



INSTALLATION • OPERATION • MAINTENANCE INSTRUCTIONS

RELAY TYPE CVE, CVE-1, CVE-2 AND CVE-3 SYNCHRO-VERIFIER RELAYS

CAUTION

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

APPLICATION

The Types CVE, CVE-1, CVE-2 and CVE-3, Figures 1, 2 and 3, synchro-verifier relays are used to check that the voltages on both sides of a breaker are approximately the same in magnitude and phase. The synchro-verifier relays are not automatic synchronizers 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 frequency and determined by the speed of operation of the circuit breaker so that the two systems are connected at synchronism.

The CVE type relays supervise the automatic or manual closing of a circuit breaker. A common application of the synchro-verifier relay 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 that automatic equipment to reclose the breaker.

The CVE-1 has the CVE unit and is additionally equipped with line and bus voltage sensing, telephone type relays. These permit the relay reclosing to be initiated when the bus is hot and the line is dead (HBDL) or vice versa (HLDB). When both the line and the bus are live and in synchronism, the synchro-verifier relay permits the automatic reclosing equipment to reclose the breaker.

The CVE-2 relay is comprised of three (3) telephone type relays and two (2) over or under voltage toggle-type relays in addition to the CVE unit and is used for selective initiation of reclosures. The reclosing is modified by the nature of the trip: high speed relay trips initiate high speed and delayed time reclosures; time-delayed relay trips initiate only time-delayed synchronism reclosures; and manual trips which do not initiate reclosures.

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 ASEA BROWN BOVERI representative should be contacted.

The CVE-3 relay also has the CVE unit. A telephone relay is added for the purpose of sealing-in the CVE contacts once they have closed. The CVE-3 relay is capable of being energized with the CVE unit contacts closed and will carry current continuously.

CONSTRUCTION

A. Operating Element (Rear Element) Fig. 1

An "E" type laminated electromagnet is part of the operating element of the synchro-verifier relays. The center leg has two main coils and the left leg contains a lag coil. A variable resistor or a potentiometer connected across the lag coil provides adjustment for the different operating circles of the relay. Increasing or decreasing the amount of resistance effectively decreases or increases the contact closing torque of the relay.

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 cause a contact closing torque.

B. Restraining Element (Front Element) Fig. 2

The restraining element is comprised 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 of the applied voltages. This flux divides and returns through the outer legs of the electromagnet. The lag coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the disc gap cause a contact opening torque.

C. Indicating Contactor Switch Unit (ICS) - (When Used)

The dc indicating contactor switch is a small clapper-type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation, two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pick-up value of the switch.

D. AC Indicating Contactor Switch (ACS) - (When Used)

The ACS is similar in construction to the ICS. It is used where the ac current is too large for the ICS to handle or when the ICS will have to carry the ac current for too long a period.

OPERATION

A. CVE Operation With External Voltage Relays (Fig. 4)

Figure 4 shows the external connections of the CVE relay with two type SG relays for the line and bus voltage relays. Connected in this manner, the scheme will provide the following operations:

1. Hot line - Dead Bus, HLDB

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

2. Hot Bus - Dead line, HBDL

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

3. Synchronism check

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

In the CVE with external relay arrangement, it is recommended that the number of reclosures be limited by using a single-shot or multi-shot reclosing relay in the scheme.

B. CVE-1 Operation (Fig. 5)

The CVE-1 relay shown in Fig. 5 operates as the CVE described above and with its internal telephone relays, V_1 and V_2 , it performs the same functions as the external SG relays described above.

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

C. CVE-2 Operation

The CVE-2 relay has two low drop-out telephone relays which have buffered contacts. Also, the CVE-2 relay has two SX auxiliary relays where one is used to initiate high-speed reclosure and the other initiates time-delayed reclosures. The reclosing action is dictated by the nature of the trip, i.e., a high speed relay trip will initiate high speed and time-delayed reclosures; time delayed relay trips will initiate only time delayed synchronism check reclosures; and manual trips do not initiate reclosures.

D. CVE-3 Operation

The CVE-3 relay, Fig. 6, incorporates a circuit to seal-in the CVE function of the relay. This circuit is comprised of a SPDT CVE contact and a DPST telephone relay contact.

CHARACTERISTICS

The relays containing the type CVE units can be adjusted for operating circles from 20 to 60 degrees as shown in Fig. 7. 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 CVE element of the relay is shown in Fig. 8. These time curves are obtained from the number 11 time-dial setting when the applied voltages are equal to rated voltage, of the same frequency and the phase angle between the voltages is varied for three typical settings. Shorter operating times can be obtained at different time-dial settings for values of voltage which are equal and in-phase as shown in Fig. 9.

Fig. 10 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. 11 shows typical CVE reset times for the 20, 40 and 60 degree circle settings.

A. Burden

1. CVE Unit

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

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

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

	<u>60 Hertz</u>	<u>50 Hertz</u>
Volt-Amperes	10.8	13.8
Power Factor	.422	.309
Watts	4.6	4.2

2. Auxiliary Relays

For the CVE-1 relay, the additional burden of each telephone relay at 120 Vac is as follows:

	<u>60 Hertz</u>	<u>50 Hertz</u>
Volt-Amperes	10.62	13.29
Power Factor	0.64	0.47
Watts	6.8	6.2

For the CVE-2 relay, the additional burden of each at 120 Vac is as follows:

	<u>V₁</u>		<u>V₂</u>	
	<u>60 Hz</u>	<u>50 Hz</u>	<u>60 Hz</u>	<u>50 Hz</u>
Volt-Amperes	3.36	4.16	7.92	9.80
Power Factor	.997	.733	.997	.733
Watts	3.35	3.05	7.90	7.18

3. SX Units (CVE-2)

The SX auxiliary relay units contained in the CVE-2 each has a dc burden of 5.5 watts at rated voltage and one (1) watt at rated current.

4. Continuous Ratings

These relays will continuously stand 110% of rated voltage applied to the line and bus circuits, either separately or simultaneously.

SETTINGS

A. Disc Unit

As shipped from the factory the relays are calibrated for a 20 degree circle. Other operating circles from 20 degrees to 60 degrees can be obtained by adjusting the left hand resistor or potentiometer (front view). 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 number 11 time-dial setting is recommended when the 60 degree circle setting is used. A setting of number 4 or higher on the time-dial is

recommended with the 40 degree circle. A setting as low as 1/2 on the time-dial should be satisfactory with the 20 degree circle. From Fig. 9 note that the relay will operate in 1.4 seconds in the 1/2 time-dial position and with the 20 degree 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 worse-case phase-angle difference between the two systems at the instant of breaker closure, refer to Fig. 8. For example, assume that the systems are slipping at a frequency of 0.048 hertz which is the maximum slip for which the relay will operate at a 1/2 time-dial position and a 20 degree setting.

This means that the voltage vector moves out of the circle an indication that the systems would be 40 degrees out-of-phase at the instant that the breaker close circuit is energized. The phase angle at the instant of breaker closure is:

$$0 = 40 \text{ deg.} + 0.048 \times 350T_B = 40 \text{ deg} + 17.3T_B$$

where T_B = breaker closing time in seconds

Let $T_B = 0.5$ seconds

$$\text{Then } 40 \text{ deg.} + 17.3 \times .05 = 48.6 \text{ deg}$$

B. Indication Contactor Switch (ICS) - (When Used)

Tap settings of either 0.2 or 2.0 amperes are required on the ICS unit. Selection is made by connecting the lead located in the front of the tap block to the desired setting by means of the connecting screw.

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 relays 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 on the stud and then turning the proper nut with a wrench. See Figs. 32 and 33 for the Outline and Drilling Plan. For detailed FT Case information refer to I.L.41-076. For mounting hardware information, see Technical Data sheet No. 41-020.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

A. General

It is recommended that upon receipt of a synchro-verifier relay, the following checks be made to assure it is in proper working order. Although some of the checks appear to be and are the same, care should be taken that the test set-up used is for the unit under test.

B. CVE (Fig. 12)

1. Indicating Contactor Switch (ICS) - (When Used)

Close the main relay contacts and pass sufficient dc current through the disc unit contact circuit to close the contacts of the ICS. This value of current should not be greater than the value marked on the nameplate. The operation indicator target should drop freely.

The contact gap should be approximately 0.047 inches between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

2. AC Contactor Switch - (When Used)

The core screw, which is adjustable from the top of the ACS unit, determines the pickup value. The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a wipe of 1/64 to 3/64 inches with the armature against the core pin. For units with double trip contacts, the adjustment procedure is the same as with the single trip unit.

Close the main relay contacts and pass sufficient ac current through the trip circuit to close the ACS contacts no later than 98 percent of the value given on the relay nameplate. Dropout must occur at 90 percent of that rating.

3. Disc Unit

- a. Contacts (Mechanical) - 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 inches. The placement of the various time-dial positions in line with the index mark will give operating times as shown on the time curve.
- b. Operating Circle - Set up the CVE relay per the test diagram in Fig. 12. When $V_2 = V_1 =$ rated voltage and their phase difference is between 18 degrees and 22 degrees, (either leading or lagging), the contacts should just close. Another condition for the contacts to just close is when $V_1 =$ rated voltage and V_2 is increased from a low value to 94 ± 4 volts.
- c. Time Curve - The contacts should close when with the time-dial set at position 11 and V_1 and V_2 are equal to rated voltage and in phase, the contacts should close in 20 ± 1 seconds.

C. CVE-1 (Figs. 13 and 14)

1. Indicating Contactor Switch (ICS) - (When Used)

Close the main relay contacts and pass sufficient dc current through the disc unit contact circuit to close the contacts of the ICS. This value of current should not be greater than the value marked on the nameplate. The operation indicator target should drop freely.

The contact gap should be approximately 0.047 inches between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

2. AC Contact Switch (ACS) - (When Used)

The core screw, which is adjustable from the top of the ACS unit, determines the pickup value. The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a wipe of 1/64 to 3/64 inches with the armature against the core pin. For units with double trip contacts, the adjustment procedure is the same as with the single trip units.

Close the main relay contacts and pass sufficient ac current through the trip circuit to close the ACS contacts no later than 98 percent of the value given on the relay nameplate. Dropout must occur at 90 percent of that rating.

3. Disc Unit

- a. Contacts (Mechanical) - 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 inches. The placement of the various time-dial positions in line with the index mark will give operating times as shown on the time curve.
- b. Operating Circle - Set up the CVE relay per the test diagram in Figs. 13 and 14. When $V_2 = V_1 =$ rated voltage and their phase difference is between 18 degrees and 22 degrees, (either leading or

lagging), the contacts should just close. Another condition for the contacts to just close is when V_1 = rated voltage and V_2 is increased from a low value to 94 ± 4 volts in phase with V_1 .

- c. Time Curve - With the time-dial set at position 11, the contacts should close in $20 \text{ AC} \pm 1$ second when V_1 and V_2 , equal to the rated voltage at zero phase angle, are applied.

4. Telephone Relays

Apply an ac voltage to each telephone relay circuit. The telephone relay must pickup when 95 volts is applied.

D. CVE-2 (Fig. 15)

1. Indicating Contactor Switch (ICS) - (When Used)

Close the main relay contacts and pass sufficient dc current through the disc unit contact circuit to close the contacts of the ICS. This value of current should not be greater than the value marked on the nameplate. The operation indicator target should drop freely.

The contact gap should be approximately 0.047 inches between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

2. AC Contactor Switch (ACS) - (When Used)

The core screw, which is adjustable from the top of the ACS unit, determines the pickup value. The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a wipe of $1/64$ to $3/64$ inches with the armature against the core pin. For units with double trip contacts, the adjustment procedure is the same as with the single trip unit.

Close the main relay contacts and pass sufficient ac current through the trip circuit to close the ACS contacts no later than 98 percent of the value give on the relay nameplate. Dropout must occur at 90 percent of that rating.

3. Disc Unit

- a. Contacts (Mechanical) - 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 inches. The placement of the various time-dial positions line with the index mark will give operating times as shown on the time curve.
- b. Operating Circuit - Set up the CVE-2 relay per the test diagram in Fig. 15. When $V_2 = V_1$ = rated voltage and their phase difference is between 18 degrees and 22 degrees, (either leading or lagging), the contacts should just close. Another condition for the contacts to just close is when V_1 = rated voltage and V_2 is increased from a 10W value to 94 ± 4 volts in phase with V_1 .
- c. Time Curve - With the time-dial set at position 11, the contacts should close in 20 ± 1 seconds when V_1 and V_2 , equal to the rated voltage at zero phase angle, are applied.

4. Telephone Relays

- a. A rated d-c voltage applied to terminals 17 (positive) and 19 (negative) will check telephone relay "X". The telephone relay should pickup at 80% of rated voltage and dropout when de-energized.
- b. Telephone relay V_1 can be checked by applying an ac voltage to terminals 12 and 14. The unit should pickup between 72 and 96 volts and dropout between 64 to 84 volts. Pickup can be varied by adjusting the middle left hand resistor (front view).
- c. Telephone relay unit V_2 is checked by applying an ac voltage to terminals 16 and 15. The unit should pickup between 36 and 38 volts and dropout between 6 to 30 volts. Pickup of the unit can be varied

by adjusting the upper left hand resistor (front view) of the relay. **The pickup should not be adjusted for values of voltage less than 36 volts a-c to avoid exceeding the continuous rating of the circuit.**

E. CVE-3 (Fig. 16)

1. Indicating Contactor Switch (ICS) - (When Used)

Close the main relay contacts and pass sufficient dc current through the disc unit contact circuit to close the contacts of the ICS. This value of current should not be greater than the value marked on the nameplate. The operation indicator target should drop freely.

The contact gap should be approximately 0.047 inches between the bridging moving contact and the adjustable stationary contacts. The bridging, moving contact should touch both stationary contacts simultaneously.

2. Disc Unit

- a. Contacts (Mechanical) - 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 inches. The placement of the various time-dial positions in line with the index mark will give operating times as shown on the time curve.
- b. Operating Circle - Set up the CVE-3 relay per the test diagram in Fig. 16. A dc power source supplying 125 volts must be connected to terminal 10 (positive) and 2 (negative). A light or trip-coil type indicator is to be connected between terminals 1 (positive) and 2 (negative).

After the above set-up is accomplished, the contacts should just close when either of the following two conditions is applied.

- 1) When $V_2 = V_1 =$ rated voltage and their phase difference is between 18 degrees and 22 degrees, (either leading or lagging).
- 2) When $V_1 =$ rated voltage and V_2 is increased from a low value to 94 ± 4 volts in phase with V_1 .
- c. Time Curve - With the time-dial set at position 11, the contacts should close in 20 ± 1 seconds when V_1 and V_2 , equal to the rated voltage at zero phase angle, are applied.

3. Telephone Relay

In order to check the pickup of the CVE-3 telephone relay, the time-dial must be turned to zero to close the CVE contact continuously. Then apply a dc voltage across terminal 10 (positive) and 2 (negative). Pickup should occur at 80% of rated voltage and dropout when de-energized.

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 Style #182A836H01 is recommended for this purpose. The use of abrasive materials 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 proper working order (See Acceptance Check).

A. Contacts

The index mark on the movement frame coincides with the "0" mark on the time-dial when the stationary contacts 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 inches. 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.

B. 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 purpose 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.

C. Spurious Torque Adjustments

With the relay set as per the preliminary adjustments, open the lag coil circuit of the rear electromagnet. This is done by opening the screw connection on the lag coil or by inserting a piece of insulating material under the adjustable point of the left hand potentiometer or resistor (front view). Connect the relay per the following test circuits:

- CVE Fig. 12
- CVE-1 Figs. 12 and 14
- CVE-2 Fig. 15
- CVE-3 Fig. 16

Apply rated voltage at zero phase angle on both circuits. With the right hand plugged 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.

D. 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. 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.

E. Spring Adjustment

Adjust the left potentiometer or 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 degrees and 41 degrees, 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 ± 4 volts in phase with V_1 . If necessary, readjust the spring slightly to obtain this condition. The relay is now calibrated for a 20 degree circle.

F. 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 ± 0.6 seconds with V_1 and V_2 equal to rated voltage at zero phase angle.

G. Circles Other Than 20 Degrees

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

If a circle other than 20 degrees is desired, adjust the left hand potentiometer or resistor (front view) 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 degree phase angle. It may be necessary to readjust the right hand resistor to position the desired circle symmetrically about the zero degree line. See Paragraph 4, "Circle Centering" for the procedure. The time of operation will be shown in the time curves of Fig. 8.

ELECTRICAL CHECKPOINTS

A. Approximate voltage across coils (Figures 12 thru 16).

With V_1 equal to rated voltage, the following approximate voltages should be obtained across the coils of the 120 volt relay. The relay is set for a 20 degree circle.

With 120 volts applied to V_1 circuit only.

	<u>60 Hz</u>	<u>50 Hz</u>
<u>Operating Electromagnet</u>		
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 V_2 equal to rated voltage, the following approximate voltages should be obtained across the coils of the 120 volt relay. The relay is set for a 20 degree circle.

With 120 volts applied to V_2 circuit only.

	<u>60 Hz</u>	<u>50 Hz</u>
<u>Operating Electromagnet</u>		
Upper terminals	57volts	58.5volts
Lower terminals	59volts	61volts
Lag coil circuit	22 volts	24 volts

<u>Restraint Electromagnet</u>	<u>50 Hz</u>	<u>60 Hz</u>
Upper terminals	54 volts	57volts
Lower terminals	58 volts	61volts

B. Approximate dc resistances of the coils are as follows:

Operating Electromagnet

Upper terminals	59 ohms
Lower terminals	80 ohms
Lag coil-open circuit	245 ohms

Restraint Electromagnet

Upper terminals	66 ohms
Lower terminals	92 ohms

C. Approximate resistance values of the left hand resistor for various operating circles.

Resistance values can vary appreciably between relays.

20 deg circle	4800 ohms
40 deg circle	2250 ohms
60 deg circle	890 ohms

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be ordered by customers equipped for doing repair work. When ordering parts, always furnish complete data from the nameplate.

FIGURES FOR CVE IL

Figure 1	CVE Relay Without Case	
Figure 2	CVE-1 Relay Without Case	
Figure 3	CVE-3 Relay Without Case	
Figure 4	External Schematic of CVE	184A863
Figure 5	External Schematic of CVE-1	3527A76
Figure 6	External Schematic of CVE-3	9646A85
Figure 7	Curves	184A997
Figure 8	Curves	184A998
Figure 9	Curves	184A999
Figure 10	Curves	185A123
Figure 11	CVE Reset Time	619457
Figure 12	Test Connections CVE Relay	185A001
Figure 13	Test Connections CVE-1 Relay	775B995
Figure 14	Test Connections CVE-1 Relay	775B994
Figure 15	External Schematic CVE-2 Relay	1609C06
Figure 16	Test Connections CVE-3 Relay	1497B86
Figure 17	Internal Schematic CVE Relay	184A540
Figure 18	Internal Schematic CVE Relay	185A122
Figure 19	Internal Schematic CVE-1	880A624
Figure 20	Internal Schematic CVE-1	878A184
Figure 21	Internal Schematic CVE-1	880A496
Figure 22	Internal Schematic CVE-2	188A389
Figure 23	Internal Schematic CVE-3	9646A84
Figure 24	Curve	471191
Figure 25	Curve	471192
Figure 26	External Schematic CVE-1	3511A01
Figure 27	External Schematic CVE-1	408C823
Figure 28	External Schematic CVE1	188A515
Figure 29	Internal Schematic CVE-1	188A029
Figure 30	Internal Schematic CVE-1	880A495
Figure 31	Internal Schematic CVE-1	880A759
Figure 32	Outline & Drilling Diagram	57D7901
Figure 33	Outline & Drilling Diagram	57D7903

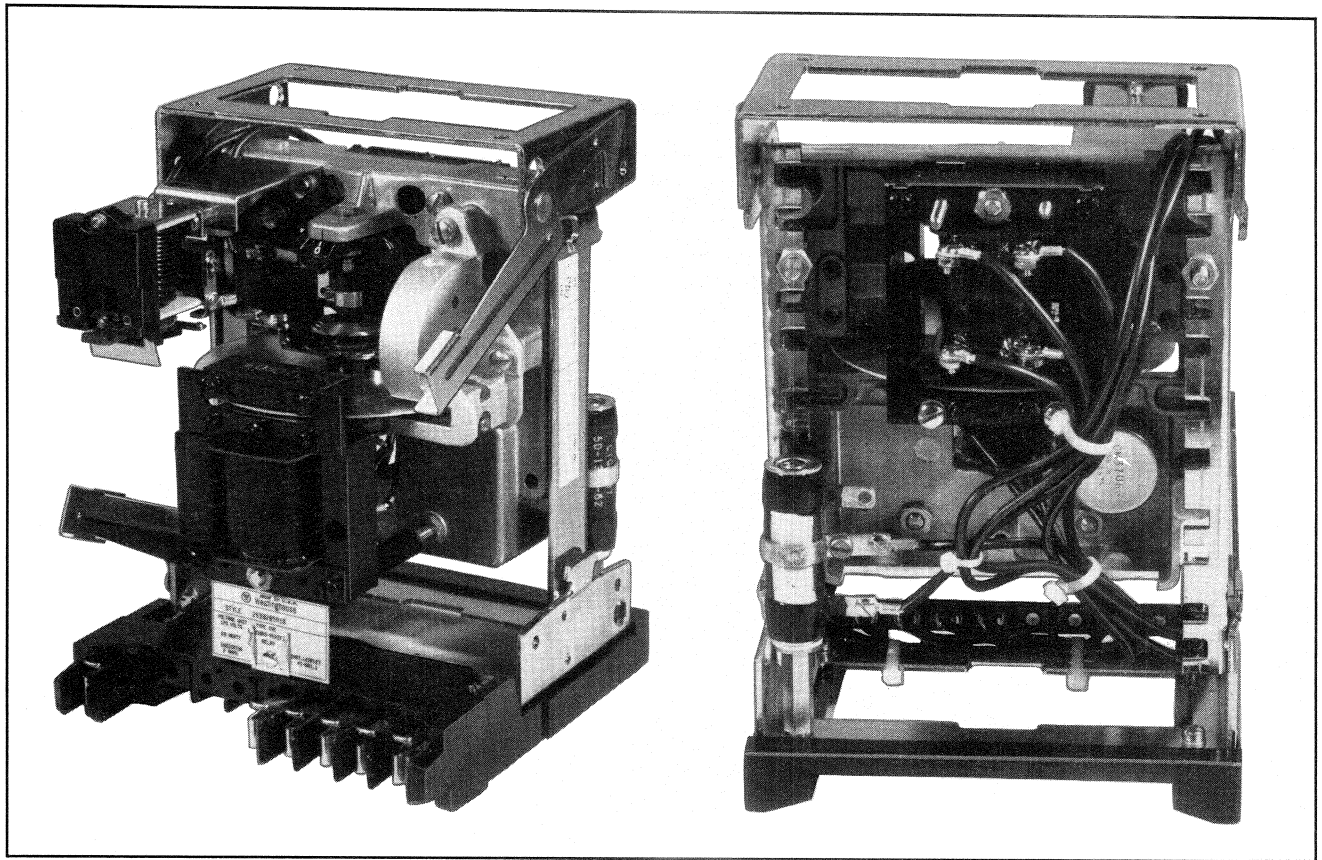


Fig. 1 CVE Relay Front & Rear Views Out of Case

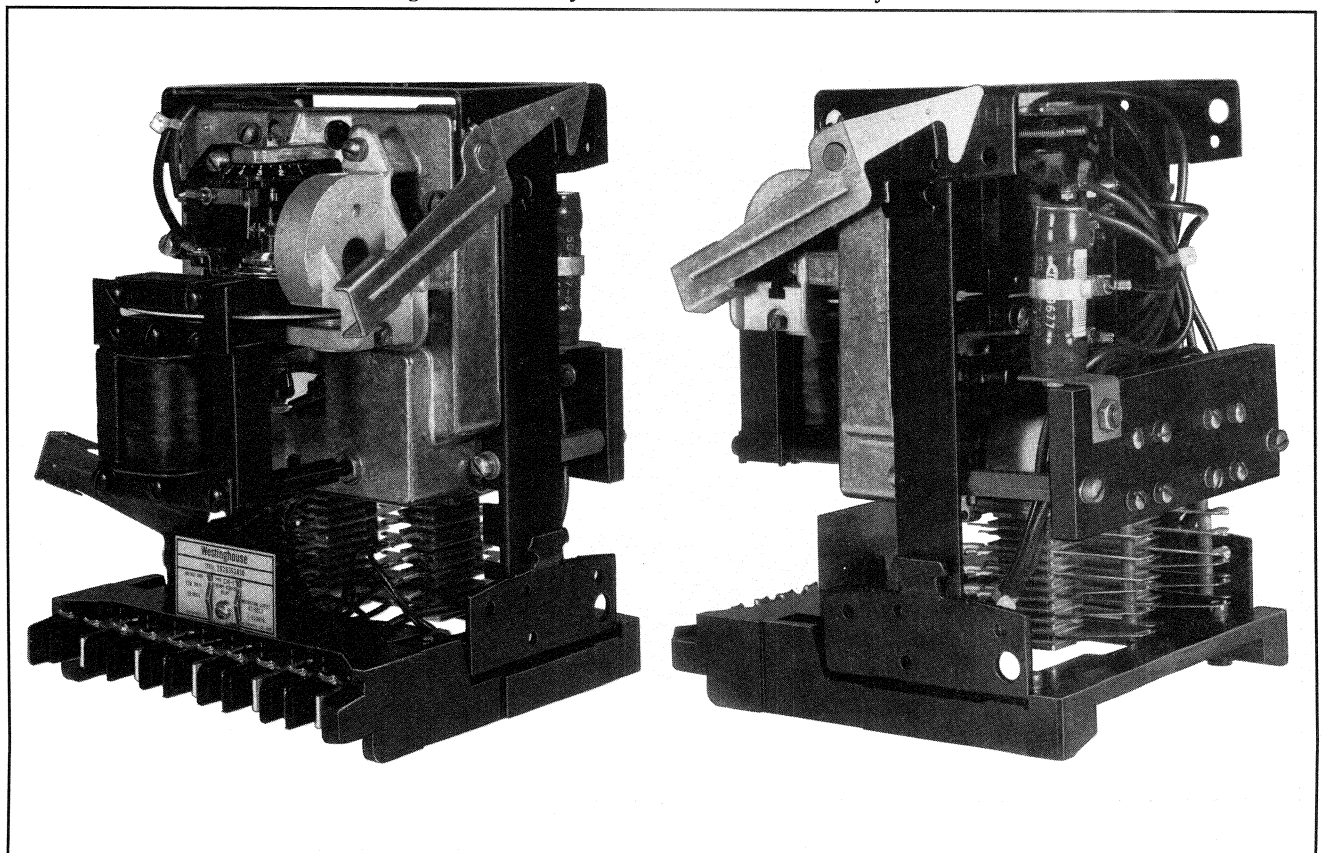


Fig. 2 CVE-1 Relay Front & Rear View Out of Case

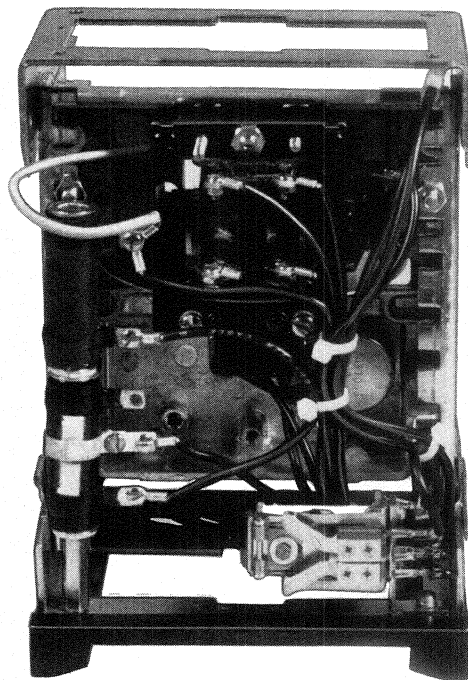
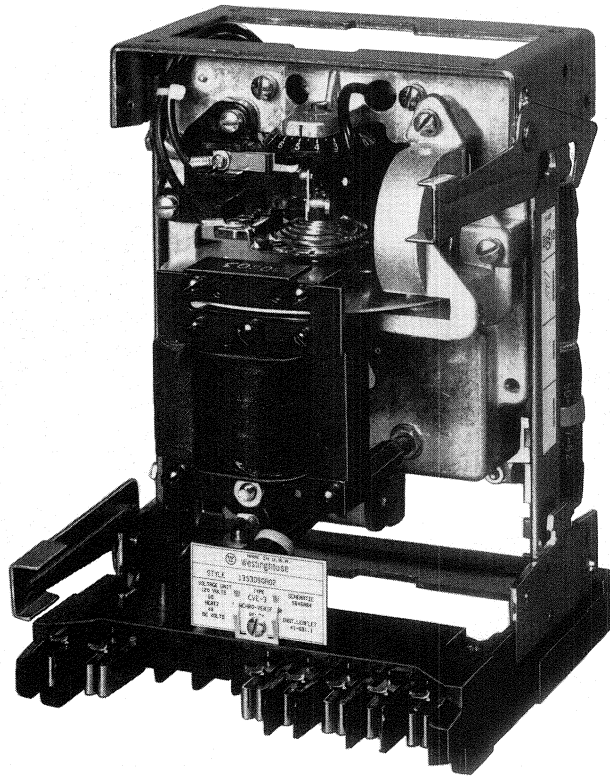


Fig. 3 CVE-3 Relay Front & Rear Views, Out of Case

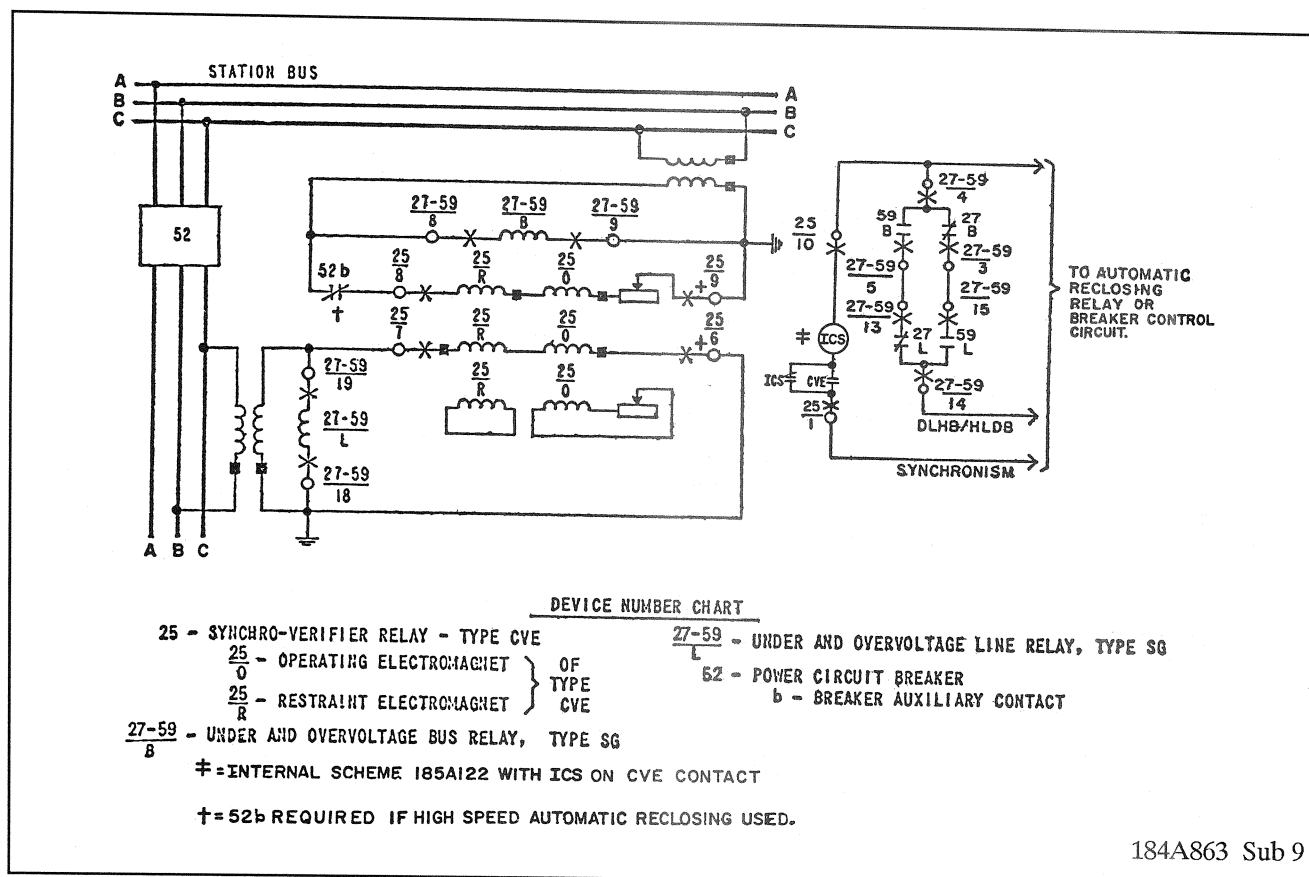


Fig. 4 External Schematic of CVE

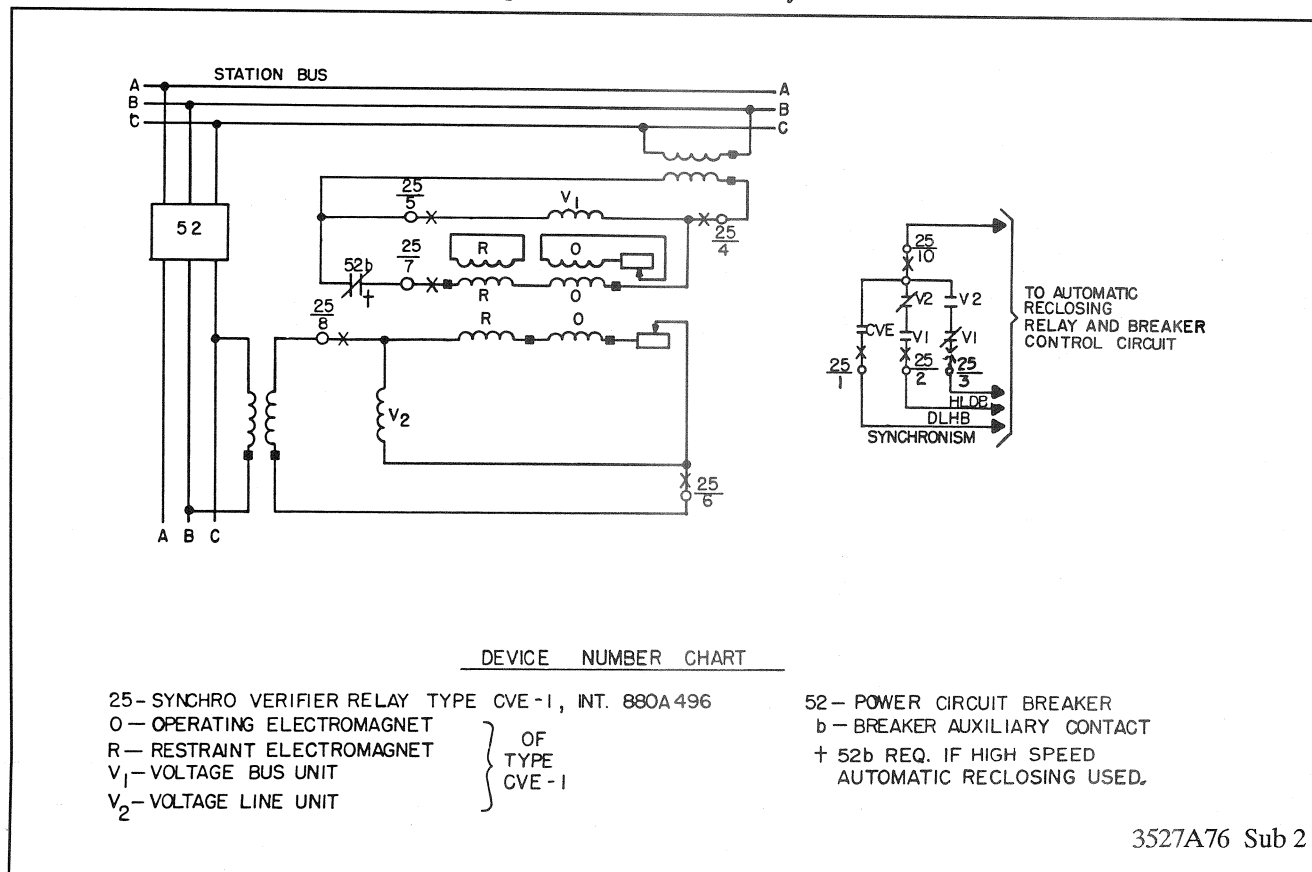


Fig. 5 External Schematic of CVE-1

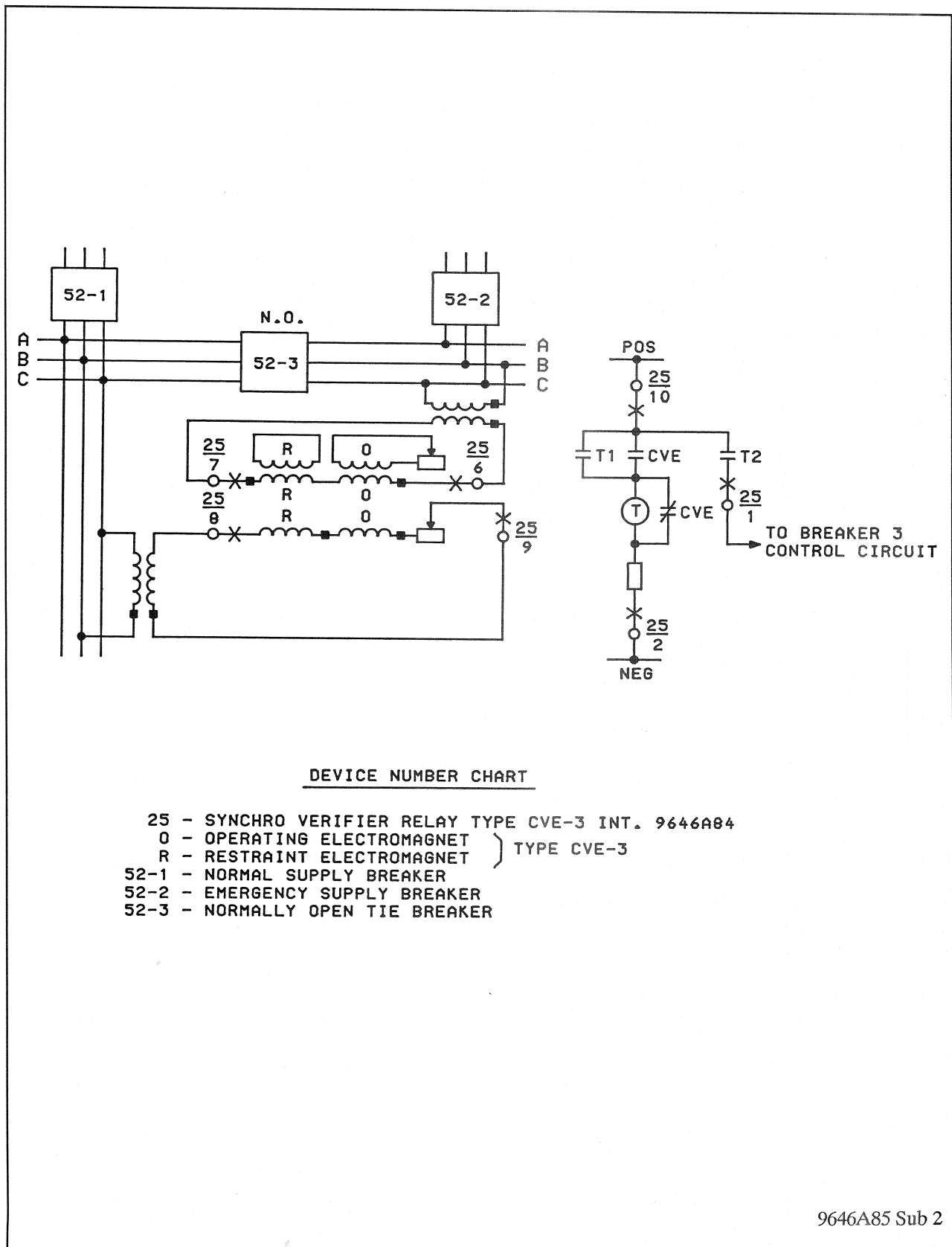
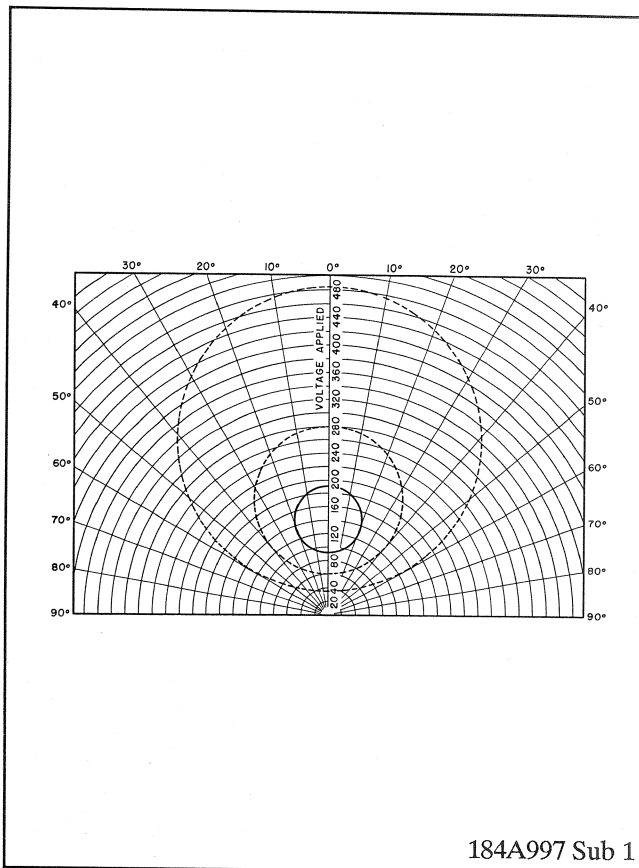
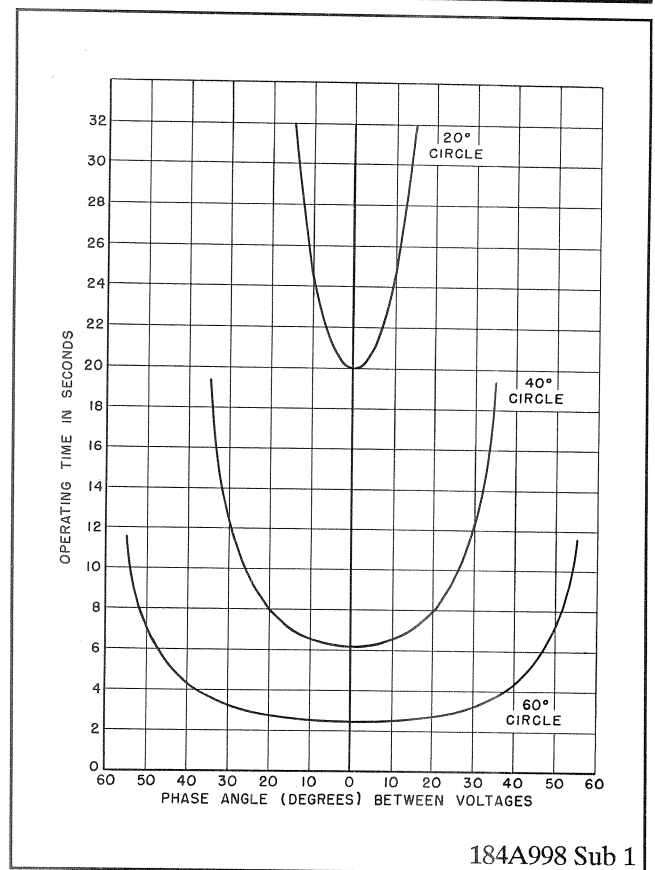


Fig. 6 External Schematic of CVE-3



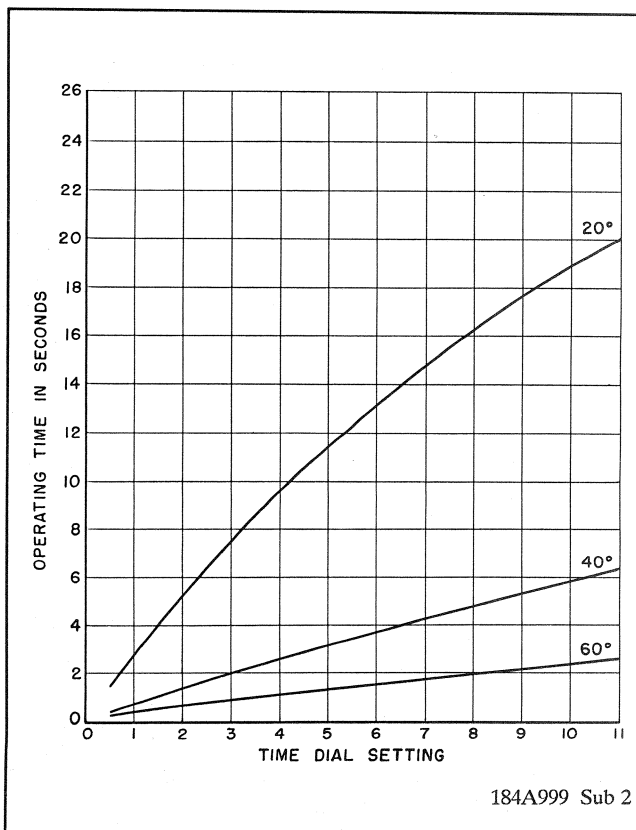
184A997 Sub 1

Fig. 7 Typical Voltage Angle Characteristic of CVE for Various Closing Angle Settings. Rated Voltage on One Circuit.



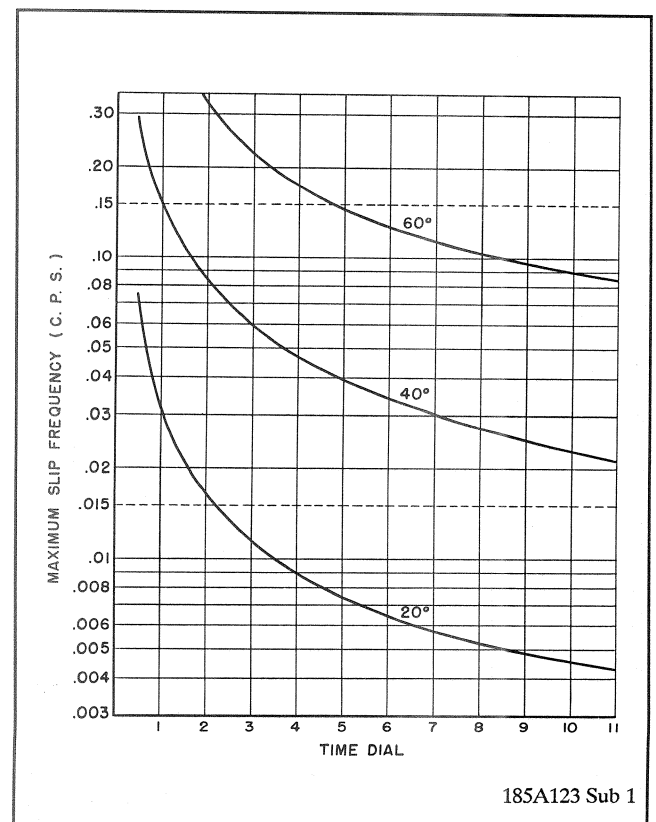
184A998 Sub 1

Fig. 8 Typical Time Phase Angle Curves of CVE. Rated Voltage on Both Circuits No. 11 Dial Time Settings.



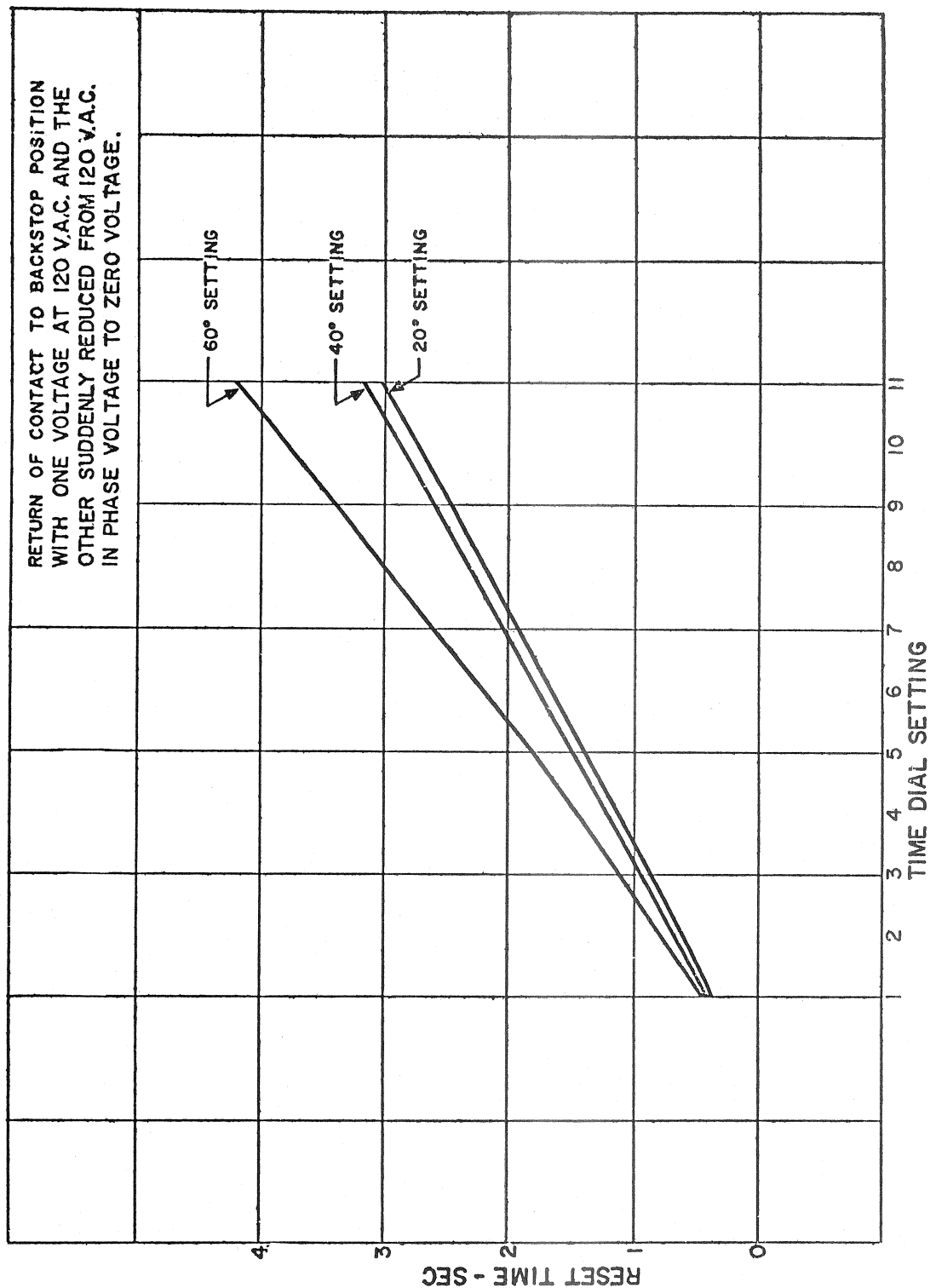
184A999 Sub 2

Fig. 9 Operating Time Variations with Changes in Time-dial Settings. Rated In-Phase Voltage on Both Circuits, 20° 40° and 60° Circle Settings



185A123 Sub 1

Fig. 10 Approximate Maximum Slip Frequency for which Operation Occurs - Rated Voltage on Both Sides



619457 Sub 1

Fig. 11 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.

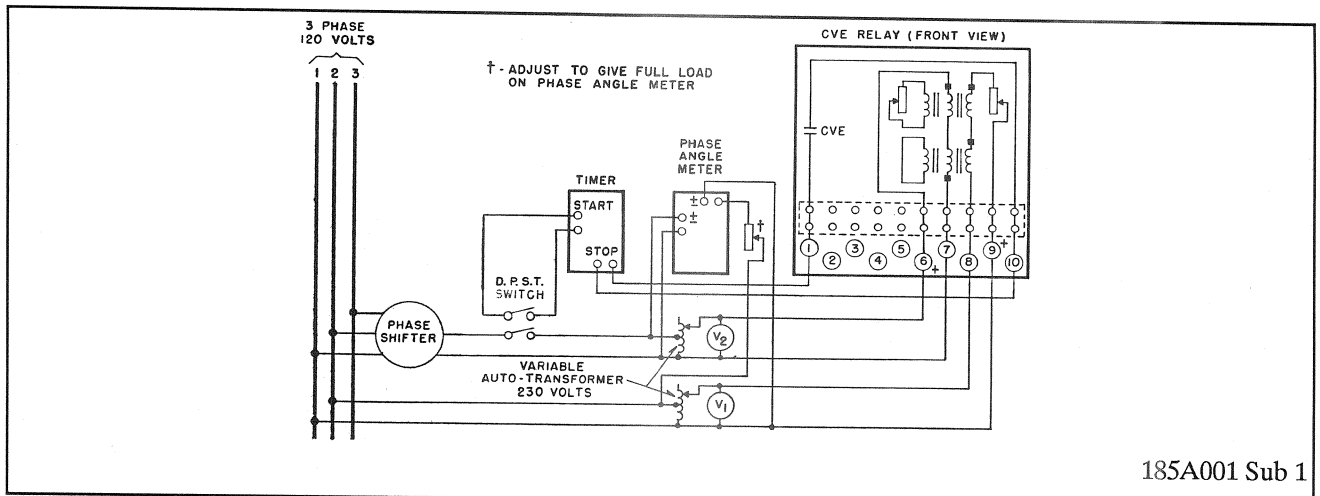


Fig 12 Diagram of CVE Test Connections

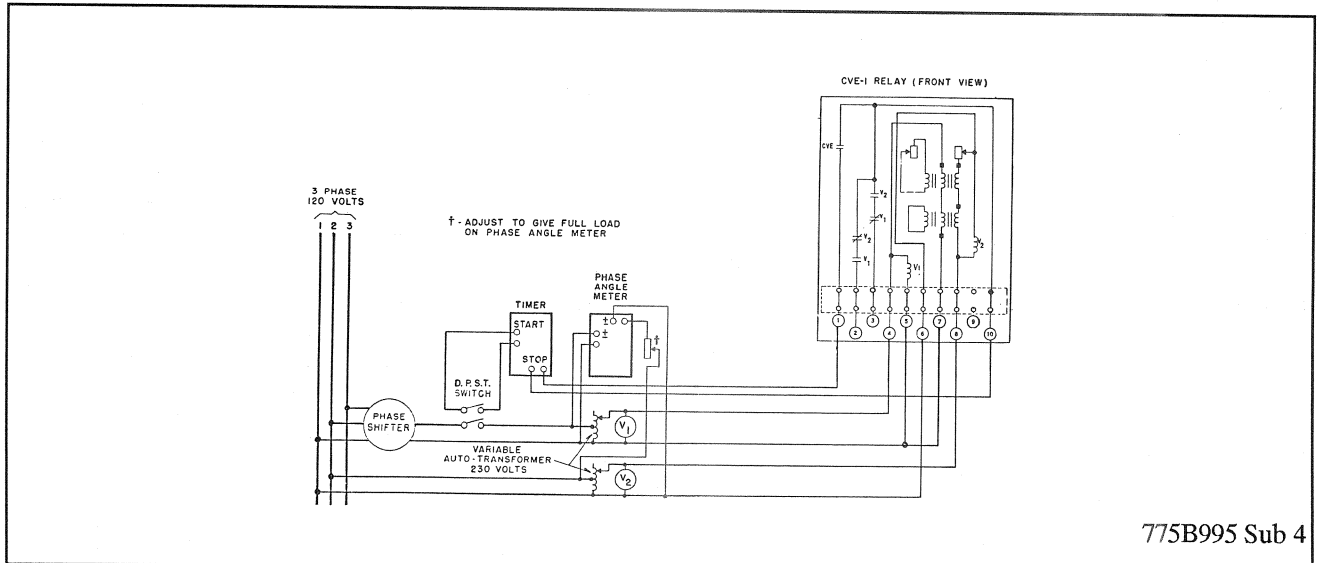


Fig. 13 Diagram of CVE-1 Test Connections without Commoned Potential Coils.

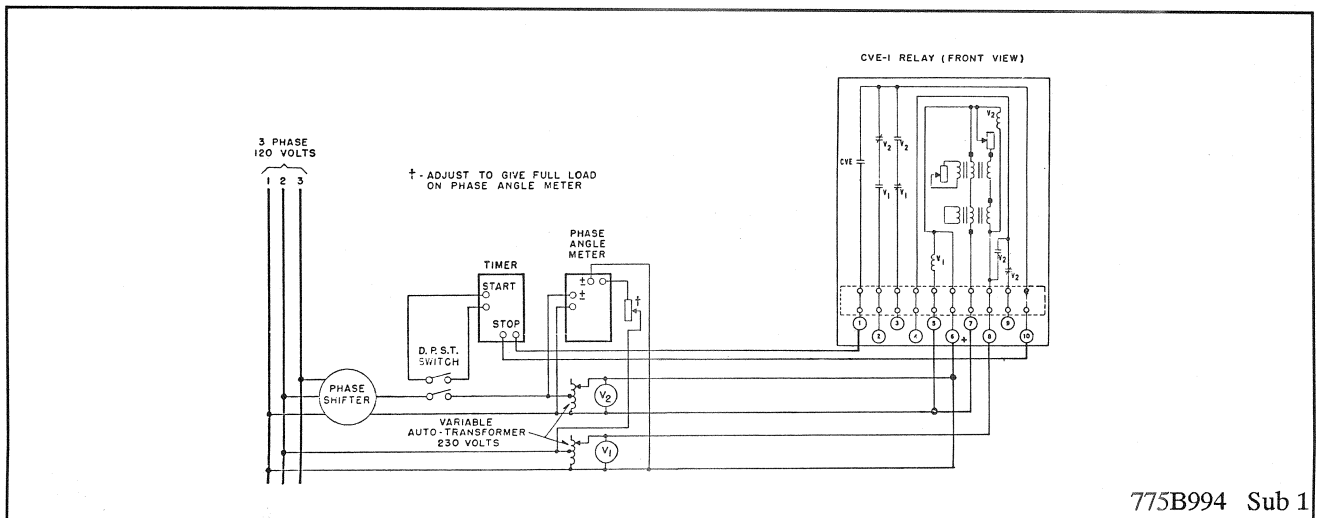
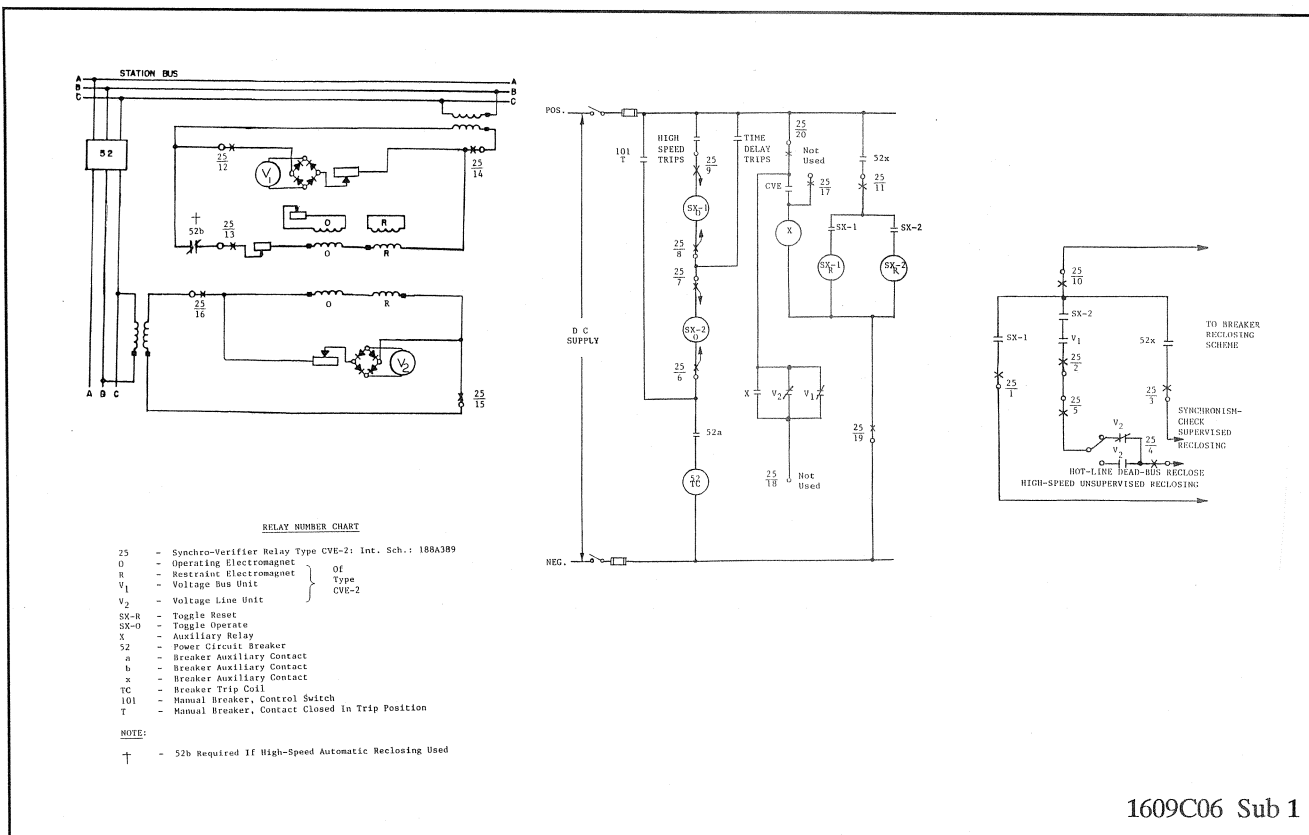
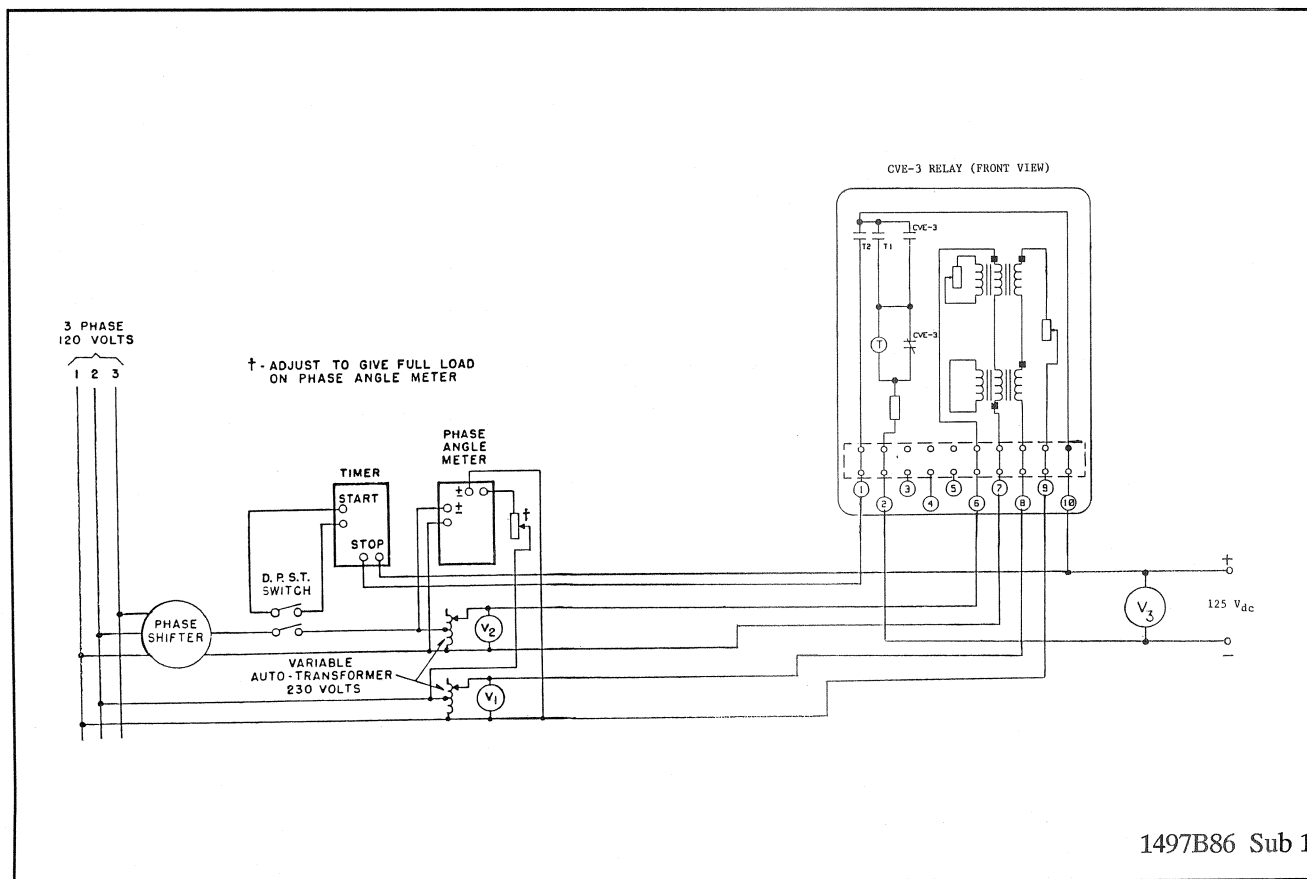


Fig 14 Diagram of CVE-1 Test Connections with Commoned Potential Coils.



1609C06 Sub 1

Fig. 15 External Schematic CVE-2 Relay



1497B86 Sub 1

Fig. 16 Test Connections CVE-3 Relay

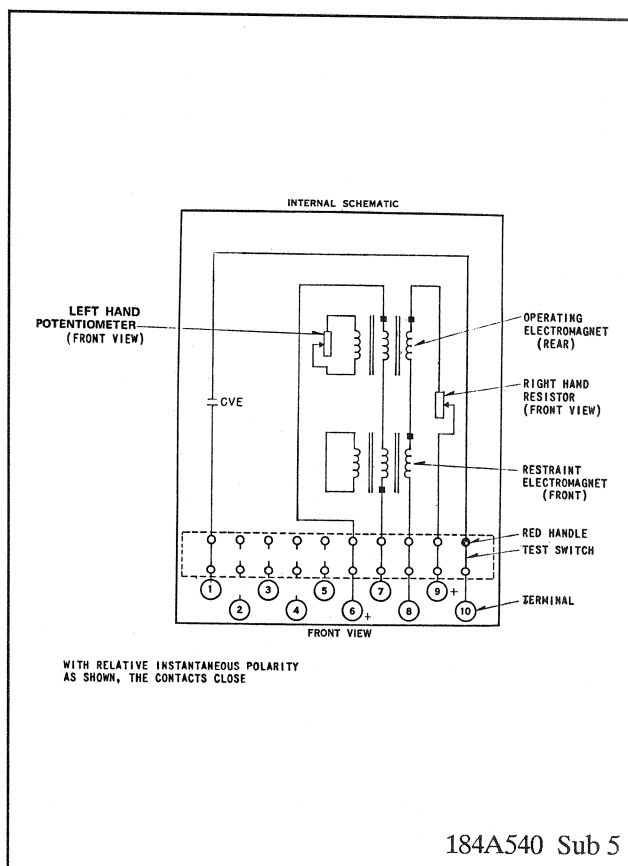


Fig. 17 Internal Schematic CVE Relay
without ICS unit

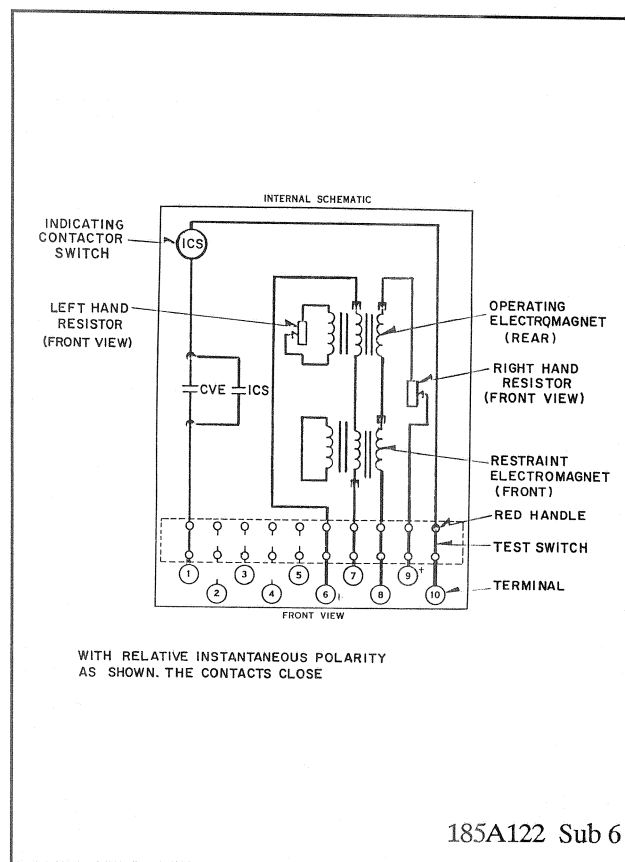


Fig. 18 Internal Schematic CVE Relay
with ICS unit

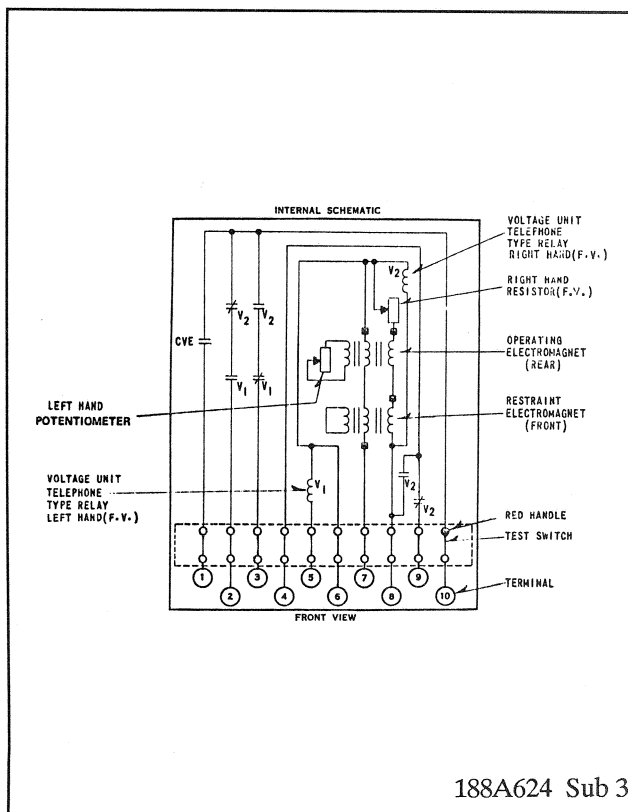


Figure 19 Internal Schematic CVE-1 for use with
RC Reclosing (See Fig. 27 for external
schematic) With commoned Voltage coils, use
with phase to phase connected vt's.

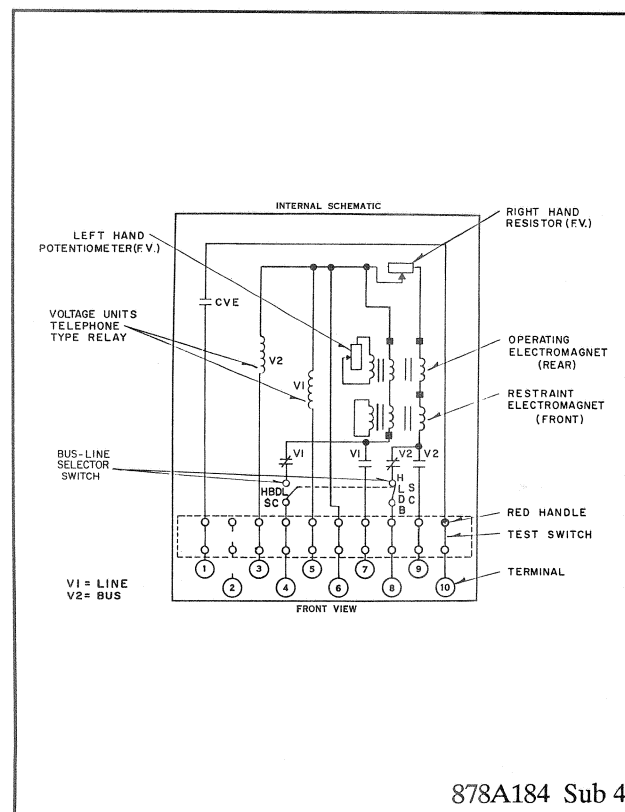
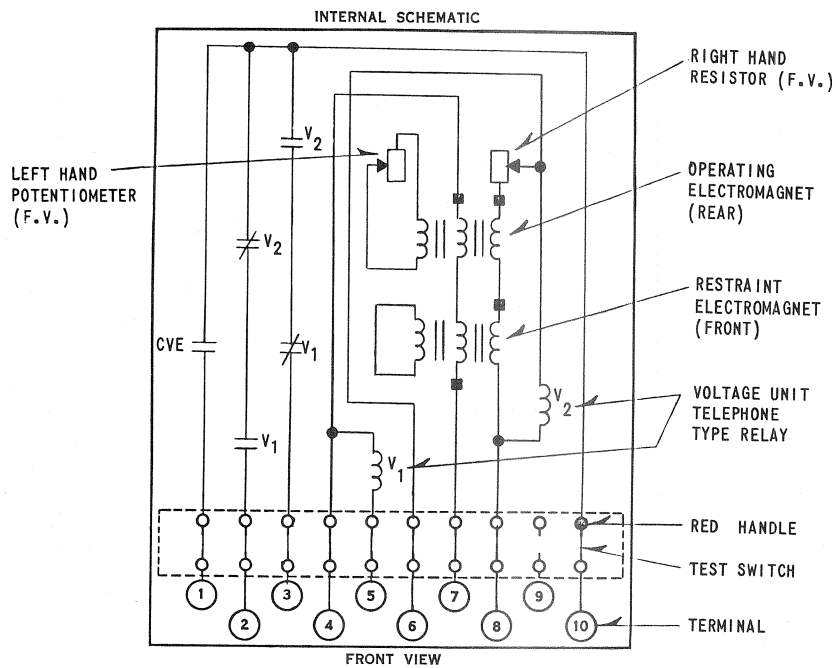
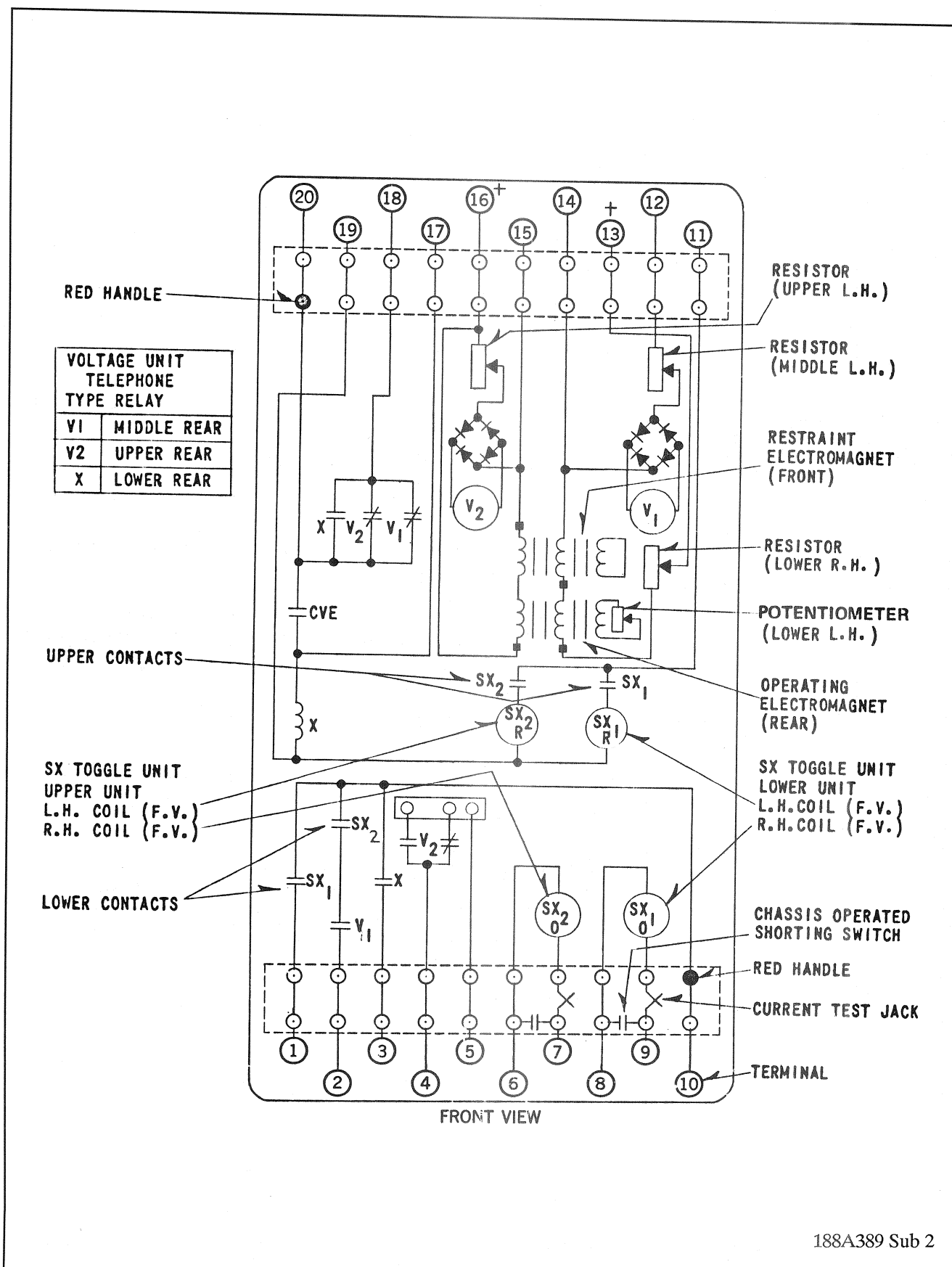


Figure 20 Internal Schematic CVE-1 with internal Switch
for HBDL or HLDB. (See Fig. 26 External
Schem.). With commoned voltage coils, use
with phase to phase connected vt's



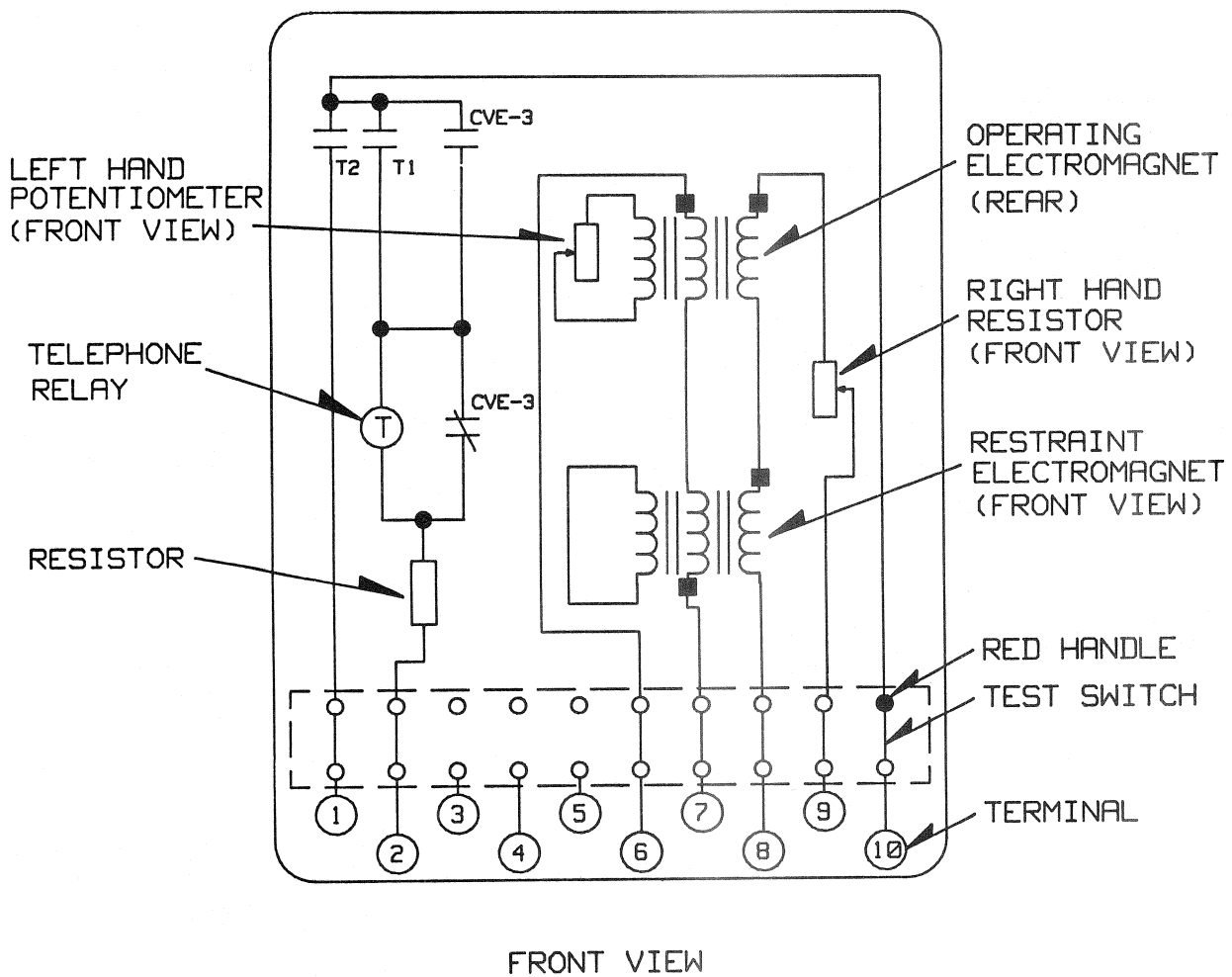
880A496 Sub 1

Fig. 21 Internal Schematic CVE-1 without Commoned Potential Coils (See Fig. 5 for External Schematic.)



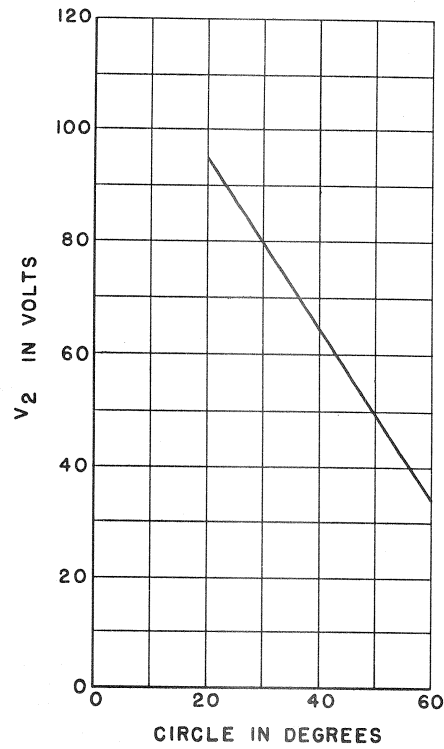
188A389 Sub 2

Fig. 22 Internal Schematic CVE-2



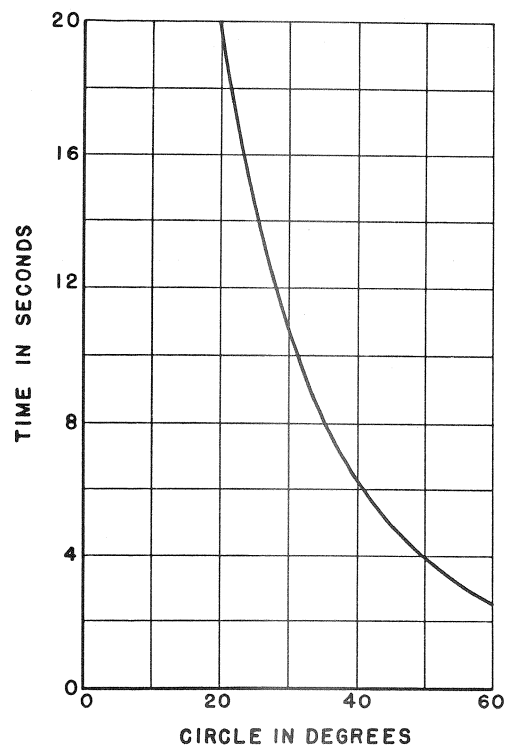
9646A84 Sub 2

Fig. 23 Internal Schematic CVE-3



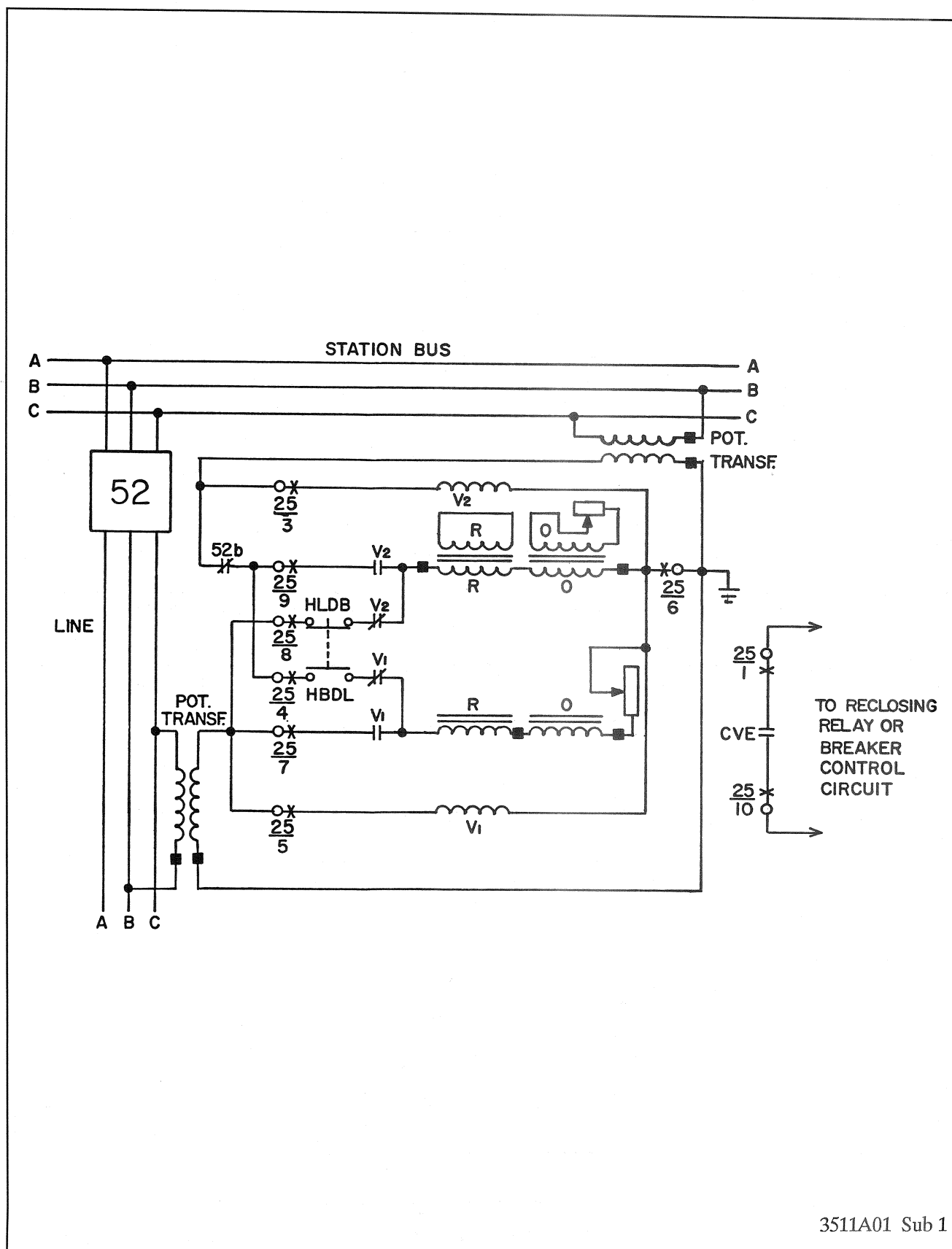
471191

Fig. 24 V_1 Voltage for Different Operating Circle. V_2 Equal to Rated Voltage at Zero Phase Angle.



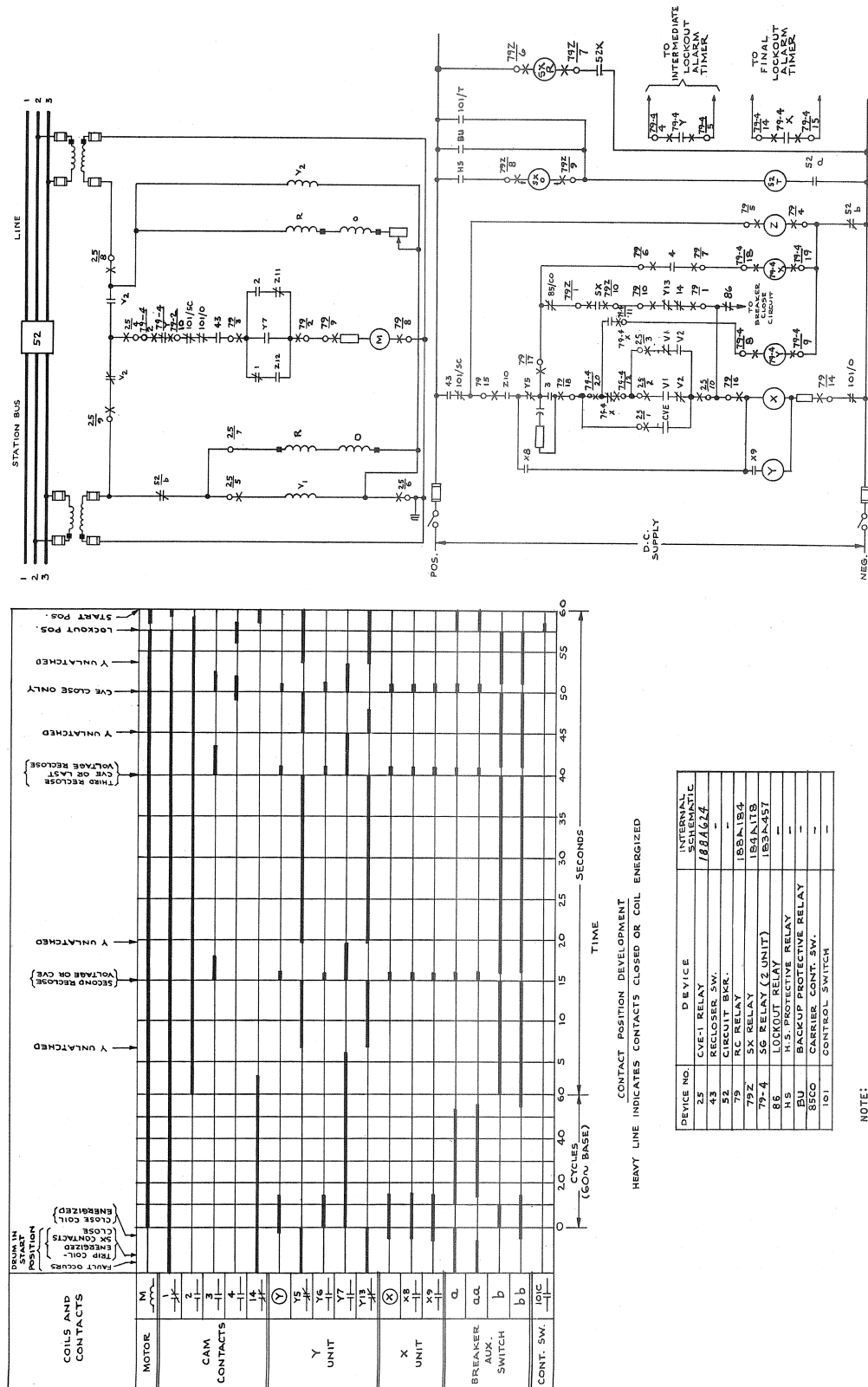
471192

Fig. 25 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.



3511A01 Sub 1

Fig. 26 External Schematic CVE-1



DEVICE NO.	DEVICE	INTERNAL SCHEMATIC
25	CVE-1 RELAY	188A1624
43	RECLOSER SW.	-
52	CIRCUIT BKR.	-
79	RC RELAY	188A184
79Z	RC RELAY	184N118
79-4	RC RELAY (2 UNIT)	183A-457
86	LOCKOUT RELAY	-
HS	N.S. PROTECTIVE RELAY	-
BU	BACKUP PROTECTIVE RELAY	-
850	CARRIER CONT. SW.	-
101	CONTROL SWITCH	-

NOTE:
SPECIAL SETTING OF CONTACT #4 FOR
INTERMEDIATE LOCKOUT FOR SYNCH
CHECK CLOSE ONLY.

Fig. 27 External Schematic CVE-1

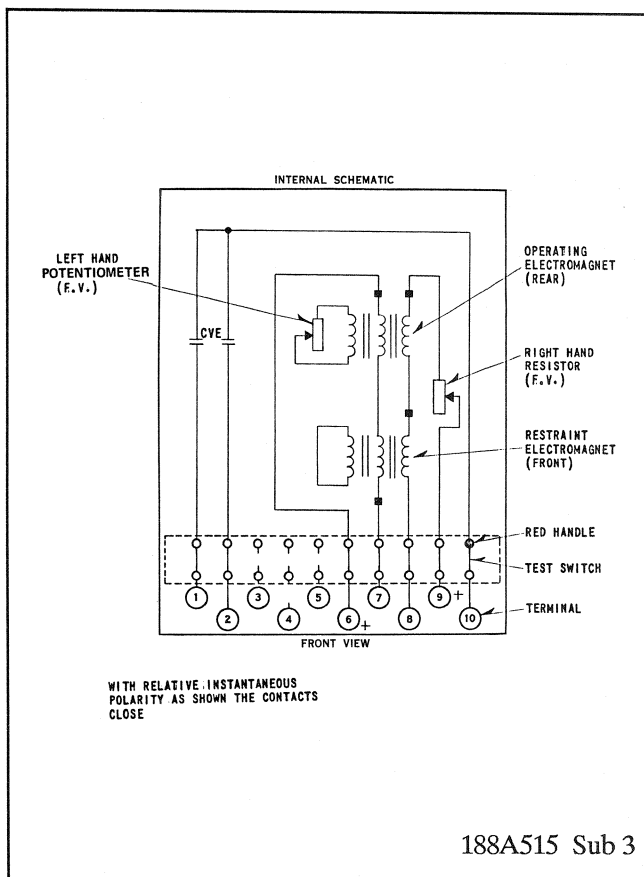


Fig. 28 Internal Schematic of CVE Synchro-Verifier DPST Contacts

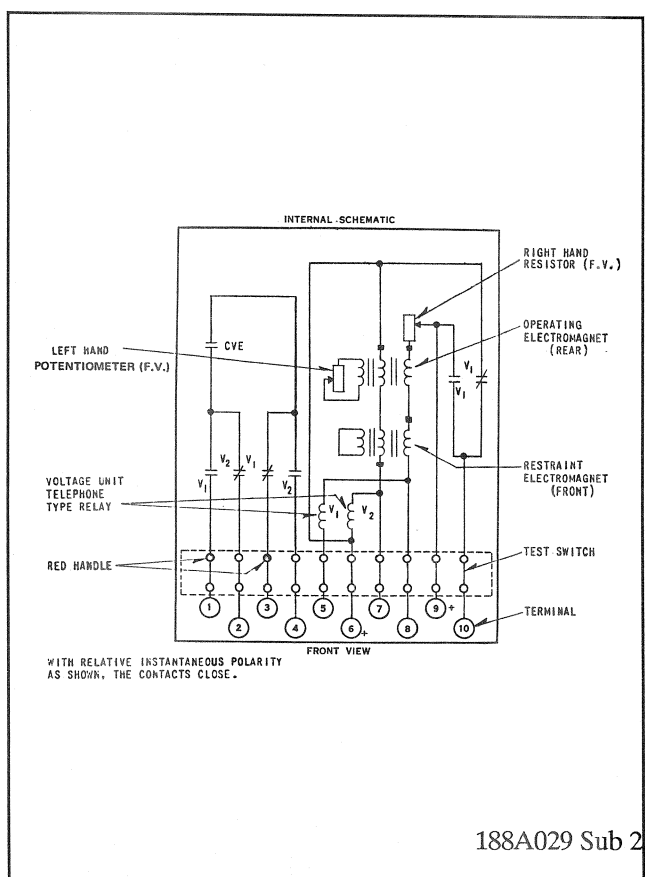


Fig. 29 Internal Schematic of CVE-1 with CVE Contacts Supervised By Voltage Contacts.

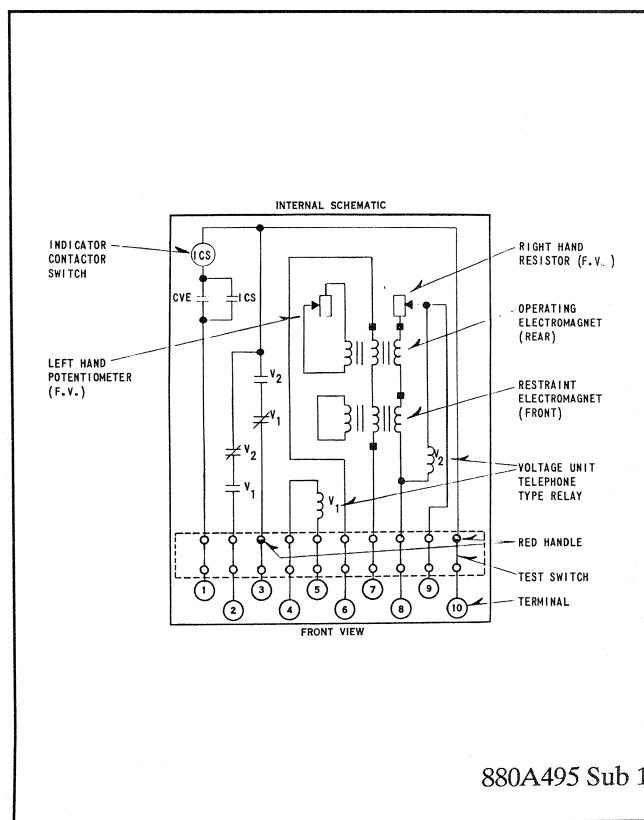


Fig. 30 Internal Schematic of CVE-1 without Commoned Potential Coils, with ICS.

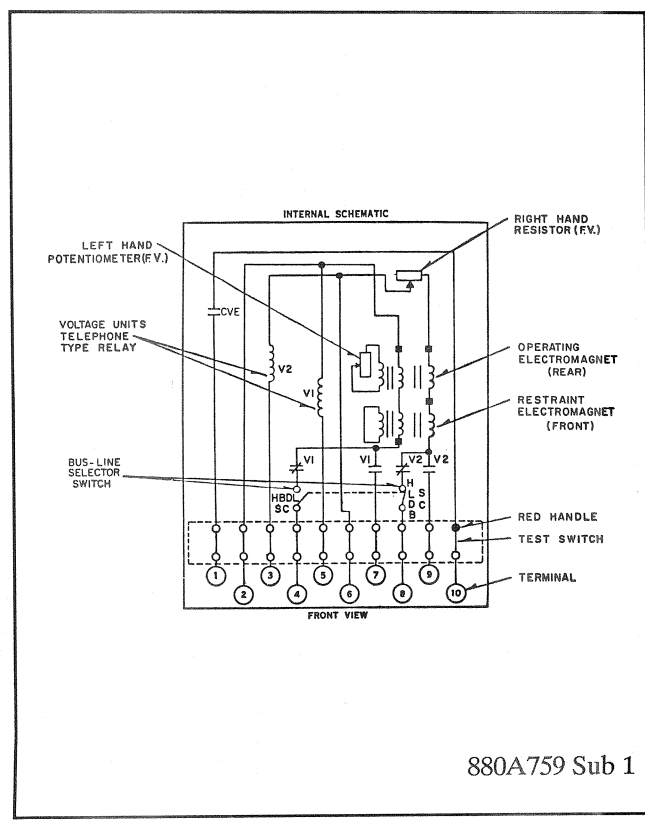


Fig. 31 Internal Schematic of CVE-1 with DPDT Switch, without Commoned Potential Coils

29



Fig 33 Outline & Drilling Diagram for Relay Case Type FT-32

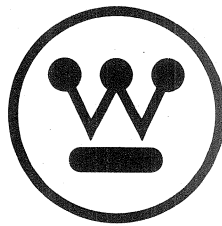


ABB Power T&D Company Inc.
Relay Division Coral Springs, FL 33065

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