INSTRUCTIONS

For Installation

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INTRODUCTION

⚠ CAUTION

The equipment covered by this publication must be selected for a specific application and it must be installed, operated, and maintained by qualified persons who are thoroughly trained and who understand any hazards that may be involved. This publication is written only for such qualified persons and is not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

The S&C Switch Operator—Type CS-2A is a high-speed, high-torque operator expressly designed for power operation of S&C Circuit-Switchers—Mark IV, Center-Break Style, rated 345 kv and 500 kv, with six gaps. It is not intended for operation of any other devices.

High-speed, high-torque power operation of six-gap Center-Break Style Mark IV Circuit-Switchers, by means of S&C Switch Operator—Type CS-2A, is required to provide two-time duty-cycle fault-closing ratings (345-kv Circuit-Switchers only) of 40,000 amperes rms three-phase symmetrical, 102,000 amperes peak; opening and closing without hesitation under 1½-inch ice formation; close interphase simultaneity; long life of fault-closing contacts under normal operating duties; and avoidance of excessive switching transients due to prolonged or unstable prestrike arcing.

SWITCH OPERATORS—Type CS-2A①

Application		Motor and Control Voltage	Maximum Operating Time, Seconds②	Minimum Locked-Rotor Torque at Rated Control Voltage, Inch-Lbs.	Accel-erating Current, Amperes	Catalog Number	Schematic Wiring Diagram Drawing Number
High-Voltage Device	Style and Rating of High-Voltage Device						
S&C Mark IV◆ Circuit-Switcher without Shunt-Trip Device	Center-Break, 345 and 500 kv, 6 gaps	125 v dc	2.0	40 000■	104	38841R1-B	CDR-3130R1
S&C Mark IV◆ Circuit-Switcher with Shunt-Trip Device	Center-Break: 345 and 500 kv, 6 gaps	125 v dc	2.2	40 000■	104	38840R1-B	CDR-3129R2

① Type CS-2A Switch Operators rotate clockwise to open (as viewed from the top)

② Based on minimum battery and external control wire-size requirements specified in S&C Data Bulletin 719-60, operating time will be less if larger-than-minimum battery size and/or external control wire size is utilized. Maximum blade-travel time is 1.9 seconds for Switch Operator Catalog Number 38841R1-B, 2.1 seconds for Switch Operator Catalog Number 38840R1-B.

◆ The Type CS-2A Switch Operator is also suitable for use with equivalent models of Mark II Circuit-Switchers.

■ This minimum torque is at the interphase shaft and includes a 6.25 to 1 gear reduction in the gearbox at the Circuit-Switcher base.

Supersedes Instruction Sheet 719-510 dated 4-21-86

INTRODUCTION — Continued

S&C Switch Operators—Type CS-2A include the following features as standard:

- Built-in internal decoupling mechanism, operable by integral external selector handle, with padlocking provisions. Laminated safety-plate window permits "visible air-gap" verification of complete disengagement of output shaft.
- Open-close control switch, mounted inside the enclosure.
- Removable manual operating handle, stored inside the enclosure door.
- Mechanical position indicators for both switch operator and Circuit-Switcher "open" and "closed" positions.
- Non-reset electric operation counter.
- Laminated safety-plate window for inspection of built-in internal decoupling mechanism and of mechanical position indicators.
- Foolproof recoupling. Impossible with position-indicating drums to couple the switch operator and the Circuit-Switcher "unsynchronized."
- Fingertip precision adjustment of output-shaft rotation using self-locking spring-biased cams.
- Eight-pole auxiliary switch, coupled to motor, with fingertip precision adjustment of individual contacts using self-locking spring-biased cams.
- Antifriction bearings throughout; tapered roller bearings for all high-torque gear-train shafts.
- Two-pole pull-out fuseholder for space-heater circuit; two-pole pull-out fuseholder and series disconnect switch for motor-control circuit.
- Weatherproof, dustproof enclosure, equipped with 120/240-volt ac space heater, factory-connected for 240-volt ac operation. Can readily be field reconnected for 120-volt ac operation.
- Tamper-resistant design—welded enclosure; baffled louvers; gasketed, flanged door openings; cam-action door latch; provisions for padlocking.
- Foul-weather accessibility to interior of enclosure. Access is by door rather than by removal of entire enclosure.

Switch operator catalog numbers are suffixed with one or more letters. The first letter following the catalog number, -B, designates the motor and control voltage, 125 volts dc. Other suffix letters which may be added to the switch operator catalog number indicate the inclusion of optional accessories as follows:

ACCESSORIES

Item	Suffix Added to Switch Operator Catalog Number
Space Heater Thermostat	-K
Key Interlock with Switch, locks Circuit-Switcher open and disconnects motor-control circuit	-L
Position-Indicating Lamps (one red, one green), mounted inside the enclosure	-M
Extra Auxiliary Switch (individually adjustable contacts), 4-PST (coupled to motor)	-Q
Duplex Receptacle and Convenience-Light Lampholder with Switch	-V
Extra Auxiliary Switch (individually adjustable contacts), 8-PST (coupled to Circuit-Switcher)	-W

Step 1

Mount the switch operator as indicated on the erection drawing. Do not install the vertical shaft until so directed in Step 5.

Step 2

Mark the conduit-entrance location for the control-circuit wiring on the conduit-entrance plate in the bottom of the switch operator enclosure. See Figure 1.

Remove the conduit-entrance plate and cut out the necessary opening. (If Circuit-Switcher is equipped with the optional S&C Shunt-Trip Device, an entrance cutout for an additional one-inch-diameter conduit should also be made at this time.)

Replace the conduit-entrance plate and make up the entrance fittings. Apply sealing compound (provided with each switch operator) when replacing the conduit-entrance plate. Verify that the entrance fittings are properly sealed to prevent water ingress.

Step 3

If Circuit-Switcher is equipped with the optional shunt-trip device, install the one-inch-diameter conduit between adjacent shunt-trip solenoid housings and between one solenoid housing and the switch operator. Refer to S&C Instruction Sheet 711-600.

Step 4

⚠ CAUTION

To avoid accidental energizing of the operator after the external connections have been completed, remove the motor-circuit two-pole pull-out fuseholder. See Figure 1. Reinsert the fuseholder only when preparation for electrical operation is under way.

Connect the external control-circuit wiring (including space-heater source leads) to the terminal blocks of the switch operator in accordance with the wiring diagram furnished.

⚠ CAUTION

Unauthorized changes should not be made in the wiring of this switch operator. Should a control-circuit revision appear desirable, it should be made only on the authority of a revised wiring diagram which has been approved by both the user and S&C Electric Company.

⚠ IMPORTANT

Observe recommended minimum wire-size requirements for the control-circuit wiring, and the shunt-trip device wiring where applicable, as shown in S&C Data Bulletin 719-60 and on the switch-operator schematic wiring diagram furnished.

Note: Wiring must be complete and adequate control voltage must be available at the switch operator before checkout by an S&C factory specialist.

Step 5

Install the vertical shaft as follows:

(a) Bring the switch operator output shaft to the same position (open or closed) as that of the Circuit-Switcher, as explained in detail under MANUAL OPERATION.

(b) Attach the vertical shaft to the hexagonal shaft that extends downward from the center Circuit-Switcher pole-unit, using one of the two flexible couplings provided.

(c) Attach the lower end of the vertical shaft to the switch operator output shaft, using the other flexible coupling.

It may be necessary to rotate the switch operator output shaft slightly to match its hexagonal faces with those of the coupling. As a result, the alignment arrow on the Circuit-Switcher mechanical position-indicating drum may be somewhat off-center with respect to the opening through which it appears. See Figure 3. Disregard this for the moment. After the travel-limit switch has been adjusted (Steps 9 and 10), the arrow may require a final centering, instructions for which are given in Step 12.

(d) Attach the braidless vertical-shaft grounding device as follows:

First mount the contact-shoe-and-support assembly to a suitable mounting angle, at least 5¼ inches above the top of the switch operator output shaft. (S&C Mounting Pedestals incorporate this mounting angle.)

Next, loosely attach the contact-sleeve-and-weather-shield assembly to the vertical shaft and slide it down to a position where the contact shoes are fully engaged with the contact sleeve. Tighten the attachment bolts equally so that the two sections pull together evenly.

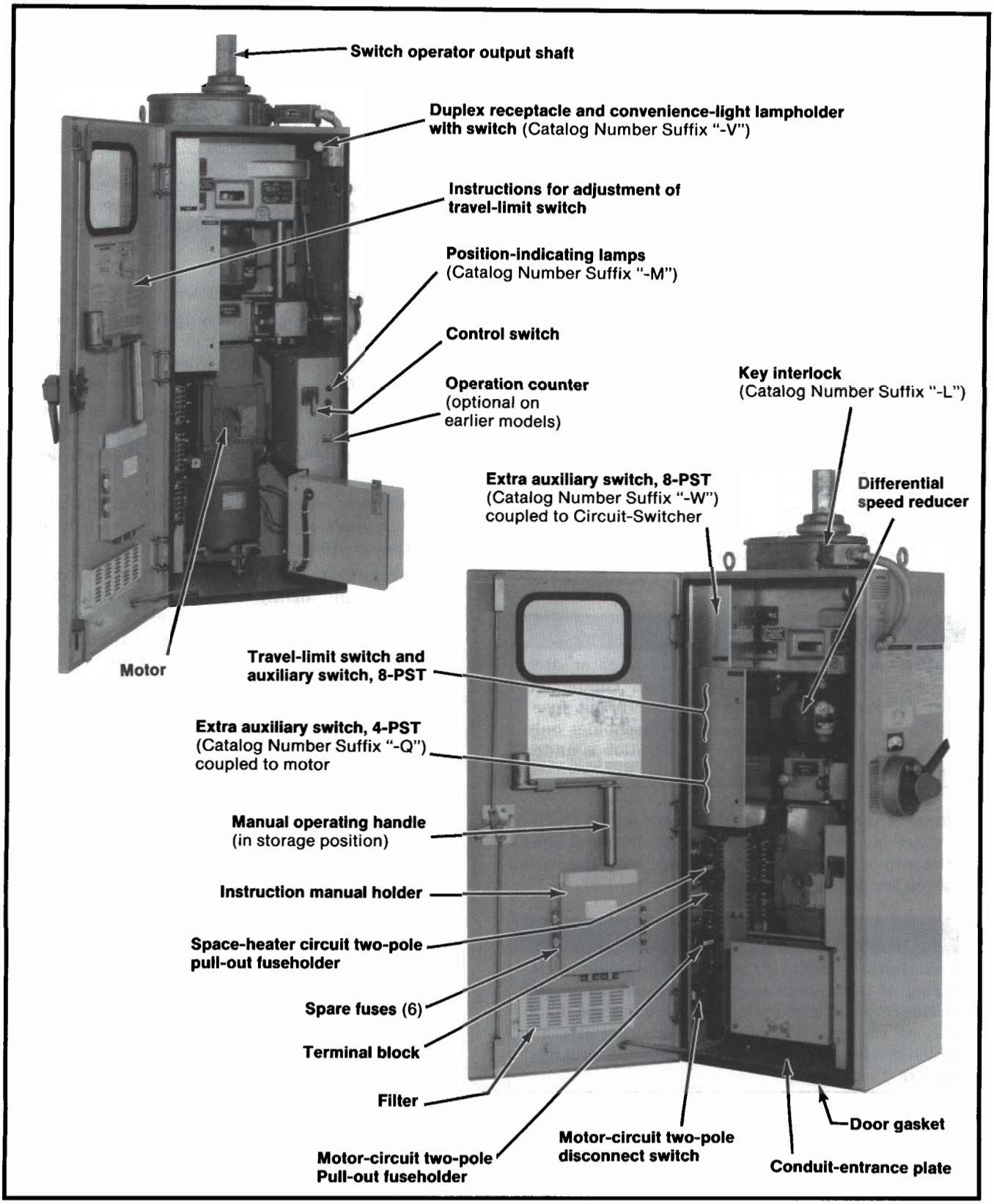

Figure 1. Internal views of switch operator.

Before proceeding further, the user should become familiar with the operation of the manual operating handle and the selector handle as described on the switch operator nameplate on the right-hand side of the enclosure and in Steps 6, 7, and 8 below. See Figures 2 and 3.

Step 6

To decouple: To permit electrical operation, testing or exercising of the switch operator without affecting the position of the Circuit-Switcher, or to permit manual operation of the Circuit-Switcher, an internal decoupling mechanism is provided.

The selector handle, for external operation of the built-in internal decoupling mechanism, is located on the right-hand side of the switch operator enclosure. See Figure 2. Pull the latch knob to release the selector handle and rotate it counterclockwise approximately 100 degrees to the decoupled position. Release the latch knob to lock the handle in position. Moving the selector handle to its decoupled position releases the switch operator motor and gear train from the switch operator output shaft, and connects the manual-operating-handle shaft to the output shaft. When the selector handle is in the decoupled position, the shunt-trip device (when this option is provided) is rendered inoperative.★ Electrical testing of the operator may be performed in its decoupled position. Do not, however, operate electrically while the switch operator is in the coupled position until the adjustments described in Steps 9, 10, and 11 are completed.

Visual inspection, through the observation window, will verify whether the internal decoupling mechanism is in the coupled or decoupled position. See Figure 3. The selector handle may be padlocked in either position.

★ Only the shunt-trip device is rendered inoperative. The switch operator can still be opened through the user's protective-relay circuit. Thus "elective" checkout of the system protective scheme is possible at any time.

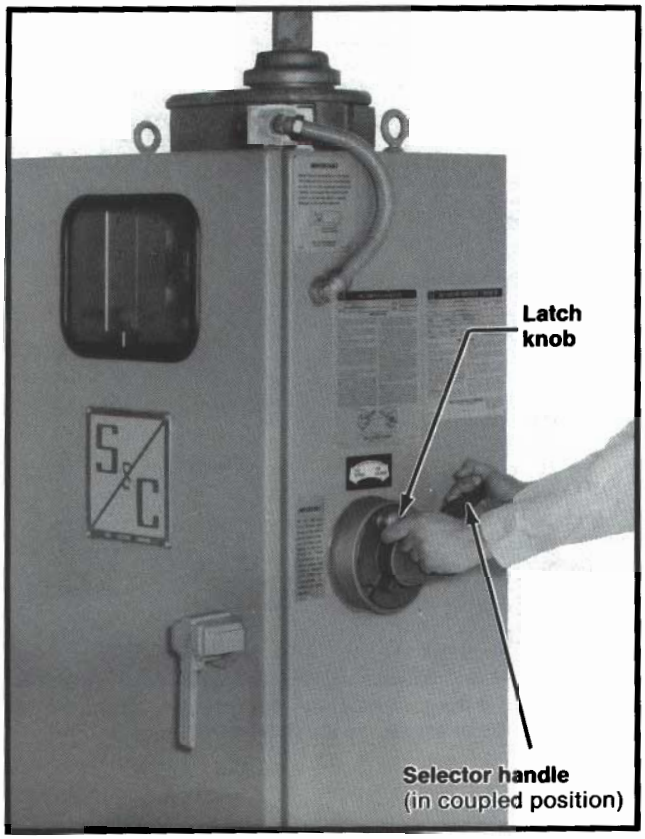

Figure 2. Selector handle operation.

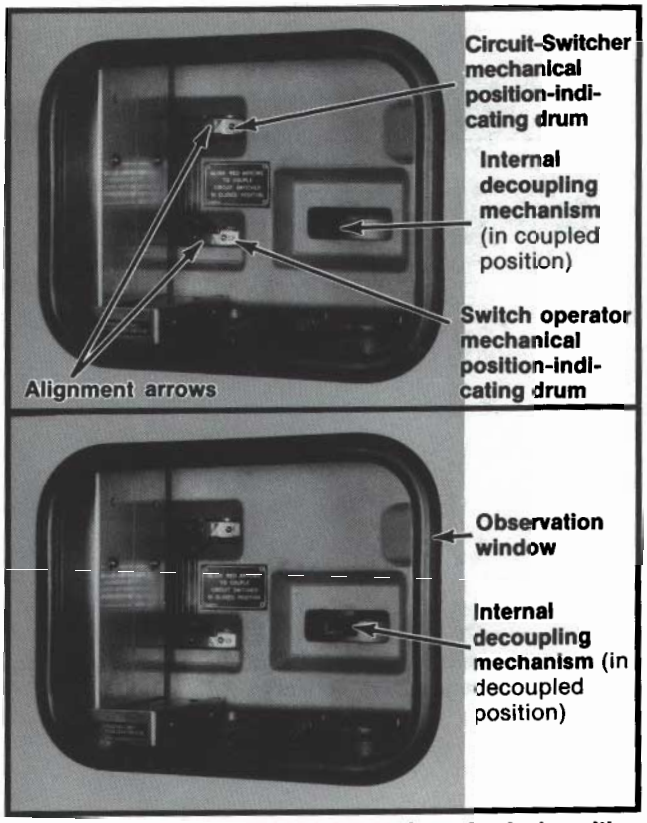

Figure 3. Decoupling mechanism and mechanical position indicators.

Step 7

⚠ CAUTION

Manual closing of an *energized* Circuit-Switcher is not recommended because of the possibility of closing into a fault. Manual opening of an energized Circuit-Switcher is permissible. Once the opening operation has been initiated, however, it should be completed with dispatch. Cranking should continue until the Circuit-Switcher is fully open, as indicated by resistance which will be felt as the Circuit-Switcher power train progresses to its stops. As the Circuit-Switcher moves toward the open position, the interrupters will close and the stored-energy source within the brains will charge and latch. The Circuit-Switcher disconnect blades should *never* be in the closed position when the interrupters are in the open position.

To operate manually: With the selector handle in the decoupled position, remove the manual operating handle from its storage position inside the enclosure door. Open the cover, located at the pivot point of the selector handle, to expose the manual-operating-handle shaft. See Figure 4. Opening the cover will automatically disconnect both leads of the control source to prevent electrical operation. However, during manual operation, the switch operator may also be disconnected from the control source by opening the two-pole motor-circuit disconnect switch. Attach the manual operating handle to the shaft and crank to open or close the Circuit-Switcher. An arrow label above the shaft indicates the cranking direction to close. Since the cover can be opened only when the selector handle is in the decoupled position, the manual operating handle can drive only the output shaft—not the motor and gear train.

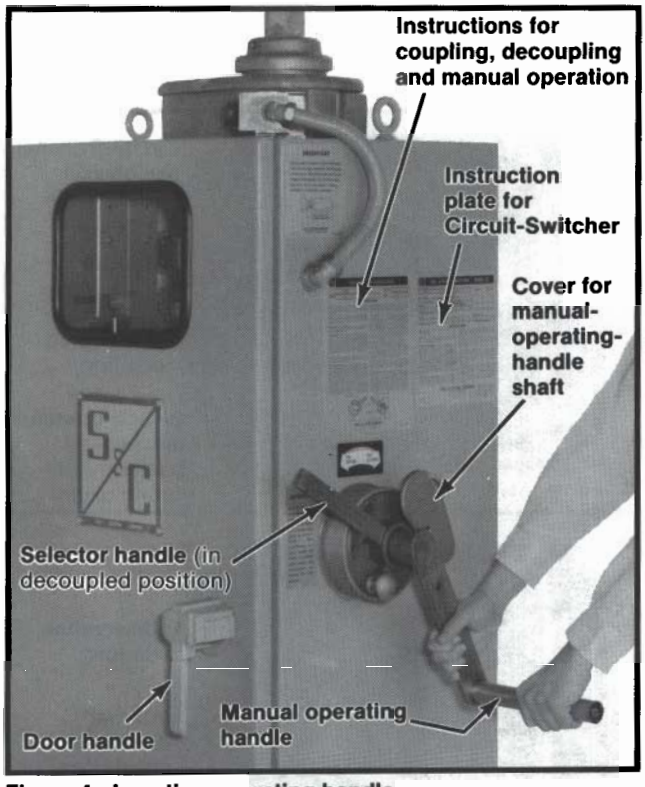

Figure 4. Inserting operating handle.

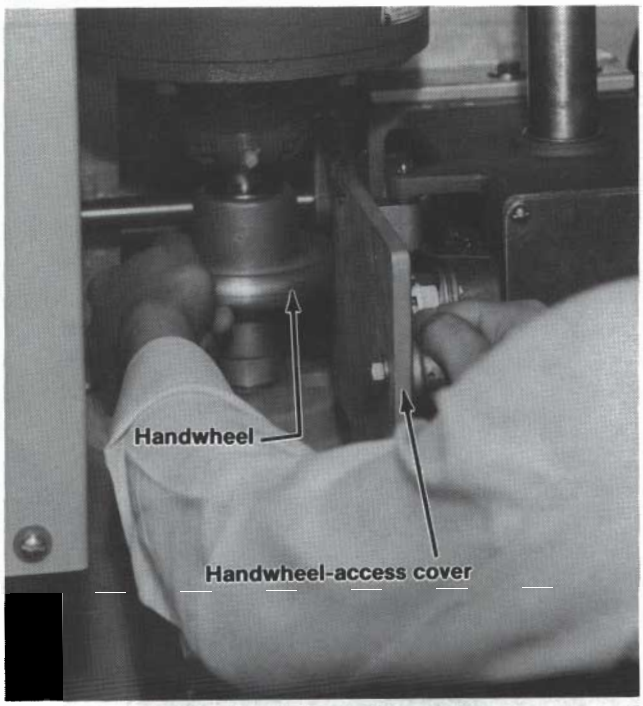

Figure 5. Operating handwheel for precise alignment of matching pairs of arrows as illustrated in Figure 3.

Step 8

To couple: Determine the position of the switch operator output shaft, and the switch operator motor and gear train, by observing the mechanical position-indicating drums which appear in the two openings inside the enclosure at the upper left. See Figure 3. The upper drum is coupled to the switch operator output shaft. The green and red arrows on this drum indicate open and closed positions, respectively, of the Circuit-Switcher. The switch operator motor and gear train can be coupled to the Circuit-Switcher power train when they are in the same relative position as indicated by the matching pairs of green or red arrows.

Approximate alignment of matching pairs of red or green arrows can be accomplished by manual operation of the Circuit-Switcher as explained in Step 6, or by electrical operation of the switch operator. When arrows are in approximate alignment, obtain precise alignment by turning the handwheel provided on the motor shaft. See Figure 5. Opening the handwheel-access cover automatically releases the motor brake and opens the motor-contactor control circuit.

When the matching pairs of red or green arrows are in precise alignment, pull the latch knob on the selector handle and rotate the handle clockwise. Release the latch knob to lock the selector handle in the coupled position.

ADJUSTMENTS

Be sure that the mechanics of coupling, decoupling, and manual operation, as explained in Steps 6, 7, and 8, are thoroughly understood. Now proceed with the adjustments of the travel-limit switch, as described in Steps 9, 10, and 11. To preclude possible damage to the power train, do not electrically operate the switch operator while the selector handle is in the coupled position until after completion of Step 11.

The travel-limit switch (coupled to the motor), which governs the extent of output-shaft rotation in the opening and closing directions, includes six contacts that are operated by cam-actuated rollers. Positioning of the cams to properly engage the rollers is facilitated by the travel-limit discs (upper one is the opening-stroke travel-limit disc; lower one is the closing-stroke travel-limit disc).

Step 9

Closing-stroke adjustment:

(a) With the selector handle in the decoupled position, attach the manual operating handle and crank the Circuit-Switcher to its *fully* closed position.

(b) Remove the manual operating handle and move the cover for the manual-operating-handle shaft to the closed position. The selector handle itself must remain in the *decoupled* position.

(c) Electrically operate the switch operator to open, and then to close.

(d) Observe the red arrows on the upper and lower position-indicating drums. Adjust the travel-limit switch so that, at the completion of the closing stroke, the red arrows are vertically aligned. (Arrows will not necessarily be centered with respect to the openings through which they appear.)

To make this adjustment, lower the closing-stroke travel-limit disc (see Figure 6A) approximately 3/16 inch and rotate the disc clockwise to increase travel, or counterclockwise to decrease travel. Then raise the disc and make sure it is engaged.

Repeat the electrical open-close operations of the switch operator, and make disc adjustments as required, until vertical alignment of the red arrows is obtained.

Step 10

Opening-stroke adjustment:

(a) With the selector handle in the decoupled position, attach the manual operating handle and crank the Circuit-Switcher to its *fully* open position.

(b) Remove the manual operating handle and move the cover for the manual-operating-handle shaft to the closed position. The selector handle itself must remain in the *decoupled* position.

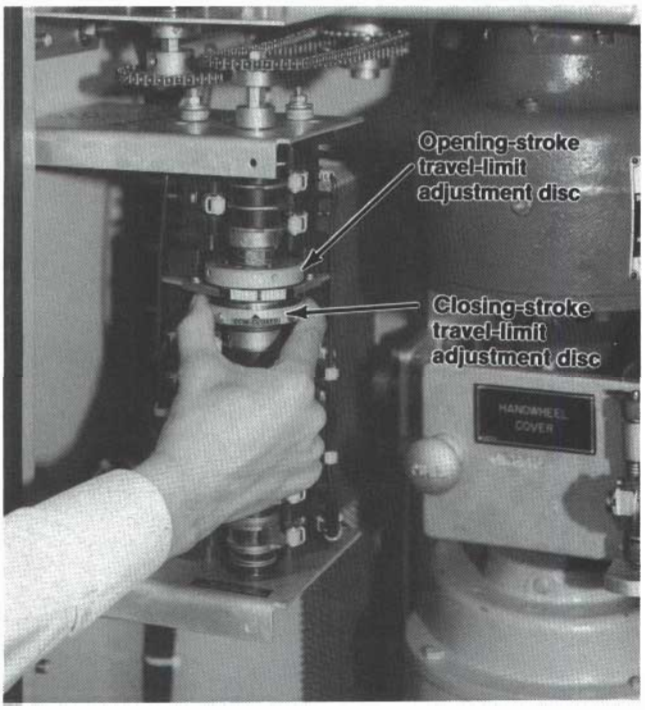

Figure 6A. Adjusting travel-limit switch.

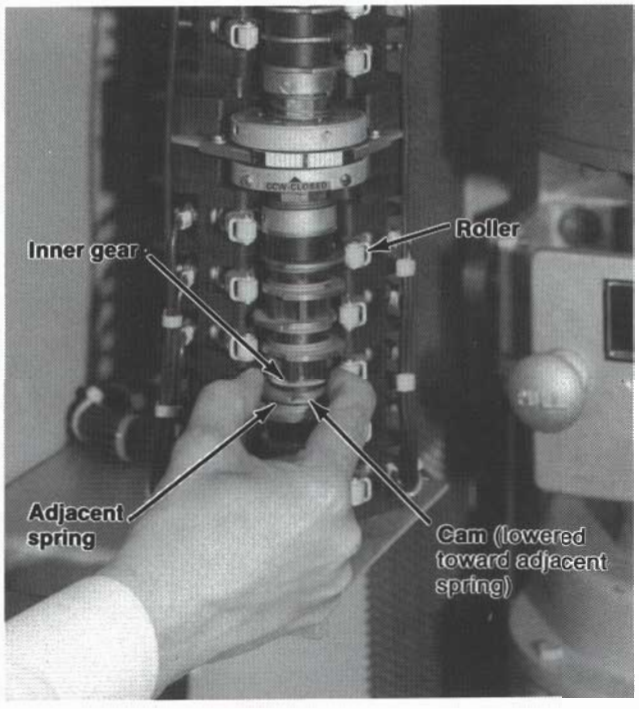

Figure 6B. Adjusting auxiliary switch.

(c) Electrically operate the switch operator to close, and then to open.

(d) Observe the green arrows on the upper and lower position-indicating drums. Adjust the travel-limit switch so that, at the completion of the opening stroke, the green arrows are vertically aligned. (Arrows will not necessarily be centered with respect to the openings through which they appear.)

To make this adjustment, raise the opening-stroke travel-limit disc (see Figure 6A) approximately 3/16 inch and rotate the disc clockwise to decrease travel, or counterclockwise to increase travel. Then lower the disc and make sure it is engaged.

Repeat the electrical close-open operations of the switch operator, and make disc adjustments as required, until vertical alignment of the green arrows is obtained.

The preceding adjustments (Steps 9 and 10) were made to effect a close approximation of the proper travel of the *switch operator*. Those adjustments were a necessary preliminary to the precise adjustments described in Step 11, which will achieve complete opening and closing of the *Circuit-Switcher*. Therefore, attention must now be directed to the drive-shaft cranks, located in each of the Circuit-Switcher pole-unit bases, at the interphase shaft point. The drive-shaft cranks may be observed through the open bottoms of the bases (with the perforated bottom panels removed).

Step 11

Place the selector handle in the coupled position and operate the switch operator electrically to open and close the Circuit-Switcher.

Observe the position of the Circuit-Switcher drive-shaft cranks in both the open and closed positions. See Figure 7. The drive-shaft cranks are now not likely to reach their respective stops in either the open or closed position. This is because the travel-limit switch was adjusted to limit the motor travel in the decoupled (or no-load) condition.

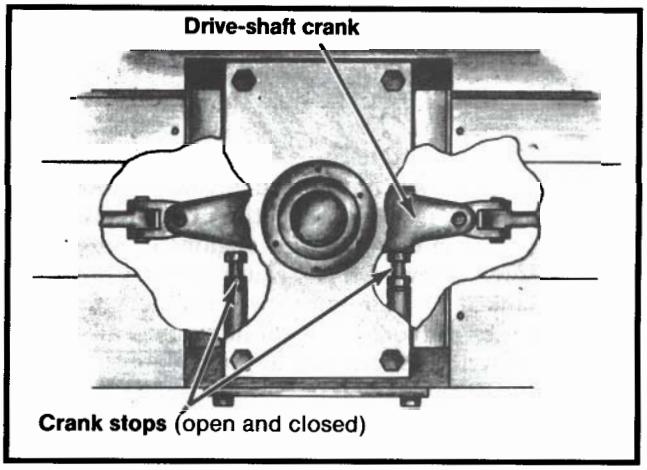

Figure 7. Drive-shaft crank stops on each Circuit-Switcher pole-unit.

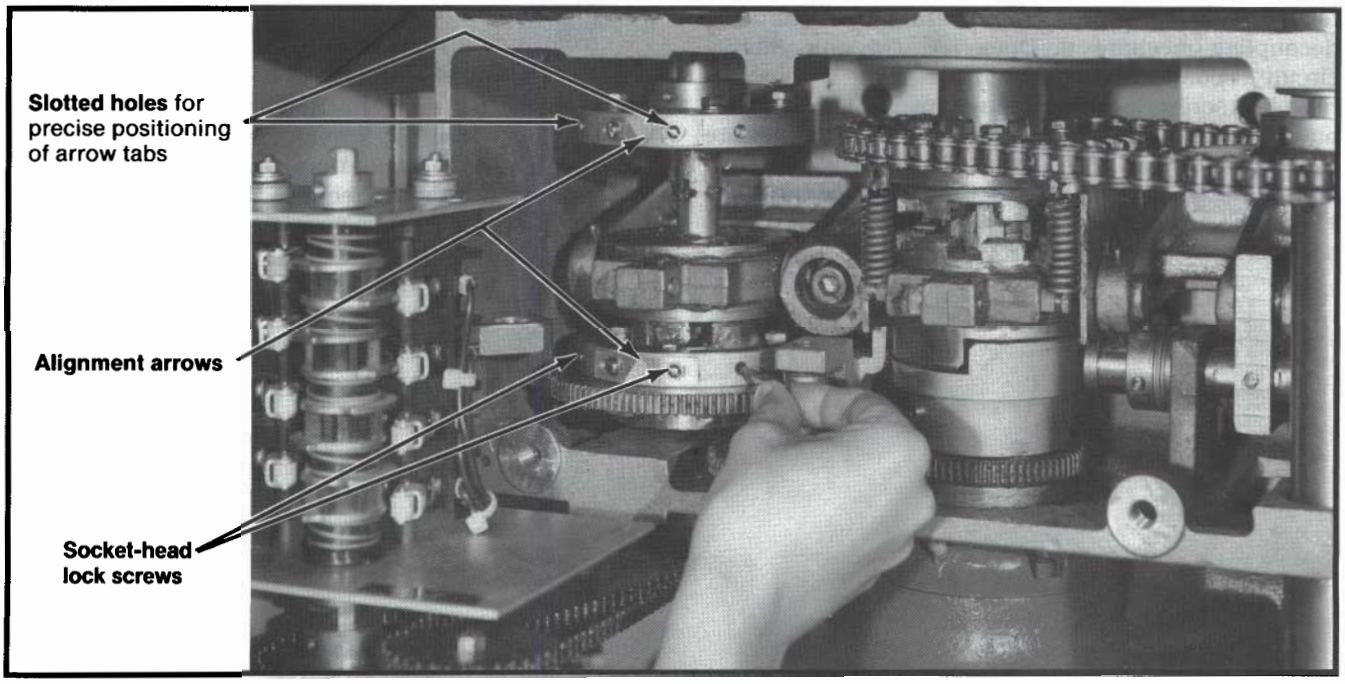

Figure 8. Resetting position-indicating drums.

ADJUSTMENTS — Continued

Carefully retard the travel-limit discs (as described in Steps 9 and 10) to increase travel, in either the opening or closing direction as required, until the Circuit-Switcher drive-shaft cranks come to rest firmly against their corresponding stops in both the open and closed positions. Operate the Circuit-Switcher several times while making these final adjustments to ensure that the drive-shaft crank of each pole-unit attains a definite overtoggle stance in both the open and closed positions. As the drive-shaft cranks strike their stops, there should be no tendency to "bounce." Bouncing indicates that the cranks on the three pole-units are not striking their stops simultaneously. Should this be observed, adjustment should be made in accordance with the Circuit-Switcher instruction sheet furnished.

Step 12

Operate the switch operator electrically to close the Circuit-Switcher. Observe the red alignment arrows on the mechanical position-indicating drums. If these arrows are not in close vertical alignment, loosen the round-headed screws which secure the arrow tabs to the mechanical position-indicating drums, and adjust the arrow tabs as required to obtain vertical alignment (arrows need not be centered in the openings through which they appear). Tighten the round-headed screws.

Operate the switch operator electrically to open the Circuit-Switcher. Adjust the green alignment arrows as described above.

In the unlikely event that the adjustment range of the arrow tabs is not sufficient to obtain vertical alignment of the arrows, unbolt and remove the cover for the mechanical position-indicating drums and the decoupling mechanism. Open the two-pole motor-circuit disconnect switch. Then loosen the two socket-head lock screws located on the drums about two inches on either side of the red arrows. See Figure 8. Rotate the outer rings of the drums as required, and then tighten the socket-head lock screws. Replace the cover and make any further adjustments of the arrow tabs as described above.

Step 13

The auxiliary switch, which is permanently coupled to the motor, includes eight contacts (terminals 11 through 26). (If the optional position-indicating lamps are included, six contacts are available.) These contacts are provided so that external circuits can be established to monitor switching operations. Each contact is operated by a cam-actuated roller. The cams are individually adjustable in 4.5-degree increments and can be positioned so that roller engagement occurs at the desired point in the operating cycle.

The "standard" configuration for the auxiliary switch consists of four "a1" contacts (terminals 11 through 18) and four "b1" contacts (terminals 19 through 26). Thus, with the switch operator in the open position, the "a1" contacts are open and the "b1" contacts are closed. Conversely, with the switch operator in the closed position, the "a1" contacts are closed and the "b1" contacts are open.

Any auxiliary-switch contact being used must be checked for proper engagement *after* the switch-operator travel-limit discs have been adjusted. Check the auxiliary-switch contacts for both the open and closed positions of the switch operator. To adjust the auxiliary-switch contacts, refer to Figure 6B and proceed as follows:

(a) With the selector handle in the coupled position, operate the switch operator to the fully closed position.

(b) Open the two-pole motor-circuit disconnect switch.

(c) Determine which "a1" contacts are not in the closed position. A contact is closed if its roller is disengaged from a cam and, conversely, a contact is open if its roller is engaged by a cam.

(d) For the "a1" contacts that are not in the closed position, raise (or lower) the corresponding cam toward its adjacent spring until the cam is separated from the teeth of the inner gear. Rotate the cam until it is in a position so that when lowered

(or raised) it will be disengaged from the roller. Lower (or raise) the cam making sure that the teeth are in mesh with the inner gear and that the cam is disengaged from the roller.

(e) Close the motor-circuit disconnect switch.

(f) Operate the switch operator to the fully open position. Open the motor-circuit disconnect switch and, if necessary, adjust the cams as described in (d) above until all "b1" contacts are in the closed position.

(g) Close the motor-circuit disconnect switch and operate the switch operator. Both sets of contacts should now be correctly positioned for both open and closed positions of the Circuit-Switcher. Sufficient adjustment is available to provide correct positioning of both sets of contacts.

Since each cam can be individually adjusted in 4.5-degree increments, any "a1" contact can be changed to a "b1" contact, or vice versa. Also, because of the many positions to which the cams can be adjusted, the various rollers can be engaged or disengaged to respectively open or close their contacts simultaneously, sequentially, randomly, or in various combinations. Adjustment of the auxiliary switch for other than the "standard" contact configuration is left to the user. Remember that the motor-circuit disconnect switch should be open when adjusting these contacts. (Switch operators having catalog numbers with the suffix "-Q" are equipped with an extra auxiliary switch, terminals 27 through 34, having four contacts—two "a1" and two "b1"—which may be adjusted as described in (a) through (g) above. See Figure 6B.)

Step 14

Switch operators having catalog numbers with the suffix "-W" are equipped with an extra auxiliary switch which is permanently coupled to the Circuit-Switcher. The suffix "-W" auxiliary switch consists of eight contacts (terminals 35 through 50). These contacts are provided so that external circuits can be established to monitor Circuit-Switcher operation. Each contact is operated by a cam-actuated roller and the cams are individually adjustable in 4.5-degree increments.

The "standard" configuration for the suffix "-W" extra auxiliary switch consists of four "a2" contacts (terminals 35 through 42) and four "b2" contacts (terminals 43 through 50). Thus, with the Circuit-Switcher in the fully closed position, the "a2" contacts should be closed and the "b2" contacts should be open. Conversely, with the Circuit-Switcher in the fully open position, the "a2" contacts should be open and the "b2" contacts should be closed. See Figure 6B.

Any suffix "-W" auxiliary-switch contact being used must be checked for proper operation after satisfactory electrical operation of Circuit-Switcher has been achieved. Check the auxiliary-switch contact engagement for both the open and closed positions of the Circuit-Switcher. Adjustment of the suffix "-W" extra auxiliary switch is identical to the adjustment performed for the auxiliary switch and the suffix "-Q" extra auxiliary switch. Therefore, if adjustment of the suffix "-W" auxiliary switch is needed, refer to Step 13 and Figure 6B.

INSPECTION SCHEDULE AND PROCEDURES

To assure continued proper performance of Circuit-Switcher and Type CS-2A Switch Operator, they should be inspected in accordance with S&C's recommended schedule and procedures contained in S&C Instruction Sheet 711-590. (These procedures, incidentally, take the place of the annual exercising which has, up until the October 28, 1985 issuance of Instruction Sheet 711-590, been recommended for Circuit-Switcher and its operator.)

The Type CS-2A Switch Operator may be conveniently decoupled from the Circuit-Switcher, thereby permitting elective exercising of the operator at any time without requiring an outage or switching to an alternate source; when the switch operator is in the decoupled position, the shunt-trip device—if furnished—is rendered inoperative, thereby permitting checkout of the system protective scheme.

CHECKING SWITCH OPERATOR AND CIRCUIT-SWITCHER POSITIONS

Do not assume that the switch operator position necessarily indicates the open or closed position of the Circuit-Switcher. Upon completion of an opening or closing operation (electrical or manual), check to be sure that the following conditions exist:

- The mechanical position-indicating drums for both Circuit-Switcher and switch operator show a matched pair of green alignment arrows for a Circuit-Switcher open position, or a matched pair of red alignment arrows for a Circuit-Switcher closed position. See Figure 3. Also note the position-indicating lamps, Figure 1, if furnished.
- The Circuit-Switcher disconnect blades on each pole-unit are fully open or fully closed.

Then tag and padlock the switch operator in accordance with standard system operating procedures. In all cases, make certain that the switch operator is padlocked before "walking away."

Correct operation of the Circuit-Switcher depends on charging and latching the stored-energy source within each brain as the disconnect blades move to the fully open position and the interrupters close. The interrupter target located on the side of each brain housing appears yellow when the interrupters are open. The target appears gray (normal) when the interrupters are closed.

Because the interrupters are closed as the Circuit-Switcher blades move to the fully open position, the target appears yellow only briefly during the opening operation. The target should not appear yellow when Circuit-Switcher is in the fully open or fully closed position.

⚠ CAUTION

Interrupters should *never* be in the open (unlatched) position when the disconnect blades are in the closed position. To close the interrupters, Circuit-Switcher must be completely opened and then reclosed. For this reason, the switch operator incorporates a control circuit that causes it to return automatically to the open position whenever power is restored while the switch operator is at any position between fully open and fully closed. Such action takes place regardless of the direction in which the switch operator was operating prior to loss of voltage. This control circuit is a built-in safety feature to prevent Circuit-Switcher from being closed from a partially open position after the interrupters have tripped open.

To restore to normal operation

So that the switch operator is ready for normal operation of Circuit-Switcher by remote automatic or supervisory control, be sure that the following conditions exist:

- The selector handle is in the coupled position.
- The two-pole motor-circuit disconnect switch is closed.
- The switch operator is tagged and padlocked in accordance with standard system operating procedures.