground amplifiers. With no output from the various amplifiers, * the SCR acts as an open circuit to the breaker's trip coil. When an output from an amplifier is fed to the gate of the SCR, the SCR turns on and connects the breaker trip coil across the station battery opening the breaker and the trip circuit.

SBR-1 Indication Lights

Phase and ground indication lights are located on the front panel of the SBR-1 relay, and they will indicate when a phase or ground fault has taken place.

TYPE SBR-2 RELAY

Reset Timer Board

* The reset timer is controlled by the integrator, the auxiliary switches on the breaker, and the phase and ground circuitry (SBR-1). The front panel settings allow a choice of 5 different times for the resetting interval. The time delay circuit is of the quick-reset type. This enables the reset times to always be consistent with times * indicated on the front panel. See Figure 6 for component location and board layout.

Reclose Timer Board

* The reclose timer is controlled by the integrator. The front panel setting allows a choice of 5 different times for each interval of reclosing. The time-delay circuit is of the quick reset type which allows a specific timing circuit to be used for all reclosing *intervals. See Figure 7 for component location and board layout.

Push to Test Sequence Switch

This switch is used to check the operation of the control and the breaker. It checks the operation of the phase instantaneous amplifier and the phase trip circuit by injecting a low-level d-c signal into the phase instantaneous circuitry which will open the breaker. The control will sequence in accordance with the front panel settings of the SBR-2 relay until lockout is reached as long as the button is held in. If the button is released before the control sequences to lockout, the reset timer will be

activated and the control will be reset to its home position. In order to insure that this switch is not pushed accidently, a circular button guard is supplied.

Lockout Alarm and Indicator

The lockout alarm and indicator are controlled by the operation of the integrator. They will be energized when the integrator is on the lockout position.

Close Relay

The operation of the close relay is controlled by the operation of a breaker auxiliary switch, the reclose timer and the automatic reclosing switch.

Integrator — See Table 1 and Table 2 for complete description.

SBR STATIC CONTROL PANEL

101 Switch

This switch, when switched to the trip position, will automatically trip the breaker open and step the integrator to the lockout position. When switched to the closed position, this switch initiates closing of the breaker. If a fault exists, the breaker will trip open and remain at the lockout position.

Cold-Load Pickup Switch

The cold-load pickup switch will desensitize the phase instantaneous circuitry by a factor of 3 * when in the "ON" position, i.e., if the phase instantaneous connector screws are in the 7-ampere tap, it would take 21 amperes to trip open the breaker, For normal operation, the switch should be in the "OFF" position.

Ground Cutout Switch

The ground cutout switch will short out the ground circuitry to battery negative and remove it from operation. For normal operation, the switch * should be in the "OFF" position.

Automatic Reclosing Switch

The automatic reclosing switch will set up the control to automatically reclose when in the "ON" position. In the "OFF" position, the switch will de-energize terminals 5 and 13 (SBR-2) to keep the relay from reclosing.

TABLE I
INTEGRATOR LEVEL AND STEP FUNCTIONS PLUS TAP BLOCK SETTINGS

Integrator	Step 10 Home Position	Step 1	Step 2	Step 3	Step 4
Level 1 and RESET TIMER TAP BLOCK SETTING	No Connection	No connection	Energize reset timer time delay circuit †	No connection	Energize reset timer time delay circuit †
Level 2	Pulses integrator to step 1 when SCR-6 or SCR-8 energizes trip coil	No connection	Pulses integrator to step 3 when SCR-6 or SCR-8 energizes trip coil	No connection	Pulses integrator to step 5 when SCR-6 or SCR-8 energizes trip coil
Level 3 and OPERATIONS TO LOCKOUT TAP BLOCK SETTING	Supplies base drive for T2 to keep reset timer inoperative	Pulses integrator to step 2 when set for one operation to lockout	No connection	Pulses integrator to step 4 when set for 1 or 2 operations to lockout	No connection
Level 4 and RECLOSE TIMER TAP BLOCK SETTING	No connection	Energizes reclose timer time delay circuit through interval one	No connection	Energizes reclose timer time delay circuit through interval two	No connection
Level 5 and GROUND INST. TAP BLOCK SETTING	Determine instantaneous	No connection	Same as step 10	No connection	Same as step 10
Level 6 and PHASE INST. TAP BLOCK SETTING	Determine instantaneous operations	No connection	Same as step 10	No connection	Same as step 10
Level 7	Short Circuits reclose timer time delay capacitors	No connection	Same as step 10	No connection	Same as step 10

† If fault is cleared, reset timer will time out and energize the integrator coil directly.

* TABLE II
INTEGRATOR LEVEL AND STEP FUNCTIONS PLUS TAP BLOCK SETTINGS

Integrator	Step 5	Step 6	Step 7	Step 8 Lockout Pos.	Step 9
Level 1 and RESET TIMER TAP BLOCK SETTING	No connection	Energizes reset timer time delay circuit †	No connection	Energizes reset timer time delay circuit †	Energizes reset timer time delay circuit †
Level 2	No connection	Pulses integrator to step 7 when SCR-6 or SCR-8 energizes trip coil	No connection	No connection	No connection
Level 3 OPERATIONS TO LOCKOUT TAP BLOCK SETTING	Pulses integrator to step 6 when set for 1, 2, or 3 operations to lockout	No connection	Pulses integrator to step 8	Energizes lockout indicator and alarm relay	No connection
Level 4 RECLOSE TIMER TAP BLOCK SETTING	Energizes reclose timer time delay circuit through interval three	No connection	No connection	No connection	No connection
Level 5 GROUND INST. TAP BLOCK SETTING	No connection	Same as step 10	No connection	Same as step 10	No connection
Level 6 and PHASE INST. TAP BLOCK SETTING	No connection	Same as step 10	No connection	Same as step 10	No connection
Level 7	No connection	Same as step 10	Same as step 10	Same as step 10	Same as step 10

† If fault is cleared, reset timer will time out and energize coil directly.

SBR Indicating Lights

The red and green lights located at the center of the front panel indicate the condition of the breaker at all times. The red light is lit when the breaker is closed and the green light is lit when the breaker is open. These lights are energized from the same source used for the closing of the breaker.

Characteristics

The control is available with the following current ranges:

Phase Time Delay	Taps
Range	
4.0 to 12.0 amp.	4.0, 5.0, 6.0, 7.5, 8.5, 10.0, 12.0
Phase Instantaneous	
Range	
7.0 to 30.0 amp	7.0, 8.0, 10.0, 12.0, 15.0, 20.0, 30.0
Ground Time Delay	
Range	
2.0 to 6.0 amp.	2.0, 2.5, 3.0, 4.0, 5.0, 6.0
Ground Instantaneous	
Range	
4.0 to 15.0 amp.	4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 15.0

The time versus current characteristics are * shown in Figures 13 through 14. These characteristics give the control operating time for the minimum and maximum settings of the phase and ground adjuster, when the indicated multiples of tap value current are applied to the control. Three different time-current characteristics are available for phase time-delay protection along with one instantaneous curve. For ground fault protection, a single time-current characteristic for delayed tripping and a single time-current characteristic for instantaneous tripping. When reclosing after lockout, the control will be set up for a time-delayed operation (unless a tap screw is placed in position 5 of the phase and ground instantaneous selector) until the integrator resets to its home position, where the effective settings then apply.

Tripping Sequences

The tripping sequences can be all instantaneous, all time delayed or any combination of instantaneous and time delayed.

Reset Time

The reset timer can be set for 10, 15, 20, 40 and 60 seconds resetting time.

Reclose Time

The reclose timer can be set for instantaneous, 2, 15, 30 and 45 seconds reclosing time for each reclosing interval or any combination of the aforementioned times.

Operation to Lockout

The control can be set to lockout the breaker after 1, 2, 3 or 4 operations.

THEORY OF OPERATION

Operation of the control will be described with * the aid of Figure 9. We will assume that the SBR control is set for two instantaneous and two time-delayed operations and that a permanent fault occurs on the line being protected. Current transformers feed the alternating current signal to the primary of the three time-delayed phase transformers (T_1, T_2, T_3) and to the primary of the three instantaneous phase transformers (T_4, T_5, T_6). The secondary * voltages from transformers T_1 to T_6 are fed to two sets of three full-wave bridges. This parallel connection of the bridges is a maximum voltage network. That is to say that the voltage applied to filter capacitor C25 or C5 is proportional to the phase with the largest magnitude of fault current.

The filtered d-c is now applied to the minimum trip circuits. When the breakdown voltage of Zener diode Z6 is exceeded (measured at pin 10, board 293B294), current flows into the gate of silicon-controlled rectifier, SCR-2. This turns SCR-2 on and the voltage at the anode of SCR-2 drops to a low value. This deprives transistor Q4 of its base drive and it no longer conducts, removing the short circuit from capacitor C16. The identical action is taking place on board 202C736 with Zener diode Z_1, SCR-1 and Transistors Q1, Q3, Q14, Q16 and Q17. This removes the short circuit from capacitors C2, C3 and C27. With transistor Q3 and Transistor Q4 in the non-conducting state, the phase amplifier is set to receive signals from the instantaneous or time-delayed circuitry. We will follow an instantaneous signal through the tripping operation.

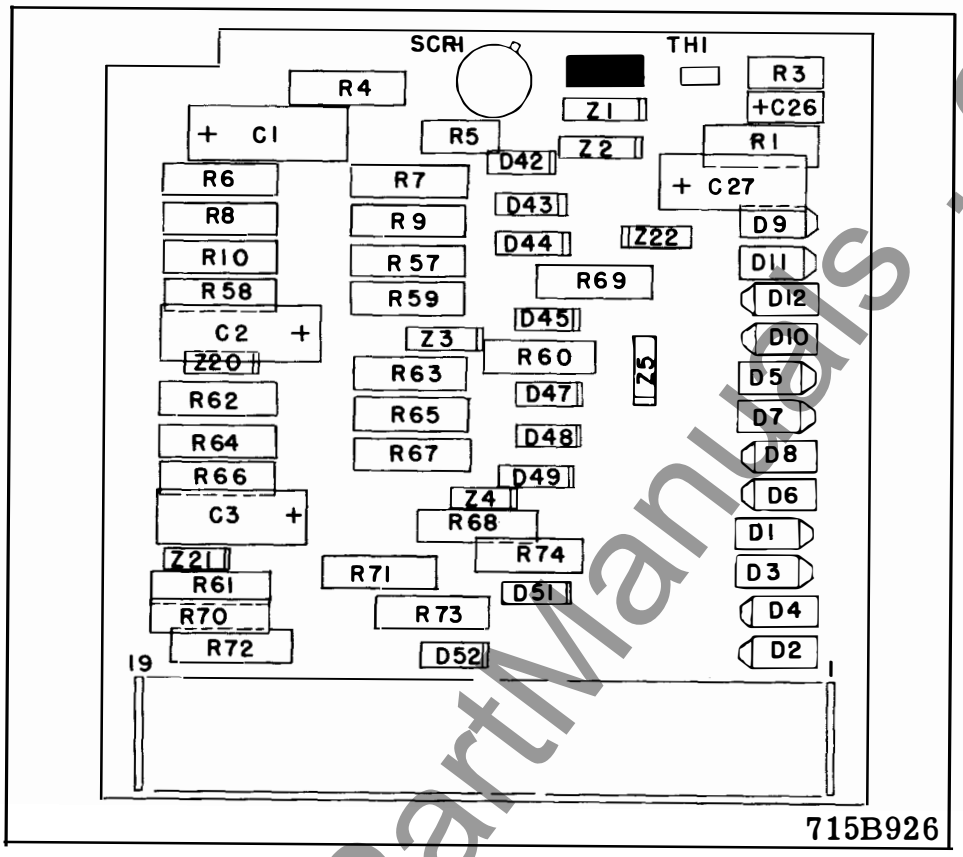


Fig. 1. Component Location on Phase Time Delay Board.

A positive signal is applied to terminal 12 of the SBR-1 relay. This signal also appears on terminal 10 of the SBR-2 relay and on the moving contact arm of the integrator on level 6. Due to the fact that we are set for an instantaneous operation, the signal is coupled to contact 10 of level 6, terminal 1 of the phase instantaneous selector tap block and then back to the SBR-1 relay by way of terminal 7 (SBR-2 relay) and terminal 13 (SBR-1 relay). When this signal, fed to a time-delay circuit consisting of resistor R32 and capacitor C16, exceeds the breakdown voltage of Zener diode Z15, a signal is applied to the base of transistor Q5, making it conduct removing the base drive from transistor Q6, and supplying base drive to transistor Q7, Capacitor C18 starts to charge through resistor R89 until it reaches a predetermined level, at this point capacitor C18 discharges through unijunction switch Q18 and Transformer T9. Transformer action takes place, and a positive pulse is applied to the gates of thyristor SCR-5 and thyristor SCR-6. SCR-6 turns on and connects the station battery across the trip coil opening the breaker contacts and removing the fault input to the phase circuitry. At the same time, thyristor SCR-5 turns on and the phase indicator indicating a phase fault comes on and will stay on until manually reset.

The 52a contact in series with terminal 10 (SBR-1 relay) opens and this stops SCR-6 from conducting as there is no longer a complete path for current to flow. With no input to the phase transformers, the voltage applied to Zener diode Z6 falls to zero. SCR-2 no longer has any current flow into its gate and because of circuit values associated with SCR-2, it turns off. The anode voltage on SCR-2 rises to a magnitude sufficiently high to breakdown Zener diode Z7 and allows current to flow into the base of transistor Q4. Transistor Q4 starts to conduct and capacitor C16 discharges. With capacitor * C16 discharged, transistors Q5 and Q7 cease conduction, and transistor Q6 starts to conduct shorting capacitor C18. At this point, no positive pulses are fed to the output SCR.

When the 52b contact in series with terminal 5, (SBR-2 relay) closes, battery positive is placed across the integrator coil through the 52b contact, the normally closed AR relay contacts, the normally

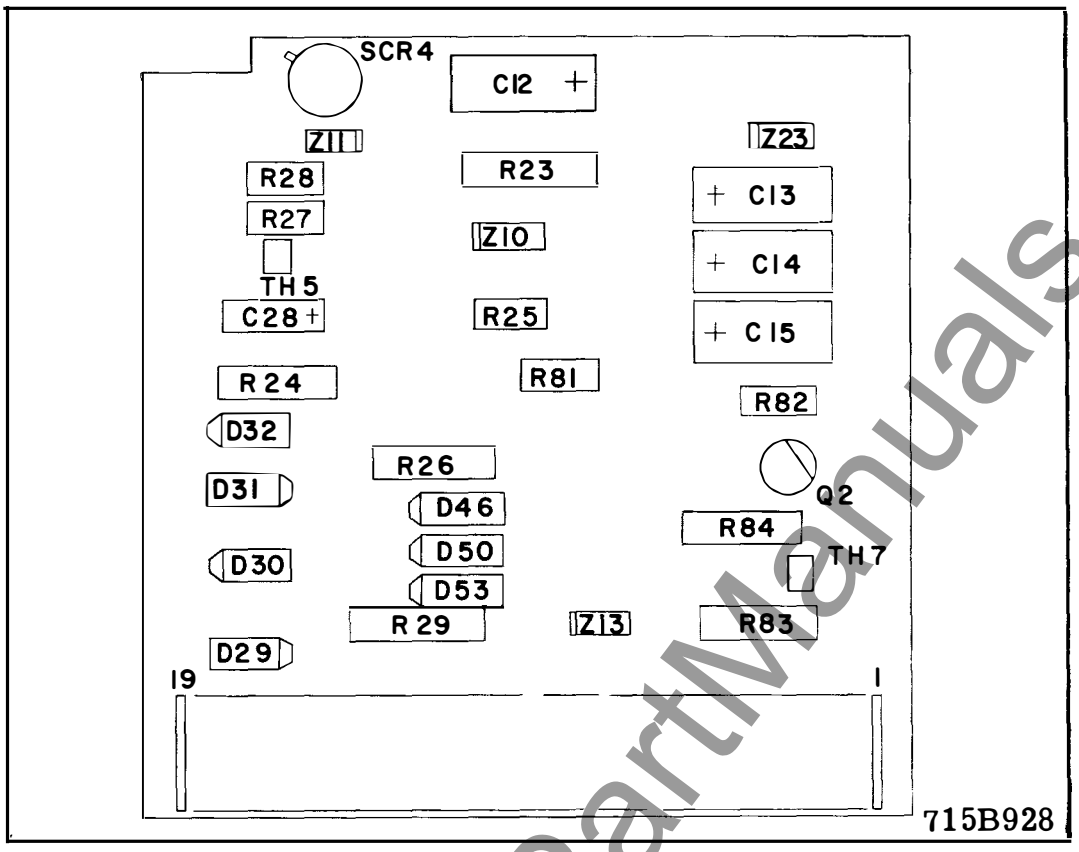


Fig. 2. Component Location on Ground Time Delay Board.

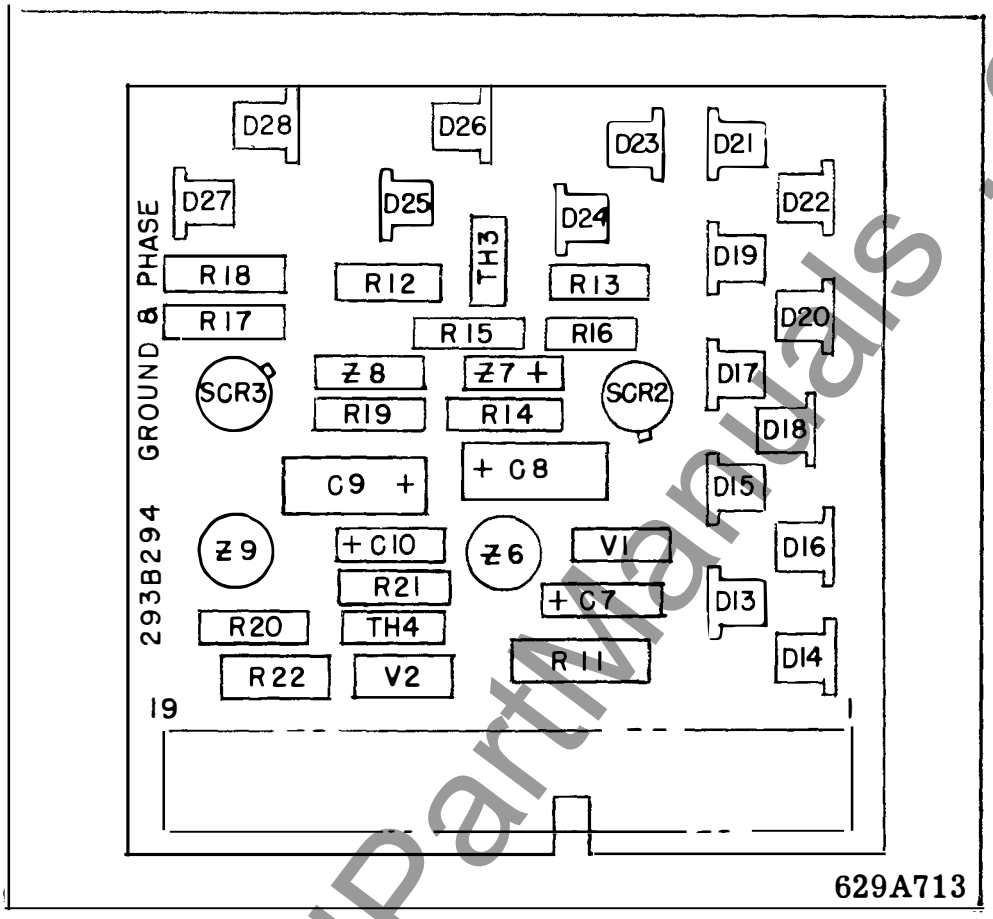
closed integrator contacts (SS-1) and level 2, step 10 of the integrator. As the armature of the integrator picks up, the normally closed contacts of the integrator (SS-1) open, stopping current flow. The integrator armature compresses a spring when the coil is energized.

When the SS-1 contacts open and the coil is de-energized, the spring moves the take-off arm to step 1.

* The reclose timer is now energized through the take-off arm of level 4, step 1 and interval one of the reclose timer tap block. With the input removed from the base of transistor T5 because of the closing of the 52b contacts between battery positive and terminals 5 and 20 (SBR-2), the resistor-capacitor timing circuit commences to charge to a voltage that will be sufficient to allow current to flow into the base of transistor T6 through Zener diode Z2. This signal is amplified by transistor T6 and applied to the gate of SCR-2, turning SCR-2 on and placing the close relay across the battery voltage through the 52b contact (terminals 4, 5, and 20 of the SBR-2 relay). The CR contacts energize the closing circuit, which closes the main contacts to the breaker and prepares the breaker for another tripping operation. When terminal 20 (SBR-2 relay) loses its positive voltage, due to the opening of the 52b, the close relay drops out. The CR contacts also energized the stepping switch coil which compresses a spring. When the 52b contact opens, the coil is de-energized and the spring moves the take-off arm to step 2.

When the breaker has closed, terminal 20 (SBR-2) goes to zero voltage and base current is applied to transistor T5 discharging the time delay capacitors (C8, C9, and C 10) on the reclose timer (board 670B115) thus setting it up for the next reclosing interval.

The reset timer (board 670B113) was energized through step 2, the take-off arm of level 1 and the RESET TIMER tap block. The reset time delay capacitors (C1 to C3) were kept inoperative by being short-circuited to battery negative by either transistor T2, or Q13 (SBR-1 relay). Transistor T2 shorts these capacitors when the breaker is open by the positive potential on terminal 5 (SBR-2)



* *Fig. 3. Component Location on Phase and Ground Instantaneous Board.*

supplying base drive to transistor T2 turning it on. Transistor Q13 provides a shorting path as long as there is a fault present and SCR-1, or SCR-4, is in the ON state. The turning on of SCR-1, or SCR-4, provides a shorting path for the base drive of Q14, or Q15, respectively, causing them to switch off, turning Q13 on. With capacitors C1 to C3 shorted, SCR-1 (SBR-2) cannot turn on to reset the integrator to its home position (step 10).

* Since the control was set for two instantaneous faults, another instantaneous fault takes place in a similar manner to that which was described for the previous operation. The 52b contact in series with terminal 5 closes, battery positive is placed across the integrator coil through the 52b contact, the normally closed AR contacts, the normally closed integrator contacts (SS-1) and level 2, step 2, of the integrator. As the armature of the integrator picks up, the normally closed contacts of the integrator (SS-1) open, stopping current flow. The integrator armature compresses a spring when the coil is energized. When the SS contacts open and the coil is de-energized, the spring moves the take-off arm to step 3.

To insure consistent reclose times when set for more than one instantaneous reclosure, the positive side of the reclose timer's time delay capacitors is short-circuited by the integrator take-off arm of level 7 on the previous steps 10 and 2, and subsequent steps 4 and 6.

The reclose timer's resistor-capacitor time-delay circuit, is now energized through the moving arm of level 4, step 3, and the setting on the RECLOSE TIMER tap block interval 2 and will operate in accordance with that setting. After a predetermined time delay, SCR-2 turns on and the close relay is energized. The close relay contacts energize the close circuit and the stepping switch coil. This prepares the stepping switch for its move to step 4 by compressing its spring. Energizing the close circuit closes the breaker. The 52b contact opens removing the voltage from terminal 5 (SBR-2). This allows the close relay to dropout and de-energize the stepping switch coil allowing it to move to step 4.

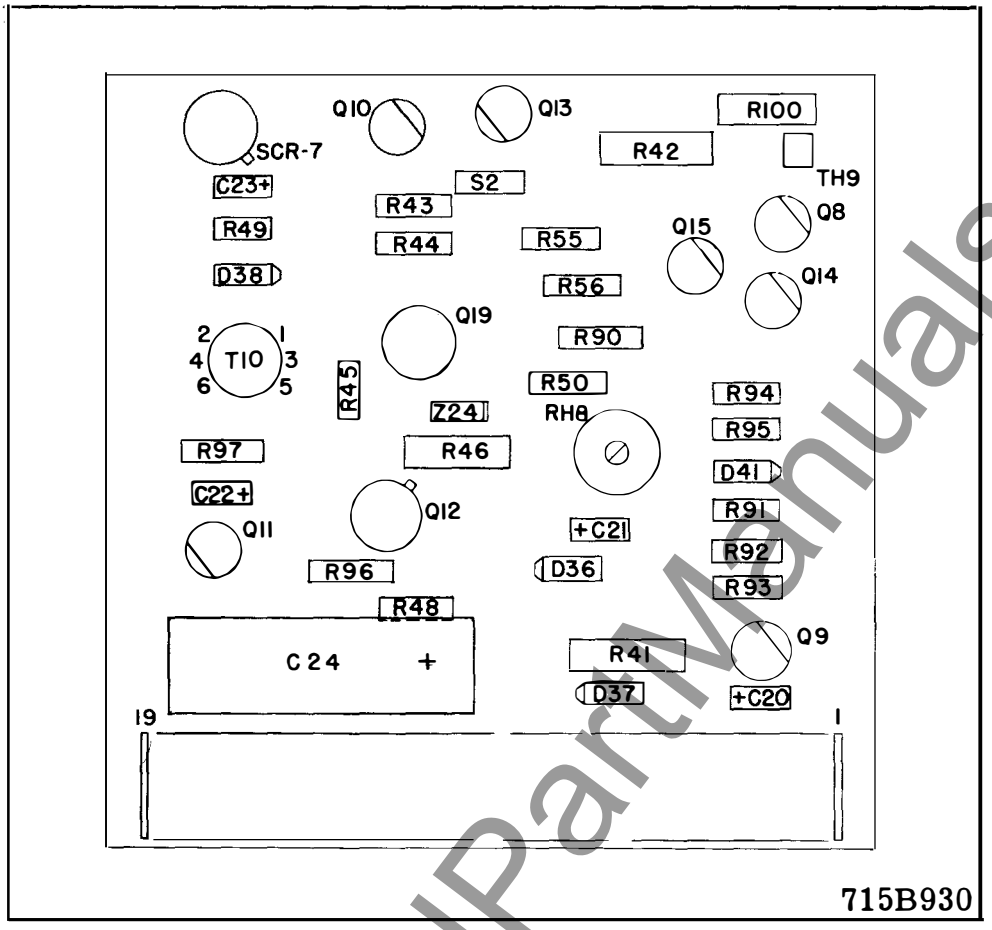


Fig. 4. Component Location on Ground Amplifier Board.

During the time that the reclose timer was operating, the reset timer was held inoperative by either transistor T2 or Q13 shorting the reset timer capacitors. Upon reclose, the phase transformers again sense the fault and the minimum trip circuitry reacts in the same way as previously described. The instantaneous signal gets as far as the PHASE INSTANTANEOUS selector tap block and reaches a dead end as the control was not set for an instantaneous operation on the third and fourth operations.

Depending upon the setting in the "PHASE CURVE SELECTOR" tap block, one of the three biased-diode curve shaping and timing circuits on phase board 202C736 apply a signal at a predetermined level to the time delay input of the amplifier through amplifier board terminal 9.

This signal is fed to the base of transistor Q5 making transistors Q5 and Q6 conduct, removing the base drive for transistor Q6. Transistor Q6 reverts to its non-conducting state, and capacitor C18 starts to charge through resistor R89. At a predetermined level unijunction switch Q18 fires, discharging capacitor C18 through transformer T9 feeding a positive pulse to the gate of SCR-6, turning SCR-6 on. This again places the station battery across the trip coil opening the breaker. Again, the operation of the 52b contact in conjunction with the wiring of level 2 moves the stepping switch to step 5.

The reclose timer is energized through the moving arm of level 4, step 5 and interval three of the RECLOSE TIME tap block. After the predetermined time delay, SCR-2 turns on picking up the closing circuit which closes the breaker main contacts, and prepares the stepping switch to move to step 6. When the 52b contact opens, the potential at terminal 5 drops to zero and de-energizes the close relay. The stepping switch moves to step 6. The reset timer is energized through the moving arm of level 1, and step 6, and it will attempt to reset the integrator to its home position (Step 10) if the fault has disappeared.

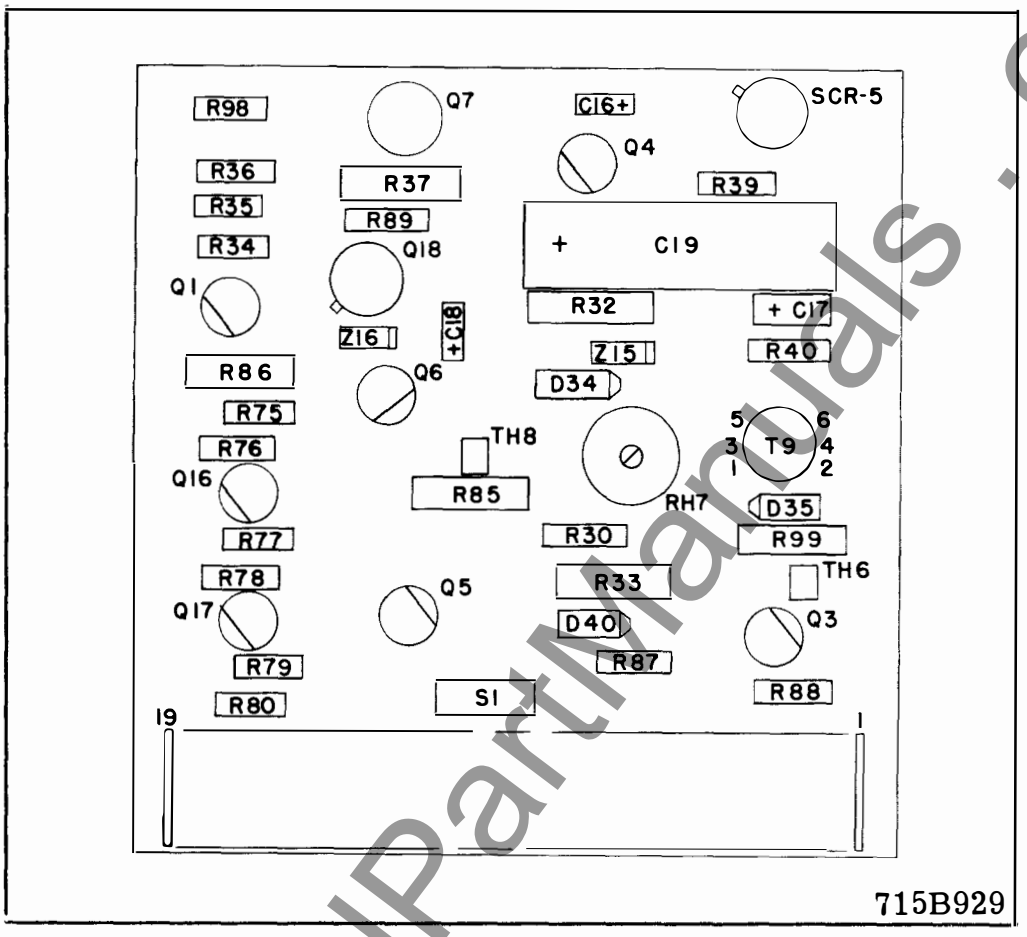


Fig. 5. Component Location on Phase Amplifier Board.

The fault reappears and the relay goes through another time-delayed operation as no instantaneous operation was preset on the PHASE INSTANTANEOUS SELECTOR tap block. The breaker opens and the 52b contact again energizes the stepping switch coil through level 2, step 6, and the normally close SS-1 contacts. This moves the stepping switch to step 7. The internal wiring of level 3, step 7, moves the stepping switch to step 8. This is the "lockout" step. The reclose timer is kept inoperative by the action of level 7. This level places a short circuit across capacitors C8, C9 and C10.

The reset timer is energized through the moving arm of level 1, step 8, and the RESET TIMER tap block setting. The time-delay capacitors are short circuited due to the base drive applied to transistor T2 by the positive voltage on terminal 5 (SBR-2 relay). The relay will remain in this condition until the breaker is manually or electrically closed.

Close the breaker utilizing the 101 switch. Assuming the fault still exists, the voltage will activate the minimum trip circuitry of the time delay and instantaneous circuits. The relay will trip out time-delayed unless a tap screw has been placed in the number 5 position of the PHASE INSTANTANEOUS SELECTOR tap block (under this condition, an instantaneous operation will take place). The operation of the SBR-1 relay will be in accordance with the description already described. When the 52b goes positive again, terminal 5 will go positive, but no signal reaches the stepping switch coil as terminal 5 is connected to the AR relay normally closed contacts. At this point, the AR relay is energized and its normally closed contacts are open. Therefore, the stepping switch remains at lockout.

Since the relay was at step 8 after the last operation, the relay will remain at "lockout" until it is manually or electrically closed. If we now assume that the fault has been cleared and the

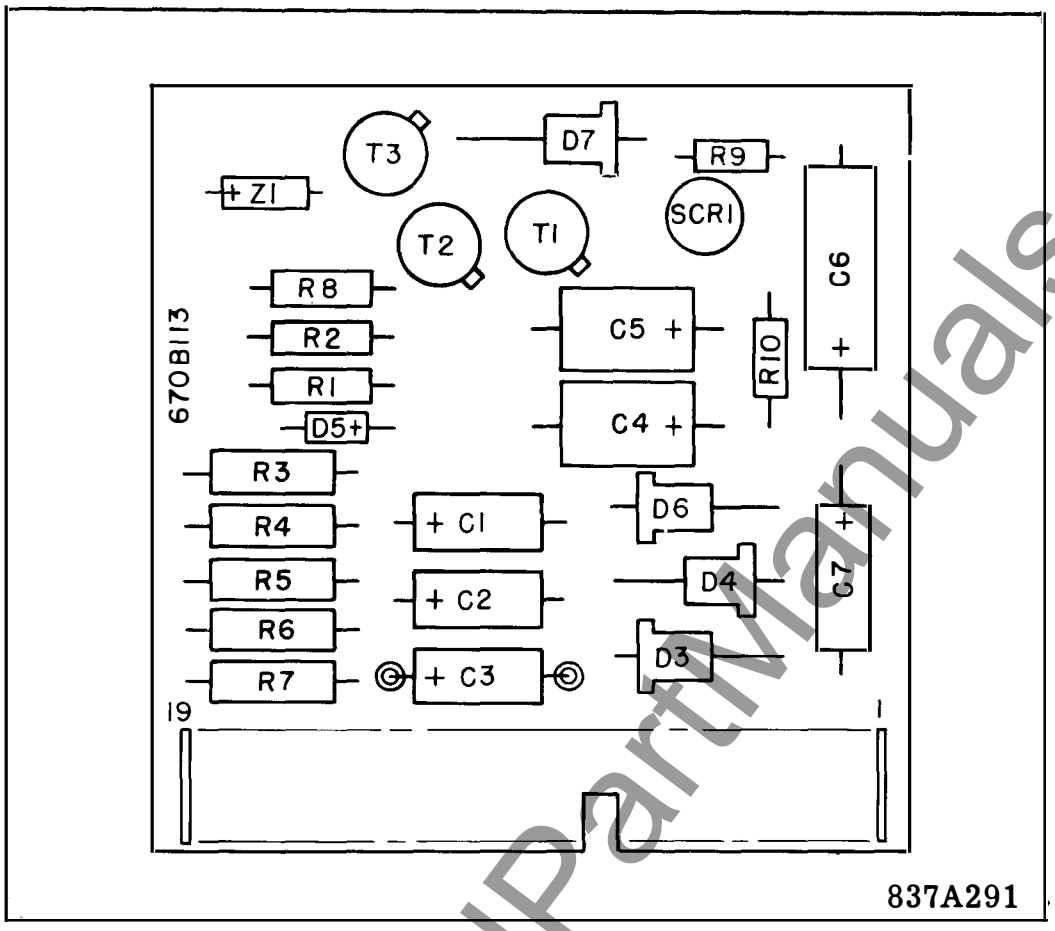
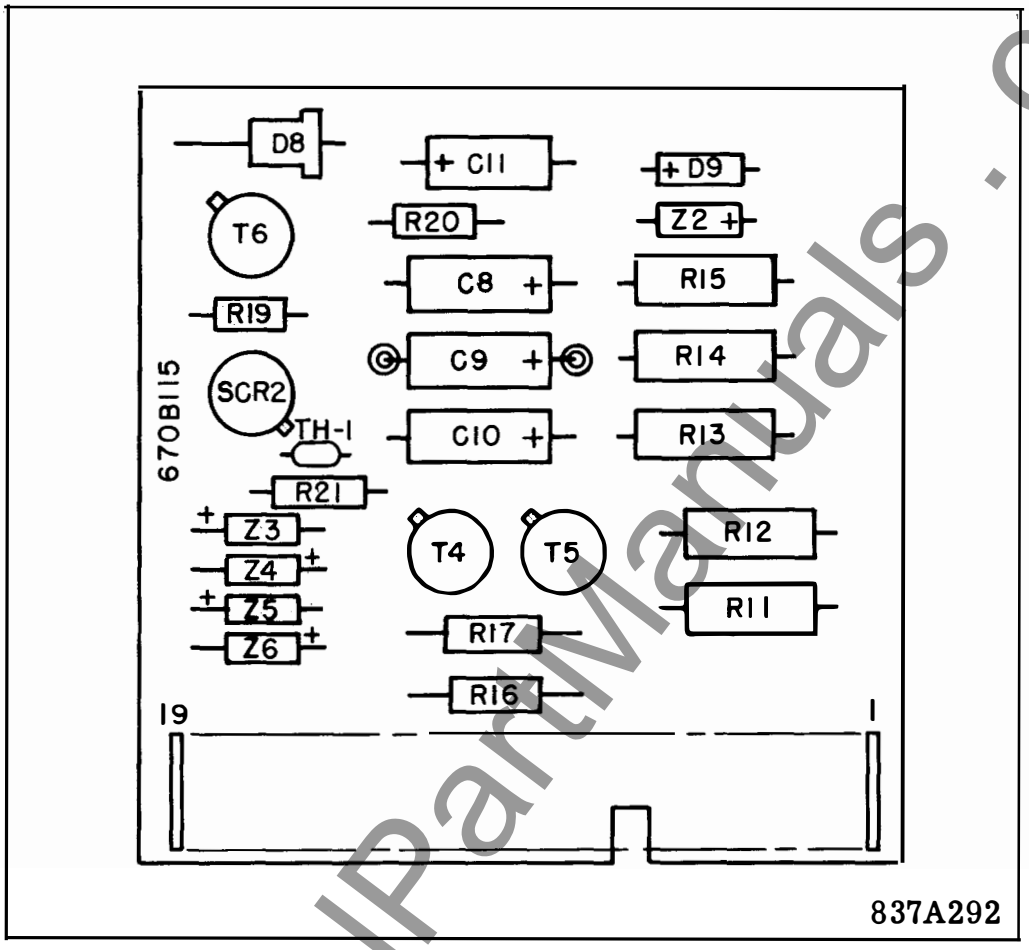


Fig. 6. Component Location on Reset Timer Board.

breaker is closed in, terminal 9 (SBR-2 relay) becomes positive and energizes the reset timer through the moving arm of level 1, step 8, and the "Reset Timer" tap block setting. With no base drive into transistor T2, transistor T2 will not conduct allowing the time delay capacitors C1 to C3 to charge up to a voltage of sufficient magnitude to make Z1 conduct current into the base of transistor T3. Transistor T3 amplified the signal which is applied to the gate of SCR-1. SCR-1 turns on placing the integrator coil across the regulated voltage through the integrator contacts (SS-2) and the homing contact (HC). As the armature pulls in, the integrator contact (SS) opens, allowing the integrator to move to step 9. SCR-1 fires again which moves the stepping switch to step 10. All circuits are de-energized except for step 10. level 3, which feeds a positive voltage to the base of transistor T2 through resistor R1 in the reset timer. This positive voltage makes transistor T2 conduct, discharging the reset timer's time delay capacitors (C1 to C3) and keeps the capacitors discharged when the integrator is at its home position (step 10). The homing contact (HC), a cam-operated switch, is open at step 10 and keeps the integrator coil from being energized when at the integrator's home position. The lockout indicator and alarm relay were energized by level 3 step 8 and will remain energized until the integrator is returned to its home position (Step 10). The SBR-2 relay is now reset and ready to go through a full sequence in line with the settings made at the beginning of this description.

Ground fault sensing and tripping occur exactly the same as described except zero sequence current is sensed instead of phase current. Ground fault sensing can be traced from transformers T7 and T8 to circuit boards 293B294 (ground instantaneous) and 202C738 (ground time delay) where the fault is sensed, and then to the 202C788 (ground amplifier). All circuits on the aforementioned board operate in a manner similar to that described for a phase fault.



* *Fig. 7. Component Location on Reclose Timer Board.*

SETTINGS

1. Phase and Ground Minimum Trip

* The connector screw on the tap plate of the phase and ground tap blocks makes connection to various turns on the primary coil of the current to voltage transformer. By placing this screw in the various tap plate holes, the control will respond to multiples of tap value currents in accordance with the various typical time curves. Since the tap block connector carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare screw (located in the phase instantaneous tap block) in the desired tap position before removing the other tap screw from its original position.

2. Phase Curve Selector

Place tap screw in proper tap to obtain desired time current characteristics for time-delayed operations.

3. Phase Curve Adjuster

Set this adjuster for the desired time on the phase curve selected in step 2. Lock in place. Curves can be adjusted between minimum and maximum values shown on typical time curves, Figure * 10 through 12. For accurate settings between minimum and maximum values, an electronic timer should be used.

4. Ground Curves Adjuster

Set this adjuster for desired curve on ground time delay tripping. Lock in place. Curve can be adjusted between minimum and maximum values * shown on typical time curve in figure 14. For accurate settings between minimum and maximum values, an electronic timer should be used.

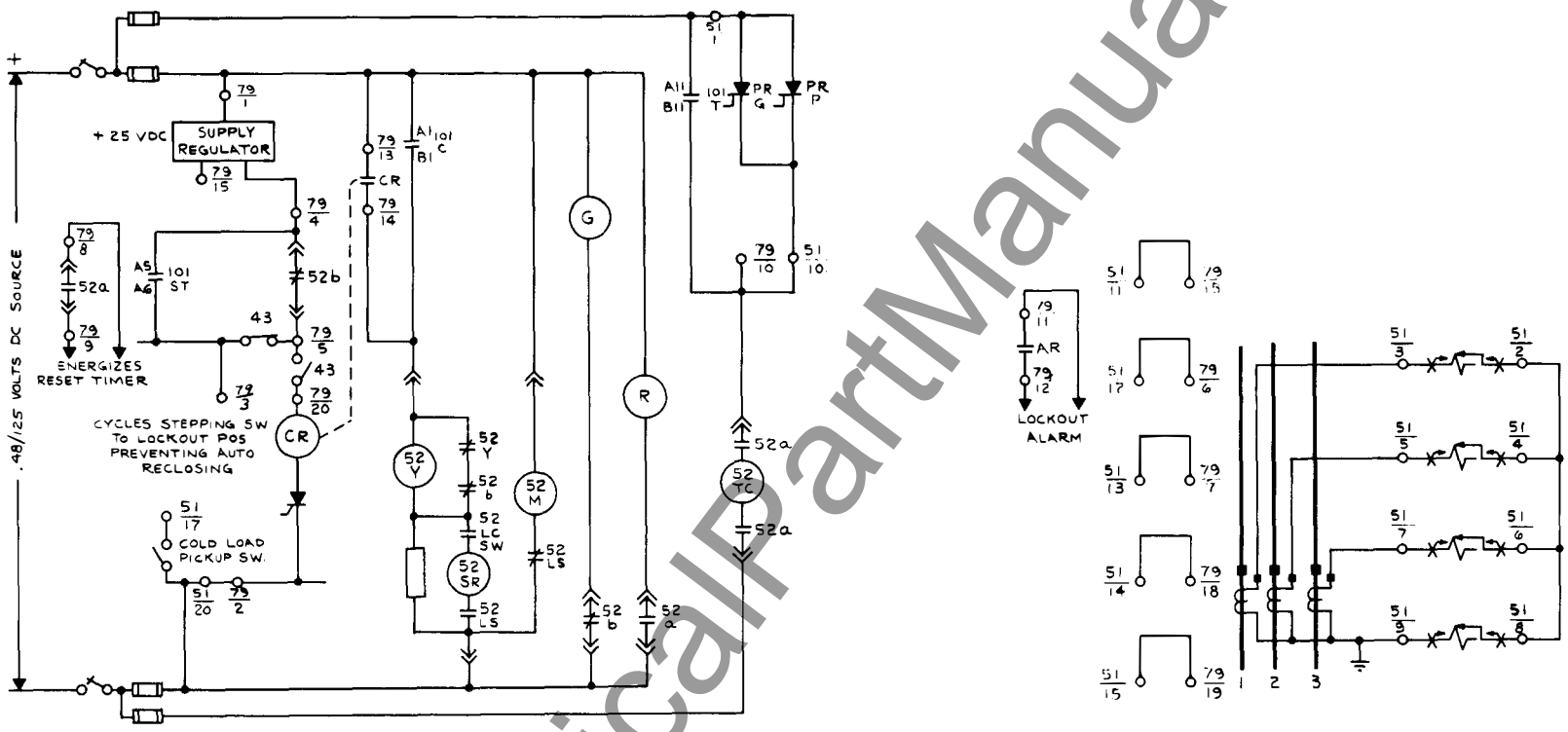


Fig. 8. External Schematic of SBR System.

TYPE SBR-2 RELAY

1. Reclosing Timer

Tap screws may be placed in different numbered reclosing times taps for all three intervals or in the same number for all intervals. A tap screw must be in each interval, otherwise the breaker will not close on that interval. When operating on less than 4 operations to lockout, the reclosing intervals will be dropped starting with the third interval first, i.e. for 3 operations to lockout, the control will reclose in accordance with the tap screws in intervals one and two, and then the control will proceed to lockout. The number above the tap indicates the time duration of the reclosing interval.

2. Reset Timer

Place tap screw in proper tap to obtain the desired reset time. The number above the tap indicates the time duration of the reset interval.

3. Operation to Lockout

Place tap screw in desired tap for obtaining 1 to 4 operations to lockout. The number above tap indicates the number of operations that will occur before lockout is reached.

4. Phase and Ground Instantaneous

Place tap screws in the desired taps for obtaining instantaneous operation. The numbers above the taps indicate which of the sequence of trips that would be instantaneous. For instantaneous operations on the first two trips, tap screws should be placed in the taps numbered 1 and 2. Time delayed trips will occur on all positions that do not have a trip screw.

A tap screw must be placed in position 5 when instantaneous tripping is desired during normal closing of the breaker.

Main Panel

1. Automatic reclosing switch: This switch should be in the "ON" position for normal use.
2. Cold Load Pickup: This switch should be in the "OFF" position for normal use.
3. Ground Cutout Switch: This switch should be in the "OFF" position for normal use.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

The following check is recommedned to insure that the control is in proper working order. Before proceeding, connect control to breaker or to a test relay:

A. Check settings, they should be as follows:

1. Type SBR-1 Relay
   a. Minimum trip current
      Phase and ground time delay — 4 amp tap
      Phase and ground time instantaneous — 7 amp tap
   b. Phase curve and ground curve adjusters set on O.
   c. Phase curve selector in position T3.
2. Type SBR-2 Relay
   a. Phase and ground instantaneous selector tap screws in positions 1 and 2.
   b. Operation to lockout tap screw in position 4.
   c. Reset timer tap screw in 10-second position.
   d. Reclosing timer intervals, all tap screws in the 2-second position.
3. Type SBR Static Control Front Panel
   a. Automatic reclosing switch in the "OFF" position
   b. Cold Load Pickup switch in the "OFF" position.
   c. Ground Cutout switch in the "OFF" position.

CAUTION: No tests should be made until both a-c and c-d connections have been made to control. Check nameplate

ENERGY REQUIREMENTS

Ampere Range	Taps	At Tap Value Current	Volt Amperes †		20X Tap Value Current
			At 3X Tap Value Current	At 10X Tap Value Current	
4/12	4	.840	7.8	76	232
	5	.875	8.0	81	275
	6	.900	8.5	88	312
	7.5	1.05	9.8	105	374
	8.5	1.15	10.7	115	400
	10	1.35	12.5	135	400
	12	1.70	15.2	174	620
7/30	7	2.08			
	8	2.15			
	10	2.43			
	12	2.90			
	15	3.48			
	20	5.3			
	30	10.5			
2/6	2	.45	3.8	28.6	87.2
	2.5	.45	3.9	31.5	101.0
	3	.47	4.1	35.2	120.0
	3.5	.49	4.2	37.1	142.0
	4	.55	6.2	42.8	160.0
	5	.69	9.6	57.0	230.0
	6	.83	14.4	75.0	300.0
4/15	4	1.61			
	6	1.76			
	7	1.79			
	8	1.94			
	10	2.30			
	12	2.80			
	15	3.72			

† Voltage taken with Rectox type voltmeter Station Battery – 48/125 V.D.C.

for proper voltage.

1. 101 Switch

Trip breaker utilizing the 101 switch on the front panel. Control should lockout, and the green indicating light should remain lit. The lockout indicator in the SBR-2 case should remain lit.

2. 101 Switch

Close breaker utilizing the 101 switch on the front panel. The control should close the breaker instantaneously and the red light should light. After approximately 10 seconds, the integrator should step to its home position, and the lockout indicator should go out.

3. Automatic Reclosing Switch

Energize terminals 8 and 9 of the SBR-1 relay with 2X tap value current. The breaker should trip and remain open. De-energize terminals 8 and 9. Move the Automatic Reclosing Switch to the "ON" position, and the breaker will automatically reclose.

4. Ground Time Delay Minimum Trip Current

Energize terminals 8 and 9 of the SBR-1 relay with approximately tap value current, place VTVM (5-volt scale) from test point 2 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Raise current until a slowly increasing voltage can be seen on the voltmeter. Check value of current, this value should be equal to the tap value setting on the ground minimum trip block plus or minus 5%.

5. Ground Instantaneous Minimum Trip Current

Place a short circuit from test point 2 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Energize terminals 8 and 9 of the SBR-1 relay with approximately tap value current of the ground instantaneous tap block. Raise current until the breaker trips open. Note this value of current should be equal to the tap value setting of the ground instantaneous tap block plus or minus 5%. Remove short circuit from test point 2 and battery negative.

6. Phase Time Delay Minimum Trip Current

Place VTVM across test point 1 (SBR-1 Front Panel) and test point common (SBR-1 Front Panel). Energize terminals 2 and 3 of SBR-1 relay with approximately tap value current, raise current until a slowly increasing voltage can be seen on the voltmeter. Check value of current, this value should be equal to the tap value setting on the top phase tap block plus or minus 5%. Repeat the above procedure energizing terminals 5 and 2 and terminals 7 and 2. This will check all three phases for the correct minimum trip setting.

7. Phase Instantaneous Minimum Trip Current

Place a short circuit from test point 1 (SBR-1 Front Panel) to test point common (SBR-1 Front Panel). Energize terminals 3 and 2 of the SBR-1 relay with approximately tap value current of the phase instantaneous tap block. Raise current until the breaker trip opens, and note this value of current. This value of current should be equal to the tap value setting of the phase instantaneous tap block plus or minus 5%. Repeat the above procedure energizing terminals 5 and 2 and terminals 7 and 2. This will check all three phases for the correct minimum trip settings.

8. Operations to Lockout - Phase and Ground Instantaneous

a. Observe if the control locks the recloser open in the correct number of operations, and note if the correct number of fast and time-delayed operations occur in line with the settings that were made when terminals 7 and 2 of SBR-1 relay are energized with 2 times tap value current.

b. Repeat 8a except energize terminals 9 and 2 of SBR-1 relay with 2 times tap value current.

9. Ground Time Delay Curve

Remove tap screws from the ground instantaneous tap block in the SBR-2 relay. Repeat step 8b and check the time required for tripping the breaker open. Repeat step 8b using different value as fault current. The times obtained minus the breaker operating times should equal the times shown under * typical time curve Figure 14 plus or minus 5%.

10. Ground Instantaneous Time Curve

Replace the tap screws in the ground instantaneous tap block in the SBR-2 relay. Energize terminal 9 and 2 of the SBR-1 relay with 2X the instantaneous tap block setting, and time the opening of the breaker. Repeat using different values of current. These times minus the breaker opening time should equal the times of the instantaneous * curve Figure 14 plus or minus 5%.

11. Phase Time Delay Curve

Remove tap screws from the phase instantaneous tap block in the SBR-2 relay. Repeat steps 8a and check the time required for tripping the breaker open. Repeat 8a using different multiples of minimum pickup. The times obtained, minus the breaker * opening time, should equal the times shown under typical time curve Figure 10 plus or minus 5%.

12. Phase Instantaneous Time Curve

Replace the tap screw in the phase instantaneous tap block in the SER-2 relay. Energize terminals 7 and 2 of the SBR-1 relay with 2X instantaneous tap block setting, and time the opening of the breaker. Repeat the above procedure using different multiples of minimum pickup. The times obtained minus the breaker opening time should equal the times shown under typical time curve Figure 13 plus * or minus 5%.

13. Reset Timer

With the control at lockout position, close the breaker utilizing the 101 switch and simultaneously * start a stop watch, timing the interval that elapses before the integrator resets. The integrator will be resetting when the lockout light in the SBR-2 relay goes out. This time should equal the front panel RESET TIMER setting plus or minus 5%.

14. Reclose Timer

Connect a VTVM to terminals 5 and 2 of SBR-2 relay (positive lead to terminal 5). Energize terminal 9 and 2 of SBR-1 relay with 2X tap value current. When the breaker opens, terminal 5 will become positive with respect to terminal 2. Start stop watch when terminal 5 becomes positive, and time interval until the voltage falls to zero. This time should equal the first interval of the RECLOSER TIMER SETTINGS on the front panel plus or minus 10%. Repeat timing procedure to check the second and third reclosing intervals. For instantaneous reclosing, an electronic timer will have to be utilized.

ROUTINE MAINTENANCE

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

CALIBRATION

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

SBR-1 RELAY

1. Ground Time Delay Minimum Trip Current

Place VTVM (5-volt scale) across test point 2 (SBR-1 Front Panel) and test point common. Test point 2 is positive with respect to common. Energize terminals 9 and 2 with tap value current, adjust control RH-5 (rear sub base) so that a slowly increasing voltage can be seen on the voltmeter at the value current plus 1%, and the aforementioned voltage should fall to zero at tap value current minus 1%. With tap value current plus 1%, the ground timer should trip open the breaker.

2. Ground Instantaneous Minimum Trip Current

Place a short circuit from test point 2 to test point common. Energize terminals 9 and 2 with ground instantaneous tap value current. Adjust control RH-4 (rear sub base) so that the control trips open the breaker with tap value current plus or minus 1%. Remove short circuit from test point 2.

3. Phase Time Delay Minimum Trip Current

Place VTVM (1.5-volt scale) across test point 1 (SBR-1 Front Panel) and test point common. Test point 1 is positive with respect to test point common. Energize terminals 3 and 2 with phase time delay tap value current, adjust control RH-1 (rear sub base) so that a slowly increasing voltage can be seen on the voltmeter at tap value current plus 1%, and the aforementioned voltage should fall to zero at tap value current minus 1%. With tap value current plus 1%, the phase timer should trip the breaker open. Place a short circuit across test point 1 and test point common. Place VTVM (50-volt scale) across terminal 18 and battery negative. Voltage * at this point should read 25.8 to 26.2 volts d-c when terminals 3, 5, or 7, and terminal 2 are energized with tap value current.

4. Phase Instantaneous Minimum Trip Current

Place a short circuit from test point 1 to test point common. Energize terminals 3 and 2 with

phase instantaneous tap value current and adjust control RH-3 (rear sub base) so that the control trips open the breaker with tap value current plus or minus 1%. Energize terminals 5 and 2, and 7 and 2; control should trip open the breaker at tap value current plus or minus 1%. Remove short circuit from test point 1.

5. Time Curve Calibration - Phase Time Delay

Remove tap screws from PHASE INSTANTANEOUS TAP BLOCK. Set phase curve adjuster to maximum (fully clockwise). Place VTVM (1.5-volt scale) across test point 1 (SBR-1 front panel) and test point common. Energize terminals 7 and 2 with 1.1 times tap value current. Adjust RH-7 (phase amplifier board 202C755 so that the control trips open the breaker when .88 to .90 volts are seen on the VTVM. De-energize circuit. Set phase curve adjuster to zero. Energize circuit with 2 times tap value current. Check to see that the control will trip open the breaker in .655 seconds plus or minus 5%. When presetting current, place a short circuit across test point 1 and battery negative. Do not leave high currents on for long periods when the short circuit is across test point 1 and test point common. This will cause overheating and could cause destruction of some of the components. Apply currents as multiples of tap value setting and measure operating time of the breaker. The operating times obtained minus the breaker opening time should equal those listed in typical time curves Figure 10 plus or minus 5%. Replace tap screws in the phase instantaneous tap block.

6. Time Curve Calibration - Phase Instantaneous

No adjustments necessary.

7. Time Curve Calibration - Ground Time Delay

Remove tap screws from ground instantaneous tap block. Set ground curve adjuster to maximum (fully clockwise). Place VTVM (5-volt scale) across test point 2 (SBR-2 Front Panel) and test point common. Energize terminals 9 and 2 with 1.1 times tap value current. Adjust RH-8 (ground amplifier board 202C788 so that the control trips open the breaker when 1.24 to 1.26 volts are seen on the VTVM. De-energize circuit. Set ground curve adjuster to zero. Energize circuit with 2 times tap value current. The control will trip open the breaker in 14.5 seconds plus or minus 5%. When presetting current, place a short circuit across test point 2 and battery negative. Do not leave high currents on for long periods when the short circuit is across test point 2 and battery negative. This will cause overheating and could cause destruction of some of the components. Apply currents as multiples of tap value setting and measure operating time of the breaker. The operating times minus the opening time of the breaker should equal those listed in typical time curve Figure 14 plus or minus 5%.

8. Time Curve Calibration - Ground Instantaneous

No adjustments necessary.

SBR-2 RELAY

RH-1 Calibration

1. Place VTVM from terminal 8 to common test point. Adjust RH-1 (rear sub base) so that 18 volts d-c can be seen on the VTVM when terminals 1 and 2 are energized with rated voltage.
2. No other calibration necessary.

RENEWAL PARTS

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

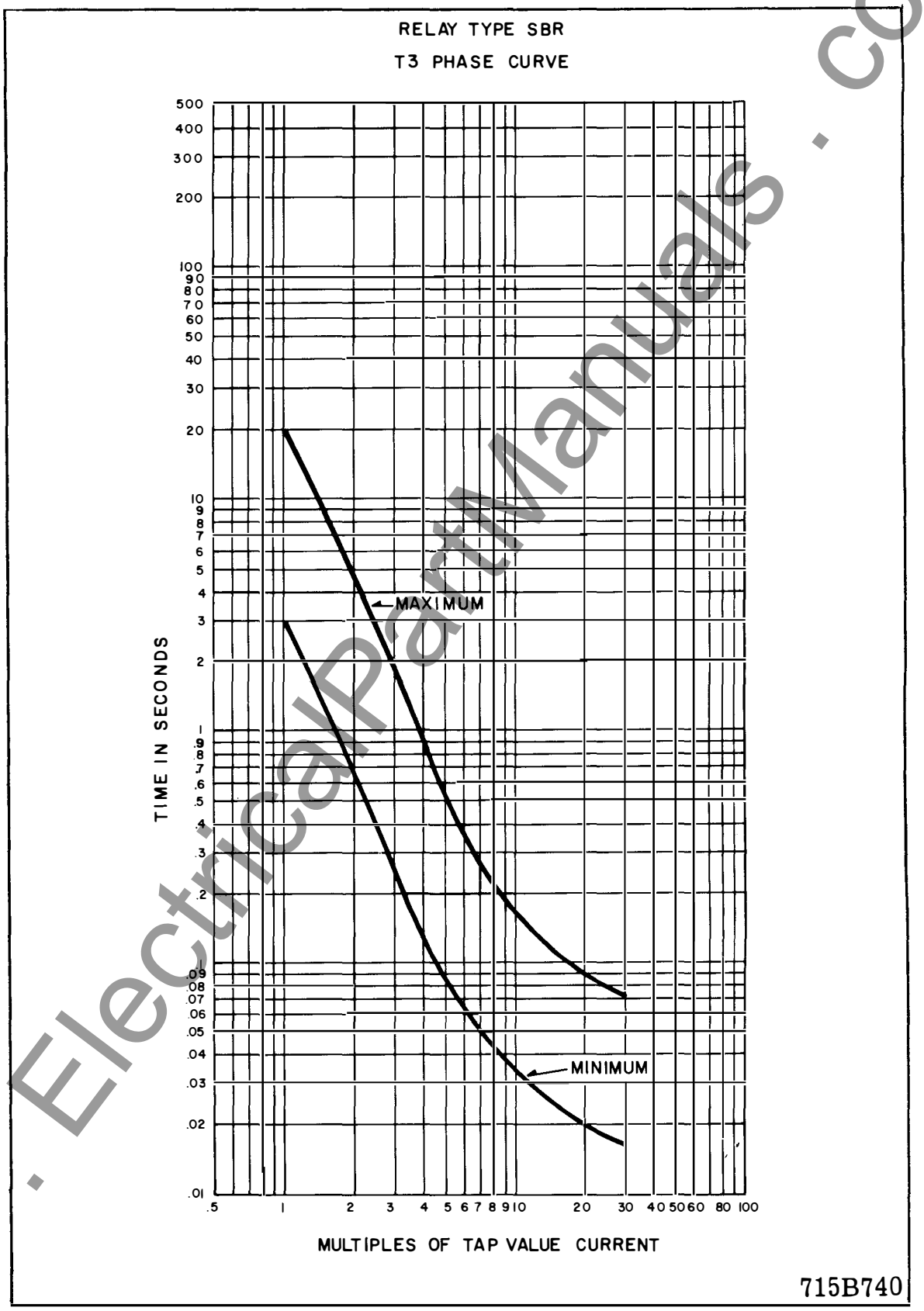


Fig. 10. Time Curves for Phase Time Delay T3 Curve Selector.

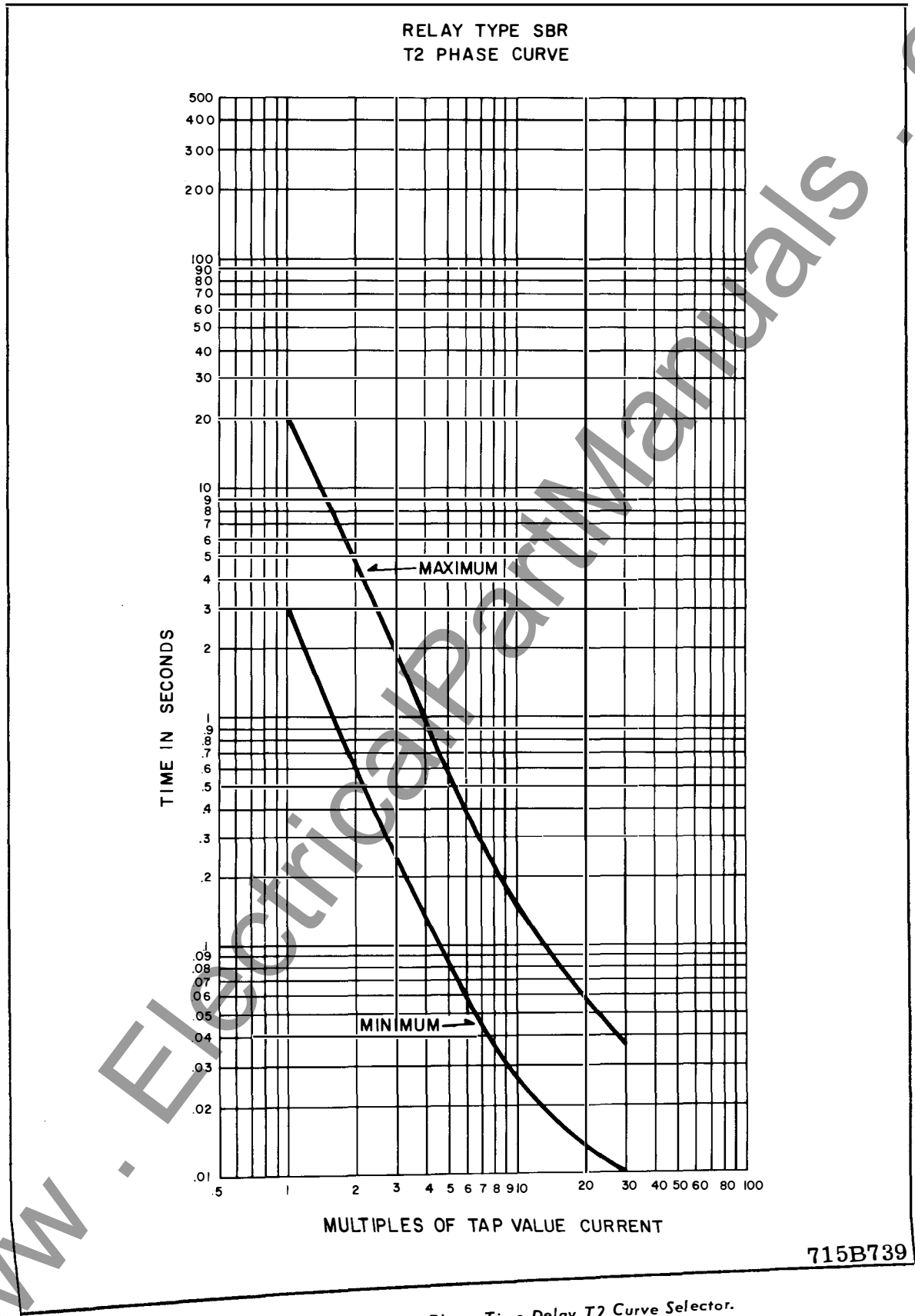


Fig. 11. Times Curves for Phase Time Delay T2 Curve Selector.

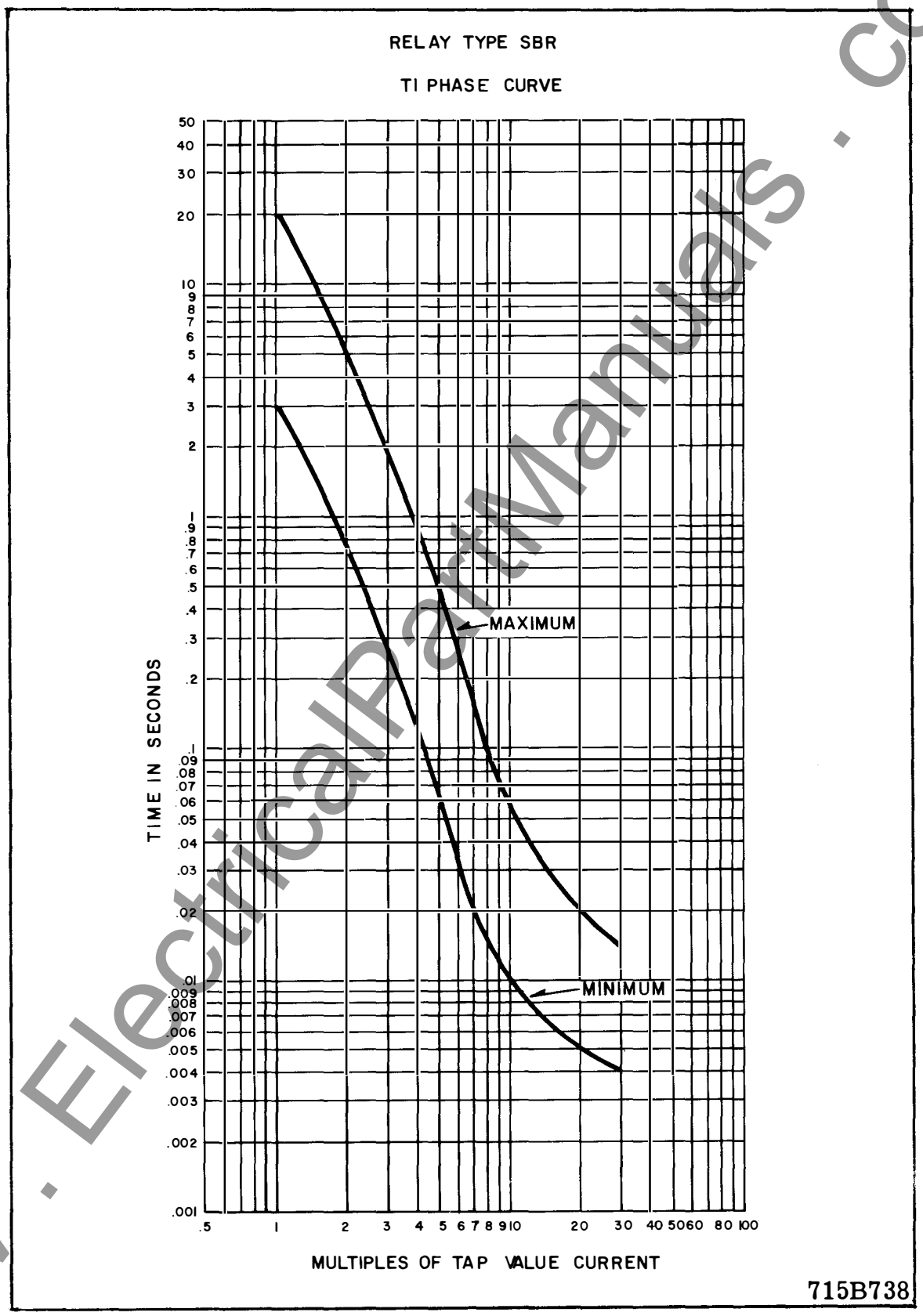


Fig. 12. Time Curves for Phase Time Delay T1 Curve Selector.

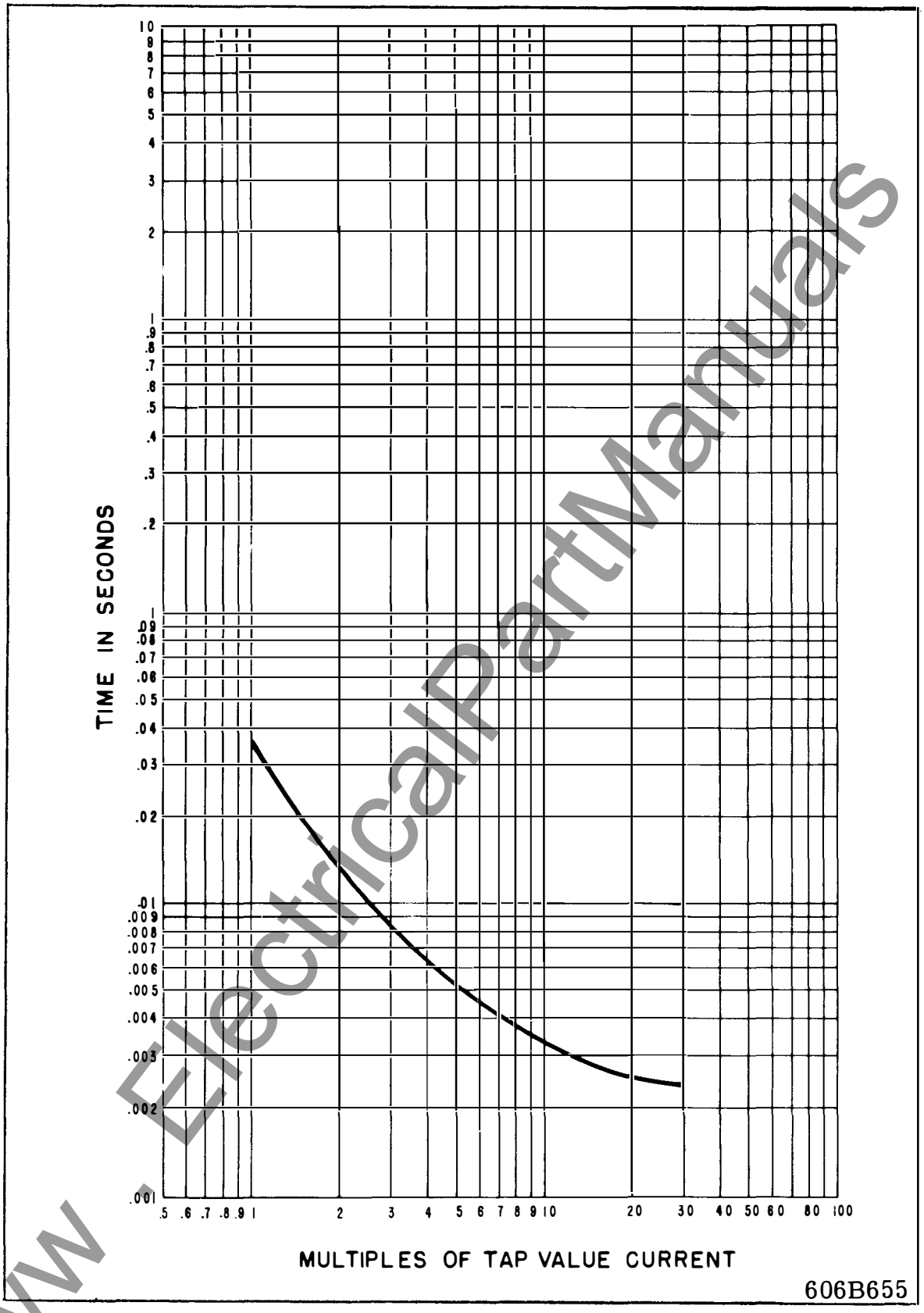


Fig. 13. Time Curve for Phase Instantaneous.

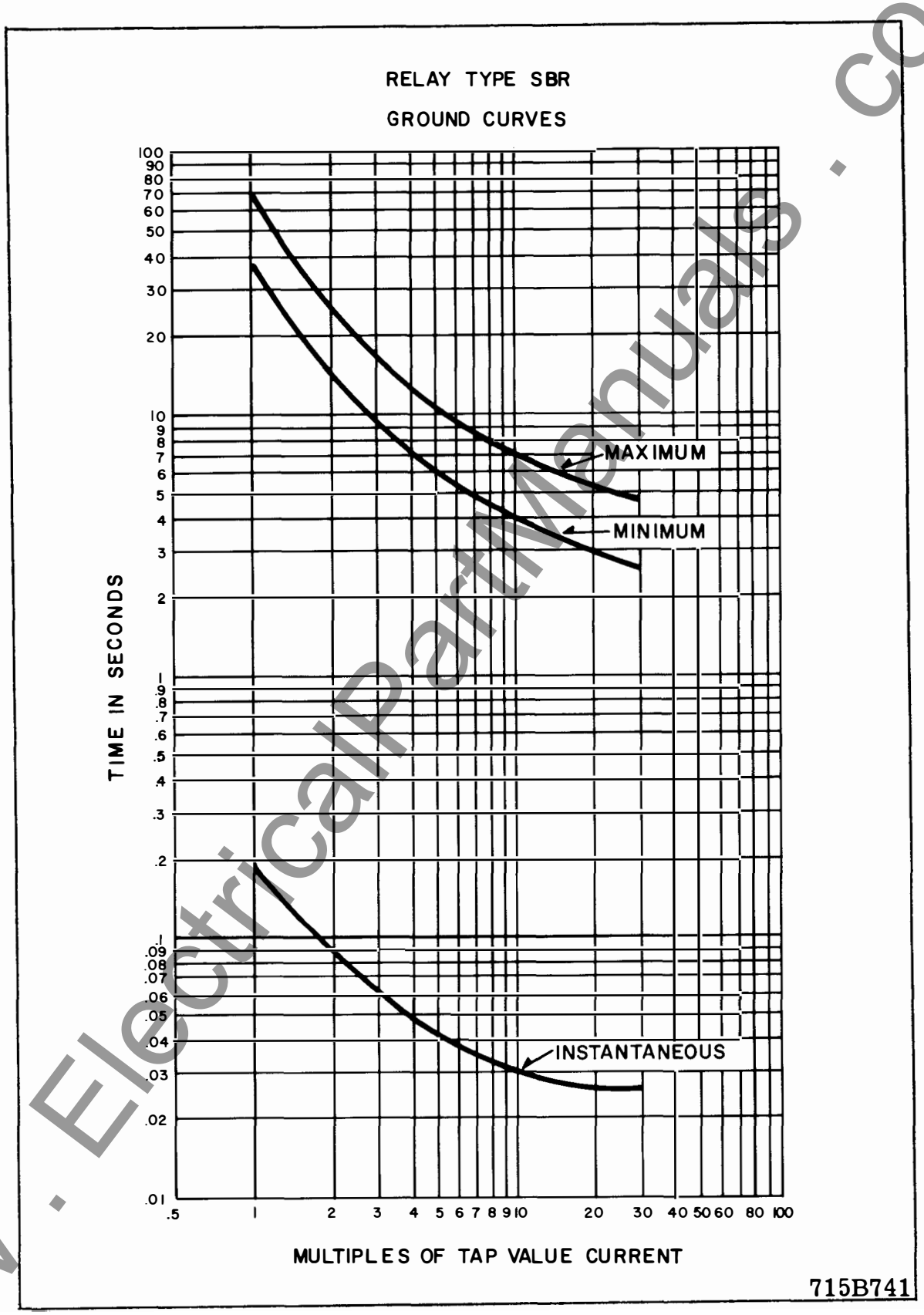
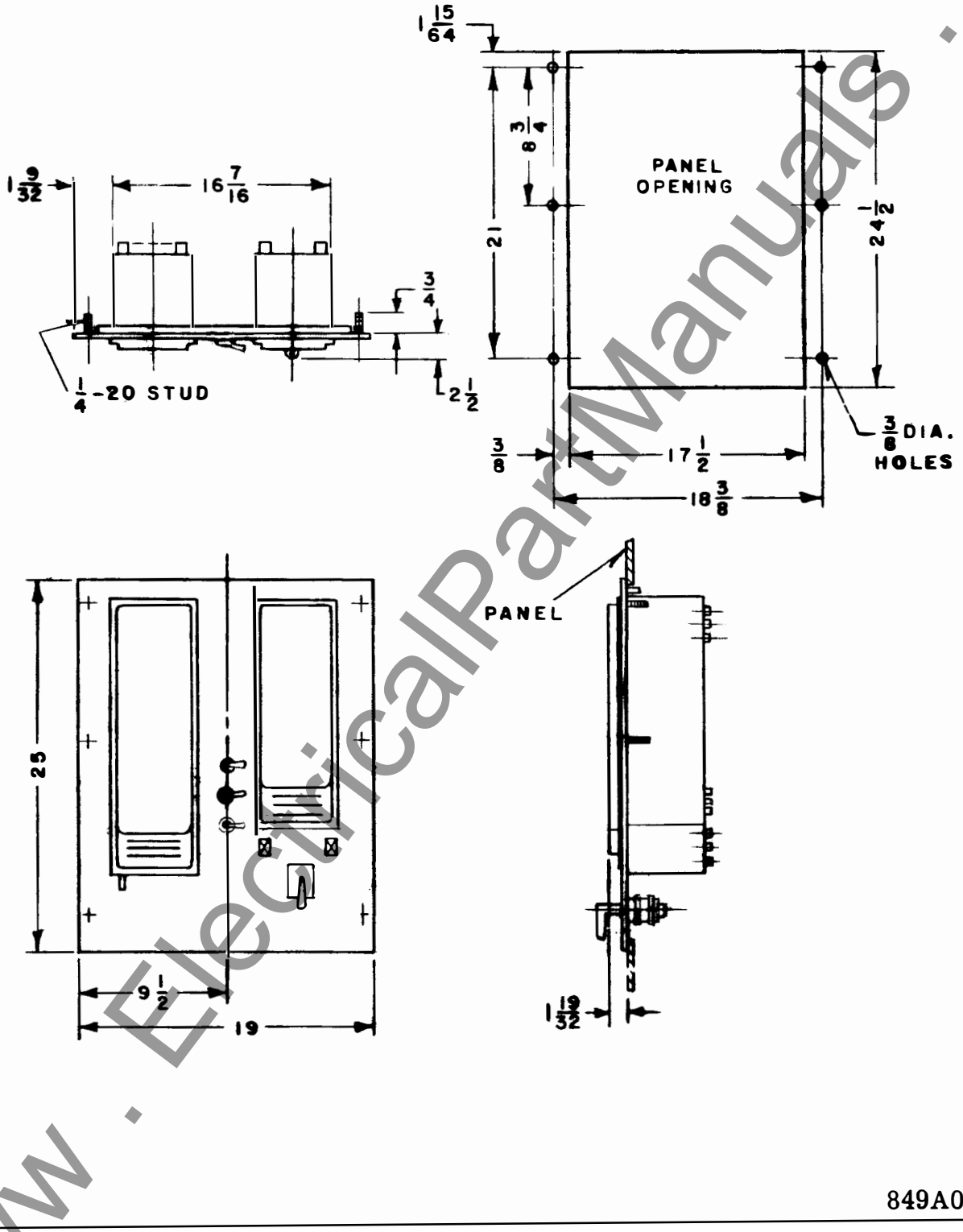


Fig. 14. Time Curves for Ground Instantaneous and Time Delay.



** Fig. 15. Outline and Drilling for SBR Panel.*

* ELECTRICAL PARTS LIST – SBR-1

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
	RESISTORS	
R1	27,500 3 W 1%	763A126H60
R2	560 ½W 5%	184A763H21
R3	680 ½W 5%	184A763H23
R4	30.100 ½W 1%	862A377H47
R5	4,700 ½W 5%	184A763H43
R6	2,000 ½W 1%	862A376H30
R7	33,200 ½W 1%	862A377H51
R8	2,490 ½W 1%	862A376H39
R9	49,900 ½W 1%	862A377H68
R10	10,000 ½W 1%	862A377H01
R11	7,500 3 W 5%	184A636H01
R12	560 ½W 5%	184A763H21
R13	680 ½W 5%	184A763H23
R14	27,000 ½W 5%	184A763H61
R15	6,800 ½W 5%	184A763H47
R16	10,000 ½W 5%	184A763H51
R17	6,800 ½W 5%	184A763H47
R18	10,000 ½W 5%	184A763H51
R19	27,000 ½W 5%	184A763H61
R20	560 ½W 5%	184A763H21
R21	680 ½W 5%	184A763H23
R22	7,000 3 W 5%	184A636H01
R23	30,100 ½W 1%	862A377H47
R24	10,000 3 W 1%	763A126H20
R25	4,700 ½W 5%	184A763H43
R26	7,000 3 W 5%	184A636H01
R27	680 ½W 5%	184A763H23
R28	560 ½W 5%	184A763H21
R29	715,000 ½W 1%	862A378H83
R30	47,000 ½W 5%	184A763H67
R32	68,100 ½W 1%	862A377H81
R33	47,500 ½W 1%	862A377H66
R34	100,000 ½W 5%	184A763H75
R35	10,000 ½W 5%	184A763H51
R36	100,000 ½W 5%	184A763H75
R37	100 1 W 5%	187A643H03
R39	180 ½W 5%	184A763H09
R40	1,500 ½W 5%	184A763H31
R41	332,000 ½W 1%	862A378H51
R42	47,500 ½W 1%	862A377H66
R43	100,000 ½W 5%	184A763H75
R44	10,000 ½W 5%	184A763H51
R45	100,000 ½W 5%	184A763H75
R46	100 1 W 5%	187A643H03
R48	180 ½W 5%	184A763H09
R49	1,500 ½W 5%	184A763H31
R50	47,000 ½W 5%	184A763H67
R52	1,120 – 48 V.D.C.	1955252
	4,750 – 125 V.D.C.	1955274
R53	200	1202586
R54	475 – 48 V.D.C.	1955289
	2,000 – 125 V.D.C.	1267296
R55	68,000 ½W 5%	184A763H71
R56	27,000 ½W 5%	184A763H61

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
	RESISTORS (Continued)	
R57	110,000 ½W 1%	862A378H05
R58	56,200 ½W 1%	862A377H73
R59	274,000 ½W 1%	862A378H43
R60	845,000 ½W 1%	862A378H90
R61	24,900 ½W 1%	862A377H39
R62	3.32K ½W 1%	862A376H51
R63	82,500 ½W 1%	862A377H89
R64	11,000 ½W 1%	862A377H05
R65	100,000 ½W 1%	862A378H01
R66	100,000 ½W 1%	862A378H01
R67	332,000 ½W 1%	862A378H51
R68	619,000 ½W 1%	862A378H77
R69	20,000 ½W 1%	862A377H30
R70	12,100 ½W 1%	862A377H09
R71	110,000 ½W 1%	862A378H05
R72	90,900 ½W 1%	862A377H93
R73	324,000 ½W 1%	862A378H50
R74	619,000 ½W 1%	862A378H77
R75	10,000 ½W 5%	184A763H51
R76	470 ½W 5%	184A763H19
R77	10,000 ½W 5%	184A763H51
R78	470 ½W 5%	184A763H19
R79	10,000 ½W 5%	184A763H51
R80	470 ½W 5%	184A763H19
R81	470 ½W 5%	184A763H19
R82	10,000 ½W 5%	184A763H51
R83	221,000 ½W 1%	862A378H34
R84	1,000,000 ½W 1%	862A379H01
R85	3,090,000 ½W 1%	862A379H48
R86	768,000 ½W 1%	862A378H86
R87	470 ½W 5%	184A763H19
R88	10,000 ½W 5%	184A763H51
R89	2,200 ½W 5%	184A763H35
R90	470 ½W 5%	184A763H19
R91	470 ½W 5%	184A763H19
R92	470 ½W 5%	184A763H19
R93	10,000 ½W 5%	184A763H51
R94	10,000 ½W 5%	184A763H51
R95	10,000 ½W 5%	184A763H51
R96	2,200 ½W 5%	184A763H51
R97	10,000 ½W 5%	184A763H51
R98	10,000 ½W 5%	184A763H51
R99	243,000 ½W 1%	862A378H38
R100	243,000 ½W 1%	862A378H38
	POTENTIOMETERS	
RH-1	25,000 ohms	185A067H03
RH-2	1,500,000 ohms	185A086H14
RH-3	10,000 ohms	185A067H02
RH-4	10,000 ohms	185A067H02
RH-5	10,000 ohms	185A067H02
RH-6	200,000 ohms	185A086H27
RH-7	100,000 ohms	629A430H04
RH-8	100,000 ohms	629A430H04

* ELECTRICAL PARTS LIST – SBR-1 (Continued)

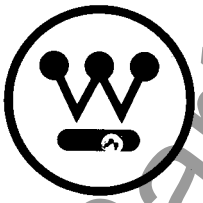
CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
CAPACITORS		
C1	47 MFD. 10% 35V.	187A508H12
C2	47 MFD. 5% 50V.	862A177H06
C3	68 MFD. 5% 60V.	862A177H03
C5	1 MFD. 10% 330V.	1876999
C6	1 MFD 10% 330V.	1876999
C7	6.8 MFD. 20% 35V.	184A661H10
C8	47 MFD. 20% 35V.	184A661H03
C9	47 MFD. 20% 35V.	184A661H03
C10	6.8 MFD. 20% 35V.	184A661H10
C11	1 MFD. 10% 330V.	1876999
C12	47 MFD. 10% 35V.	187A508H12
C13	150 MFD. 5% 30V.	862A177H05
C14	150 MFD. 5% 30V.	862A177H05
C15	150 MFD. 5% 30V.	862A177H05
C16	1.5 MFD. 5% 20V.	184A661H22
C17	6.8 MFD. 5% 35V.	184A661H21
C18	.47 MFD. 5% 35V.	837A241H21
C19	2 MFD. 10% 100V.	764A278H13
C20	6.8 MFD. 5% 35V.	184A661H21
C21	1.5 MFD. 5% 20V.	184A661H22
C22	.47 MFD. 5% 35V.	837A241H21
C23	6.8 MFD. 5% 35V.	184A661H21
C24	2 MFD. 10% 200V.	764A278H13
C25	1 MFD. 10% 300V.	1876999
C26	2.2 MFD. 5% 35V.	837A241H16
C27	68 MFD. 5% 60V.	862A177H03
C28	2.8 MFD. 5% 35V.	837A241H16
TRANSISTORS		
Q1 to Q6	2N3417	848A851H02
Q7	2N4249	849A441H03
Q8 to Q11	2N3417	848A851H02
Q12	2N2647	629A435H01
Q13 to Q17	2N3417	848A851H02
Q18	2N2647	629A435H01
Q19	2N4249	849A441H03
SCR'S		
SCR-1	K1149-13	184A640H13
SCR-2	K1149-14	184A640H14
SCR-3	K1149-14	184A640H14
SCR-4	K1149-13	184A640H13
SCR-5	K1149-13	184A640H13
SCR-6	2N1850	184A614H05
SCR-7	K1149-13	184A640H13
SCR-8	2N1850	184A614H05
ZENER DIODES		
Z1	1N748A	186A797H13
Z2	1N748A	186A797H13
Z3	1N957B	186A797H06
Z4	1N957B	186A797H06
Z5	1N957B	186A797H06
Z6	1N705	837A693H06
Z7	1N748A	186A797H13
Z8	1N748A	186A797H13
Z9	1N705	837A693H06
Z10	1N705	186A797H13
Z11	1N748A	186A797H13
Z13	1N753A	186A797H03

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
ZENER DIODES (Continued)		
Z14	1N3051	187A936H01
Z15	1N705	837A693H06
Z16	HW22B	185A212H16
Z19	1N2988B	762A631H15
Z20	1N960B	186A797H10
Z21	1N960B	186A797H10
Z22	1N960B	186A797H10
Z23	IN960B	186A797H10
Z24	HW22B	185A212H16
DIODES		
D1 to D12	1N5053	188A342H12
D13 to D28	1N4822	188A342H11
D29 to D32	1N5053	188A342H12
D34 to D38	1N4816	188A342H10
D40	1N4816	188A342H10
D41	1N4816	188A342H10
D42 to D45	TI-55	183A790H09
D46	1N4816	188A342H10
D47 to D49	TI-55	183A790H09
D50	1N4816	188A342H10
D51	TI-55	183A790H09
D52	TI-55	183A790H09
D53	1N4816	188A342H10
THERMISTORS		
TH-1	1D203	185A211H02
TH-3	1D203	185A211H02
TH-4	1D203	185A211H02
TH-5	1D203	185A211H02
TH-6	RL23S1	185A211H01
TH-7	RS23S1	185A211H01
TH-8	55TM1	187A375H03
TH-9	RL23S1	185A211H01
VARISTORS		
V1	68D5010	183A640H03
V2	68D5010	183A640H03
SENSISTORS		
S1	1.2K 10%	187A685H03
S2	1.2K 10%	187A685H03
TRANSFORMERS		
T1	Phase	408C374G06
T2	Phase	408C374G06
T3	Phase	408C374G07
T4	Phase Inst.	408C374G05
T5	Phase Inst.	408C374G02
T6	Phase Inst.	408C374G08
T7	Ground Inst.	408C374G02
T8	Ground	408C374G03
T9	UTC-H62	629A372H02
T10	UTC-H62	629A372H02
T11	Reactor	691B678G01
MISCELLANEOUS		
I1	Ground Indicator	183A825G05
I2	Phase Indicator	183A825G05

* ELECTRICAL PARTS LIST – SBR-2

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RESISTORS		
R1	82,000 ½W 5%	184A763H73
R2	220,000 ½W 5%	184A763H83
R3	118,000 ½W 1%	837A131H05
R4	174,000 ½W 1%	837A131H04
R5	232,000 ½W 1%	837A131H07
R6	453,000 ½W 1%	836A503H87
R7	665,000 ½W 1%	837A131H06
R8	2,700 ½W 5%	184A763H37
R9	2,200 ½W 5%	184A763H35
R10	200 ½W 5%	184A763H11
R11	649,000 ½W 1%	837A131H01
R12	442,000 ½W 1%	837A131H03
R13	221,000 ½W 1%	836A503H80
R14	28,700 ½W 1%	837A131H02
R15	2,670 ½W 1%	836A503H36
R16	12,000 ½W 5%	184A763H53
R17	220,000 ½W 5%	184A763H83
R19	2,700 ½W 5%	184A763H37
R20	2,200 ½W 5%	184A763H35
R21	200 ½W 5%	184A763H11
R22	5,000 125 V.D.C. 5%	1205214
R22	1,400 48 V.D.C. 5%	1267292
R23	2,500 125 V.D.C. 5%	1267299
R23	560 48 V.D.C. 5%	1267282
R24	6,800 125 V.D.C.	187A643H47
R24	1,000 48 V.D.C.	187A643H27
POTENTIOMETERS		
RH-1	250 ohms	762A790H04
CAPACITORS		
C1	100MFD. 6V 5%	184A661H06
C2	100MFD. 6V 5%	184A661H06
C3	To be determined in test.	
C4	.25MFD. 200 V.D.C. 10%	187A624H02
C5	.25MFD. 200 V.D.C. 10%	187A624H02
C6	10MFD. 150 V.D.C. 20%	27D5476H09
C7	.05MFD. 200 V.D.C.	187A624H05
C8	150MFD. 6 V.D.C. 5%	184A661H08
C9	To be determined in test.	
C10	100MFD. 6 V 5%	184A661H06
C11	33MFD. 20 V 20%	184A661H11
C12	1MFD. 200 V.D.C. 20%	187A177H06
C13	1MFD. 200 V.D.C. 20%	187A177H06

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
TRANSISTORS		
T1	2N3417	848A851H02
T2	2N3417	848A851H02
T3	2N3417	848A851H02
T4	2N3417	848A851H02
T5	2N3417	848A851H02
T6	2N3417	848A851H02
ZENER DIODES		
Z1 to Z6	1N748A	186A797H13
Z7 to Z10	1R200 (1N3051)	629A369H01
THERMISTOR		
TH-1	2D504	185A211H07
CONTROLLED RECTIFIERS		
SCR-1	K1149-13	189A640H13
SCR-2	125 V – K1149-13	189A640H13
SCR-2	250 V – K1149-12	184A640H12
SCR'S		
D3	1N4822	188A342H11
D4	1N4822	188A342H11
D5	T1-55	183A790H09
D6	1N4822	188A342H11
D7	1N4822	188A342H11
D8	1N4822	188A342H11
D9	T1-55	183A790H09
MISCELLANEOUS		
SS	Stepping Switch 125 V.D.C.	411C693G01
SS	Stepping Switch 48 V.D.C.	411C693G02
AR	Alarm Relay 125 V.D.C.	541D514H06
AR	Alarm Relay 48 V.D.C.	541D514H08
CR	Close Relay 125 V.D.C.	541D514H05
CR	Close Relay 48 V.D.C.	541D514H07
I1	Lockout Indicator – 52410-993	183A825G05



WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.