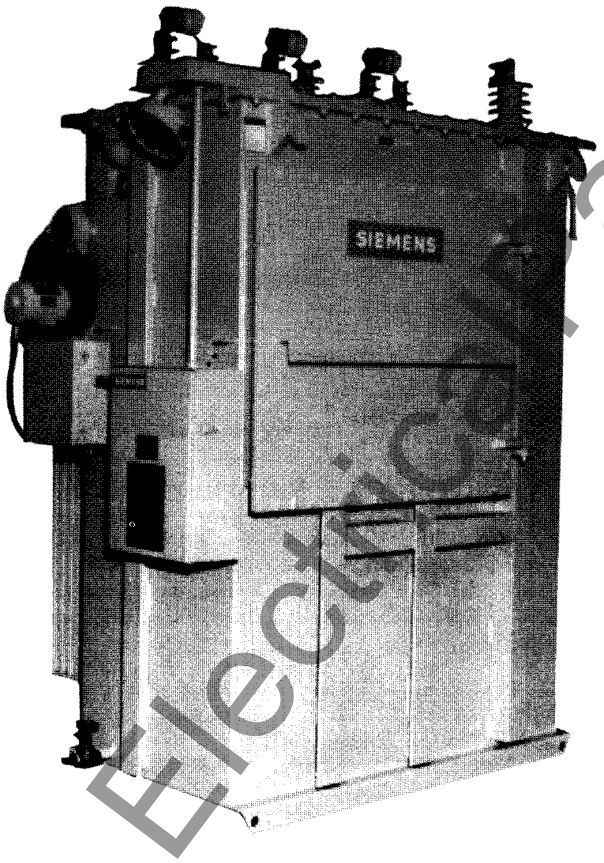
SIEMENS

**Installation • Operation • Maintenance**

# Instructions

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SUPERCEDES
21-115527-007
PR4022-01

SFR DISTRIBUTION
STEP-VOLTAGE REGULATOR

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# INTRODUCTION



The SFR three-phase step-voltage regulators are designed to give dependable service and to make installation, operation and maintenance as simple as possible.

Technological advances, especially in the realm of the control apparatus, make it efficient to provide a separate instruction manual for the *AcculStat*™ control provided with this SFR Regulator. For specific control information, refer to the *Accu/Stat* control manual included with the regulator.

## ⚠ WARNING

This equipment contains hazardous voltages. Severe personal injury or property damage can result if safety instructions are not followed.

Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices, and maintenance procedures contained herein. The successful and safe operation of this equipment is dependent upon proper handling, installation, operation and maintenance.

## QUALIFIED PERSON

FOR THE PURPOSE OF THIS MANUAL AND PRODUCT LABELS, A QUALIFIED PERSON IS ONE WHO IS FAMILIAR WITH THE INSTALLATION, CONSTRUCTION AND OPERATION OF THE EQUIPMENT, AND THE HAZARDS INVOLVED. IN ADDITION, HE HAS THE FOLLOWING QUALIFICATIONS:

(a) Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

(b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

(c) Is trained in rendering first aid.

Distinctive signal words (DANGER, WARNING, CAUTION) are used in this instruction book to indicate degrees of hazard that may be encountered by the user. For the purpose of this manual and product labels these signal words are defined below.

DANGER — Indicates death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

WARNING — Indicates death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

CAUTION — Indicates minor personal injury or property damage **could** result if proper precations are not taken.

# RECEIVING INSPECTION



## INSPECTION FOR DAMAGE IN SHIPMENT

Check each item with the shipping manifest immediately upon receipt of the regulator. Make a thorough visual inspection of the regulator. Check for evidence of damage attributable to mishandling in shipment. Should any shortage or damage be found, notify the local agent of the carrier making the delivery and make appropriate notation on the freight bill. A claim should be made immediately with the carrier. Siemens should be notified.

## STORAGE PRIOR TO INSTALLATION

The regulator may be stored without any particular precautions or protection. Assure, however, that

- The control compartment enclosure is tightly closed.
- The two caps of the undirectional breather are replaced with screens to allow normal breathing. (See page 12).

Note that oil may splash into the breather pipes during transit. It is desirable, therefore, to be prepared with a container to catch this oil upon removing the plugs.

The caps should be kept available for reuse on the pipes at the time of relocating the regulator to its installation site.

# INSTALLATION



## PHYSICAL CONSIDERATIONS

- Handling. Type SFR regulators are designed to be lifted by use of the four lifting hooks on the side of the tank. The number of hooks has been established to provide a margin of safety on lifting when all hooks provided are used.

**⚠ WARNING**

UNIT CAN FALL. COVER LIFTING EYES MAY NOT SUPPORT COMPLETE UNIT WHEN LIFTING.

CAN CAUSE SEVERE INJURY OR DEATH AND PROPERTY DAMAGE.

DO NOT USE COVER LIFTING EYES TO LIFT COMPLETE UNIT. COVER LIFTING EYES ARE FOR UNTANKING ONLY. LIFT COMPLETE UNIT BY USING ALL LIFTING HOOKS ON TANK WALL.

- Location. Type SFR regulators are designed for outdoor installation. When the regulator is installed in a substation, it is recommended that a minimum elevation to the live connection be established, as required by applicable codes.

**⚠ DANGER**

HIGH VOLTAGE IS PRESENT AT BUSHING TERMINALS.

WILL CAUSE SEVERE INJURY OR DEATH.

DE-ENERGIZE AND ISOLATE REGULATOR BEFORE SERVICING.

- Elevation. When the regulator will be used at an elevation above 1000 meters (3300 feet) the kVA rating must be reduced to assure operating temperature limits are not exceeded.
- For air cooled (OA) rating, derate kVA rating 0.4% for every 100 meters (330 feet) elevation above 1000 meters.
- For forced air cooled (FA) rating, derate kVA rating 0.5% for every 100 meters (330 feet) elevation above 1000 meters.

## LINE TERMINALS AND CONNECTIONS

Siemens step-voltage regulators are routinely equipped with line bushing terminals per the following criteria.

| Nameplate Line Current Rating | Conductor Size Range or Threaded Stud Size |
|---|---|
| 150A or less | #8 to #4/0 |
| 141A to 300A | #2 to 477 MCM |
| 301A to 668A | #2 to 800 MCM |
| 669A to 1200A | 1.125 - 12 UNF-2A |
| 1201A to 2000A | 1.500 - 12 UNF-2A |

Clamp type terminals for use through 668 amperes are capable of accepting an aluminum or copper conductor.

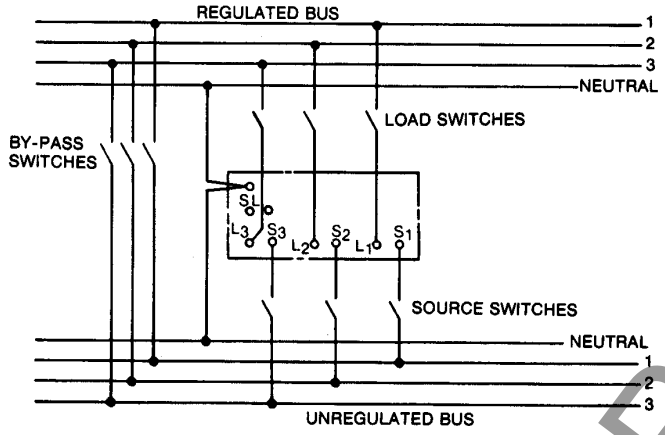
Tank grounding provision consists of a copper faced pad with two 0.5 - 13UNC tapped holes welded to tank base.

## ELECTRICAL CONSIDERATIONS

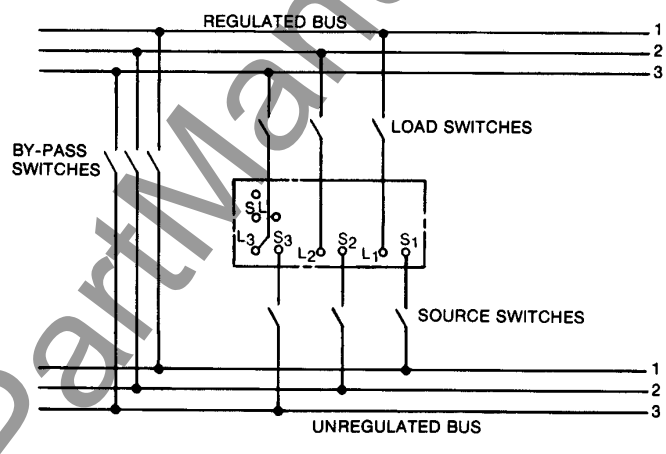
Type SFR regulators are designed and factory connected with three phases connected in wye. The neutral connection of the wye is fully insulated and made accessible at the $S_oL_o$ bushing terminal

- If the system neutral is grounded, the regulator neutral ($S_oL_o$) should also be grounded.
- If the system neutral is isolated, the regulator neutral ($S_oL_o$) should also be isolated from ground.

## INSTALLATION DIAGRAMS




3-phase SFR regulator on a 3-phase grounded system.




3-phase SFR regulator on a 3-phase isolated neutral system.

Figure 4A

## WARNING

HAZARDOUS SYSTEM CONDITIONS. THIRD HARMONICS OR REGULATOR NEUTRAL SHIFT CAN OCCUR IF REGULATOR NEUTRAL AND SYSTEM NEUTRAL DO NOT CONFORM TO THE INSTALLATION DIAGRAMS.

CAN CAUSE SEVERE EQUIPMENT DAMAGE.

CONNECT $S_oL_o$ TO GROUND WHEN THE REGULATOR IS INSTALLED ON A GROUNDED NEUTRAL SYSTEM. ISOLATE $S_oL_o$ WHEN THE REGULATOR IS INSTALLED ON AN ISOLATED NEUTRAL SYSTEM.

# INSTALLATION



## PROTECTIVE MEASURES

- Bypass Arresters. All SFR regulators are equipped with three properly sized arresters, connected externally between the 'S' and 'L' line terminals. The arrester is provided to protect the series windings of the regulator from line surges. Of itself, a bypass arrester does not provide lightning protection for the regulator.

- Lightning Protection. The number of lightning arresters used will be a judgemental decision on the part of the user, considering such factors as frequency of thunderstorm occurrence, and degree of risk of damage to be accepted. The minimum recommended lightning protection consists of properly sized arresters between 'S' or 'L' bushings and ground. Additional protection can be obtained with the use of arresters at both the 'S' and 'L' terminals.

  For best results, install lightning arresters adjacent to the bushings near the top of the tank. Ground the arresters and the regulator tank solidly to the same ground connection. Be careful to keep the ground lead connections as short as possible.

- Through Fault. Type SFR regulators are rated under condition of through faults for twenty-five times the OA rated current for 2 seconds or 40 times the OA rated current for 0.8 seconds or 40 times the OA rated current for 0.8 second to a maximum of 20,000 amperes rms symmetrical. The fault current may be asymetrical to the extent that the peak of the first current loop is equal to 2.26 times the rms value of the current wave.

  The user is advised to provide for additional source impedance, bus sectionalizing or other means of limiting the available through fault current if these criteria are exceeded at the installation.

## CONTROL CONNECTIONS

Many regulators can be used at different nominal system voltages. It is therefore necessary to assure that the regulator is properly connected at the 19 pin upper terminal block for the system voltage on which the particular regulator will be used.

Exhibit 5A

For this purpose, it is necessary to use the nameplate drawing and control diagram found in the control enclosure.

1. Refer to the Nameplate Diagram. A column is indicated to connect lead P2 to P( ), based on the applicable system voltage. The control diagram will aid in identification of the appropriate pin on the 19 pin terminal block.

2. Depending on the regulator, there may be a second column indicating that lead U2 is to be connected to U ( ). The same procedure is followed.

3. For regulators equipped with fans for forced air cooling, another set of connections will be shown.

NOTE

Matters specifically relating to the *Accu/Stat*™ control used in conjunction with the regulators are not included in this manual. Refer to the appropriate instruction manual.

# PLACING THE REGULATOR IN SERVICE



The following checks will be useful in assuring the regulator is ready for use. The list cannot be all inclusive, careful attention on the part of a qualified operator remains imperative.

## BEFORE INSTALLATION

- Check oil level at oil sight window. If low, add sufficient oil (ASTM D-3487 Type II) to bring level to that desired.
- Check dielectric strength of the oil per ASTM D-877. If found to be below 24 kV, filtering should be accomplished and additional testing of oil integrity is justified. Note: This is not necessary if regulator is being installed immediately upon receipt from the factory.
- Take power factor reading of all bushings (common) against ground (tank). Reading should be less than 2.0%
- Verify from the nameplate that the unit is connected for the proper output voltage, motor voltage and control panel voltage.
- Assure that the regulator is on the neutral tap position. This should be accomplished by observing the position indicator pointer **and** by powering the control from a 120V external source and observing the *Neutralite*™ to be illuminated.

## AT INSTALLATION

- Replace upper and lower breather caps with screens. Be prepared to catch a small amount of oil which will drip from the pipe due to having splashed into the pipe in transit. Place caps in control cabinet for future use in shipping. (See also page 12).
- Identify $S_1$ $L_1$, $S_2L_2$, $S_3L_3$, and $S_0L_0$ bushings on the cover. Make electrical connections per the appropriate installation diagrams, page 4.
- Set *Vari-Amp*™ limits on position indicator, if necessary. See page 11.
- Set *Accu/Stat* Control as desired. See *Accu/Stat* instruction manual.

## SWITCHING THE REGULATOR "ON THE LINE"

- It is absolutely imperative that the regulator be on the neutral tap position before switching the regulator on the line

### ⚠ WARNING

Unit can fail. Electrical failure and high pressure may occur.

Can cause severe personal injury or death and equipment damage.

Energize regulator only with regulator on neutral tap position.

Follow Instructions:

1. Make certain regulator is in neutral (N) position.
2. Turn voltage source switch to "OFF".
3. Remove power fuse.
4. Close, sequentially, the source and load switches.
5. Open the bypass switches.
6. Visually observe that bypass circuit has opened.
7. Replace power fuse.
8. Place voltage source switch to normal.

# REMOVING THE REGULATOR FROM SERVICE



## CHECKING REGULATOR OPERATION

(Refer to applicable ACCU/STAT Control Instruction Manual)

1. Turn the transfer switch to MANUAL.
2. Run the tapchanger in the lower direction, at least until the control is observed to go out of band "LOW".
3. Turn the transfer switch to AUTO. After a time delay, the regulator will return to an "IN" band condition.
4. Turn the transfer switch to MANUAL.
5. Run the tapchanger in the raise direction, at least until the control is observed to go out of band "HIGH".
6. Turn the transfer switch to AUTO. After a time delay, the regulator will return to an "IN" band condition.

## REMOVING THE REGULATOR FROM SERVICE

In order to remove a regulator from service without dropping load, it is imperative that the regulator be on the neutral tap position. If, for any reason, the regulator cannot be run to the neutral position, the system must first be de-energized before removal. The routine removal procedure is essentially the reverse of the procedure used to place the regulator on the line.

### ⚠ WARNING

UNIT CAN FAIL. ELECTRICAL FAILURE AND HIGH PRESSURE MAY OCCUR.

CAN CAUSE SEVERE PERSONAL INJURY OR DEATH AND EQUIPMENT DAMAGE.

BYPASS REGULATOR ONLY WITH REGULATOR ON THE NEUTRAL TAP POSITION.

FOLLOW INSTRUCTIONS:

1. RUN THE REGULATOR UNDER NORMAL VOLTAGE SOURCE TO THE NEUTRAL POSITION, AS REVEALED BY THE TAP POSITION INDICATOR
2. CONFIRM VIA THE *NEUTRALITE™* INDICATOR THAT THE REGULATOR IS ON NEUTRAL. IF THE INDEPENDENT CHECKS OF POSITION INDICATOR AND NEUTRALITE INDICATOR DO NOT CONFIRM THE NEUTRAL POSITION, BYPASSING MUST NOT BE ATTEMPED. IN SUCH EVENT, DE-ENERGIZE THE SYSTEM TO REMOVE THE REGULATOR FROM SERVICE.
3. AFTER ASSURING THAT THE REGULATOR IS ON NEUTRAL, TURN VOLTAGE SOURCE SWITCH TO "OFF" AND REMOVE MOTOR FUSE.
4. CLOSE THE BYPASS SWITCHES.
5. OPEN SEQUENTIALLY THE LOAD AND SOURCE SWITCHES.
6. EXERCISE APPROPRIATE CARE IN THE REMOVAL OF THE REGULATOR. HIGH VOLTAGE WILL STILL BE PRESENT AT THE BYPASS SWITCH AND THE SOURCE AND LOAD SWITCH TERMINALS.

# MAINTENANCE



## GENERAL INSTRUCTIONS

Failure to properly maintain the regulator can result in severe personal injury and product failure. The instructions contained herein should be carefully reviewed, understood and followed. The following maintenance procedures should be performed regularly:

1. Operational checks
   - Control performance
   - Tapchanger performance
   - *VARI/AMP* limit performance
2. Periodic inspection
   - Oil sample
   - Oil oxidation inhibitor addition
   - Contact wear
   - Fans

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the regulator. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens sales representative.

When powered, dangerous voltages are present in the equipment which can cause severe personal injury, death and product failure. Always de-energize and ground the equipment before maintenance requiring access to high voltage parts.

The use of unauthorized parts in the repair of the equipment, tampering by unqualified personnel, or faulty repair and adjustments will result in dangerous conditions which can cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

## OPERATIONAL CHECKS

Basic regulator operation can be checked while the regulator remains in service. Simply provide means to observe the output voltage (such as a voltmeter connected at the test terminals).

- Observe that the voltmeter reads the voltage level setting required by the control, to within one-half of the band-width tolerance. Note 1: The control must be "in" band. Note 2: Line drop compensation must be set to zero if the regulator is carrying load.
- Run the tapchanger several steps in one direction in the manual mode until the output voltage is outside of the bandwidth. Return the control to automatic mode. After the predetermined time delay, the tapchanger motor will be observed to run to return the output voltage in-band. Repeat this operation, running the tapchanger in the opposite direction.
- The *Vari-Amp* limit switches can be checked by attempting to run the tapchanger beyond the position to which the switches are set. The limit switches should function to open the circuit. Note: If the limit switch is set at the maximum 10% range and fails to function, the tapchanger will stall against a mechanical stop. The motor is designed to be stalled continuously without damage.

## PERIODIC INSPECTION

- A sample of oil from the regulator should be subjected to dielectric breakdown test, per ASTM D-877. It is recommended that oil testing less than 24 kV be filtered. Other tests, especially Neutralization Number, Interfacial Tension and Power Factor are also useful and may be preferred by particular users.
- The oxidation inhibitor in the oil will be depleted over a period of a few years and should be replaced. The inhibitor is 2,6-ditertiary-butyl-para-cresol (DBPC) at a concentration level of 0.2 to 0.3%.

The time interval between internal inspections will depend upon frequency of tapchanger operation and the load on the regulator. Regulators subjected to numerous overloads and a high load factor may require more frequent inspections than those carrying normal loads. While internal inspection is not a necessity, preventive maintenance inspections will help assure the continuity of service.

# MAINTENANCE



SFR regulators are furnished with a side inspection door to facilitate internal inspection without untanking of the regulator.

To prepare for internal inspection of an SFR regulator:

1. Remove the regulator from service, as described on Page 7.
2. Lower the oil inside the regulator to a level below the elevation of the side inspection door, but above the main transformer assembly.
3. Remove the bolts securing the side inspection door in place. Swing the door open to expose the internal assembly.

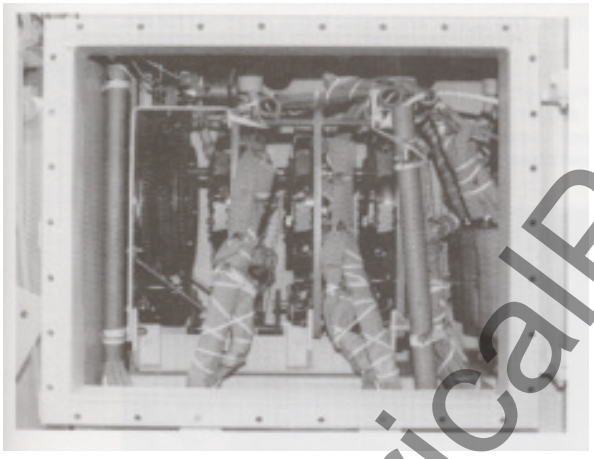


Exhibit 9A

When inspecting, check to be certain all hardware and connections are tight. The principal point of the internal inspection will be the condition of the arcing contacts on the tapchanger. Since numerous factors influence the rate of contact tip wear, no one criteria can be stated to recommend when a contact should be changed.

- Contact Deterioration.

A number of factors must be considered in the replacement of contacts. Even though two contacts are in identical condition, their replacement depends on their individual histories. As an example, assume that a moving contact has been burned down so that a flat contact surface of approximately 1/4 inch wide remains. If this occurred within three months after the regulator was installed, the deterioration would be abnormal and there should definitely be a detailed check made as to why it occurred. The cause for it should be found and corrected, and the contact should be replaced to put the regulator back in first-class condition. The operator may then expect the usual years of service without replacement.

On the other hand, it is possible that the moving contact might be burned to a 1/4 inch wide contact surface after ten years of operation and the contact inspected on a mere routine inspection program. The 1/4 inch flat contact surface still leaves a very adequate low temperature contact and a great deal of material that can still be burned away. The rate of deterioration would indicate that there are many years of service left, and there would be no particular reason to replace these contacts.

If a contact surface has burned down so that only a 1 /8 inch wide line contact area remains, the contact will probably be giving adequate service at low contact temperatures, but much further deterioration will probably result in decreased spring pressure and possibly faulty operation. Therefore, the contact should definitely be replaced. (See Figure below)

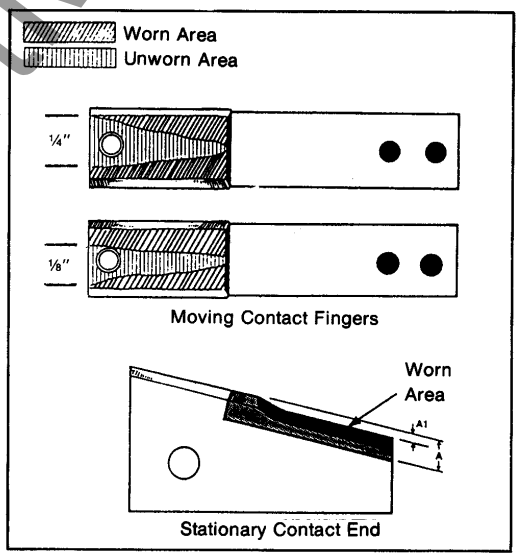



Exhibit 9B

The figure also depicts the possible condition of stationary contact wear after a period of operation. Generally, if A1 exceeds 80% of A it will be desirable to change he contacts; however, it may be advisable to change at somewhat less than 80% depending on the loading of the particular unit and the time duration which resulted in the present condition.

- Fans.

The fans used for cooling (when supplied) feature a totally enclosed weather proof motor with sealed ball bearings for low maintenance. The motor is a permanent split-capacitor-type with automatic overload protection. The double sealed motor bearings lubricated with a heavy duty grease resist dirt and moisture and hold the permanent bearing lubricant. All motor parts including rotor, starter and shaft are treated to resist corrosion.

# SPECIAL FEATURES



## POLARIZED DISCONNECT SWITCH (JACK PLUG) AND HINGED CONTROL PANEL

The *Accu/Stat* control panel is hinged and may be removed completely from the regulator control box by removing the wing nuts on the polarized jack plug and pulling the jack from its fixed portion. This will automatically de-energize the regulator to remove the control.

A spring loaded shorting bar in the plug automaticaly short circuits the current transformer secondary when the jack is removed.

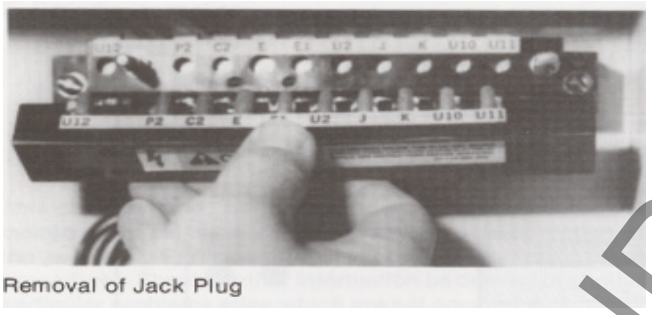



Exhibit 10A

## HAND CRANK OPERATION

A 2 1/2 inch NPT pipe plug, located above the 20° C oil level, provides access to a hex bar which may be driven using a 3/4 inch socket to operate the tap changer in the event of loss of power or drive motor failure. The tapchanger contact operation, when driven in this manner, is the same as when powered by the motor, consequently this procedure may be used for under load tapchanging.


Exhibit 10B

## *VARI-AMP* POSITION INDICATOR

The *Vari-Amp* feature provides a method of operating the regulator at increased load by decreasing the range of operation. It provides operator flexibility by allowing the range of regulation to be adjusted in 1 1/4 percent increments. The various regulation ranges together with the corresponding current capacities for standard regulators are listed on page 11. All that is necessary to adjust the range of regulation anywhere from +5 percent to +10 percent is to turn the adjusting knobs until the proper range of regulation is shown on the side of the position indicator. The upper and lower limits need not be the same.

It is not necessary to remove the regulator from service to make this adjustment. The switches are, however, in the motor power circuit so the motor should not be running while the switches are being set.


Exhibit 10C

# SPECIAL FEATURES



## OPERATION AT LESS THAN RATED VOLTAGE

SFR regulators may be operated at less than the voltage for which they were designed. All system voltages for which control system taps have been provided are shown on the nameplate. When this is to be accomplished it may be necessary to reconnect particular leads at the upper 19 pin terminal block as illustrated on page 5.

***VARI/AMP* TABLE**

| Rating | | Range and Current Ratings Available | | | | |
|---|---|---|---|---|---|---|
| Volts | kVA | +/- 10% | +/- 8 3/4% | +/- 7 1/2% | +/- 6 1/4% | +/- 5% |
| 13200 | 500 | 219 | 241 | 263 | 296 | 350 |
| | 625* | 274 | 301 | 329 | 370 | 438 |
| | 750 | 328 | 361 | 394 | 443 | 525 |
| | 937* | 410 | 451 | 493 | 554 | 656 |
| | 1000 | 437 | 481 | 524 | 590 | 668 |
| | 1250* | 547 | 601 | 655 | 668 | 668 |
| | 1500 | 656 | 708 | 754 | 787 | 853 |
| | 2000** | 875 | 945 | 1006 | 1134 | 1154 |
| | 2667* | 1166 | 1259 | 1300 | 1300 | 1300 |

*Forced air ratings **Forced air or self-cooled rating

Regulators can be modified at factory for 50 Hz operation with appropriate derating of voltage

## UNIDIRECTIONAL BREATHER

Type SFR regulators are designed to operate as a nonsealed system in order to safely vent to the atmosphere the combustible gases produced during routine tapchange operations.

The unidirectional breather protects the regulator and reduces the number of times filtering is necessary. Ventilation lowers the possibility of moisture condensation and rust formation by providing a continuous flow of warm air over the oil.

The breather consists of a pipe with a screened opening near the bottom of the regulator tank, extending up through and projecting above the surface of the oil.

A second pipe exiting near the top of the tank provides the outlet. Air enters the lower breather, is warmed by the hot oil in the regulator, rises in the pipe, blows across the air space, and out the upper breather.

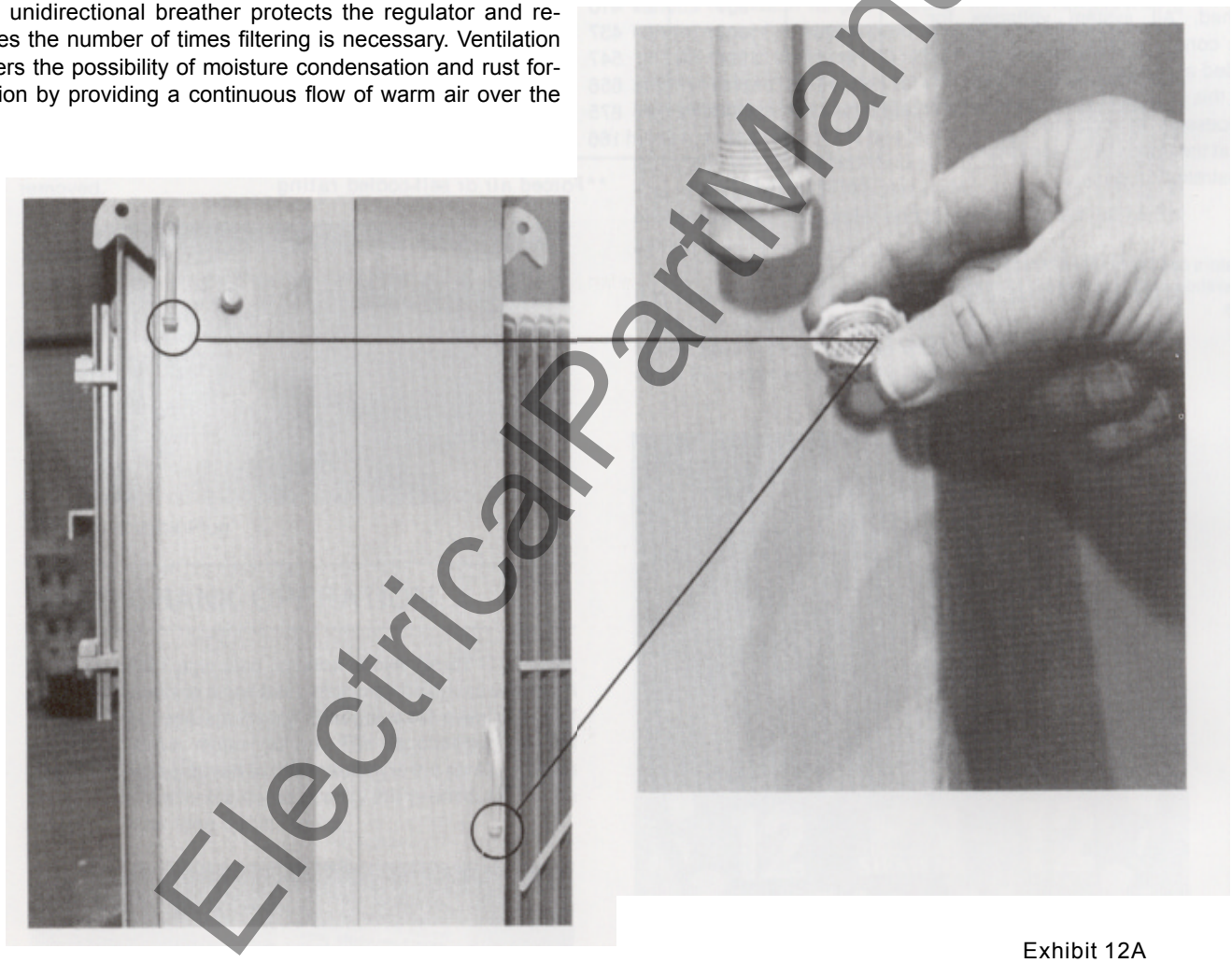


Exhibit 12A

# SPECIAL FEATURES



## OIL TEMPERATURE INDICATOR

An oil temperature indicator provides a clear indication of the voltage regulator's top oil temperature. This oil temperature indicator is used to activate forced air cooling when provided. The oil temperature indicator is provided with a hand that registers the top oil temperature. A drag hand is provided to indicate the maximum temperature recorded since last reset. This drag hand is easily reset by removing the plug on the oil temperature indicator and wiping a magnet across the face of the dial until the drag hand is reset on the recording hand.

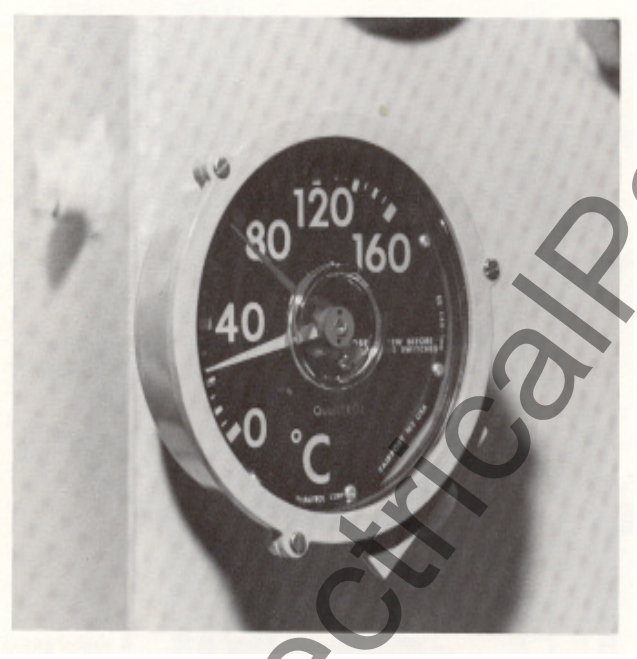


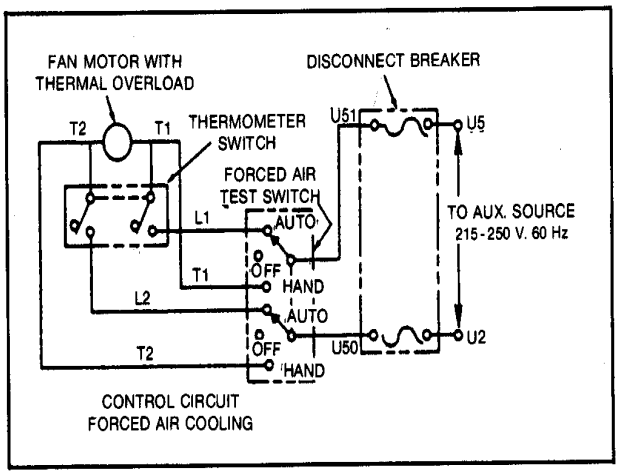

Exhibit 13A

## FORCED AIR COOLING

Certain ratings may be equipped for forced air cooling and include fans mounted on the radiators. The fans are usually automatically controlled by means of the change in oil temperature (see Connection Diagram). The thermometer located in the top transformer oil contains two identical switches which control fan operation when fan control switch is in "Auto" position.

The switches are normally set to start the fans at 65° C and to stop them at 55° C top oil temperature, but may be adjusted plus or minus 5° C.

A thermal overload relay is mounted on each fan motor. Any fan that develops trouble will be automatically disconnected from the line without affecting the other fans of the system. One fan can be removed from the radiators without affecting the operation of the others. When fans are out of service, care must be exercised to prevent overloading the regulator. Fans should be removed and replaced carefully to prevent damage to the radiators.




Control circuit forced air cooling.

Exhibit 13B

## UNIT CONSTRUCTION

Unit construction allows fast, low cost untanking of a voltage regulator in a service shop or out in the field. To untank a three phase voltage regulator, proceed as follows:

1. Remove the three bolts that secure the control panel cabinet to the regulator tank. Note that one of these bolts is located behind the control panel.
2. Disconnect any auxiliary equipment that may be connected to the control panel but not mounted on the control panel or its enclosure.
3. Remove all the cover bolts securing the cover to the regulator tank.
4. The regulator can now be untanked by lifting the regulator from the untanking eyes located on the cover. Make sure that the lifting device is centered between the lifting eyes on the cover and utilize all lifting eyes provided. Lift the regulator straight out of the tank.

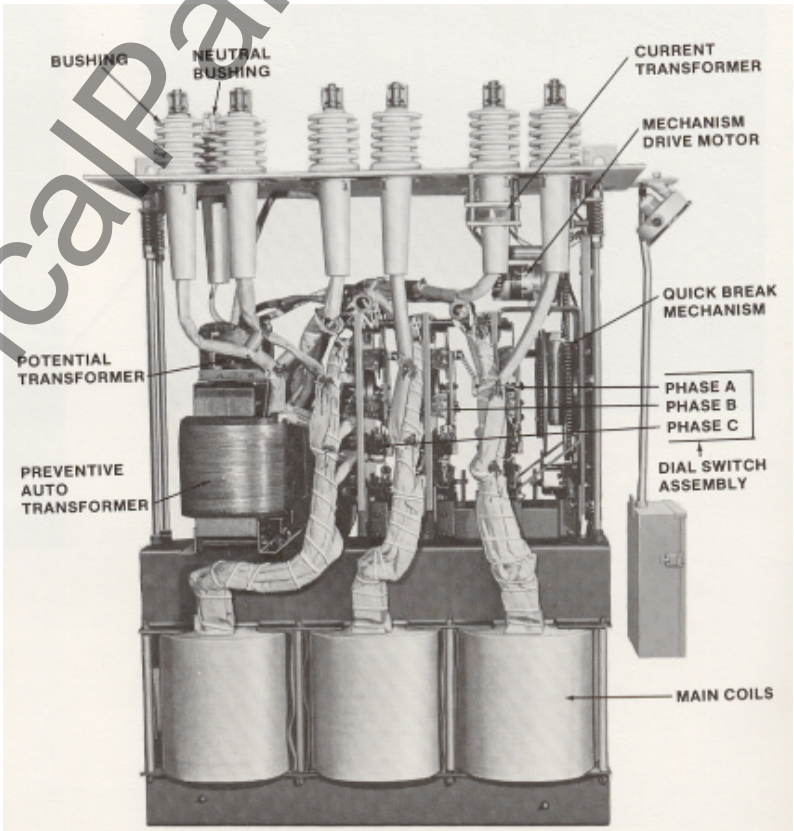
*NOTE:* On certain SFR regulators you may have to remove the oil temperature indicator prior to untanking. No internal mechanical or electrical connections must be disconnected to untank the voltage regulator. With all assemblies suspended from the cover, operation and testing can be performed with the regulator untanked by using an external 120 volt source. It is recommended to keep the core and coil assembly under oil while checking if possible.

### WARNING

UNIT CAN FALL. COVER LIFTING EYES MAY NOT SUPPORT COMPLETE UNIT DURING LIFTING.

CAN CAUSE SEVERE INJURY OR DEATH.

DO NOT USE COVER LIFTING EYES TO LIFT COMPLETE UNIT. COVER LIFTING EYES ARE FOR UNTANKING ONLY. LIFT COMPLETE UNIT BY USING ALL LIFTING HOOKS ON TANK WALL.




**Untanked View: SFR Internal Assembly**

Exhibit 14A

# PARTS LIST



## MAJOR COMPONENTS PARTS LIST

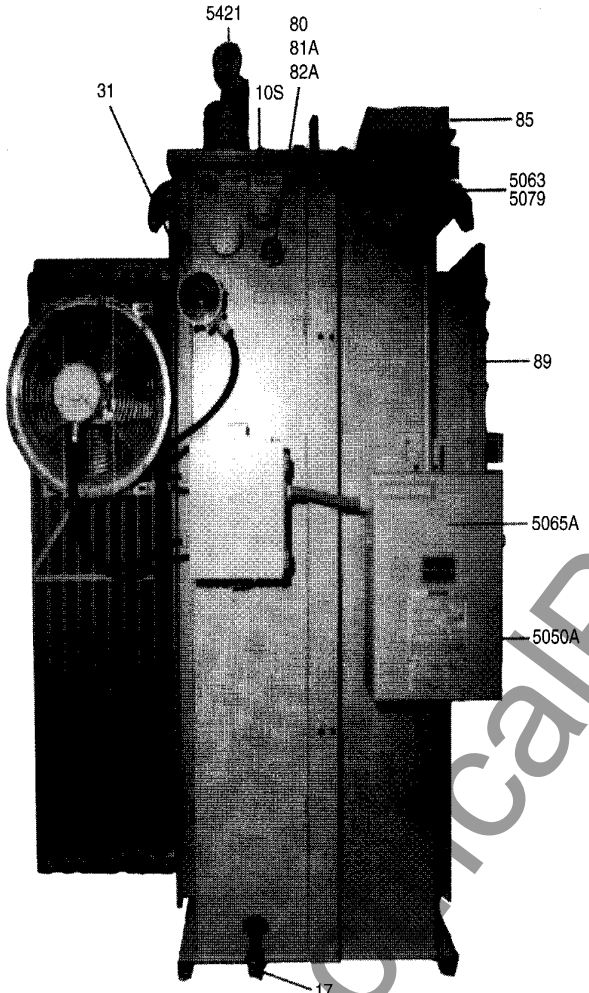



Exhibit 15A

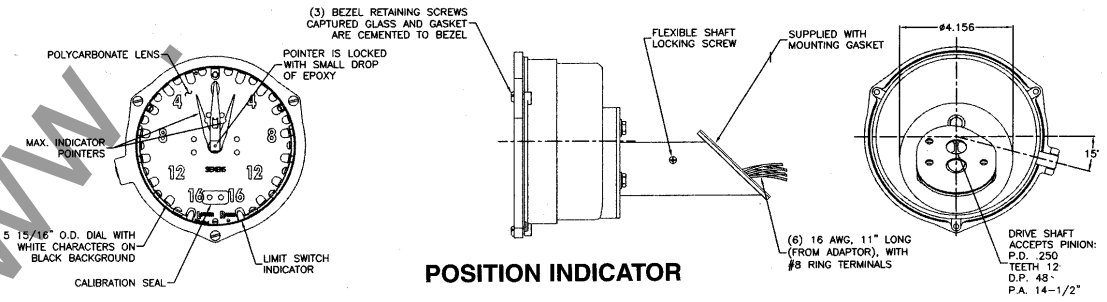
**INSTRUCTIONS FOR ORDERING PARTS**

When ordering parts, give the quantity of parts required, the regulator serial number, parts list item number, complete description, and method of shipping. State whether for emergency repair, maintenance, spare parts, etc.

All shipments will be made F.O.B. Factory.

| Item 01-11 | Description |
|---|---|
| 10S | Cover Gasket |
| 17 | Drain Valve and Sampling Device |
| 31 | Thermometer |
| 80 | Oil Sight Glass |
| 81A | Oil Sight Gauge |
| 82A | Oil Sigh Gauge Gasket |
| 85 | Terminal Box Cover |
| 89 | Side Inspection Door Gasket |
| 5050A | Control Cabinet Gasket |
| 5063 | Position Indicator Assembly |
| 5065A | Control Cabinet |
| 5079 | Position Indicator Gasket |
| 5421 | By-Pass Arrester Crystal |

| SPARE PARTS LIST FOR QUALITROL POSITION INDICATOR | | |
|---|---|---|
| Description | Part No. | Price |
| Bezel (Includes Lens, Bezel ring, 3 mounting screws) | BEZ-621-2 | SEE QUALITROL |
| Hinge For Bezel | TNN-004-13 | |
| Mounting Adaptor | ADP-632-1 | |
| Flexible Shaft Retraining Screw | SCR-003-19 | |
| Flexible Shaft Sealing Washer | WHR-05602 | |
| Adaptor Mounting Screws (3) | SCR-077-1 | |
| Sealing Washer (3) | WHR-056-1 | |
| Gasket (Adaptor to Case) | GAS-097-1 | |
| Gasket (Adaptor to Bicycle Seat) | GAS-095-1 | |




**POSITION INDICATOR**

Exhibit 15B

# QUICK BREAK MECHANISM - TYPE TLS



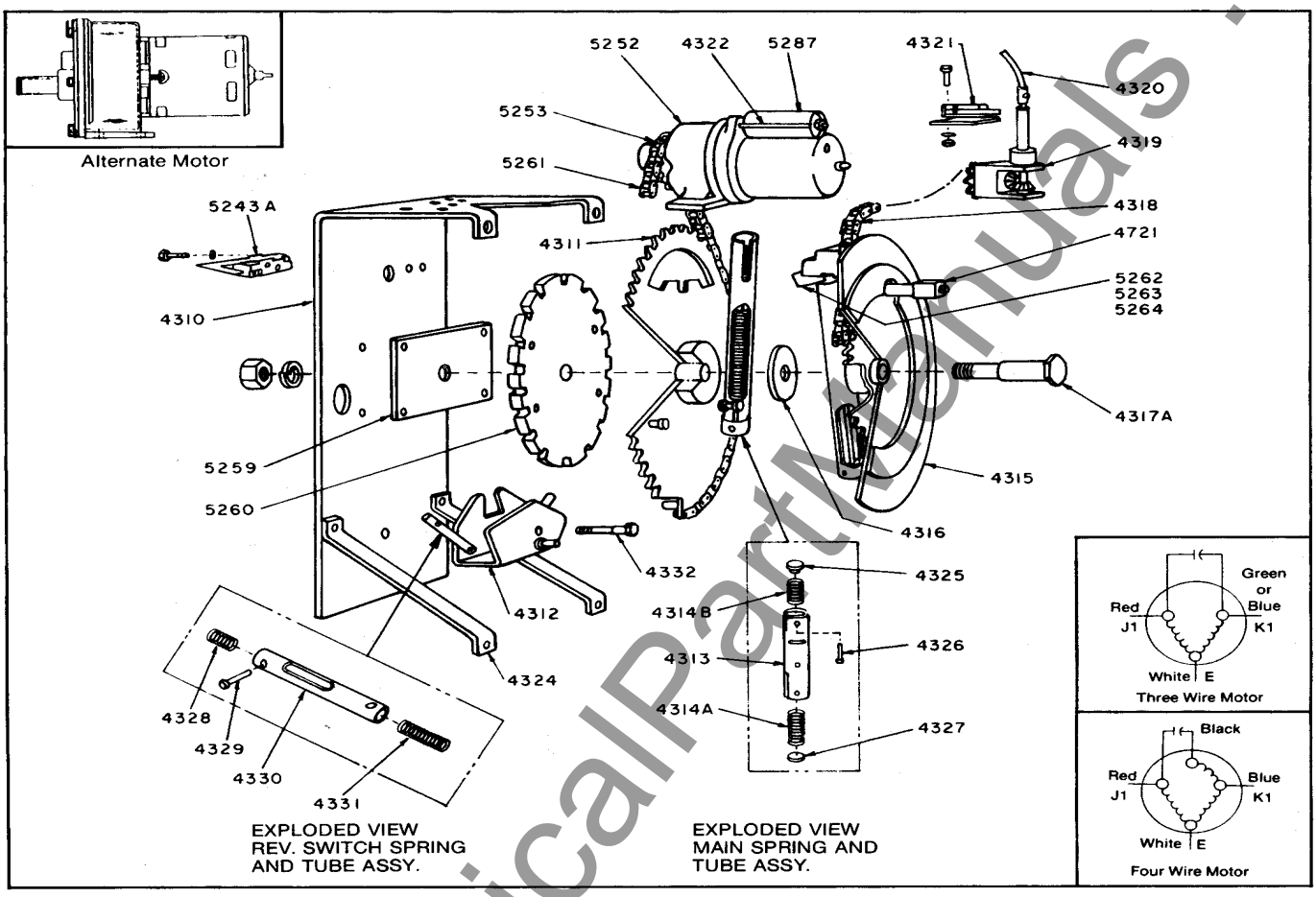


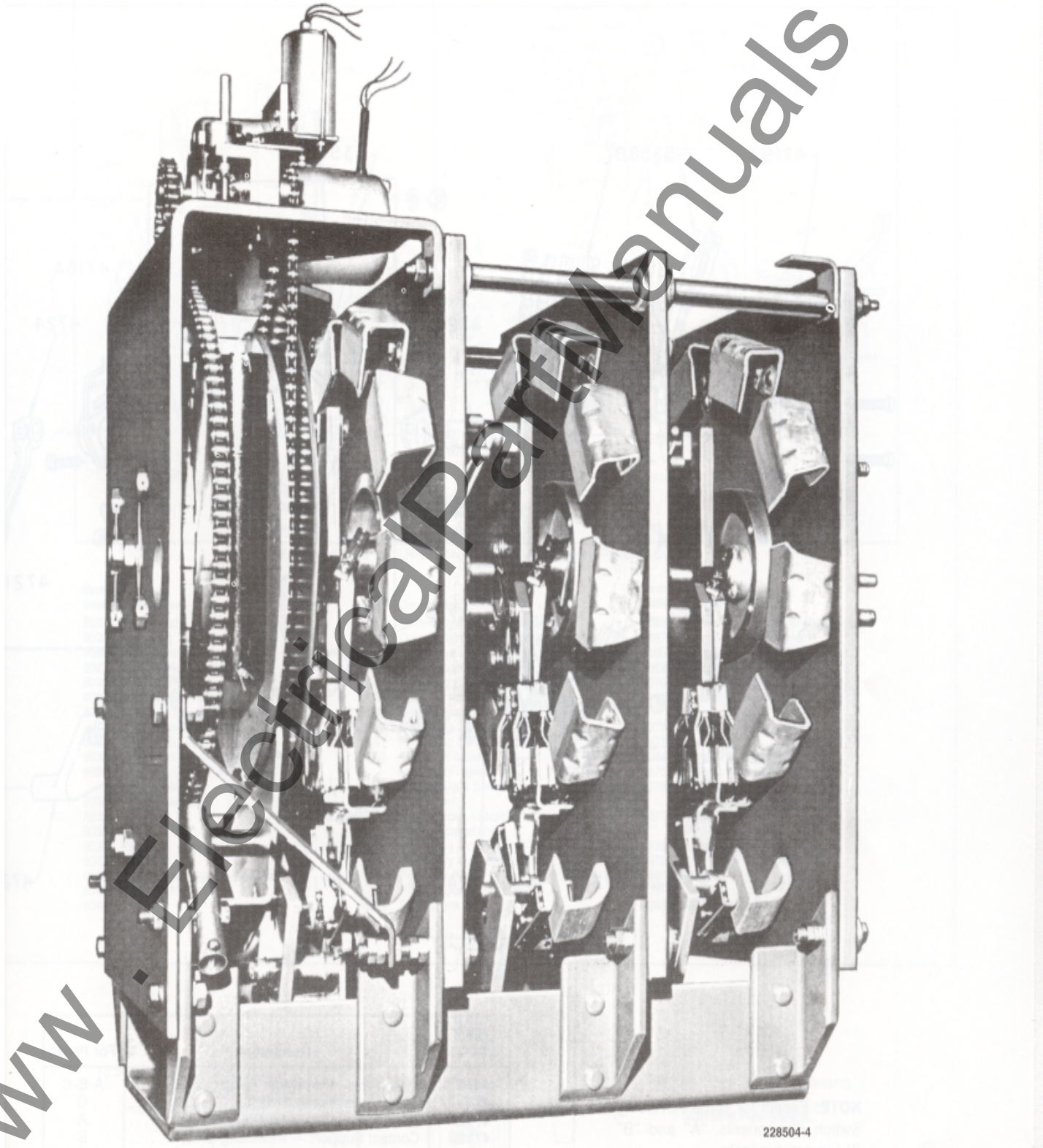

EXHIBIT 16A

| Item 01-11 | Description |
|---|---|
| 4310 | Mounting Frame |
| 4311 | Actuating Disc and Sprocket |
| 4312 | Reversing Switch Drive Arm |
| 4313 | Drive Spring Tube |
| 4314A | Main Drive Spring |
| 4314B | Snubbing Spring |
| 4315 | Interlocking Disc and Drive Sprocket Assembly |
| 4316 | Brass Spacer Washer |
| 4317A | Quick Break Mechanism Shaft |
| 4318 | Drive Chain - Position Indicator |
| 4319 | Position Indicator Actuator |
| 4320 | Flexible Shaft |
| 4321 | Operation Counter Switch Assembly |
| 4322 | Capacitor Mounting Bracket |
| 4324 | Brace |
| 4325 | Spring Cap |
| 4326 | Pin |

| Item 01-11 | Description |
|---|---|
| 4327 | Spacer Washer |
| 4328 | Snubbing Spring |
| 4329 | Retaining Pin |
| 4330 | Reversing Switch Spring Tube |
| 4331 | Reversing Switch Toggle Spring |
| 4332 | Turned Bolt |
| 4721 | Adjusting Block |
| 4243A | Neutral Switch |
| 5252 | Motor Assembly w/Capacitor & Sprocket |
| 5253 | Motor Sprocket |
| 5259 | Spacer |
| 5260 | Index Plate |
| 5261 | Main Drive Chain |
| 5262 | Latch |
| 5263 | Latch Spring |
| 5264 | Latch Pin |
| 5287 | Motor Capacitor |

# ASSEMBLED VIEW -- TLS






Assembled view of Type TLS Load Tap changer

# DIAL SWITCH ASSEMBLIES -- TYPE TLS



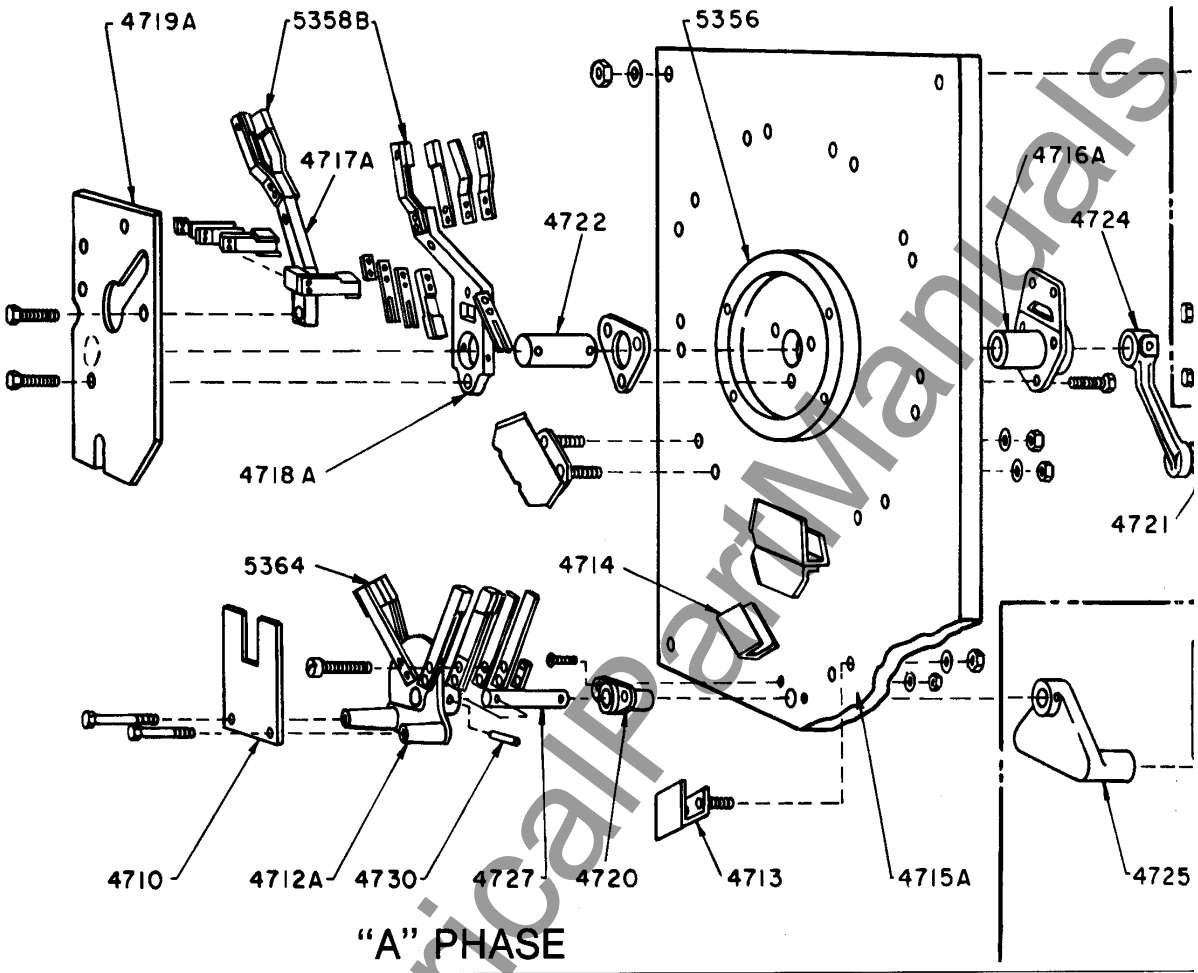



Exhibit 18A

**NOTE:** Except for some Reversing Switch components, "A" and "B" Phase are duplicate.

| Item 01-11 | Description | For Phase |
|---|---|---|
| 4710 | Drive Arm--Reversing | A-B-C |
| 4711 | Shaft-Reversing Switch | C |
| 4712A | Contact Support-Reversing Switch | A |
| 4712B | Contact Support-Reversing Switch | B |
| 4712C | Contact Support-Reversing Switch | C |
| 4713 | Reversing Switch Stationary Contact R.H. | A-B-C |
| 4714 | Reversing Switch Stationary Contact L.H. | A-B-C |
| 4715 | Bakelite Panel | C |
| 4715A | Bakelite Panel | A-B |
| 4716 | Shaft-Collector Hub | C |
| 4716A | Collector Hub | A-B |
| 4717 | Contact Finger Support | C |

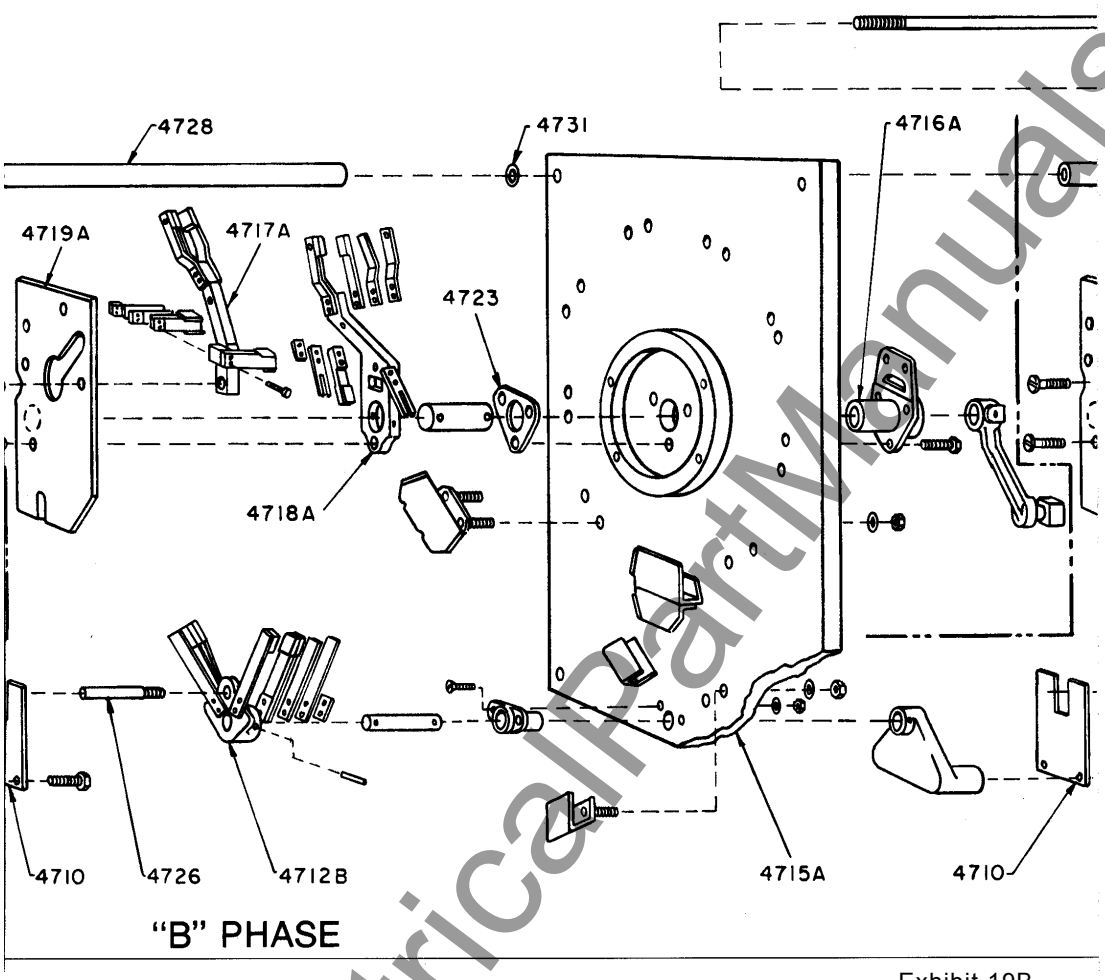
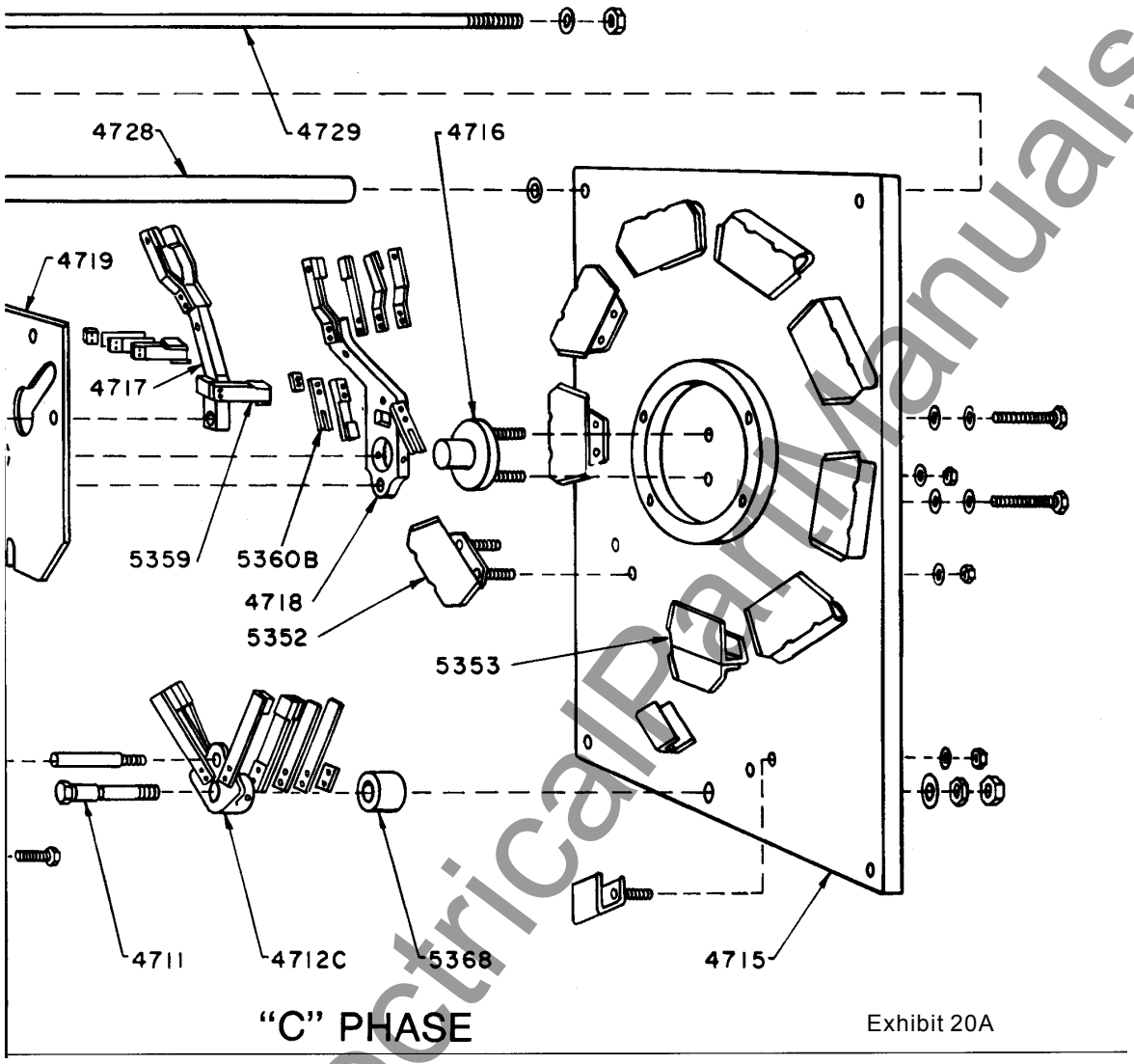



Exhibit 19B

| Item 01-11 | Description | For Phase |
|---|---|---|
| 4717A | Contact Finger Support | A-B |
| 4718 | Contact Finger Support | C |
| 4718A | Contact Finger Support | A-B |
| 4719 | Bakelite Drive Arm | C |
| 4719A | Bakelite Drive Arm | A-B |
| 4720 | Bearing | A-B |
| 4721 | Adjusting Block | A-B-C |
| 4722 | Drive Shaft | A-B |
| 4723 | Flange | A-B |
| 4724 | Fork Crane | A-B |
| 4725 | Reversing Switch Drive Casting | B-C |
| 4726 | Reversing Switch Drive Pin | B-C |



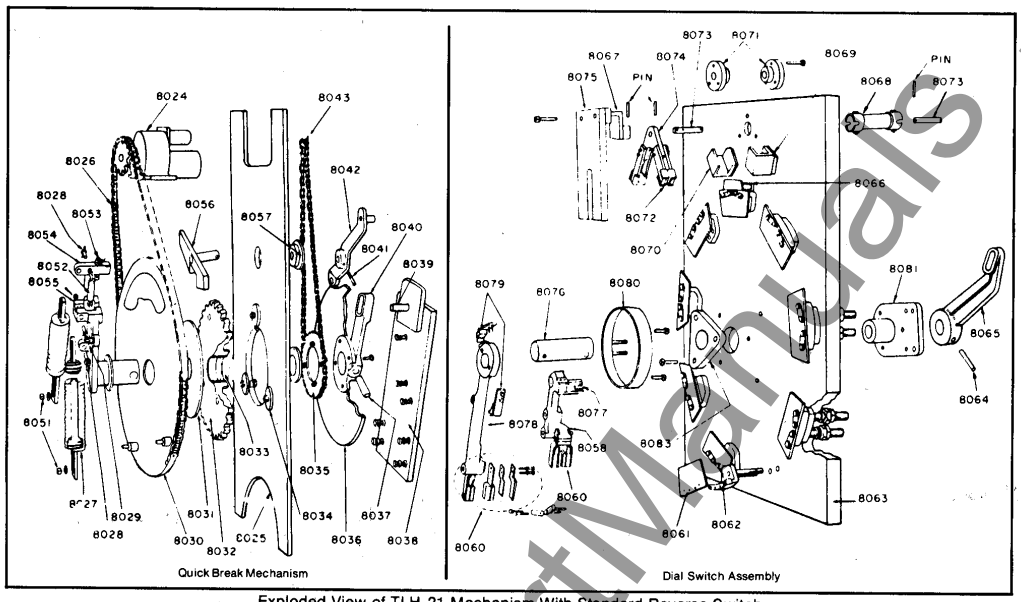

"C" PHASE

Exhibit 20A

| Item 01-11 | Description | For Phase |
|---|---|---|
| 4727 | Reversing Switch Drive Shaft | A-B |
| 4728 | Spacer Tube | B-C |
| 4729 | Tie Rod | -- |
| 4730 | Drive | A-B |
| 4731 | Spacer Washer | A-B-C |
| 5352 | Stationary Contact-Main | A-B-C |
| 5353 | Stationary Contact-Neutral | A-B-C |
| 5356 | Collector Ring | A-B-C |
| 5358B | Main Finger Assembly | A-B-C |
| 5359 | Collector Ring Finger Assembly | A-B-C |
| 5360B | Collector Hub Finger Assembly | A-B-C |
| 5364 | Reversing Switch Finger Assembly | A-B-C |
| 5368 | Spacer | C |

# QUICK BREAK AND DIAL SWITCH -- TLH-21






Exploded View of TLH-21 Mechanism With Standard Reverse Switch

Exhibit 21A

| Item 9996 | Description |
|---|---|
| 8024 | Motor and Capicitor |
| 8025 | Mounting Plate |
| 8026 | Drive Chain |
| 8027 | Drive Spring Assembly |
| 8028 | Latch Spring Pin |
| 8029 | Latch Pin |
| 8030 | Sprocket and Actuating Disc Assembly |
| 8031 | Washer Spacer |
| 8032 | Notched Index Plate |
| 8033 | Bushing Index Plate (part of 8032) |
| 8034 | Index Plate Bolts |
| 8035 | Sprocket |
| 8036 | Interlock Disc |
| 8037 | Pin |
| 8038 | Drivearm |
| 8039 | Crank Pin & Counter Weight |
| 8040 | Main Fork Crank |
| 8041 | Pin |

| Item 9996 | Description |
|---|---|
| 8042 | Reversing Switch Pin Crank |
| 8043 | Drive Chain |
| 8051 | Castle Nut |
| 8052 | Latch Spring |
| 8053 | Adjusting Screw |
| 8054 | Latch |
| 8055 | Quick Breakarm |
| 8056 | Reversing Switch Lever |
| 8057 | Reversing Switch Bearing |
| 8058 | Contact Support (for Ring Fingers) |
| 8059 | Neutral Light Switch (not shown) |
| 8060 | Main Finger Assembly (copper tungsten) |
| 8061 | Stationary Contact |
| 8062 | Stationary Contact Support |
| 8063 | Phenolic Panel |
| 8064 | Pin (included with 8065) |
| 8065 | Fork Crank |

| Item 9996 | Description |
|---|---|
| 8066 | Stationary Contact (Neutral) |
| 8067 | Reversing Switch Arm |
| 8068 | Drive Shaft Assembly |
| 8069 | Stationary Contact R.H. |
| 8070 | Stationary Contact L.H. |
| 8071 | Reversing Switch Bearing Screws & Nuts |
| 8072 | Contact Finger Assembly |
| 8073 | Shaft |
| 8074 | Contact Support Assembly |
| 8075 | Drive Arm (First Phase only) |
| 8076 | Main Shaft (included with 8078) |
| 8077 | Collector Ring Finger Assembly |
| 8078 | Contact Support (Hub Finger) |
| 8079 | Hub Finger Assembly |
| 8080 | Collector Ring |
| 8081 | Collector Hub |
| 8083 | Flange for Hub |

To order parts, give part number, description and regulator serial number

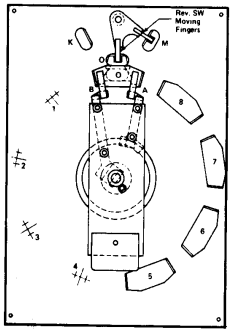



Exhibit 21B

Dial Switch Contact Arrangements with Standard Rev. Switch

# ASSEMBLED VIEW -- TLH-21



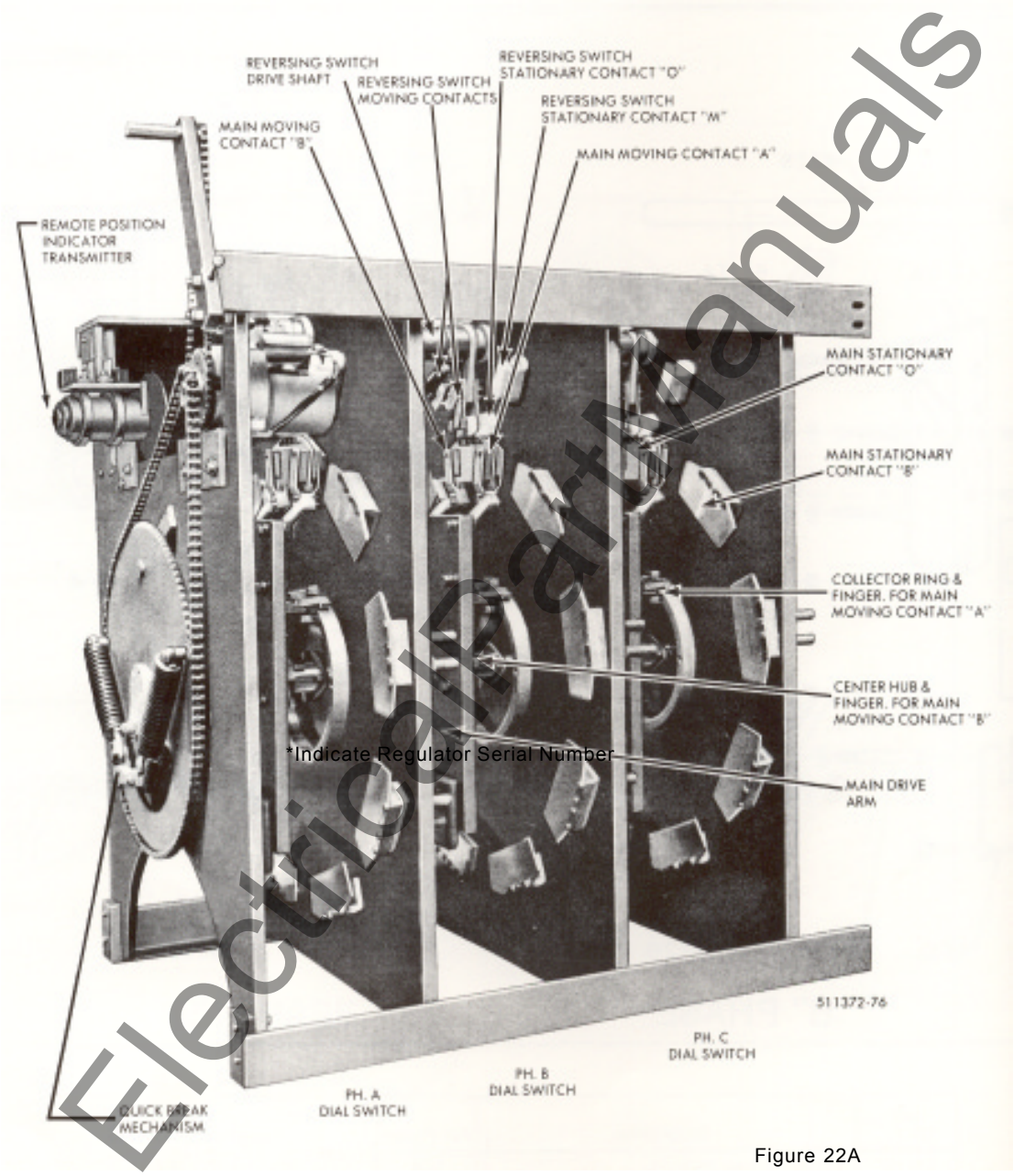



Figure 22A

Assembled View of TLH-21 Load Tap
Changing Mechanism With Standard Reversing Switch

# BY-PASS ARRESTERS AND BUSHINGS



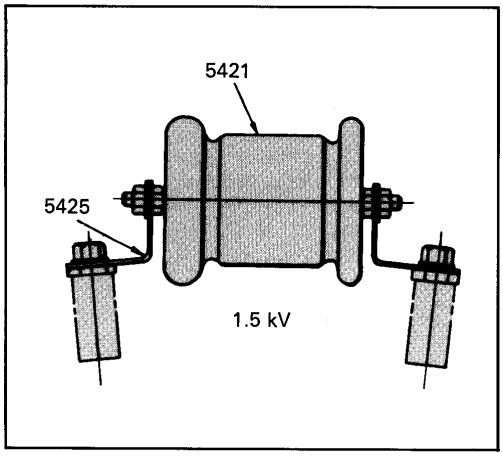



Exhibit 23 A

**BY-PASS ARRESTER***

| Item 01-11 | Description | Volts |
|---|---|---|
| 5420 | By-Pass Arrester Assembly..... | 13,200 |
| 5421 | By-Pass Arrester Crystal 1.5 kV | |
| 5425 | Mounting Bracket Assembly | |

*Indicate Regulator Serial Number

**BUSHINGS***

| Item 01-11 | Description | kVA | Volts |
|---|---|---|---|
| 5400N | Bushing Assembly - 15 kV | 500,625.750 937,1000,1250 | 13,200 |
| 5401N | Bushing Porcelain-15 kV | | |
| 4025 | Clamping Ring | | |
| 4030 | Cushion Spring | | |
| 5418 | Cap Screw | | |
| 4035 | Bushing Cap Line Terminal | | |
| 4027 | Gasket | | |
| 4032 | Gasket | | |
| 4033 | Gasket | | |

* Indicate Regulator Serial Number

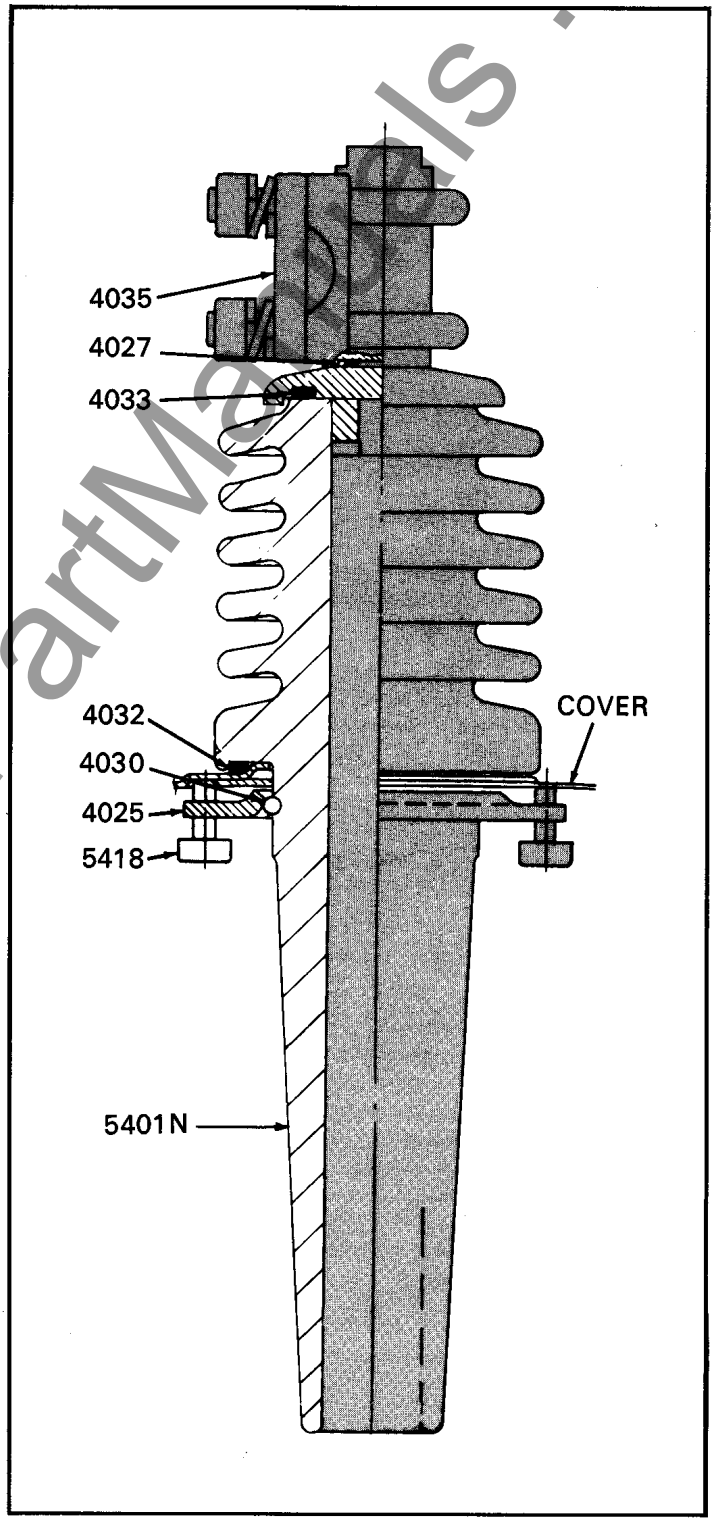



Exhibit 23 B

# BY-PASS ARRESTERS AND BUSHINGS



| Item 01-11 | Description | kVA | Volts |
|---|---|---|---|
| 5400NN | Bushing Assy. 15 kV 1200 Amp (Source and Load) | 1500<br>1500/2000 | 13,200 |
| 5400NN | Bushing Assy. 15 kV 2000 Amp (Source and Load) | 2000<br>2000/2667 | 13,200 |
| 5401NN | Bushing Porcelain 15 kV (Source and Load) | 1500<br>1500/2000<br>2000/2667 | 13,200 |
| 5430 | Terminal Cap (for 1200 A) | | |
| 5430A | Terminal Cap (for 2000 A) | | |
| 5431 | Conductor Rod (for 1200 A) | | |
| 5431A | Conductor Rod (for 2000 A) | | |
| 5432 | Terminal Gasket | | |
| 5433 | Flange Gasket | | |
| 5434 | Clamp Gasket | | |
| 5435 | Gasket | | |
| 5436 | Spring Washer (for 1200 A) | | |
| 5436A | Spring Washer (for 2000 A) | | |
| 5437 | Hex Hut (for 1200 A) | | |
| 5437A | Hex Nut (for 2000 A) | | |
| 5438 | Cap Screw | | |
| 5439 | Clamp | | |

*Indicate Regulator S/N when ordering.

**NOTE:** For the SL or neutral bushing assembly and its components, see Cat. 5400N.

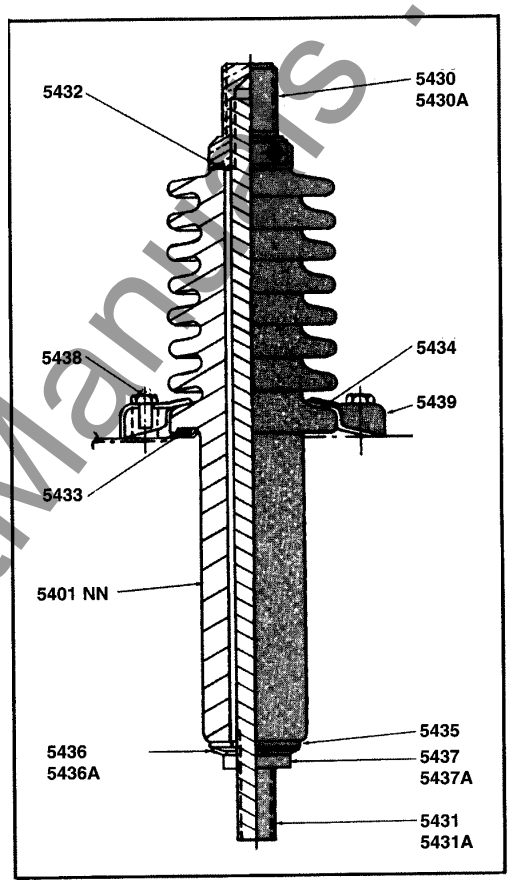



Exhibit 24B

**NOTE:**

Bushing Assy. Cat. No. 5400N is used as the SL or neutral bushing on the 1500, 2000, and 2667 kVA, 13,200 Volt, SFR Regulators.

**1.5 kV BY-PASS ARRESTER**

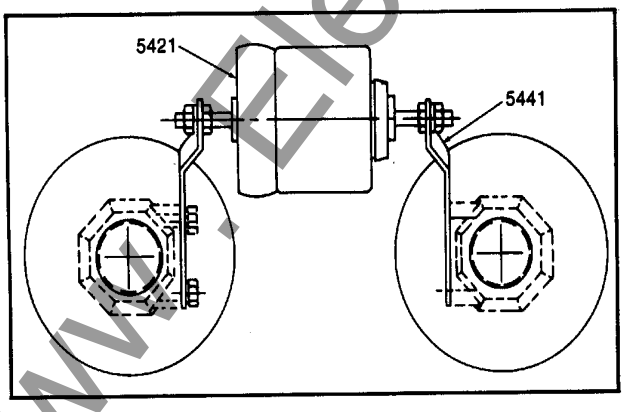



Exhibit 24A

***BY-PASS ARRESTER***

| Item 01-11 | Description | Volts |
|---|---|---|
| 5440 | By Pass Arrestor Assy. 1.5 kV | 13,200 |
| 5421 | By Pass Arrestor Crystal 1.5 kV | |
| 5441 | Mounting Bracket Assy. | |

*Indicate Regulator Serial Number

SIEMENS

Siemens Power Transmission &
Distribution, Inc.
P. O. Box 6289
Jackson, MS 39288