INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CVE AND CVE-1 SYNCHRO-VERIFIER RELAYS (WITH BUFFERED CUE CONTACTS)

CAUTION:

Before putting the Synchro-Verifier into service, remove all blocking inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

This instruction leaflet applies to the following types of relays:

CVE Synchro-Verifier Relay
CVE-1 Synchro-Verifier Relay with line and bus voltage sensing relays

The synchro-verifier is used to verify the condition of synchronism existing between two system voltages. The contacts will close when these voltages are within set limits.

The synchro-verifier is not an automatic synchronizer and should not be used as such. Automatic Synchronizers are available which permit closing ahead of synchronism at an angle of phase-advance proportional to the beat frequencies and determined by the speed of operation of the circuit breaker so that tht two systems are connected right on synchronism.

A common application of the synchro-verifier is in conjunction with automatic reclosing equipment or loop systems fed by generating stations at two or more points. When a line section trips out, the synchro-verifier is used at one terminal to check synchronism after the remote terminal is reclosed. If the two systems are in synchronism, the synchro-verifier permits the automatic reclosing equipment to reclose the breaker.

Some provision, such as a reclosing relay, must be used to control closing through the CVE(-1) contacts to avoid the possibility of pumping when closing into a fault.

CONSTRUCTION AND OPERATION

The type CVE relay consists of an operating element and a restraining element mounted on a common disc. The principal parts of the relay and their location are shown in Figs. 1, 3 and 4.

The CVE-1 Relay, Fig. 2, consists of two telephone type a-c voltage sensing relays in addition to the

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

components of the CVE relay. The principal parts of the relay are connected as per Fig. 5.

OPERATING ELEMENT

The operating unit consists of an "E" type laminated electromagnet with two coils on the center leg and a lag coil on the left leg. A resistor is connected across the shading coil.

When the relay is energized with two voltages, a flux is produced that is proportional to the sum of the applied voltages. This flux divides and returns through the outer legs of the electromagnet. The lag coil on the left leg causes the flux in that leg to lag the main pole flux. The out-of-phase fluxes thus produced in the disc gap causes a contact closing torque. The resistor connected across the lag coil of the electromagnet provides adjustment for different operating circles of the relay. Increasing or decreasing the amount of resistance effectively decreases or increases the contact closing torque of the relay.

RESTRAINING ELEMENT

The restraining element consists of an "E" type laminated electromagnet with two main coils on its center leg and a lag coil on its left leg. A flux is produced that is proportional to the difference in the applied voltages to the relay. This flux divides and returns through the outer legs of the electromagnet. The lag coil causes the flux through the leg to lag the main pole flux. The out-of-phase fluxes thus produced in the disc gap causes a contact opening torque.

TELEPHONE RELAY CVE CONTACT BUFFER

These CVE and CVE-1 relays have the CVE unit instrument contacts buffered by means of a telephone relay which receives its energy from 125 VDC through the CVE contacts. As the CVE contacts open or close, as a result of the CVE unit action the buffer relay will operate in a snap action fashion. The buffered contacts are capable of making 30 amps and carrying it for the duty cycle outlined in IEC255-0-20. Two contacts are used in series for interrupting capability. The inductive interrupting capabilities per ANSI C37.90 is 1 Amp at 125 VDC. The single contact inductive interrupting capability is .250 Amps.

TELEPHONE RELAY - CVE-1 ONLY

The telephone relay units are fast operating types energized by the application of an a-c voltage. In these relays, an electromagnet energized by a-c voltage, attracts a right angle armature which operates a set of contacts.

OPERATION WITH EXTERNAL VOLTAGE RELAYS

The connections shown in Fig. 8 using external type SG voltage relays will provide the following operation:

1. Close the breaker when the bus is live and the line is dead, through the 59B make contact and 27L break contact.

2. Close the breaker when the line is live and the bus is dead, through the 59L make contact and 27B break contact.

3. Close the breaker when the line and bus are both live and when their respective voltage are approximately normal, equal, in phase, and of the same frequency, through the CVE buffered contact.

It is recommended that the number of reclosures be limited by using either a single-or a multi-shot reclosing relay in conjunction with the CVE and SG relays.

CVE-1 OPERATION

In the CVE-1, the internal V_1 and V_2 perform the functions of external 59B and 27L relays respectively.

The connections shown in Fig. 9 using the type CVE-1 relay will provide the following operation:

1. Close the breaker when the bus is live and the line is dead, through the V_1 make contact and V_2 break contact.

2. Close the breker when the line is alive and the bus is dead, through the V_2 make contact and V_1 break contact.

3. Close the breaker when the line and bus are both alive and when their respective voltage are approximately normal, equal, in phase, and of the same frequency through the CVE buffered contact.

It is recommended that the number of reclosures be limited by using either a single-or a multi-shot reclosing relay in conjunction with the CVE-1 Relay.

CHARACTERISTECS

The type CVE and CVE-1 relays can be adjusting for operating circles from 20 to 60 degrees as shown in Fig. 10. As shipped from the factory the relay is calibrated for the 20 degree circle.

These circles apply when one side has rated voltage. The relay operates if the other voltage falls within the appropriate circle.

The operating time of the relay is shown in Fig. 11. These time curves are obtained from the #11 time dial setting when the applied voltages are equal to rated voltage and of the same frequency. Shorter operating times can be obtained at different time dial settings as shown in Fig. 12.

Fig. 13 shows the maximum slip frequency for which operation of the CVE element can occur. The maximum slip frequency is a function of the circle and time dial settings. This characteristic is of interest in estimating the worst-case angular difference at the instant of breaker closure, for cases where the two systems are slipping slowly.

Fig. 19 shows typical CVE reset times for 20°, 40°, and 60° circle settings.

BURDEN

The burden imposed on each potential source by the CVE relay, with rated voltage applied to both circuits of the relay is as follows:

	60 Hertz	50 Hertz
Volt-Amperes..	15.4	23.3
Power Factor..	.422	.309
Watts.....	6.5	7.2

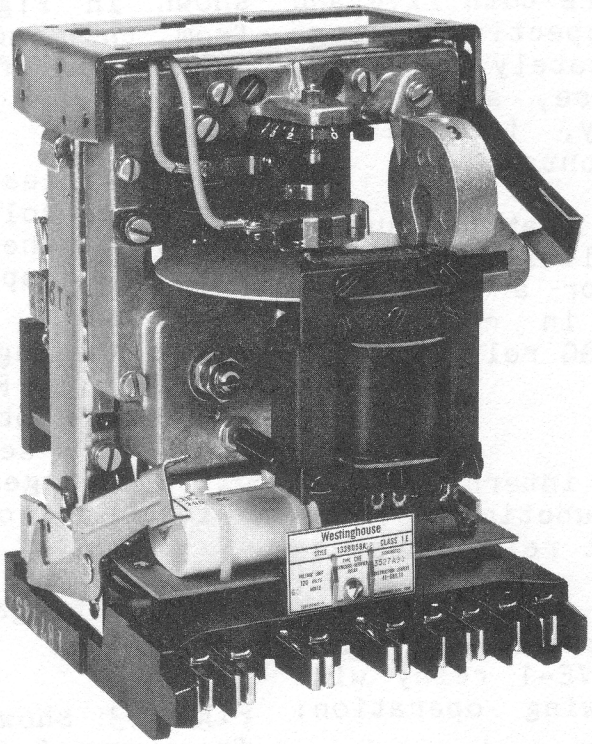


Fig. 1. CVE Relay, Without Case.

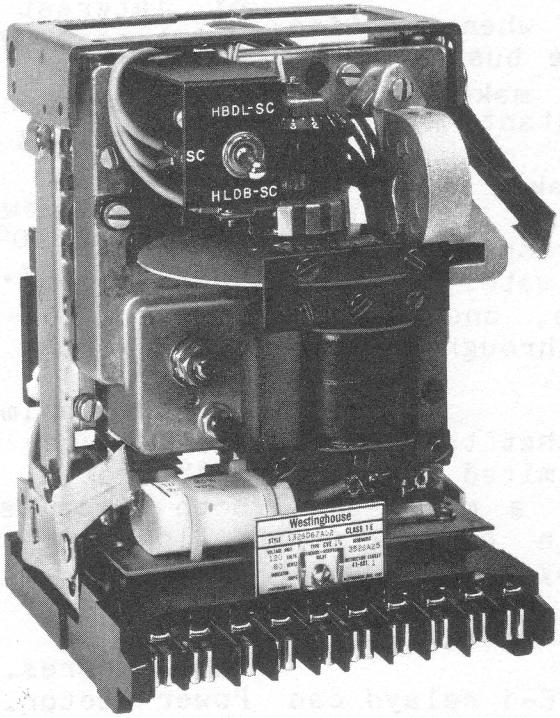


Fig. 2. CVE-1 Relay, Without Case.

The burden of the CVE relay with rated voltage applied to one circuit is as follows:

	60 Hertz	50 Hertz
Voltage-		
Amperes.....	10.8	13.8
Power Factor..	.422	.309
Watts.....	4.6	4.2

For the CVE-1 relay, additional burden of each telephone relay at 120 volts, 60 Hz, is as follows: 5.4 volt-amperes, Power Factor .14.

For 120 volts, 50 Hz, is as follows 6.2 volt-amperes Power Factor .29.

For the 125VDC telephone buffer relay the burden is 2.4 watts.

SETTINGS

DISC UNIT

As shipped from the factory the relays are calibrated for a 20 degree circle. Other operating circles from 20 to 60 degrees can be obtained by adjusting the left hand resistor (front view) in the relay. The procedure is described under Adjustments and Maintenance.

Set the time dial so that the relay will not operate when the systems are swinging too fast. The #11 time dial is recommended when the 60° circle setting is used. A setting of #4 time dial or higher recommended with the 40° circle. A setting as low as 1/2 time dial should be satisfactory with to 20° setting. If a longer delay is desired a higher time-dial setting may be used.

To evaluate the effect of time-dial and circle settings on the worst-case phase-angle difference between the two systems at the instant of breaker closure, refer to Fig. 11. For example, assume a 40° circle and #4 time-dial setting. Also assume that the systems are slipping at a frequency of 0.048 hertz which is the maximum slip for which the relay will operate. This means that the relay contacts close just as the one voltage vector moves out of the circle. This would mean that the system would be 40° out-of-phase at the instant that the breaker close circuit is energized. The phase angle at the instant of breaker closure is:

$$0 = 40^{\circ} + 0.048 \times 360TB = 40^{\circ} + 17.3TB$$

where TB = breaker closing time in seconds

Let TB = 0.5 seconds

Then $40^{\circ} + 17.3 \times 0.5 = 48.6^{\circ}$

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flanges for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts

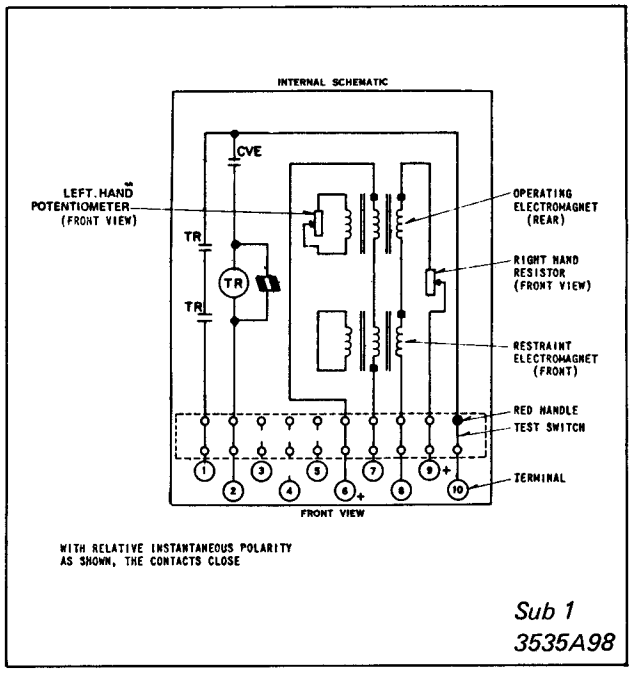


Fig. 3. Internal Schematic of CVE.

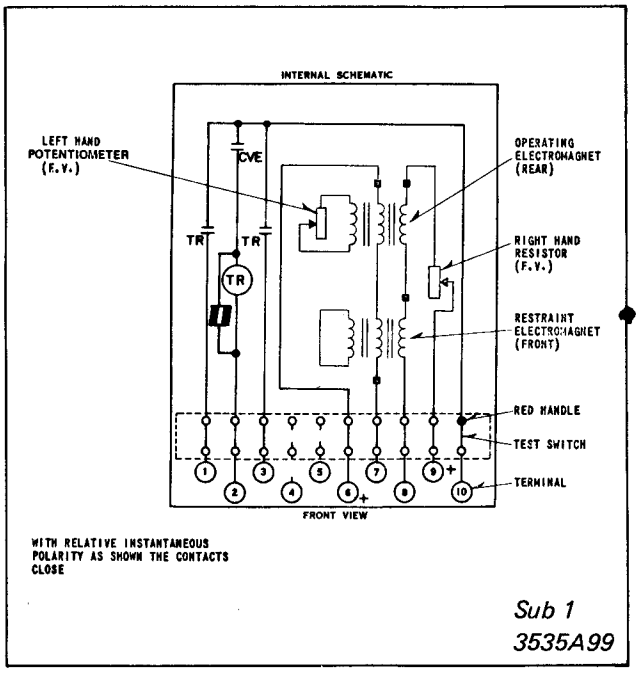


Fig. 4. Internal Schematic of CVE.

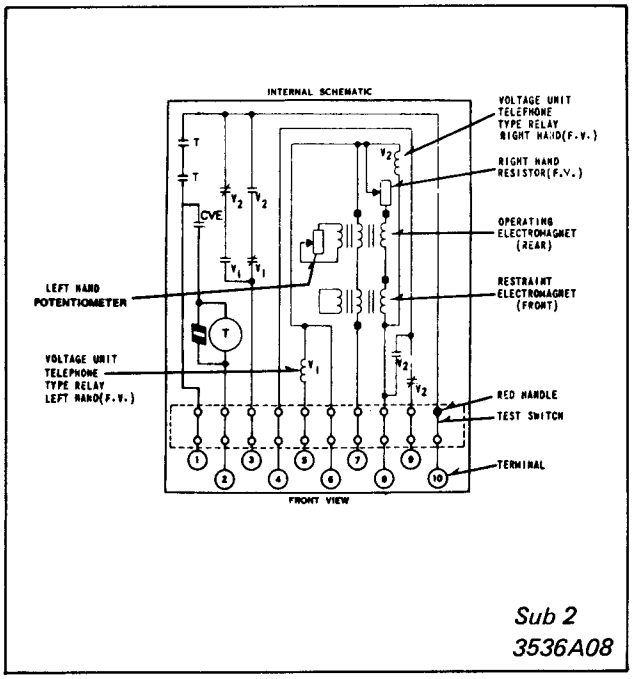


Fig. 5. Internal Schematic of CVE-1 for use with RC Reclosing Relay (See Fig. 21 for External Scheme). With commoned voltage coils, use with phase-to-phase connected vt's.

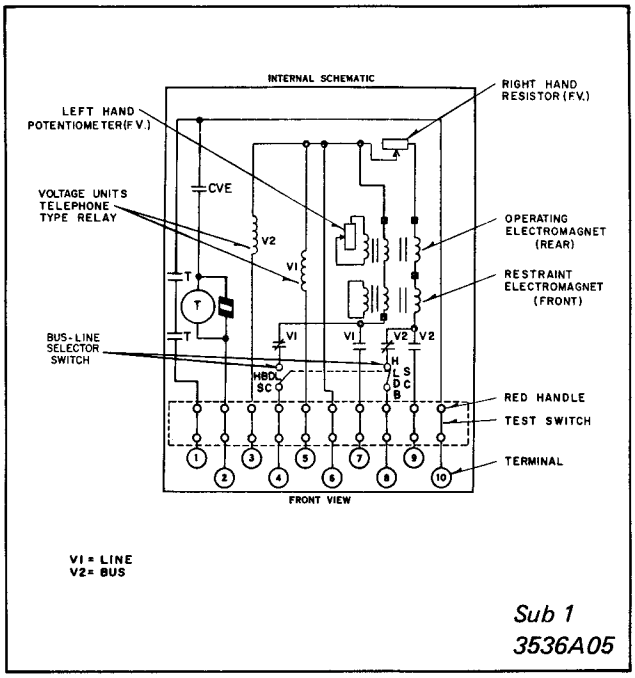


Fig. 6. Internal Schematic of CVE-1 with Internal Switch for HBDL or HLDB. (See Fig. 20 for External Scheme). With commoned voltage coils, use with phase-to-phase connected vt's.

on the stud and then turning the proper nut with a wrench. See Fig. 22 for Outline and Drilling Plan. For detailed FT Case information refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

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

DISC UNIT

1. Contacts

The index mark on the movement frame will coincide with the "0" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately 0.020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the time curve.

2. Operating Circle

Connect the CVE relay per the test diagram of Fig. 14. CVE-1 relays should be connected in a similar manner to correspond with the wiring of the particular style CVE-1 using Fig. 16. The contacts should just close under the following two conditions:

1) When $V_2 = V_1$ = rated voltage and their phase difference is between 18^o and 22^o (either leading or lagging).

*2) When V_1 = rated voltage and V_2 is increased from a low value to 94 $\pm$ 4V in phase with V_1.

3. Time Curve

With the time dial set at position 11, the contact should be close in 20 $\pm$ 1 seconds when V_1 and V_2, equal to rated voltage at zero phase angle, are applied.

TELEPHONE RELAYS (CVE-1 ONLY)

Apply a-c voltage to each telephone relay circuit. The telephone relay should pickup when 95 volts a-c is applied.

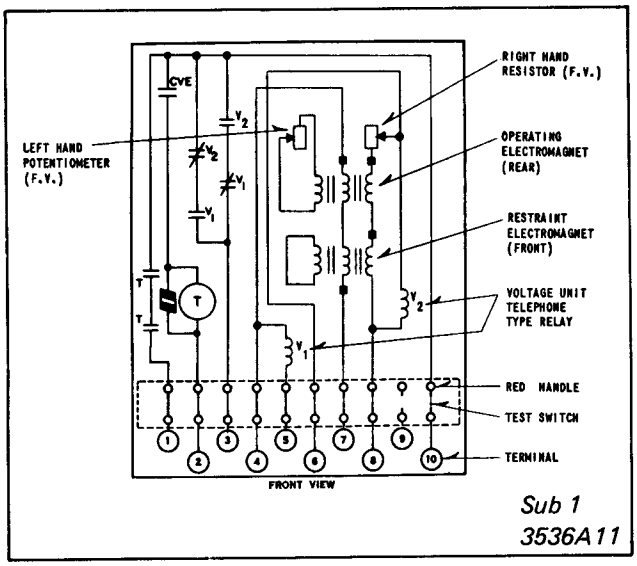


Fig. 7. Internal Schematic of CVE-1 without Commoned Potential Coils. (See Fig. 9 for External Scheme).

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

1. Contacts

The index mark on the movement frame coincides with the "0" mark on the time dial when the stationary contacts have moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately 0.020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time curves.

2. Preliminary Adjustments

Remove the permanent magnet from the relay and set the time dial on the number 11 position. Next unwind the spring for zero tension on the number 11 position. This can best be noticed by unwinding the spring until the contact will not move when the time dial is moved a small distance beyond the number 11 position.

The spring convolutions may touch during this operation and the outer convolutions may hit other surfaces of the relay. This interference should be disregarded because its effect on the final calibration will be negligible. The reason for unwinding the spring is that the amount of tension on the reset spring affects the diameter of the circle. Hence, the spring tension has to be removed initially so that only the left hand resistor will affect the operating circle.

3. Spurious Torque Adjustments

With the relay set as per the preliminary adjustments, open the lag coil circuit of the rear electromagnet. This can be done by opening the screw connection on the lag coil of the rear electromagnet or by inserting a piece of insulating material under the adjustable point of the left hand resistor (front view). Connect the relay to test circuit of Fig. 14 for CVE, or Fig. 16 for CVE-1, and apply rated voltage at zero phase angle on both circuits. With the right hand plug all the way in, adjust the left hand plug of the rear electromagnet such that the disc does not move from the number 11 time dial position. This can be determined by no movement of the disc when the time dial is moved beyond the number 11 position.

4. Centering Circle

Close the lag coil circuit of the rear electromagnet and set the left hand resistor at approximately one-third of its resistance. Adjust the phase shifter in the lagging direction until

the contacts just close the V_1 and V_2 equal to rated voltage. Note the angle at which the contacts just close. Then adjust the phase shifter in the leading direction until the contacts just close with V_1 and V_2 equal to rated voltage. If the latter angle is not within ± 1 degree of the former angle, adjust the right hand resistor (front view) until the two angles are within ± 1 degree of each other.

5. Spring Adjustment

Adjust the left resistor (front view) such that the moving contact just leaves and returns to the backstop of the time dial at the number 11 position between 40° and 41°, with rated voltage on both sides. Change the angle to 20 degrees and adjust the reset spring until the contacts just make. Rotate the phase shifter to move V_2 through zero phase angle to an angle where the contacts just make. The contacts should just close at an angle of 20 ± 2 degrees with V_1 and V_2 equal to rated voltage. With V_1 equal to rated voltage the contacts should just close when V_2 is increased to 94 ± 4V in phase with V_1. If necessary, readjust spring slightly to obtain this condition. The relay is now calibrated for a 20 degree circle.

6. Time Curve

Install the permanent magnet on the relay. Adjust the permanent magnet keeper until the operating time of the relay from the number 11 time dial position is 20 ± seconds with V_1 and V_2 equal to rated voltage at zero phase angle.

7. Circles Other Than 20 Degrees

This adjustment should not be done until the above adjustments for a 20 degree circle have been completed.

If another circle other than 20 degrees is desired, adjust the left hand resistor to obtain the desired circle. For example, if a 40 degree circle is desired, adjust the left hand resistor until the contacts just close with V_1 and V_2 equal to rated voltage at 40 degrees phase angle. It may be necessary to readjust the right-hand resistor to position the desired circle symmetrically about the zero degree line. See "Centering Circle" above for procedure. The time of operation will be as shown in the time curves of Fig. 11.

ELECTRICAL CHECKPOINTS

With V_1 in Fig. 14, 15 or 16 equal to rated voltage the following approximate voltages should be obtained across the coils of the 120 volt relay. Relay set for 20 degree circle.

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.

	60 Hz	50 Hz
Operating Electromagnet		
Upper terminals.....	59 volts	61 volts
Lower terminals.....	57 volts	59 volts
Lag coil circuit.....	22 volts	24 volts
Restraint Electromagnet		
Upper terminals.....	58 volts	61 volts
Lower terminals.....	54 volts	58 volts

With 120 volts applied to V_2 circuit only.

	60 Hz	50 Hz
Operating Electromagnet		
Upper terminals.....	57 volts	58.5 volts
Lower terminals.....	59 volts	61 volts
Lag coil circuit.....	22 volts	24 volts
Restraint Electromagnet		
Upper terminals.....	54 volts	57 volts
Lower terminals.....	58 volts	61 volts

Approximate d-c resistances of the coils are as follows:

Operating Electromagnet
  Upper terminals -- 59 ohms
  Lower terminals -- 80 ohms
  Lag coil -- open circuit -- 245 ohms
Restraint Electromagent
  Upper terminals 66 ohms
  Lower terminals 92 ohms

Approximate resistance values of left hand resistor for various operating circles. Resistance values can vary appreciably between relays.

20 degree circle -- 4800 ohms
40 degree circle -- 2250 ohms
60 degree circle -- 890 ohms

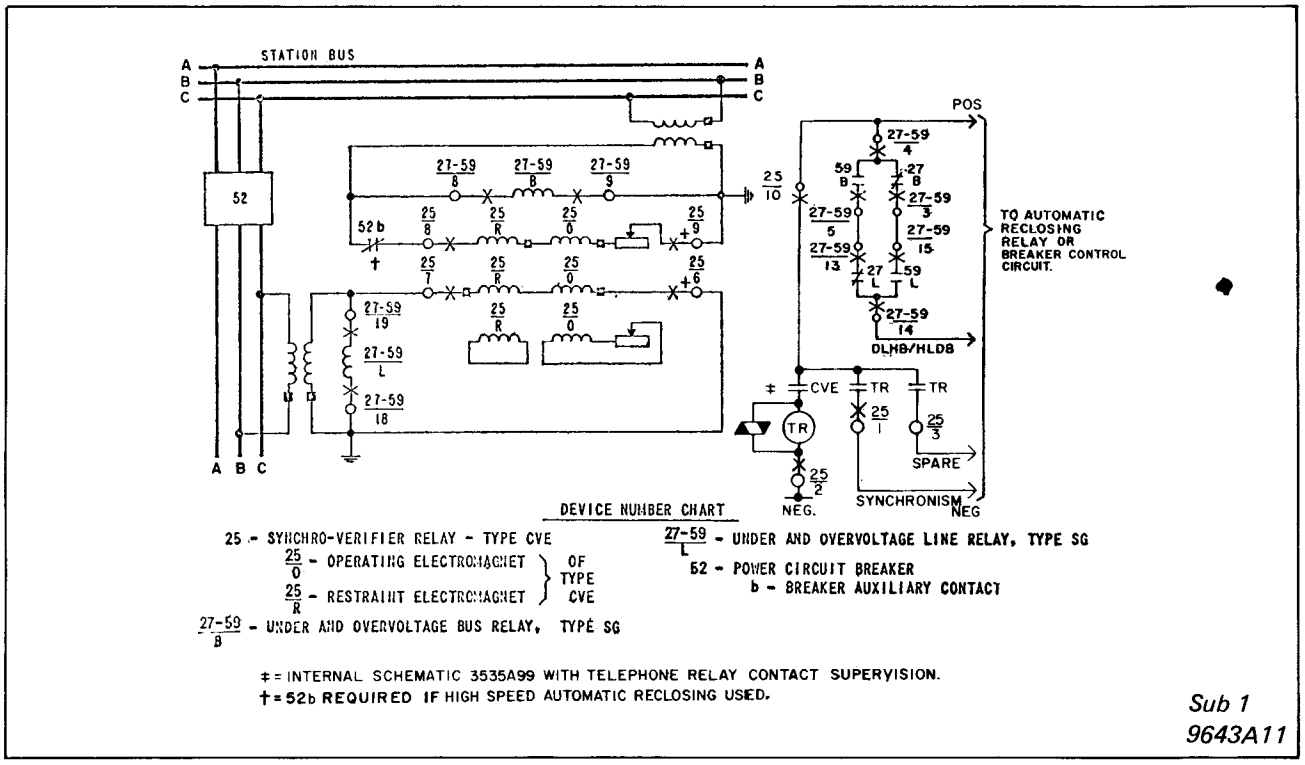


Fig. 8. External Schematic of the CVE with SG Relay for Dead-Line-Hot Bus and Hot Line-Dead Bus Reclosing.

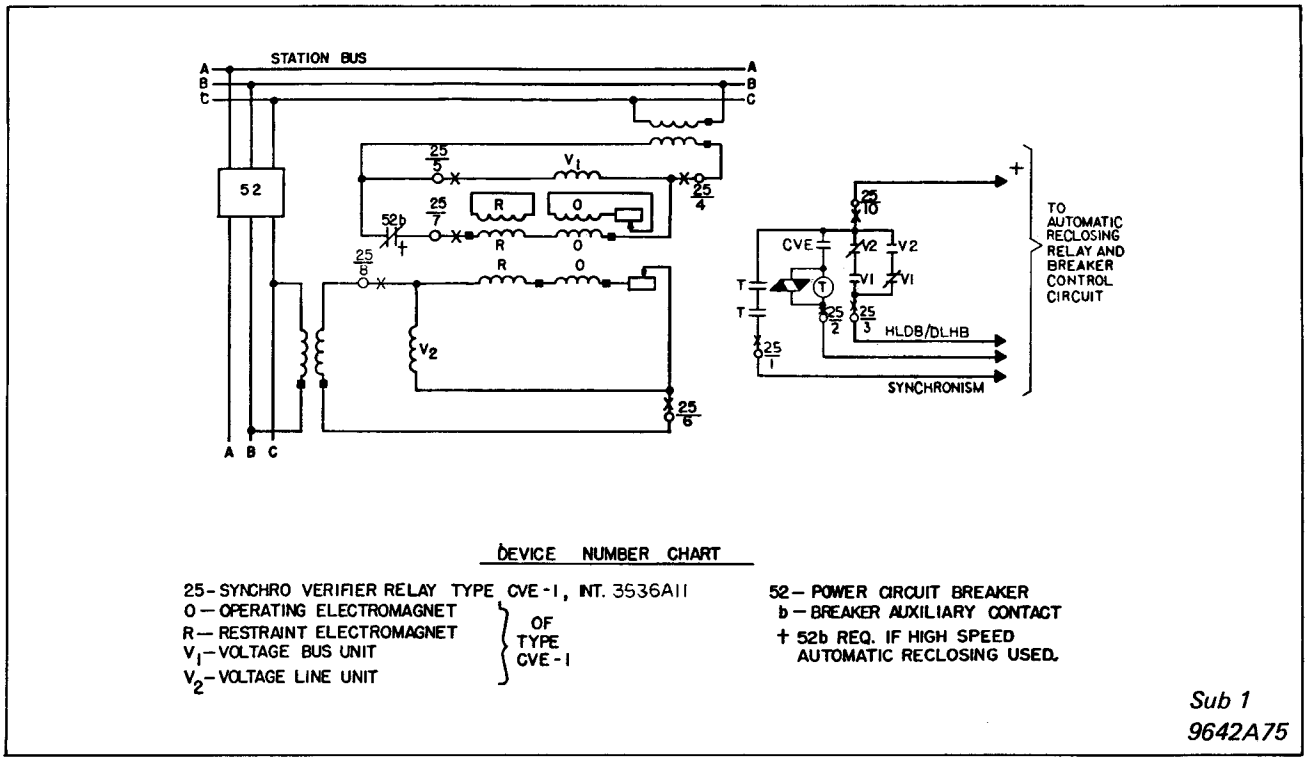


Fig. 9. External Schematic of CVE-1 for Dead-Line-Hot-Bus and Hot-Line-Dead-Bus Reclosing.

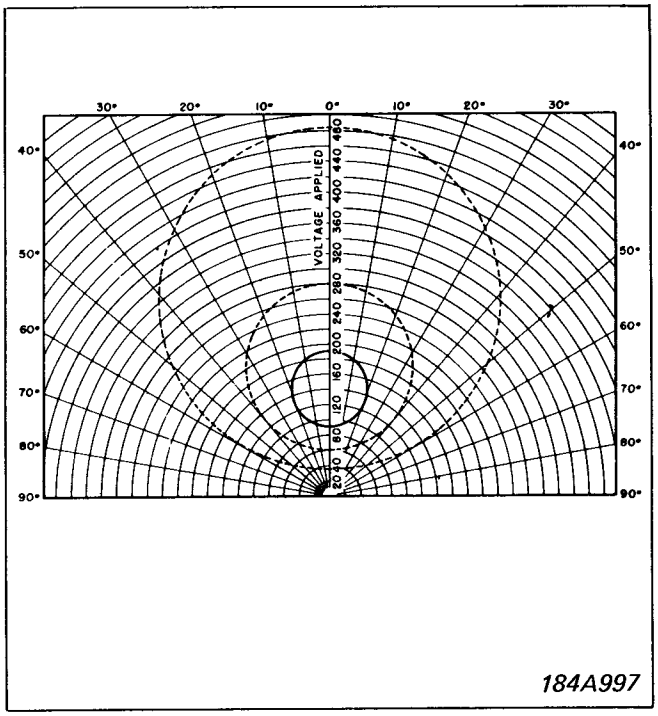


Fig. 10. Typical Voltage-Angle Characteristic of CVE for Various Closing Angle Settings. Rated Voltage on One Circuit.

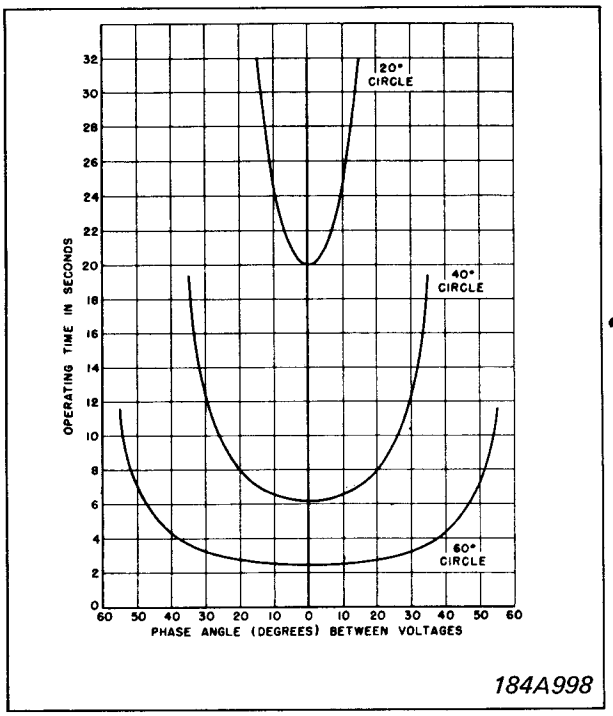


Fig. 11. Typical Time-Phase Angle Curves of CVE. Rated Voltage on Both Circuits No. 11 Dial Time Setting.

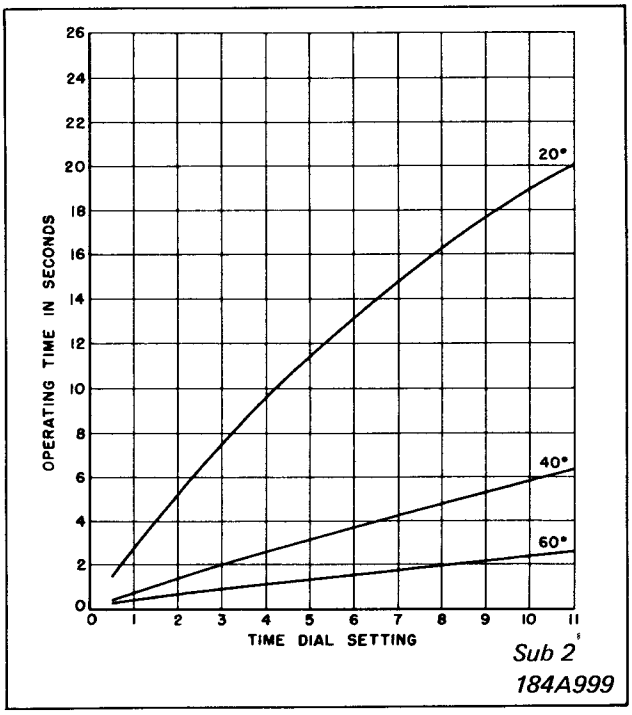


Fig. 12. Operating Time Variations with Changes in Time-Dial Settings. Rated In-Phase Voltage on Both Circuits, 20°, 40° and 60° Circle Setting.

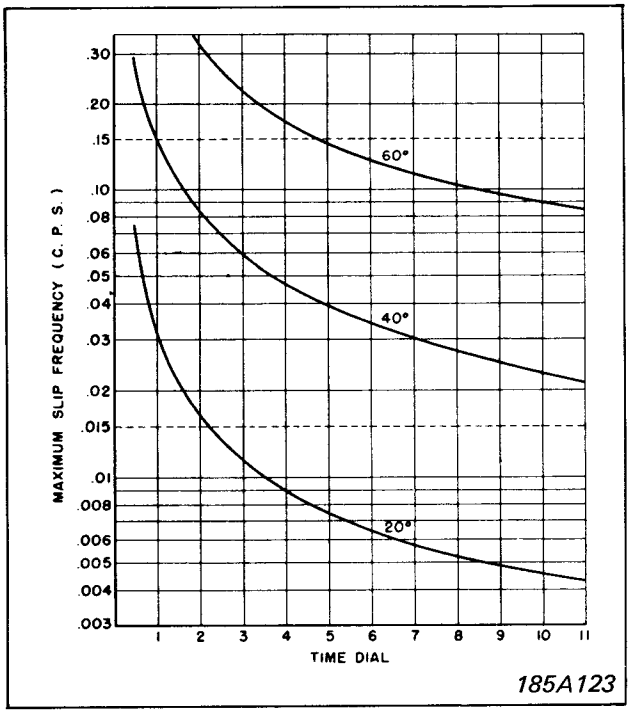


Fig. 13. Approximate Maximum Slip Frequency for which Operation Occurs – Rated Voltage on Both Sides.

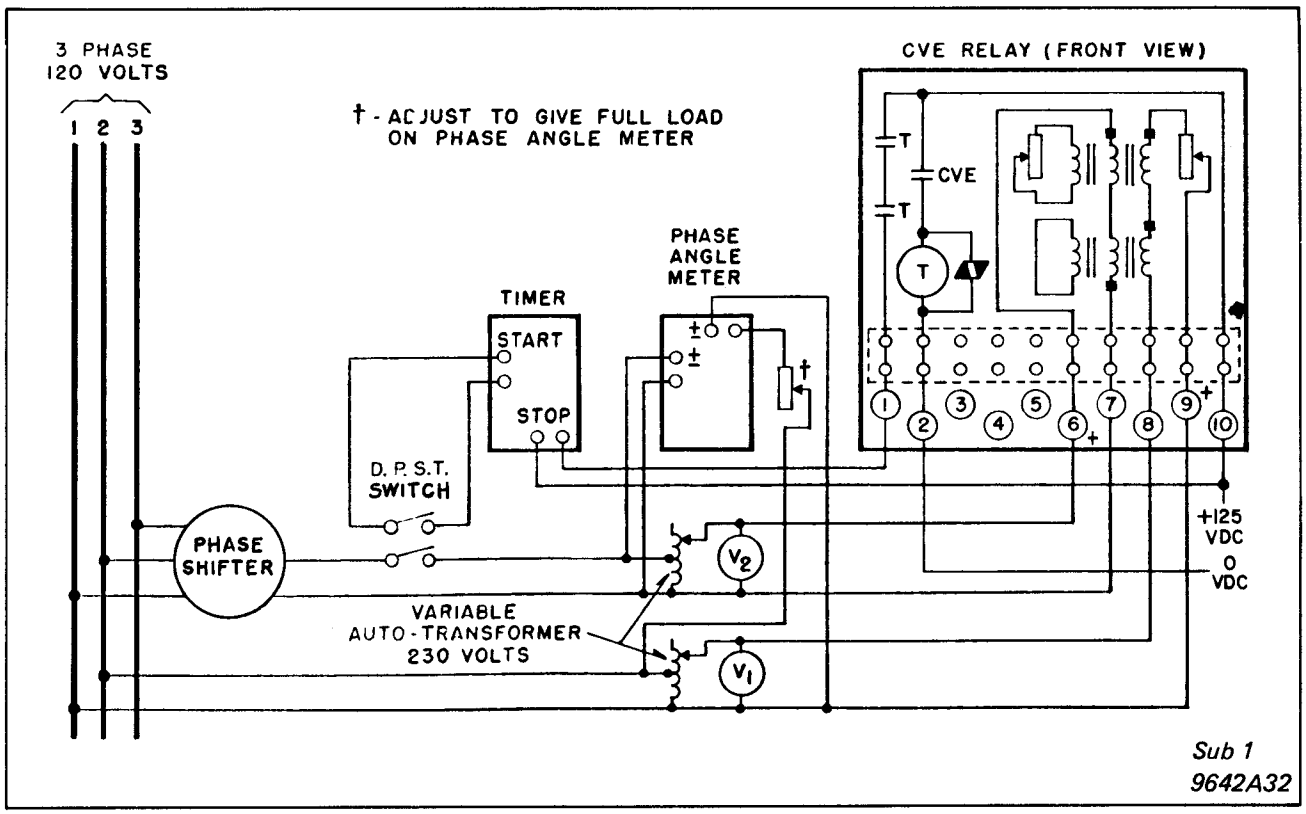


Fig. 14. Diagram of CVE Test Connections.

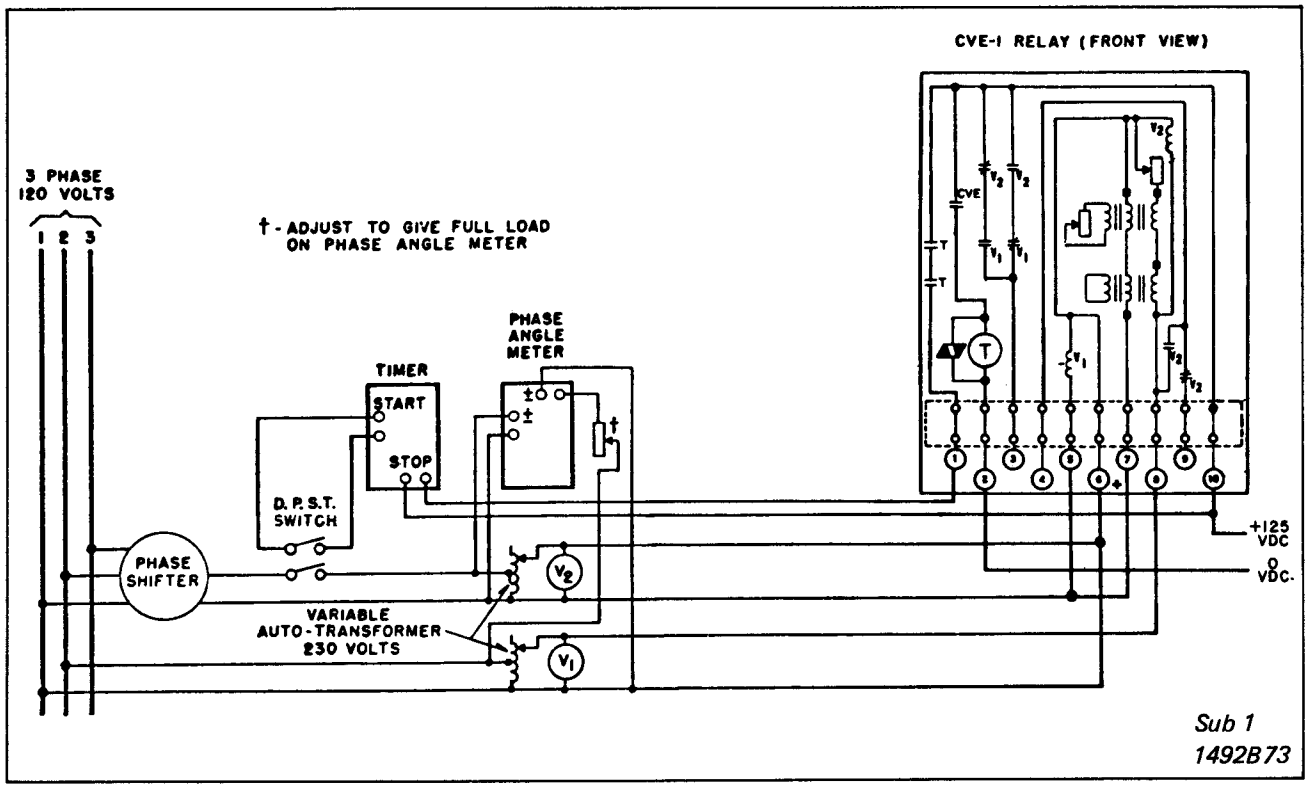


Fig. 15. Diagram of CVE-1 Test Connections with Commoned Potential Coils.

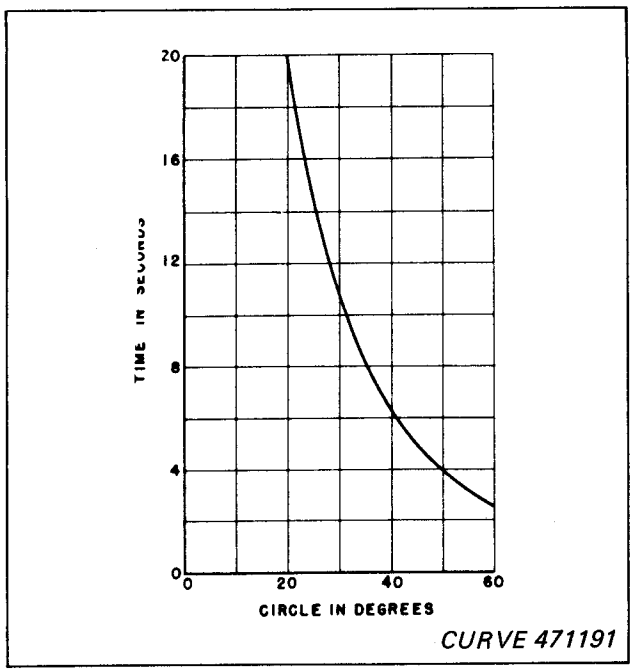


Fig. 16. V_1 Voltage for Different Operating Circle. V_2 Equal to Rated Voltage at Zero Phase Angle.

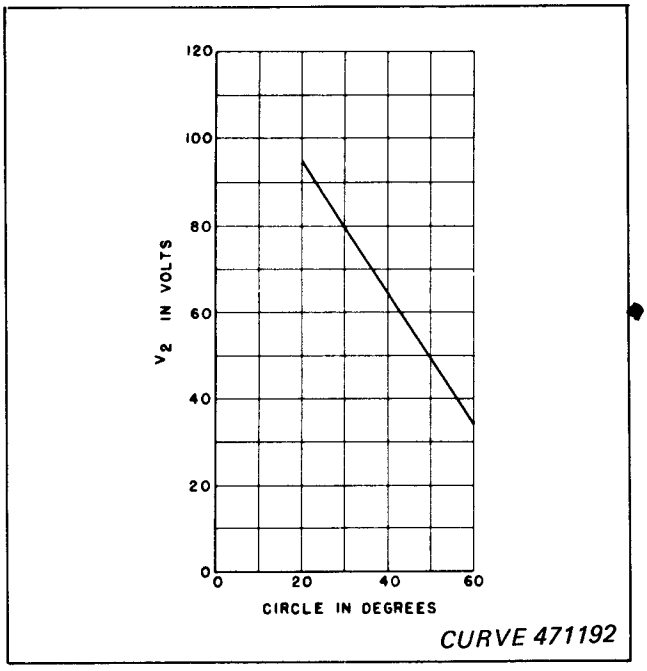


Fig. 17. Operating Times from the No. 11 Time Dial Position for the Type CVE Relay set for Different Operating Circles. V_1 and V_2 Equal to Rated Voltage at Zero Phase Angle.

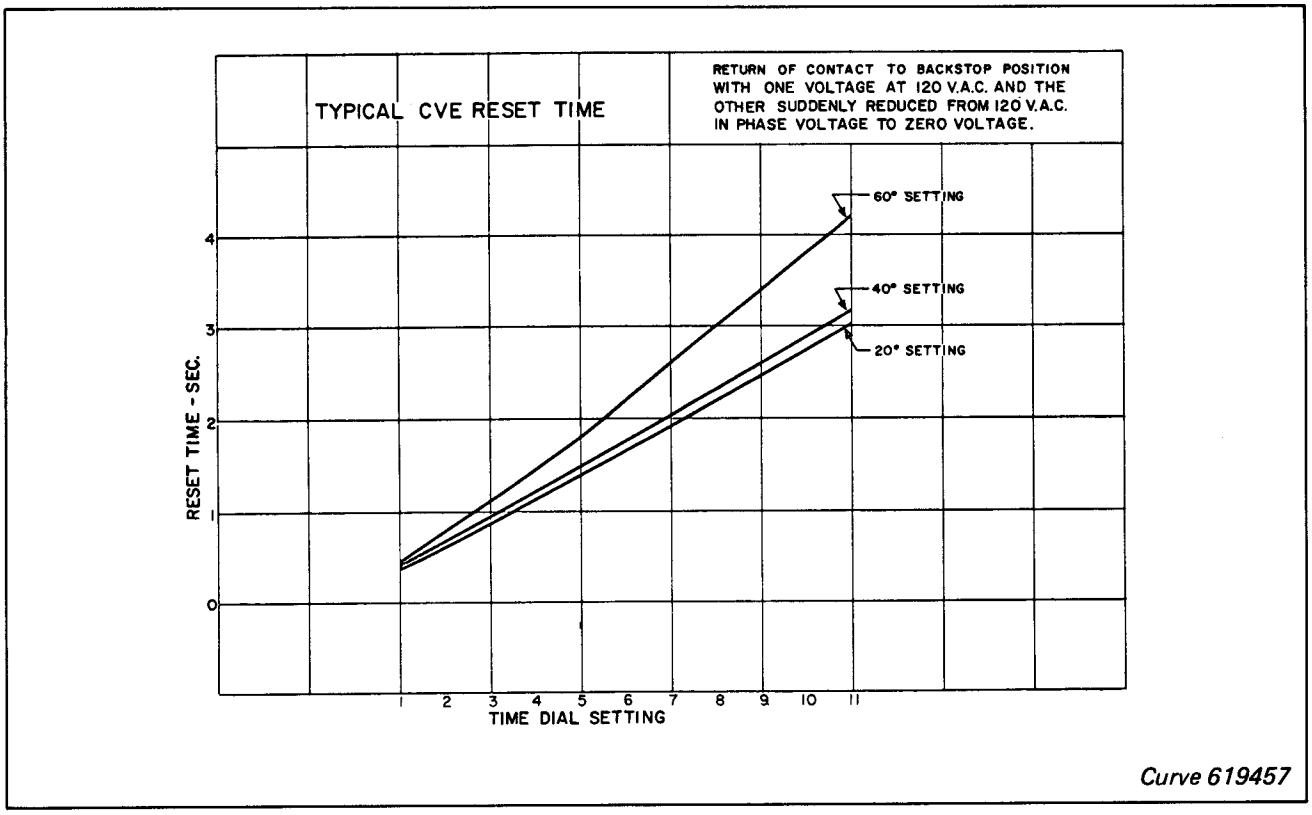


Fig. 18. Typical CVE Reset Times. Return of Contact to Backstop Position with One Voltage at Rated Voltage and the Other Suddenly Reduced from Rated in Phase Voltage to Zero Voltage.

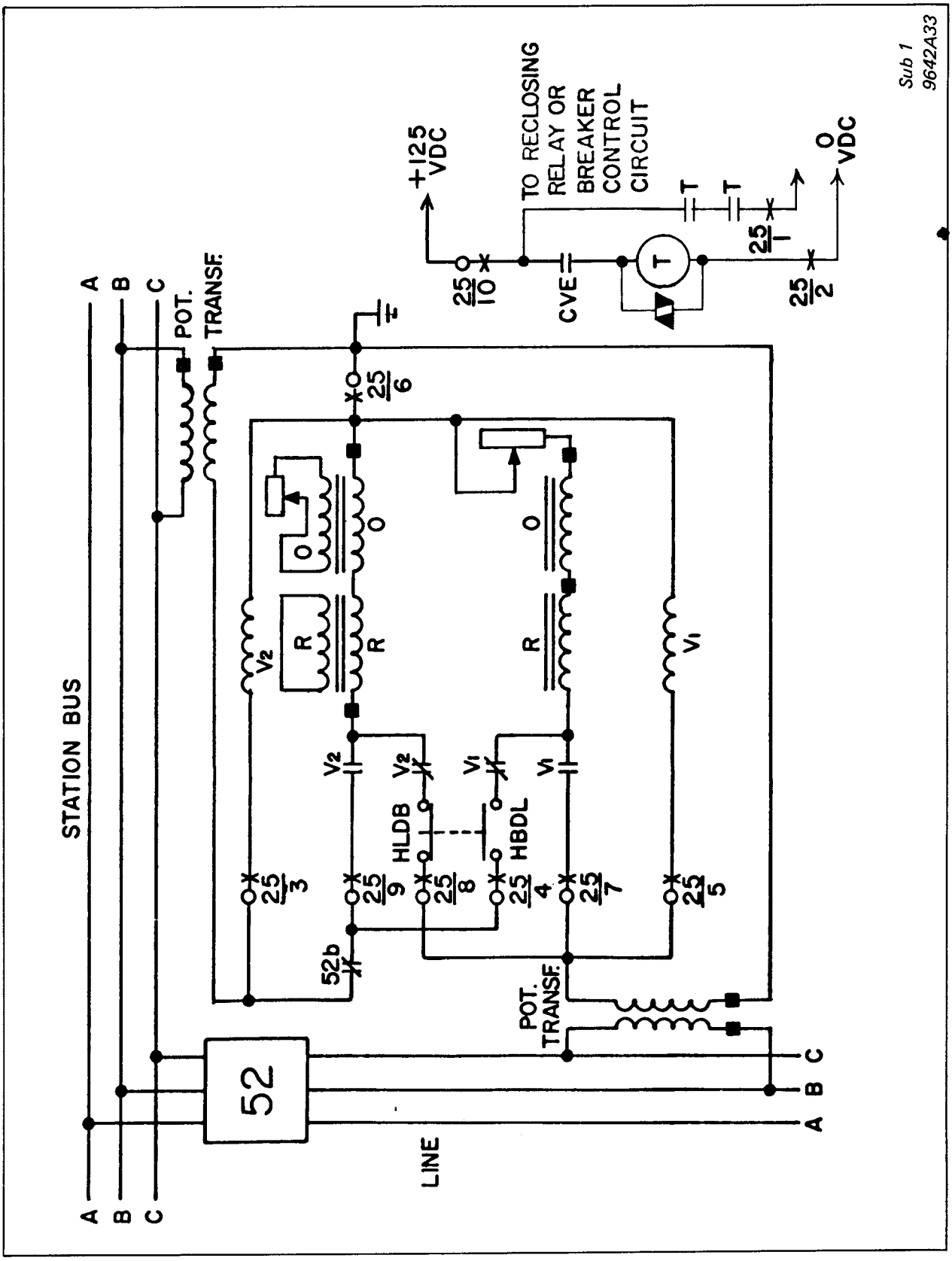
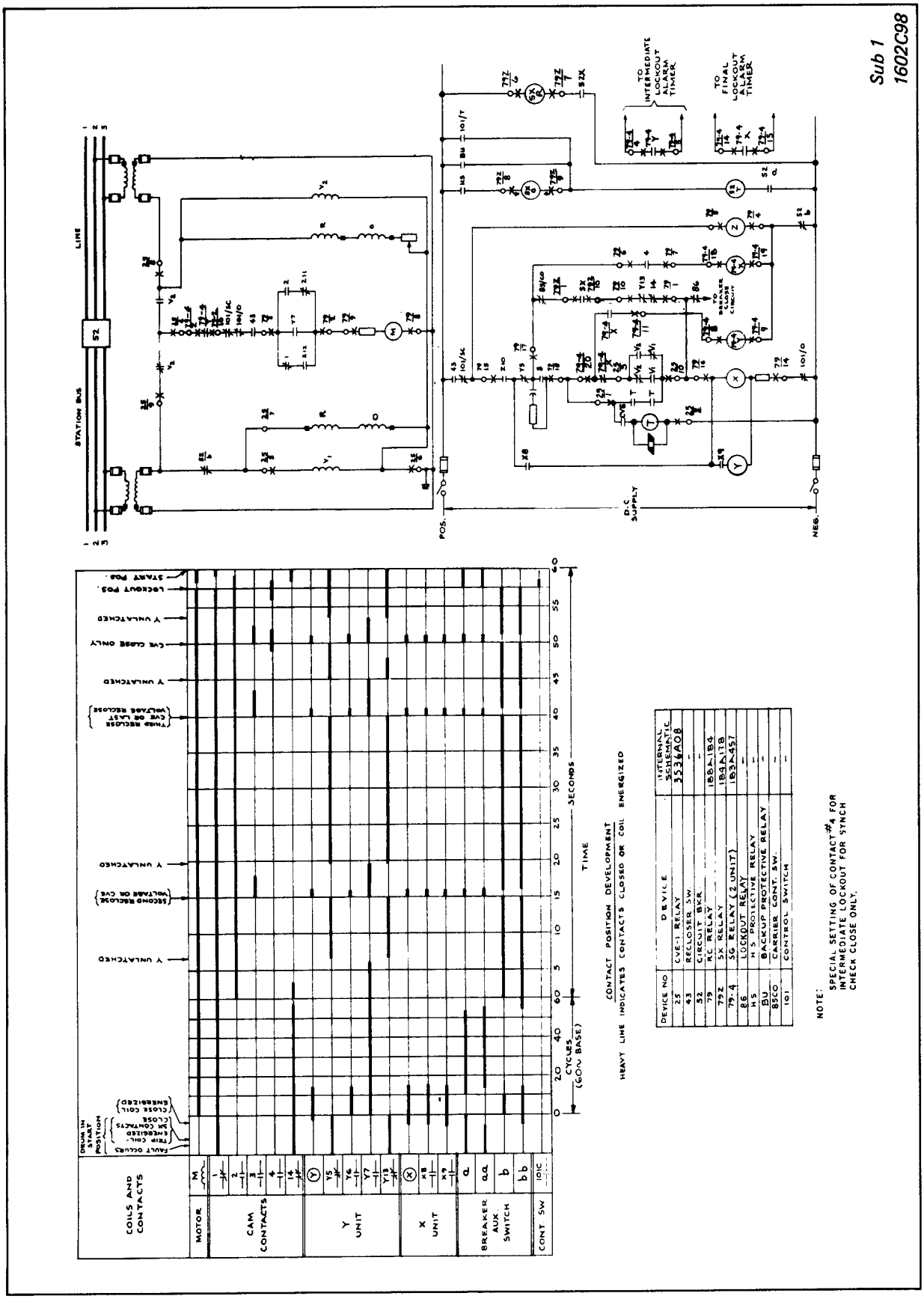


Fig. 19. External Schematic for CVE-1 with HLDB/HBDL Selector Switch, Internal Scheme 3536A05.



DEVICE NO	DEVICE	INTERNAL SCHEMATIC
25	CVE-1 RELAY	3536A08
43	RECLOSER SW	–
52	CIRCUIT BKR.	–
79	RC RELAY	188A184
79Z	SX RELAY	194A178
79-4	SG RELAY (2 UNIT)	183A457
86	LOCKOUT RELAY	–
94S	ANTI-PROTECTIVE RELAY	–
BU	BACKUP PROTECTIVE RELAY	–
BSCO	CARRIER CONT. SW.	–
101	CONTROL SWITCH	–

Fig. 20. External Schematic for CVE-1, Int. Scheme 188A624, with RC Reclosing Relay. Refer to RC I.L. 41-661 for additional data.

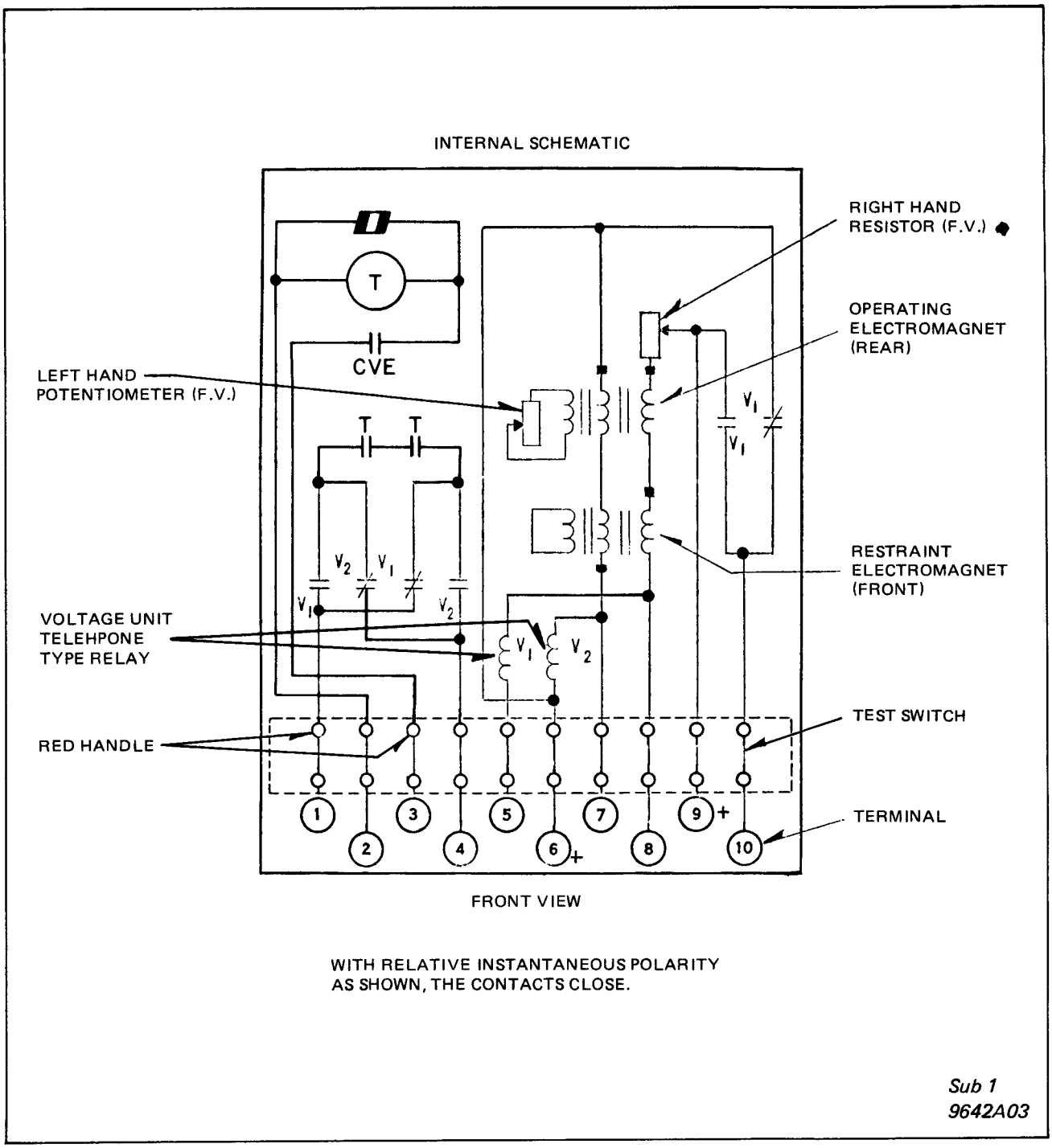


Fig. 21. Internal Schematic of CVE-1 with CVE Contacts Supervised by Voltage Contacts.

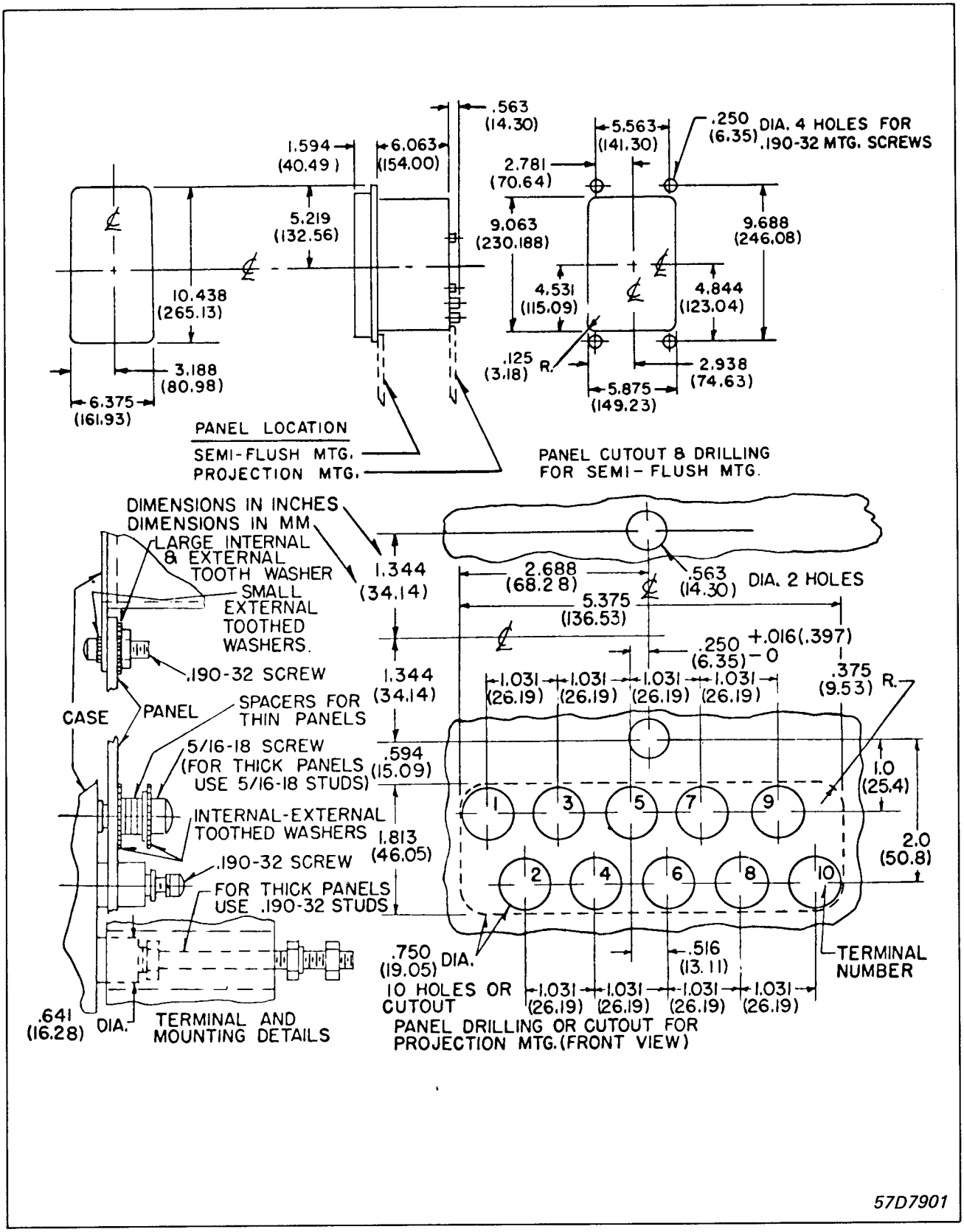
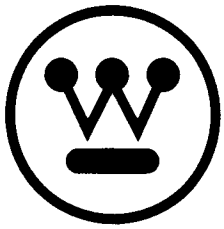


Fig. 22. Outline and Drilling Plan for the CVE and CVE-1 in FT21 Case.



WESTINGHOUSE ELECTRIC CORPORATION

RELAY AND TELECOMMUNICATIONS DIVISION

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