INSTALLING, OPERATING

AND MAINTAINING

AUTOMATIC TRANSFER SWITCHES

STYLES 2, 3 and T-200

Lake Shore Electric Corporation
205 Willis Street
Bedford, Ohio 44146

TABLE OF CONTENTS

WARNING

IN INSTALLATION AND USE OF THIS PRODUCT, COMPLY WITH THE NATIONAL ELECTRICAL CODE; FEDERAL, STATE AND LOCAL CODES; AND ALL APPLICABLE SAFETY CODES. IN ADDITION, TURN OFF POWER AND TAKE OTHER NECESSARY PRECAUTIONS TO PREVENT PERSONAL INJURY AND EQUIPMENT DAMAGE.

NOTE

Engineering changes may have been made after publication date. Any departure from this manual should be checked with Lake Shore Electric Corporation.

Lake Shore Electric Corporation reserves the right to change specifications without prior notice.

CAUTION: WHEN WORKING ON EQUIPMENT OF THIS TYPE, EXTREME DANGER FROM ELECTRICAL HAZARD EXISTS. DO NOT ATTEMPT ANY REPAIRS OR ADJUSTMENTS TO THIS EQUIPMENT WITHOUT TAKING EVERY PRECAUTION TO PREVENT AN ACCIDENT.

Lake Shore Electric Automatic Transfer Switches are guaranteed against defective materials and workmanship for one year from date of shipment. This guarantee is limited to repair or replacement of defective materials at the manufacturer's factory. Lake Shore Electric does not accept responsibility for unauthorized repairs to this equipment, even though defective, and no claims for this work will be honored.

Many of the adjustments and connections on this equipment are sealed against tampering. Violation of these seals may void the guarantee. Each switch is tested through 20 operations before shipment to eliminate the need for field adjustment.

1. CONSTRUCTION

All Lake Shore Electric Trans-O-Matic Automatic Transfer Switches (Style 2, 3, and T-200) employ the use of two molded-case switches and/or circuit breakers and a motor operating mechanism to affect power source transfer. In all cases, the molded-case switches and/or circuit breakers and operating mechanism are rigidly mounted on a common baseplate.

On Style 2 and T-200 Transfer Switches (Figure 1), a single-phase universal gear motor is mechanically linked to the operating levers of the switches and/or circuit breakers through an adjustable friction drive. Style 3 Transfer Switches (Figure 2) employ two universal gear motors, one operating each molded-case switch and/or circuit breaker. This allows a time delay between disconnecting one source and connecting the other source. A maintenance disconnection or "Both Off" position is also possible with the Style 3 switches if specified at time of order.

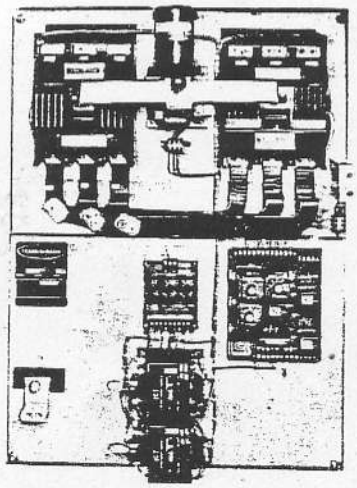
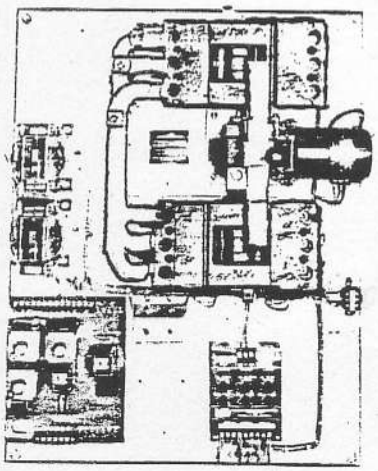


Figure 1.



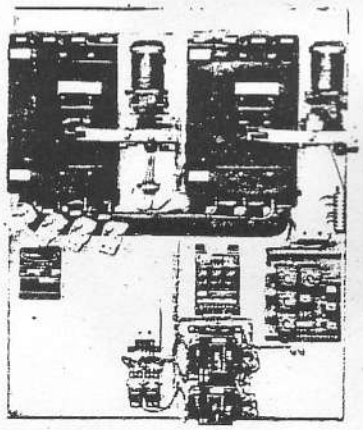


Figure 2.

All of the molded case switches and/or circuit breakers are electrically interlocked through control relays and auxiliary switches, and mechanically interlocked through a walking beam mechanism which is located on the rear of the baseplate. This mechanism is a fulcrum and lever device which positively prevents both circuit breakers from being in the ON position simultaneously. It provides a "Fail-Safe" design.

The gear motors are capable of operating on either AC or DC, and the gear reduction unit is hermetically sealed and permanently lubricated so that no maintenance is required.

All styles of transfer switches are provided with an insulated operating handle to enable personnel to manually operate the transfer switch should this become necessary. The handle is permanently mounted and readily accessible in an emergency.

All relays are of the enclosed industrial type to ensure long life and minimum maintenance. All relays are rated for continuous duty to eliminate overheating of coils. The only relay that is continuously energized is the Outage Delay Relay (ODR) or Control Relay (CR).

All timed control relays are of the solid state or pneumatic type with relay output contacts designed for long electrical life.

Standard wiring harnesses are manufactured from 16-gauge insulated machine tool wire. All transfer motor control circuits are protected with miniature overload circuit breakers. All control relays and logic are unfused for maximum reliability in the event of an emergency.

The basic types of transfer switch mechanisms have been described. The relay panel for these switches has been omitted because this is a separate panel that varies from switch to switch.

2. DESCRIPTION OF OPERATION

The following description of operation applies to all styles of Trans-O-Matic Transfer Switches. Certain accessory additions may modify the sequence of operations as required to suit specific applications.

Normally, the transfer switch operates on the preferred power source with the Normal circuit breaker in the closed position and the Emergency circuit breaker in the open position. (Refer to Wiring Diagrams, Pages 9 and 10.) The preferred power source is continuously monitored by voltage sensitive relays of the adjustable or non-adjustable type. In the event of a drop in power voltage below the drop-out level (70% of standard) of the voltage relay in one or more phases of the preferred source, the voltage relay(s) sends a signal to the control relay which drops out, closing the engine start contacts. As soon as the engine starts, which generally takes from three to ten seconds, the transfer switch motor is energized by the emergency relay, opening the Normal breaker and closing the Emergency breaker, thus affecting the power source transfer. With the switch now operating on the emergency source, the voltage continues to monitor the preferred source. When all three phases of the preferred source return to the pickup level of the voltage relays (90%) the control relay is again energized, disconnecting the engine-start contacts and transferring the load back to the preferred source.

The above sequence of operation is based on a transfer switch without any time delay relays or any other auxiliary features. It describes the basic operation. This operation will be altered if time delay relays and auxiliary features are added as specified for individual customer requirements.

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The alternate (emergency) power source is connected in a like manner to the Emergency circuit breaker terminals marked EL1, EL2 and EL3. (Note: Be careful to pass through any current transformers or other devices which may be part of a generator control.) The load connections are made to the common bus at the terminals marked L1, L2, and L3. On three-phase, four-wire transfer switches or single-phase, three-wire transfer switches, a neutral lug is provided on the base plate for neutral connections.

When installing the power cables, be careful not to disturb or damage the control wires that go to the various terminals.

CAUTION: Be sure to check that all lugs are torqued to the applicable requirement for the switch.

The only external control circuit provided on standard transfer switches is the engine-start contacts, which are rated at 10 amps. These contacts are in the control relay and are wired to a terminal block and marked.

There are numerous accessories available on Trans-O-Matics which require external connections. Refer to the wiring diagram included with your transfer switch for specific instructions on connecting these accessories.

Placing the Trans-O-Matic in Operation

Before energizing the switch electrically, be certain all external connections have been properly made according to the wiring diagram. Inspect all wires, cables, and bus bar for abraded insulation, foreign matter, and electrical clearance.

Manually set the transfer switch to the normal source (Normal breaker ON) and energize the normal source. The control relay will immediately energize and the transfer switch will stay on the preferred normal source.

If Outage Delay Relay (ODR) or Control Relay (CR) does not pick up, place a voltmeter on the normal source to be sure that the voltage is adequate and within the range of the Phase Failure Relay (PFR). The switch will not operate on voltage other than that stamped on the nameplate of the PFR.

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Do not attempt to energize the alternate (emergency) source until the switch is operating satisfactorily on normal. With the normal source operating, the emergency source may now be energized for testing. Since normal is the preferred source, the switch will not transfer to emergency until one or all phases of normal drop below the drop-out setting of the Phase Failure Relay (70% of normal voltage). When no PFR is supplied, this value is approximately 60% of normal.

All Automatic Transfer Switches are furnished with a Load Test Switch mounted on the baseplate. A test can be initiated by moving this load test switch to the test position. This will cause the normal control circuits to de-energize and give a signal for engine starting.

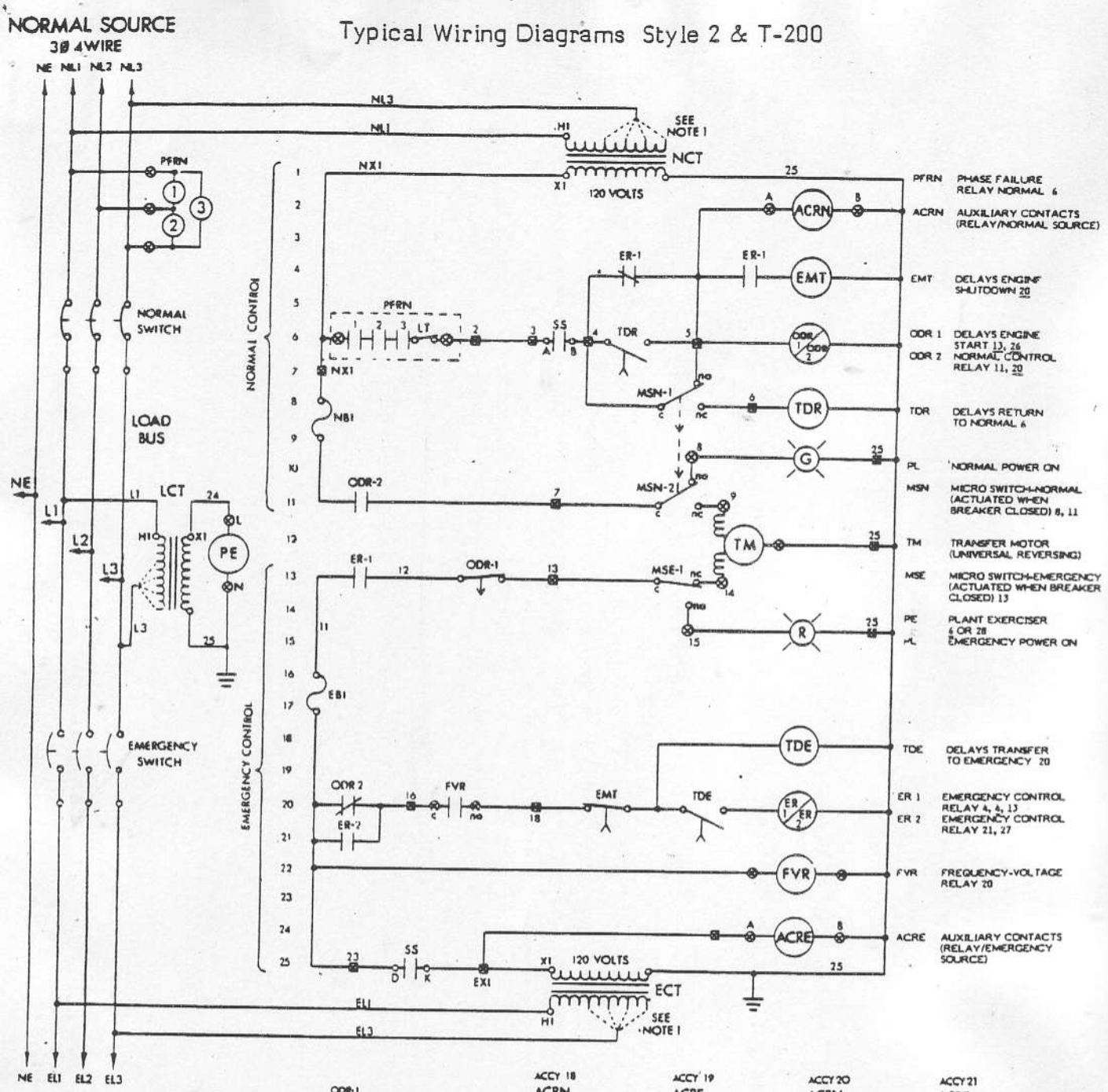
(NOTE: If an Outage Delay Relay (ODR) is included on the transfer switch, it won't transfer until the relay times out.) If any Frequency and/or Voltage Sensitive relays or Time Delay to Emergency is used in the alternate source, the transfer switch won't transfer until the generator voltage and frequency are within the required pickup levels of the relays and the timer is timed out.

After the emergency operation has been tested, place the load test switch on the PFR back to the normal position. This will cause the transfer switch to return to the preferred (normal) source. (NOTE: Time Delay to Return (TDR) may be supplied and this would delay transfer by as long as 30 minutes.)

To test the full automatic operation of the transfer switch, repeat the above procedure but do not energize the emergency source. With the transfer switch operating on normal source, place the load test switch in the test position. The engine-start contacts will close, sending a signal to the engine's automatic start panel to crank the engine. After the generator is up to voltage and frequency, the transfer switch will transfer to the emergency source. Place the load test switch in the normal position and the transfer switch will return to normal source and shut down the engine. (Some transfer switches are equipped with an adjustable Engine Maintained Timer (EMT) which will keep the engine running unloaded for a short period of time).

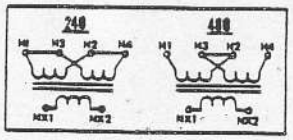
The above tests are sufficient to place the transfer switch in operation. The following pages contain specific information on the various components and troubleshooting information.

Typical Wiring Diagrams Style 2 & T-200



NOTES:

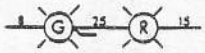
1. TRANSFORMER CONNECTION FOR:
   LCT - LOAD CONTROL TRANSFORMER
   NCT - NORMAL CONTROL TRANSFORMER
   ECT - EMERGENCY CONTROL TRANSFORMER



2. POSITIVE CONTROL TERMINATIONS ——— ⊠
3. ALL OTHER TERMINATIONS ——— ⊗
4. NB1 & EB1 ARE THERMAL MOTOR PROTECTORS

TIME DELAY ON ENERGIZATION		TIME DELAY ON DE ENERGIZATION	
NO	NC	NO	NC
TIMES CLOSED	TIMES OPEN	TIMES OPEN	TIMES CLOSED

ACCY 22
PL

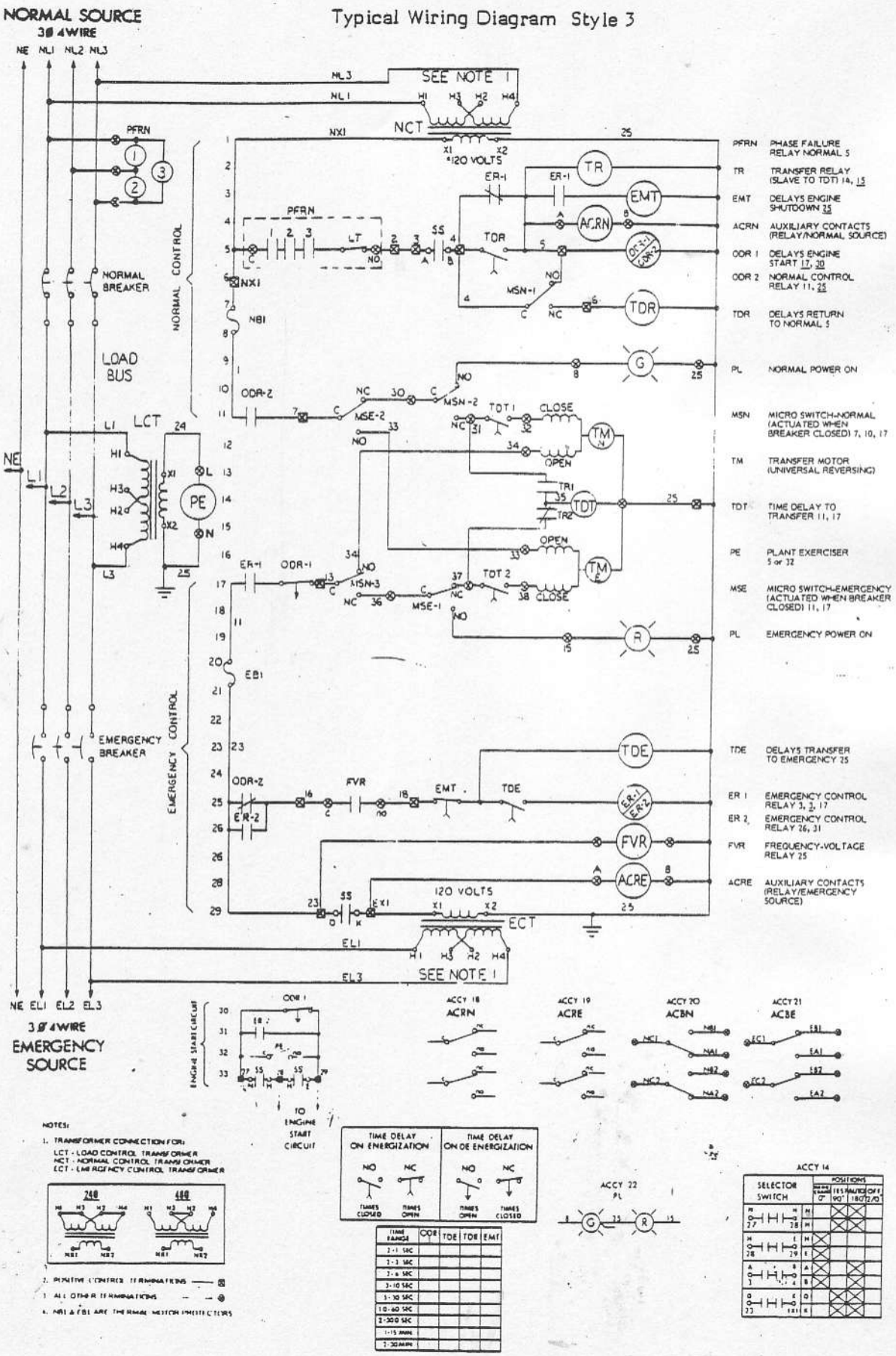


ACCY 14

SELECTOR SWITCH		POSITIONS			
		0°	90°	180°	270°
N 27 H 28	N				
	H				
M 28 E 29	H				
	E				
A 3 B 4	A				
	B				
D 23 K (X1)	D				
	K				

TIME RANGE	ODR	TDE	TDR	EMT
.2-1 SEC.				
.2-3 SEC.				
.2-6 SEC.				
.3-10 SEC.				
.5-30 SEC.				
1.0-60 SEC.				
2-300 SEC.				
.1-15 MIN.				
.2-30 MIN.				

Typical Wiring Diagram Style 3



4. OPERATING MECHANISM

General Information

The operating mechanism pictured in Figure 3 (page 13) is used on Styles 2, 3 and T-200 transfer switches. The motor (4) is a universal type, reversible gear motor and is shipped as a complete component including the gear box. Because of the wide range of circuit breakers used on Lake Shore Electric Transfer Switches, if motor replacement is necessary, please specify the serial number of the transfer switch. The operating mechanism pictured in Figure 4 (page 14) is used on all Style 2, 1600 Amps Switches and larger.

Operation

When a signal to transfer is received through the normally-closed contacts of the auxiliary switch, the motor is energized and the gear box turns the drive drum (8) which sets up a friction pull between itself and the drive shoe lining (13). This friction pull is sufficient to pull the drive arms (2) over to the new position, actuating the switch/circuit breaker handle. As soon as the drive arms have reached their new position, the auxiliary switch changes position cutting off the motor while at the same time setting up the circuit for the next transfer in the opposite direction. Because of the built-in features of the friction drive, it is possible to manually operate the switch by moving the manual handle (1) without engaging any clutches or devices, except for 1600 Amp and larger Style 2. The gear box is a sealed unit which never requires maintenance or attention.

Routine Adjustments

When excess slippage occurs in the friction drive, it is necessary to increase the tension on the friction drive shoe lining. This is done by turning the adjustment screw (3) clockwise. This action compresses the tension spring (9) and thus increases the friction. The adjustment screw should not be tightened all the way, but merely enough to ensure positive transfer of the circuit breakers when the motor operates.

Transfer switches utilizing smaller circuit breakers are equipped with a single friction drive arm as they require less force to activate. On these switches an idle arm with no adjusting screw replaces one of the drive arms shown in Figure 6. Where two friction drive arms are incorporated, it is necessary to achieve balance between the two so that both of the drive units exert dual force during transfer.

Do not tighten the adjustment screw to its limit as this will compress the spring entirely and cause the operating mechanism to jam. When this happens, the gears may strip or the roll pins inside the gear box may shear. Sheared rolled pins and/or stripped gears are indicated when the motor operates but does not turn the drive drum. This situation can only be remedied by returning the unit to the factory.

Occasionally, the tension spring loses its life due to over-adjustment. This is indicated when the motor operates and the drive drum turns but the unit does not have sufficient strength to operate the circuit breakers. In this case, the spring must be replaced with a new one.

Motor Assembly

To assemble the operating mechanism, first place the drive drum keys (11) on the two shafts which extend from the gear box. Next, slide the two drive drums (8) on the shafts. Insert one drive shoe pivot (10) into one drive arm (2) from the bottom, followed by the drive shoe (12) and the drive shoe lining (13). Be sure that the lining fits snugly into the drive shoe and that the concave cup end of the drive shoe pivot (10) engages the nipple on the drive shoe. Hold the entire assembly together and slip it onto one shaft, pushing it all the way to the drive drum. Now the spring (9) and adjustment screw (3) may be assembled into the drive arm (2) from the top. Repeat this procedure for the other drive arm assembly.

Place the lever arm support (17) in such a way that it straddles the gear box and engages the drive arm assemblies on both sides of the gear box. Tighten the mounting screws and assemble the lever arm across the two circuit breakers by fastening the lever arm to the lever arm support with the manual handle assembly (1). Observe the circuit breaker actuating lever as it is manually opening and closing the circuit breaker, checking that it does not hit the circuit breaker case when it opens and closes the circuit breaker.

The disassembly procedure of the mechanism is the reverse of the above. However, it is recommended that, before disassembling any of the components, center punch marks be placed at appropriate locations so that reassembly can be made quickly and correctly.

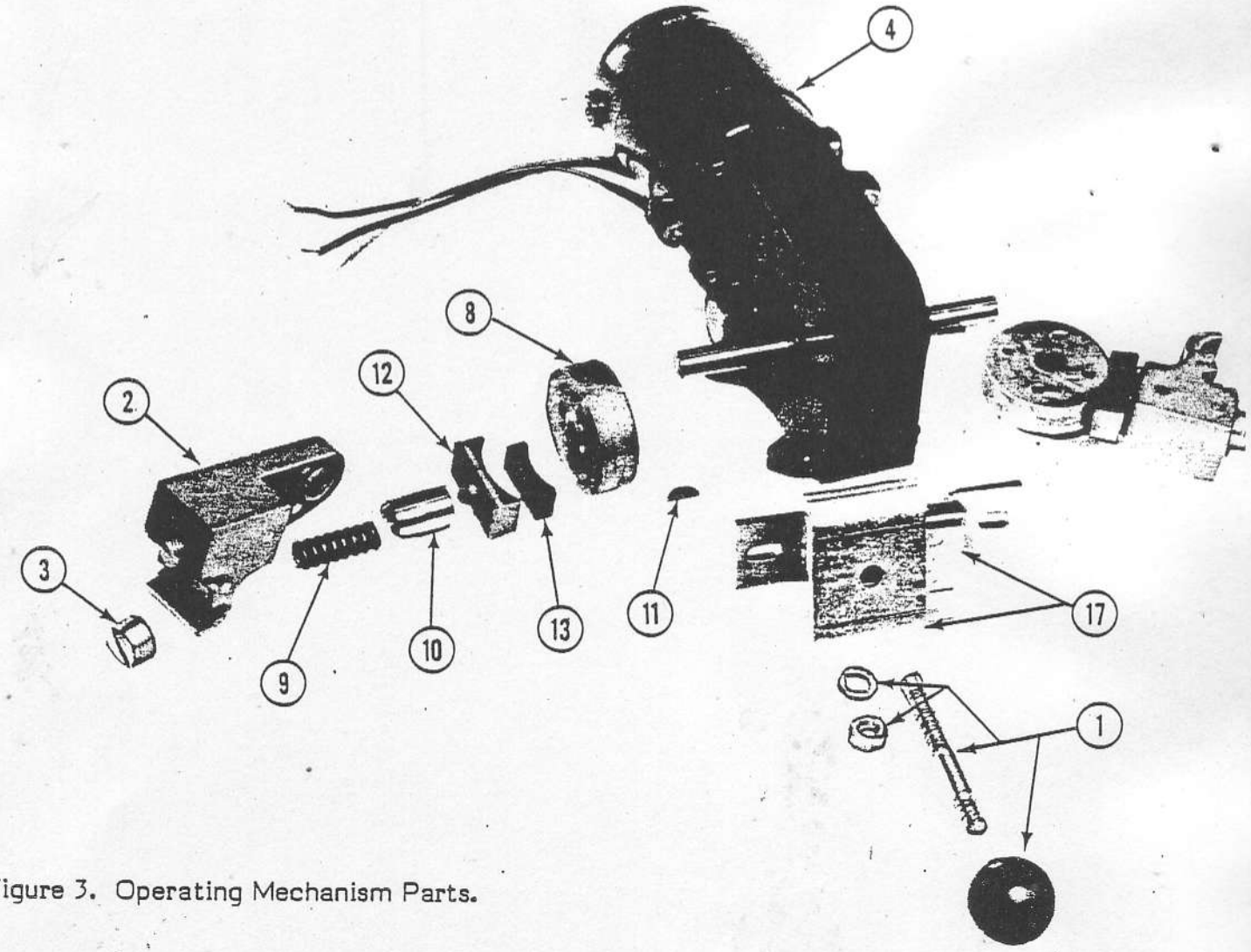


Figure 3. Operating Mechanism Parts.

Motor Assembly (Style 2, 1600 Amps and Larger)

The motor (1) will always be shipped with the hub (2) already attached to the motor shaft. To further assemble the motor operator, first place one of the friction discs (3) over the hub. Next, slide the nylon collar (4) over the drive hub. Then the drive gear (5) over the nylon collar. Slide the second friction disc next to the drive hub. Then place the pressure plate (6) with the spring holes facing away from the motor on the shaft. Add the six compression springs (7) into each hole of the pressure plate (6). Then slide the 2" O.D. diameter washer over the shaft to hold the springs (7) in place. Take the 3/4 - 16 jam nut (9) and secure tightly to the shaft. The motor operating mechanism can then be mounted with the appropriate motor mount plate (10), to the base plate and engaged with the pivot arm rack for operational purposes. It is a must that when engaging the pivot arm rack the breaker operator handle (lever arm) is either in the up or down position so that the gear will be positioned at the upper or lower end of the pivot arm rack.

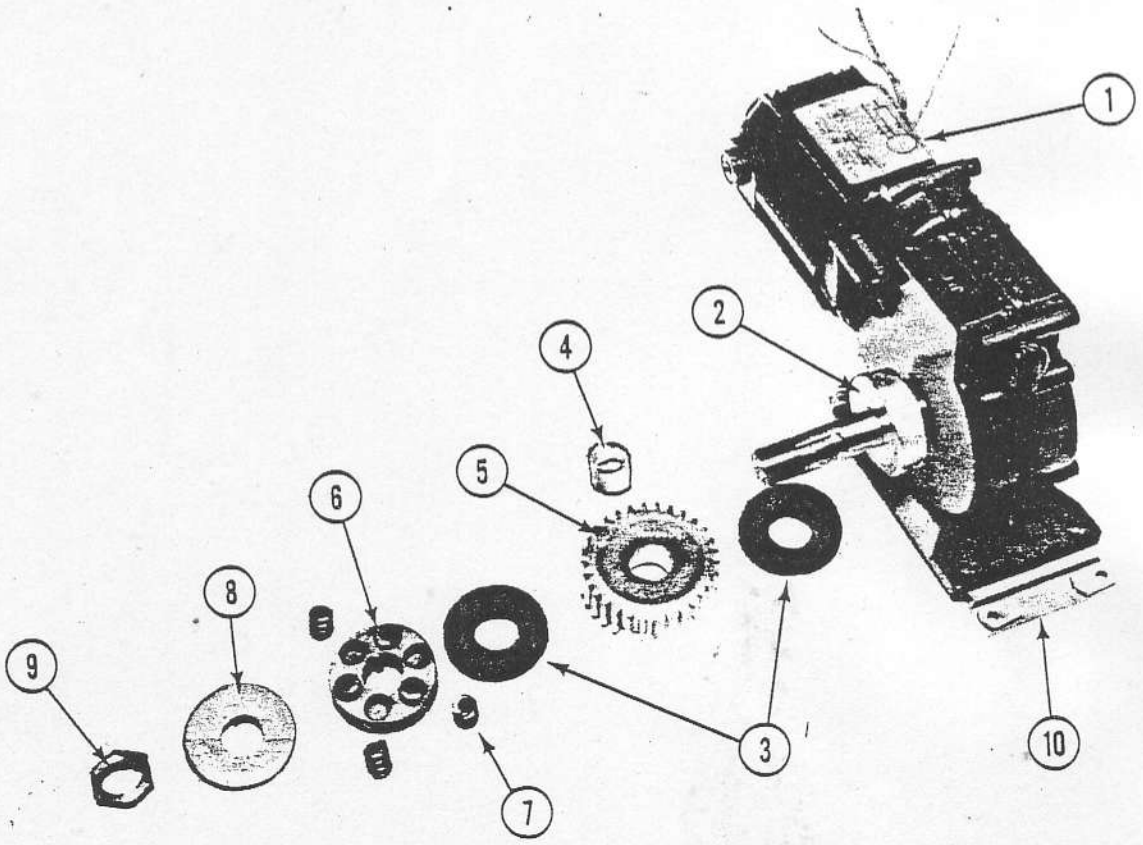


Figure 4. Operating Mechanism Parts.

5. TIMING RELAYS

(September 1982 and Later Models)

TDR, TDE & EMT RELAY

These relays can be used interchangeably. They are all ON delays and have identical operating characteristics. The setting accuracy is 10% of the range. Each timer has five dial selectable ranges as follows:-

Ranges and minimum setting:

Ranges	Minimum Setting
0-0.3 sec.	0.02 sec.
0-3 sec.	0.07 sec.
0-30 sec	0.6 sec.
0-3 min.	3.5 sec.
0-30 min.	35.0 sec.

SETTING THE RANGE:

Position the knob near mid scale. Pull the spring loaded knob out and trist clockwise to increase to a longer range; turn counter clockwise to decrease down to a smaller range. A click will be heard as you make the progression through the ranges. All graphics and electrical connections are switched by rotating the knob.

The timing begins when 120 VAC is applied to terminals 2 and 7. At the end of the delay period N.O. contacts 1 - 3 and 6 - 8 and N.C. controls 1 - 4 and 5 - 8 transfer. The timer resets when power is interrupted to terminals 2 and 7.

ODR RELAY

This relay may be pneumatic or solid state design. In both cases it is a true OFF delay relay, no power is required for timing. When power is applied to the relay coil the N.O. and N.C. contacts transfer. When power is removed for the relay coil the timing cycle starts. After the timer has timed out the contact will transfer to their original state.

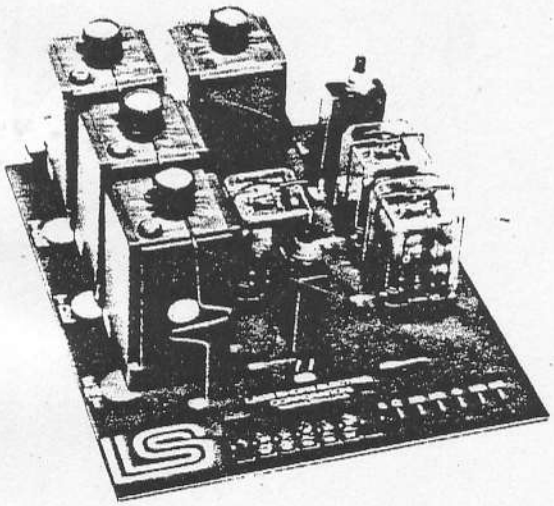
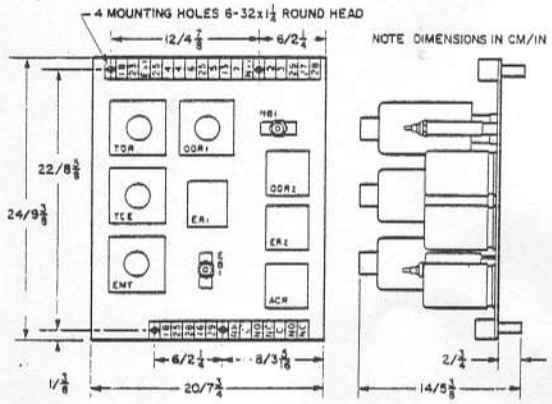
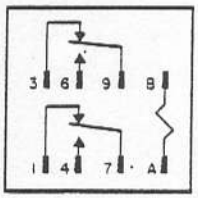


Figure 5. Typical Positive Control System with TDR, TDE, EMT and ODR Relays

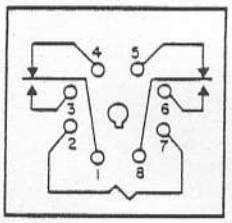
COMPONENT LAYOUT



Layout of PC Board



Contact Arrangement of ER, ODR_2, TDT and ACR Relays



Contact Arrangement of ODR_1, TDR, TDE and EMT Relays

6. VOLTAGE RELAYS

(1976 and Later Models)

Adjustment of Pickup and Drop-out Levels

The procedure that follows concerns the adjustable voltage relays only, since they can be easily adjusted in the field without special equipment.

Some variable source of voltage is required to properly set pickup and drop-out levels of the relays. When the relay is to be used with an emergency power source, this source may be used to supply the necessary levels. If an emergency power source is not available, a variac may be used. A voltmeter for the proper voltage range is also necessary.

1. Check AC input wires to make sure they are connected to proper relay terminals.

2. Turn one pickup control adjusting screw to extreme 100% position (clockwise to limit, do not force).

3. Turn the corresponding drop-out control adjusting screw to extreme 70% position (counterclockwise).

4. Start generator or energize variac or rheostat circuit to relay input terminals.

5. Observing voltmeter, set voltage from generator, variac or rheostat to voltage level desired for pickup point.

6. Slowly turn pickup control screw counterclockwise (towards 70%) until the normally open and .common contacts on the terminal block close or until the contacts in the plug-in relay of the phase you are adjusting close. For example, assume operation is on 120-volt line and indication is required when voltage level falls to 90 volts. This is drop-out point. Assume also that indication is required when voltage in line comes back to 100 volts after failure. This is pickup point.

When pickup level has been reached, as indicated on voltmeter, turn pickup control screw slowly counterclockwise (towards 70%) until the normally open and common contacts on the terminal block close or until the contacts in the plug-in relay of the phase you are adjusting close.

7. Lower the level of input voltage to relay to drop-out point desired by means of the generator variac or rheostat as indicated on the voltmeter.

8. Turn drop-out control screw clockwise (towards 100%) until relay drops out.

9. Raise the level of input voltage to above pickup point, and check relay energizing level on voltmeter, then lower to drop-out point and recheck relay drop-out level. Proceed slowly to touch up controls until exact levels are set. Two or three tries will familiarize you with this procedure.

10. Repeat the same procedure on each section of multi-phase relays.

CAUTION: Do not subject these relays to high overvoltage unless they are so rated. Transistors may be damaged if more than 25% of rated voltage is applied.

7. CIRCUIT BREAKERS

The circuit breakers used in Trans-O-Matic switches are the standard devices supplied by circuit breaker manufacturers. Figure 6 (page 20).

Most transfer switches use molded case switches, that is, without a trip unit.

When interchangeable trip units are used for thermal overload and short circuit protection, an alarm contact is included to indicate to the transfer switch circuit that the breaker has tripped due to an overload. This breaks the motor circuit and prevents oscillation. Oscillation can also be caused by dirty or open contacts in the circuit breaker or by a damaged interlock bar.

If either breaker trips due to overload, it can be reset by manually operating the transfer switch to the position that the breaker relatches, and then returning to the ON position.

Inspection and Maintenance

Terminal lugs and trip units must be tight to prevent overheating. Due to the inherent wiping action built into the moving contacts of all circuit breakers, operating the breaker several times under load will remove any high resistance film that may have formed. Under normal conditions, additional cleaning of contacts is not required. However, should operating and/or atmospheric conditions make it desirable to clean the contacts further, the following procedure is recommended.

Remove cover, arc extinguisher hold down screws (4), arc extinguishers (6) and line terminal assemblies (8). Wipe contact surfaces with a clean cloth dipped in carbon tetrachloride or other chlorinated solvent. If surfaces are excessively oxidized or corroded, scrape lightly with a fine file before wiping.

The only difference being that the auxiliary switch furnished by the Circuit Breaker manufacturer is mounted internally of the breaker, and as a result, greatly limits the amount of auxiliary switches available.

The Lake Shore auxiliary switch is mounted through the side of the Circuit Breaker by drilling one clearance hole for an actuator finger and two mounting holes for mounting the bracket. This device allows Lake Shore to mount up to four Form C auxiliary switches per breaker side. A brief description of the parts that make up this switch is as follows:

The Switch Actuating Assembly (1) is made up of a bracket (11), an actuator finger (3), and a tension spring (5). The actuating assembly is mounted to the breaker with two nylon screws (7). Micro switches (9) are mounted to the switch bracket with two #4 screws (10) and aligned in such a manner that actuates the micro switch when moving the actuator finger up or down.

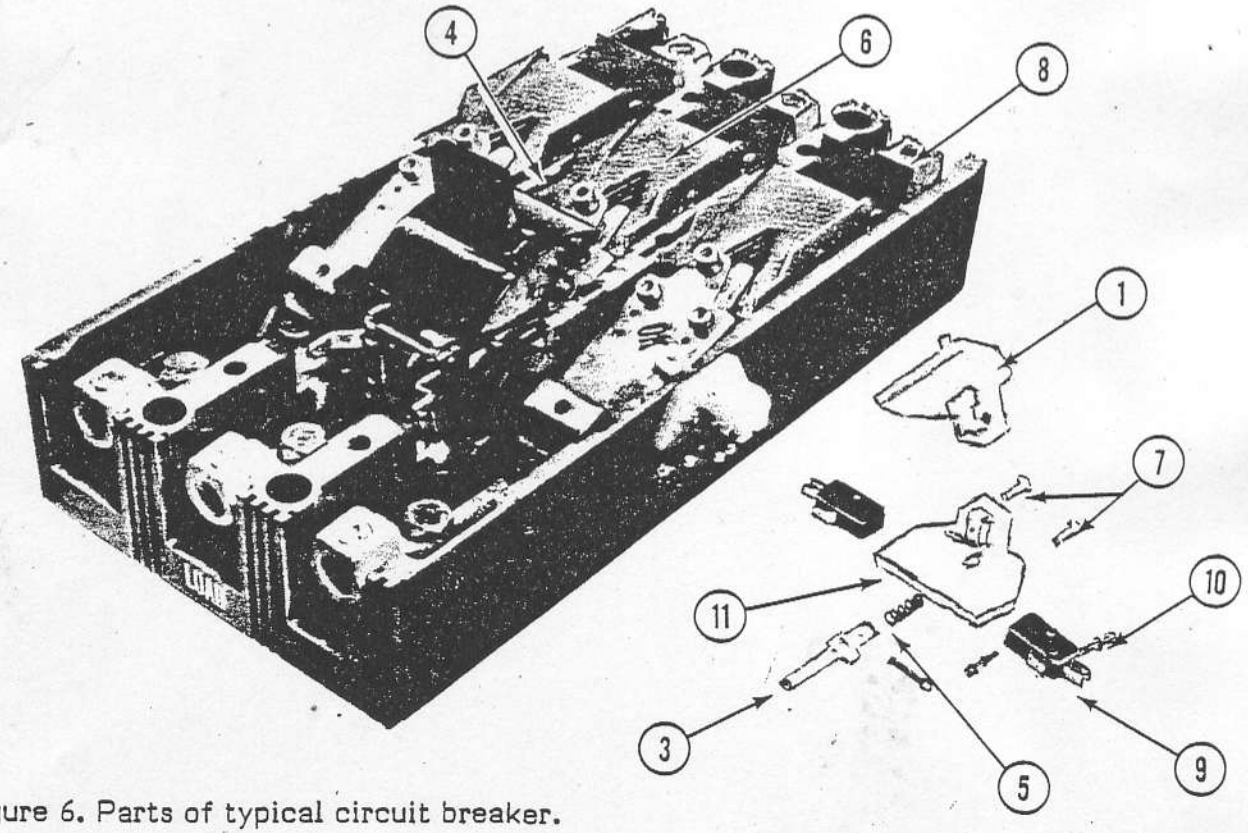


Figure 6. Parts of typical circuit breaker.

8. TROUBLESHOOTING

The following conditions MUST be met before attempting to troubleshoot a Trans-O-Matic.

1. A wiring diagram for the switch must be available. Lake Shore Electric will supply one if you provide the switch serial number.

2. Normal and emergency voltage and frequency must be available and within the correct operating limits.

3. Control circuit voltage (if transformers are used) must be 110 to 125 volts.

4. Connections to the PFR must be correct and the relay must be adjusted to pick up on the voltage at which the switch is operating. See voltage relay instructions on page 17.

5. All timers must be turned down or consideration given to them while the tests are being conducted.

6. If trip units are included in the circuit breaker, they must be reset if previously tripped due to an overload.

7. All electrical connections must be tight and in accordance with the wiring diagram.

8. All components must be free of obvious defects with the exception of normal usage.

9. All fuses must be intact.

When you are satisfied that all of the above conditions are met and all accessories are either working correctly or eliminated, the problem will be confined to:

1. the control relays
2. the circuit breakers
3. the adjustment of the operating mechanism
4. the motor and MS

The troubleshooting procedures outlined here are designed to test the control circuit and the operating mechanism of the transfer switch. It is therefore necessary that all factors external to the transfer switch are correct and that all accessory devices which are not imperative to switch operation either operate satisfactorily or be bypassed and jumpered out of the circuit.

Elsewhere in this manual are instructions for the troubleshooting of accessory devices. We recommend that the entire manual be read before attempting to make any adjustment. Above all, CAUTION is recommended.

Many of the troubleshooting tests require a simulated failure of the normal source. This can be done with the Load Test Switch, or by removing one of the miniature circuit breakers on the normal source control circuit.

Symptom	Conditions	Cause & Cures
Switch will not transfer automatically.	Motor does not operate when normal source failure is simulated.	Motor damaged, probably due to defective brushes. Replace motor. Voltage is available at motor leads.
	Motor runs continuously when normal power failure is simulated.	Friction adjustment needs tightening. See "Operating Mechanism" on Page 11.
	Motor does not operate when normal source failure is simulated. No voltage available at motor leads.	MS contacts are burned or dirty. MS contacts are not closed at the proper time to complete circuit for next transfer.
	Motor does not operate when normal source failure is simulated. MS is operating correctly.	Defective contacts or coils in CR, ODR or ER.

Symptom	Conditions	Cause & Cures
Switch transfers automatically, but only in one direction.	Switch will not automatically return to normal. Both sources are available.	1. TDR relay not timed out. TDR relay is defective. 2. ODR or CR relay is defective. 3. MS switch has not reversed. See "Operating Mechanism" on Page 11.
	Switch will not automatically transfer to emergency source Emergency source only available.	ER is defective and has not picked up or made contact or ODR CR has not dropped out and made contact or the MS has not reversed. See "Operating Mechanism" on Page 11.
Switch will not operate manually.	Manual handle will not close circuit breaker.	Interlock bar binding or adjustment screw tightened to limit of travel or operating arm hitting case of circuit breaker, before the breaker closes. See "Operating Mechanism" on Page 11.