ONAN
LOAD TRANSFER CONTROL

MODEL

LTC

959-3 2A67

TABLE OF CONTENTS

ONAN
LOAD TRANSFER CONTROL

' DEL

959-3 **LTC** 2A67

GENERAL INFORMATION

For future reference, fill in the blanks below:

Control Model Number LTC 800-4/6155C

Serial Number 223741

Wiring Diagram (Diagram furnished with control)

618C351

Installed By ______________________ *Date* ______________

IMPORTANT...RETURN WARRANTY CARD ATTACHED TO UNIT

INTRODUCTION

This *Onan* LTD series manual contains information to help install, operate, and maintain line transfer controls. Keep this manual handy and refer to it when necessary. The load transfer controls described in this manual are designed to be used with *Onan* 2-wire control remote starting generating plants. When contacting a dealer or the factory about this control, always supply the complete Model and Spec No., plus the full serial number as shown on the nameplate. This information is necessary to identify the control among the many basic and special optional types manufactured by *Onan*.

MODEL DESIGNATION

EXAMPLE - LTC200-23/1A

A — *Spec Letter* – Advances with production modification resulting in parts not interchangeable.

1 — *Spec No.* - Identifies optional equipment. No. 1 designates no options or basic as advertised.

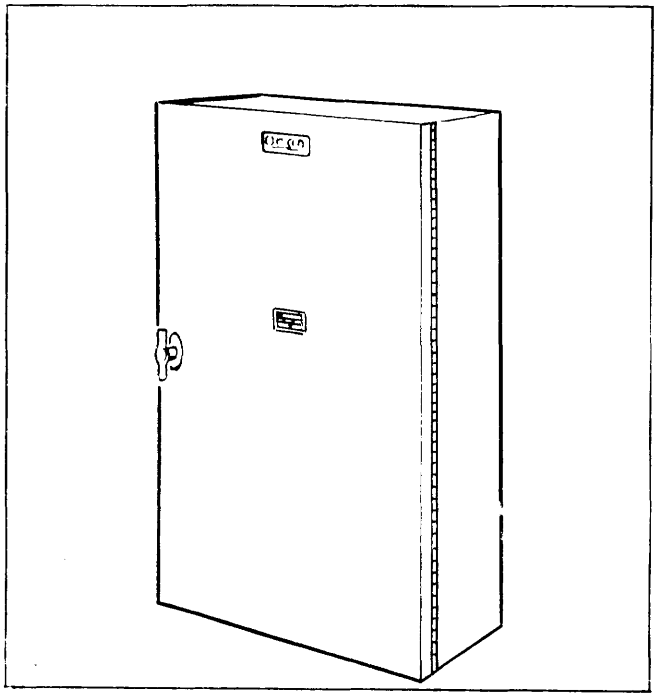
/ — *Diagonal* - Separates basic model from specification.

3 — *Code No. (Units Digit)* - Designates voltage, wire and phase. 1 is 120-volt; 2 is 240-volt; 3 is 120/240-volt 1-phase; 4 is 120/208-volt 4-wire 3-phase; 5D is 120/240-volt 4-wire 3-phase delta, center tapped.

2 — *Code No. (Tens Digit)* - No. 2 designates control serves for both 50- or 60-cycle and is considered standard. No. omitted designates 60-cycle use only. No. 5 designates 50-cycle use only.

200 — *Ampere Rating.*

LTC — *Series* - LTC Designates *Onan* Load Transfer Control for 2-wire remote start 24-volt battery charging system.



TYPICAL MODEL LTC

MANUFACTURER'S WARRANTY

The Manufacturer warrants, to the original user, that each product of its manufacture is free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to the Manufacturer's instructions.

Manufacturer's obligation under this warranty is limited to correcting without charge at its factory any part or parts thereof which shall be returned to its factory or one of its Authorized Service Stations, transportation charges prepaid, within one year after being put into service by the original user, and which upon examination shall disclose to the Manufacturer's satisfaction to have been originally defective. Correction of such defects by repair to, or supplying of replacements for defective parts, shall constitute fulfillment of all obligations to original user.

This warranty shall not apply to any of the Manufacturer's products which must be replaced because of normal wear, which have been subject to misuse, negligence or accident or which shall have been repaired or altered outside of the Manufacturer's factory unless authorized by the Manufacturer.

Manufacturer shall not be liable for loss, damage or expense directly or indirectly from the use of its product or from any cause.

The above warranty supersedes and is in lieu of all other warranties, expressed or implied, and of all other liabilities or obligations on part of Manufacturer. No person, agent or dealer is authorized to give any warranties on behalf of the Manufacturer nor to assume for the Manufacturer any other liability in connection with any of its products unless made in writing and signed by an officer of the Manufacturer.

DATED AUGUST 1, 1963

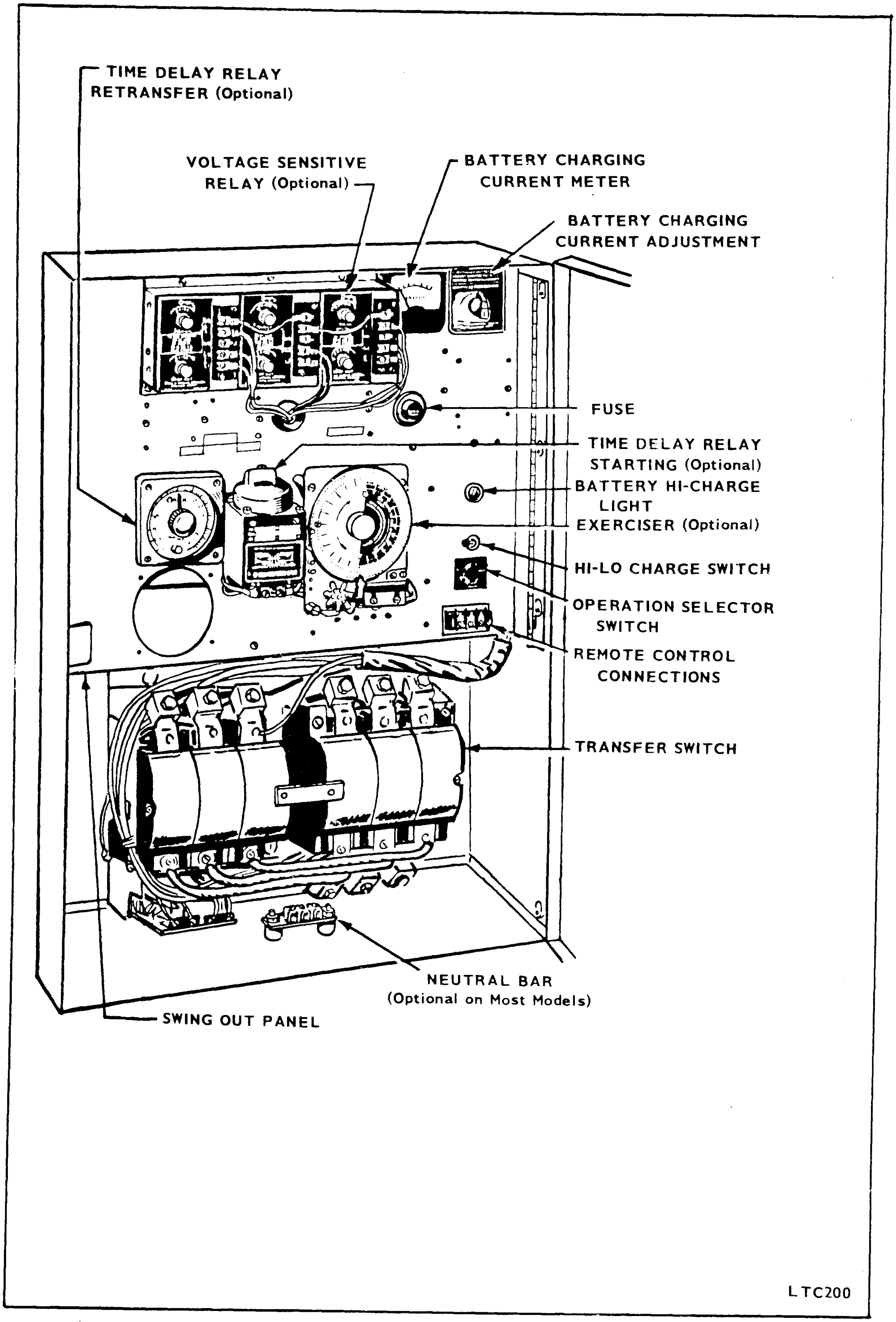

TIME DELAY RELAY
RETRANSFER (Optional)
VOLTAGE SENSITIVE
RELAY (Optional)
BATTERY CHARGING
CURRENT METER
BATTERY CHARGING
CURRENT ADJUSTMENT
FUSE
TIME DELAY RELAY
STARTING (Optional)
BATTERY HI-CHARGE
LIGHT
EXERCISER (Optional)
HI-LO CHARGE SWITCH
OPERATION SELECTOR
SWITCH
REMOTE CONTROL
CONNECTIONS
TRANSFER SWITCH
NEUTRAL BAR
(Optional on Most Models)
SWING OUT PANEL
LTC200

FIG. 1

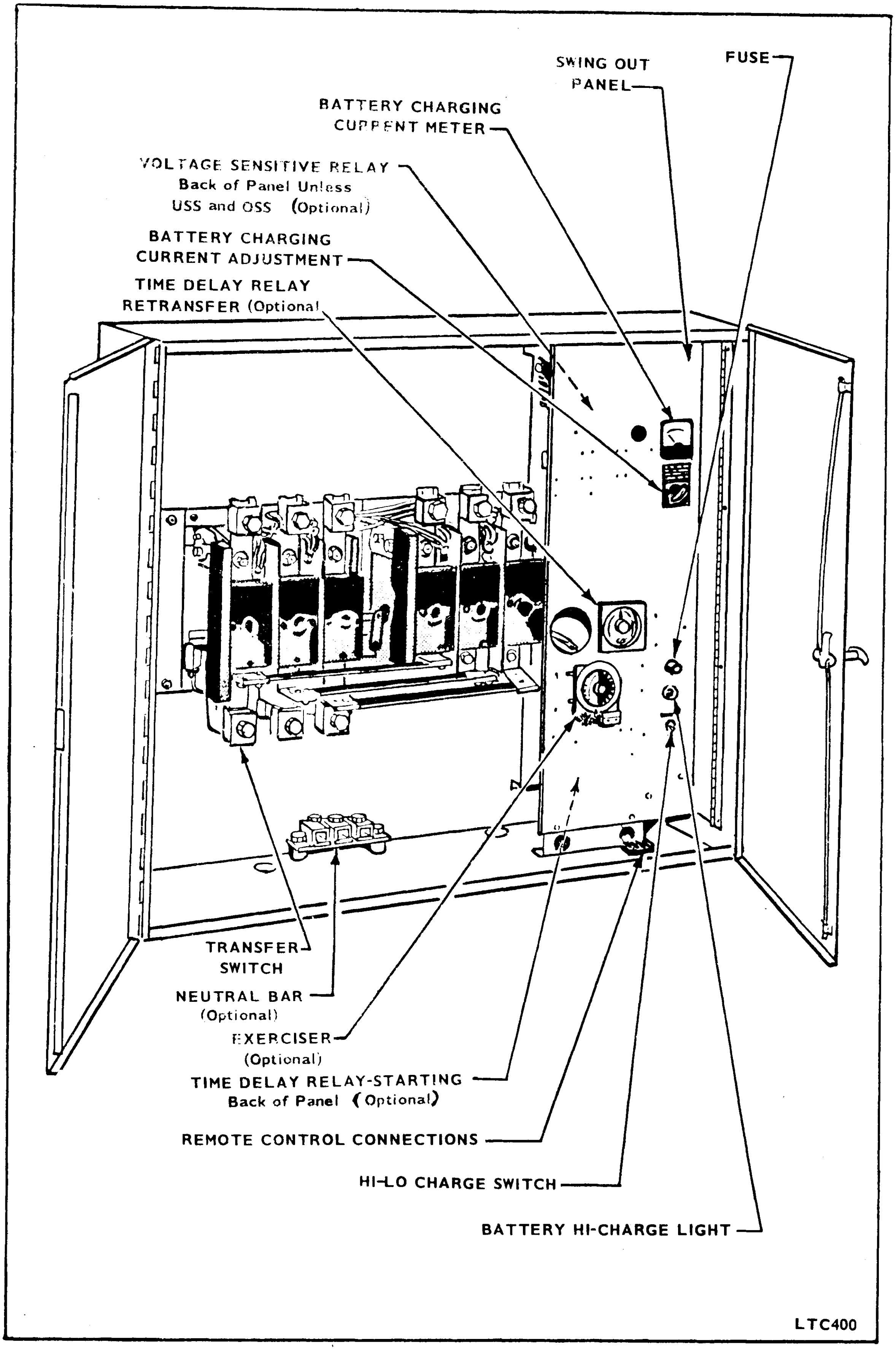

SWING OUT PANEL
FUSE
BATTERY CHARGING CURRENT METER
VOLTAGE SENSITIVE RELAY
Back of Panel Unless
USS and OSS (Optional)
BATTERY CHARGING CURRENT ADJUSTMENT
TIME DELAY RELAY RETRANSFER (Optional
TRANSFER SWITCH
NEUTRAL BAR
(Optional)
EXERCISER
(Optional)
TIME DELAY RELAY-STARTING
Back of Panel (Optional)
REMOTE CONTROL CONNECTIONS
HI-LO CHARGE SWITCH
BATTERY HI-CHARGE LIGHT
LTC400

FIG. 2

DESCRIPTION

The *Onan* series LTC (load transfer control) is designed for use with *Onan* 2-wire, 24-volt, remote-starting, generating plants installed for standby service. The LTC controls generating plant operation, supply of commercial and emergency power to the load. It assures a supply of emergency power during commercial power failures.

CIRCUIT & COMPONENTS

The basic LTC includes:

1. Load transfer switch that connects either the commercial or emergency power to the load.
2. Relays to start and stop the generating plant and control the transfer switch.
3. A battery charger which maintains starting batteries at full-charge.

NOTE: Use the wiring diagram furnished with the control in conjunction with this explanation (wiring diagrams explained in Maintenance Section).

Operation - (Mechanically Held Transfer Switch): The *transfer switch* is electrically operated and connects the load to commercial or emergency power source. An LTC's current rating is determined by the transfer switch capacity.

All transfer switches contain two separate sets of contacts; one set connects the commercial line to the load, the other connects the emergency power to the load. A pull-in coil (when energized by line power) pulls in the line-side contacts. A mechanical latch then locks the contacts closed and opens a micro-switch that disconnects the pull-in coil. This eliminates hum during normal operation.

Another coil (energized by plant output) operates the mechanical latch release, disconnecting the line-side contacts. These contacts must unlatch and drop out before the generator contacts can close. Power supplied to this coil also pulls in and holds the generator contacts closed. Both mechanical and electrical inter-locks prevent contacts from closing at the same time.

The *basic control circuit* consists of three relays:

1. Start-stop relay
2. Transfer switch pilot-relay
3. Instant transfer relay

In addition, it may contain some optional relays. The start-stop relay controls starting and stopping of the generating plant. When the relay de-energizes its contacts signal the engine control to start and run the plant. The transfer switch pilot-relay controls the mechanical latch release coil and the generator side of the transfer switch. When the pilot-relay energizes, it releases the latch and connects the coil that pulls in the generator side of the transfer switch. The instant transfer relay controls the line-side of the transfer switch and also the generator side. Whenever this relay is energized from line power, it breaks the circuit to the generator side and energizes the line-side of the transfer switch.

Normally (with commercial power on) the transfer switch line-side is closed. The start-stop relay and instant transfer relay are energized; the transfer switch pilot-relay is de-energized.

When commercial power fails, the start-stop and instant transfer relays de-energize. This closes the start-stop relay contact, signaling the plant to start. When voltage builds up, the transfer switch pilot-relay pulls in, energizing the latch disconnect coil and generator-side coil. The main line contacts open, generator contacts close, and the generator supplies power to the load.

When commercial power returns, the instant transfer relay closes which disconnects the generator side coil of the transfer switch and allows the line-side to pull in immediately. At the same time, the start-stop relay energizes to stop the generating plant.

High Rate Battery Charger: This charger includes a high rate of about 2-amps to boost low batteries and a low rate (100 - 500 milliamp, adjustable with rheostat) to maintain batteries once charged. Both are controlled by a toggle switch on the inner panel. A light indicates when the high rate is on; the meter indicates the low rate charge current.

Load Transfer Control LTC800-1200 is contained in two separate cabinets, one cabinet contains the control relays, battery charger, and optional equipment. The other cabinet contains the transfer switch. The transfer switch is rated at 800- or 1200-amps and has non-tripping circuit breakers actuated by small electric motors. A mechanical interlock (on the back of the switch) prevents line and generator contacts from being closed at the same time.

OPTIONAL EQUIPMENT

Only the most popular options are discussed here.

Time Delay Relays: A time delay is often required in one or more of the control functions such as engine starting, load pickup, engine stopping, load transfer to commercial line. Two different types of relays are used, depending on the function to be delayed and the required delay period. (See Adjustments in the Maintenance Section for complete relay delay descriptions.)

Time Delay on Starting: Delays plant starting after a power failure. It prevents plant operation during very short line failures.

Time Delay on Load Pickup: Delays the transfer of the load to allow for plant warm up.

Time Delay on Re-transfer: Allows time for the returning commercial power to stabilize before connecting it to the load. The plant supplies power during this period.

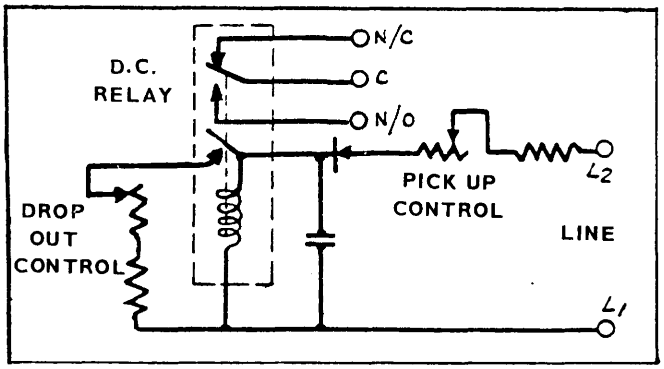


FIG. 3

Time Delay on Stopping (After Re-transfer): Allows the plant to run for a few minutes under no-load before shut-down. This stabilizes engine temperature, reducing distortion and wear.

Voltage Sensitive Relays: The basic control reacts *only to complete failure* (about 50% of nominal line voltage). *Voltage sensitive relays* allow it to react to any pre-set voltage drop and also to higher than normal voltages.

Each voltage sensitive relay consists of a direct current relay connected across the output of a half-wave rectifier. A capacitor (connected across the output of the rectifier) maintains current flow during the half cycle that no current flows through the rectifier.

The pickup control consists of a wire-wound potentiometer which is connected in series with the rectifier and relay coil. The pickup control operates by increasing or decreasing current-flow through the relay coil. The drop-out control consists of a wire wound potentiometer in parallel with the relay coil. It operates by increasing or decreasing the current by-passed around the relay coil. Increasing the by-passed current lowers the drop-out voltage. Both pickup and drop-out voltages are adjustable. In under-voltage application, the relay is connected across the line. When line voltage falls to the drop-out point, the relay de-energizes, starting the transfer to emergency power. When line voltage returns to the pre-set pickup voltage, the relay initiates the return to commercial power.

In over-voltage application the relay is normally closed, but when line voltage becomes excessively high, the relay opens, initiating the transfer to generator power. When line voltage drops to normal, the relay returns the load to commercial line power.

These relays can also be used to disconnect the generator in applications where low voltage could damage the load equipment.

A non-adjustable voltage sensitive relay is available. Though it is similar in operation, the non-adjustable relay operates at fixed voltages (drop-out at 70% of line voltage and pickup at 90%). It can be used only for under-voltage protection.

TABLE 1 - Maximum and Minimum Settings of ONAN Adjustable Voltage Sensitive Relays

TYPE RELAY	GEN. STARTING	GEN. STOPPING
Under-Voltage	54% to 96% of Normal Voltage	70% to 100% of Normal Voltage
Over-Voltage	105% to 115% of Normal Voltage	100% to 111% of Normal Voltage

Non-adjustable Low Voltage Sensitive Relay: Pre-set to initiate transfer to standby power at 70% of normal line voltage and back to the line at 90%.

Adjustable Low Voltage Sensitive Relay: Initiates transfer to standby between 54% and 96% of normal line voltage, and between 70% and 100% on retransfer to the line. Minimum voltage differential is 5%, and maximum is 17% of normal line voltage.

Adjustable High Voltage Sensitive Relay: Initiates transfer to standby between 105% and 115% of normal line voltage, and between 100% and 111% on re-transfer to the line. Minimum voltage differential is 5%, and maximum is 17% of normal line voltage.

Mechanically Held Contacts: (Generator Side) may be specified on all amp switches. Mechanically held contacts on the line side are standard.

Exerciser: The exerciser automatically starts the plant at regular intervals and allows it to run for a pre-set time. It may be ordered so the plant operates with or without normal load (depending on the installation). This assures emergency starting by keeping the fuel system filled and the batteries charged. In the event of a power failure while the plant is exercising at no-load, the control immediately switches the load to the generating plant.

Auxiliary Contacts: Extra single-pole double-throw contacts are mounted on the transfer switch. Rating is: 6-amp at 120-volts, 3-amp at 240-volts, and 1.5-amp at 480-volts. These contacts are used for signal circuits.

Signal Lights and Alarm Terminals: Available as a warning of... commercial power failure... the standby plant has started and is supplying the load... and other conditions important to your application.

Simulated Power Failure Test Switch: This manually operated switch starts the plant and allows it to assume the normal load. The switch is normally *on* and will start the plant when switched to *off*.

Operation Selector Switch: This switch is similar to the selector switch on the generating plant control box and has the same functions. Its three positions control the plant from the load transfer control. In *stop* position, the plant will not start upon line failure. For automatic operation set it on *automatic*. *Check* position starts the plant without assuming the load for testing.

Fully Automatic Battery Chargers: Using SCR (silicon controlled rectifier) are constant voltage, current limiting chargers. Designed for float charging Lead-Acid or Nickel-Cadmium starting batteries. Transistorized units, complete with built-in Equalize Charge Timer. A permanently connected battery continuously floats at a constant voltage. As the battery approaches full-charge, preset voltage, the charging current automatically tapers to zero amperes or to the steady-state load on the battery keeping starting batteries fully charged. For fast charging, manually set the equalize-charge timer for any time period up to 12 hours (Most Lead-Acid Battery Manufacturers recommend 24 hours of equalize charging every month). Setting the Timer raises the charger's output voltage and maintains the higher charging voltage for the time selected. At the end of the timed interval, the Timer automatically switches back to float voltage.

ONAN recommends that load transfer controls be installed by an experienced electrician, observing all normal safety precautions and local codes.

LOCATING THE CONTROL

The point at which the load transfer cuts into the existing electrical circuit varies according to application and type of entrance switch. There must be a switch and fuses in the commercial line before the control. Both the generator output and load should be similarly protected. To provide maximum plant protection, have a fused switch or circuit breaker with the same capacity and electrical characteristics as the plant connected between the load transfer control and plant.

When a standby plant protects the complete electrical service, it is normally installed between the main entrance switch and the distribution panel (Fig. 7). If the protection is limited to a single emergency distribution panel, cut into the circuit after the entrance switch fuses for the emergency distribution panel (Fig. 8).

If the entrance switch is of the compact type where branch and main fuses are in a single cabinet (such as used in most modern homes) cut into the main entrance between the meter and switch. Then install an additional fused switch ahead of the load transfer control (Fig. 6).

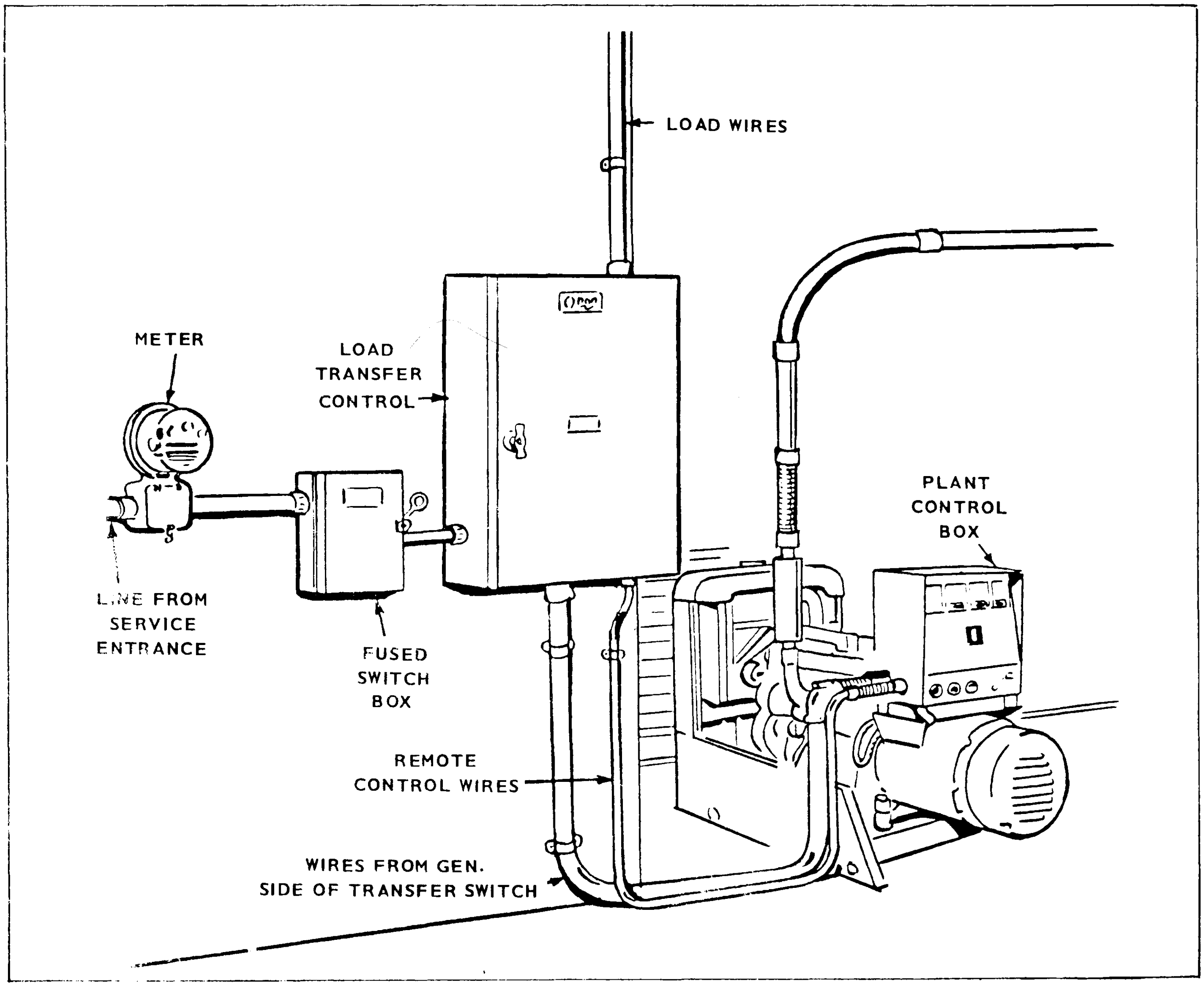


FIG. 4

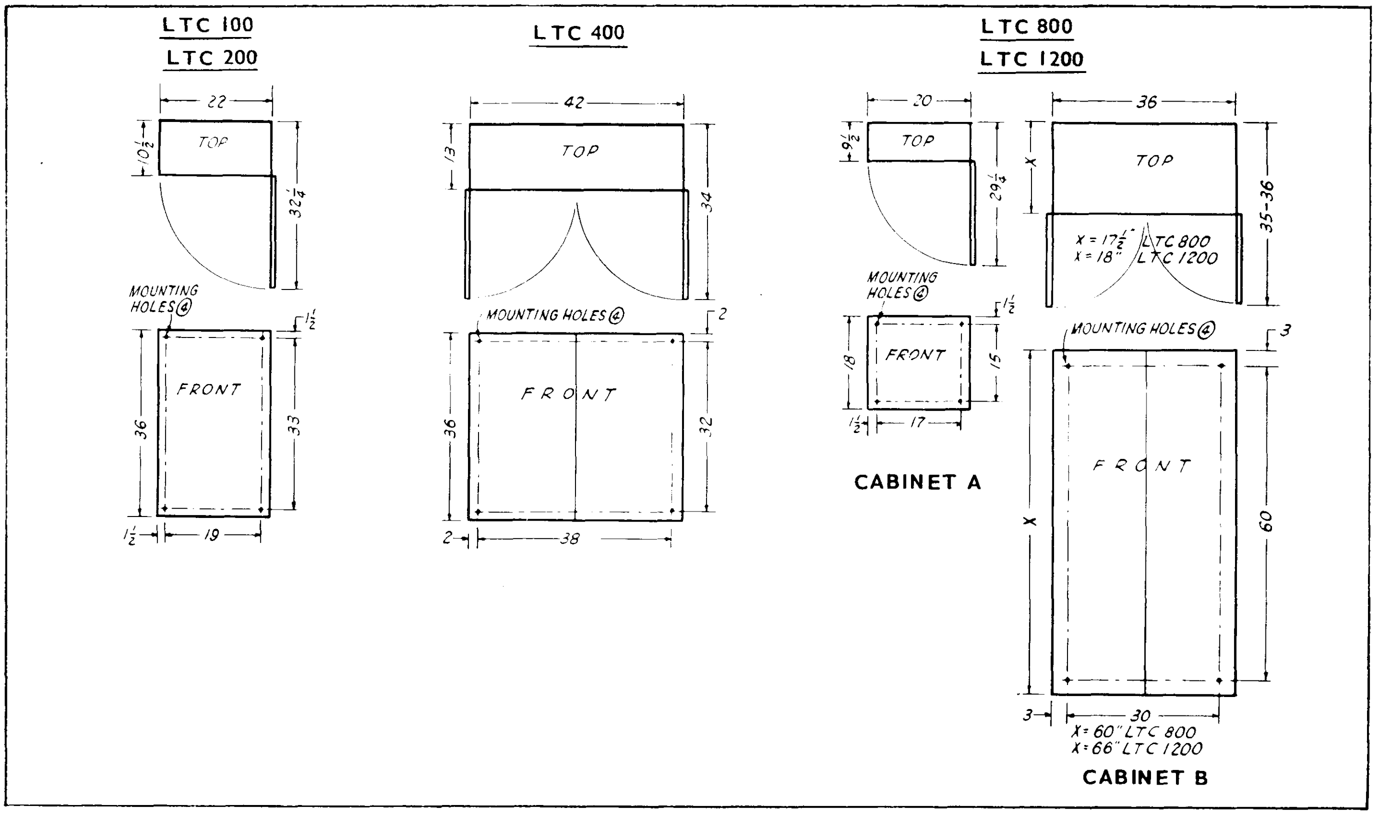


FIG. 5

Line-Load-Generator Wiring: All load wiring should be performed to meet local electrical codes. Use wires heavy enough to carry the controls rated current. The details of wiring the load, line and generating plant, will depend on their electrical characteristics: number of phases, voltage, and number of wires. In all cases, the load, line and generator, will be connected directly to the control transfer switch. The correct positions for connection are marked on the transfer switch (*gen, load, line*). Follow the instructions given under each drawing shown here for the transfer switch with your specific electrical characteristics.

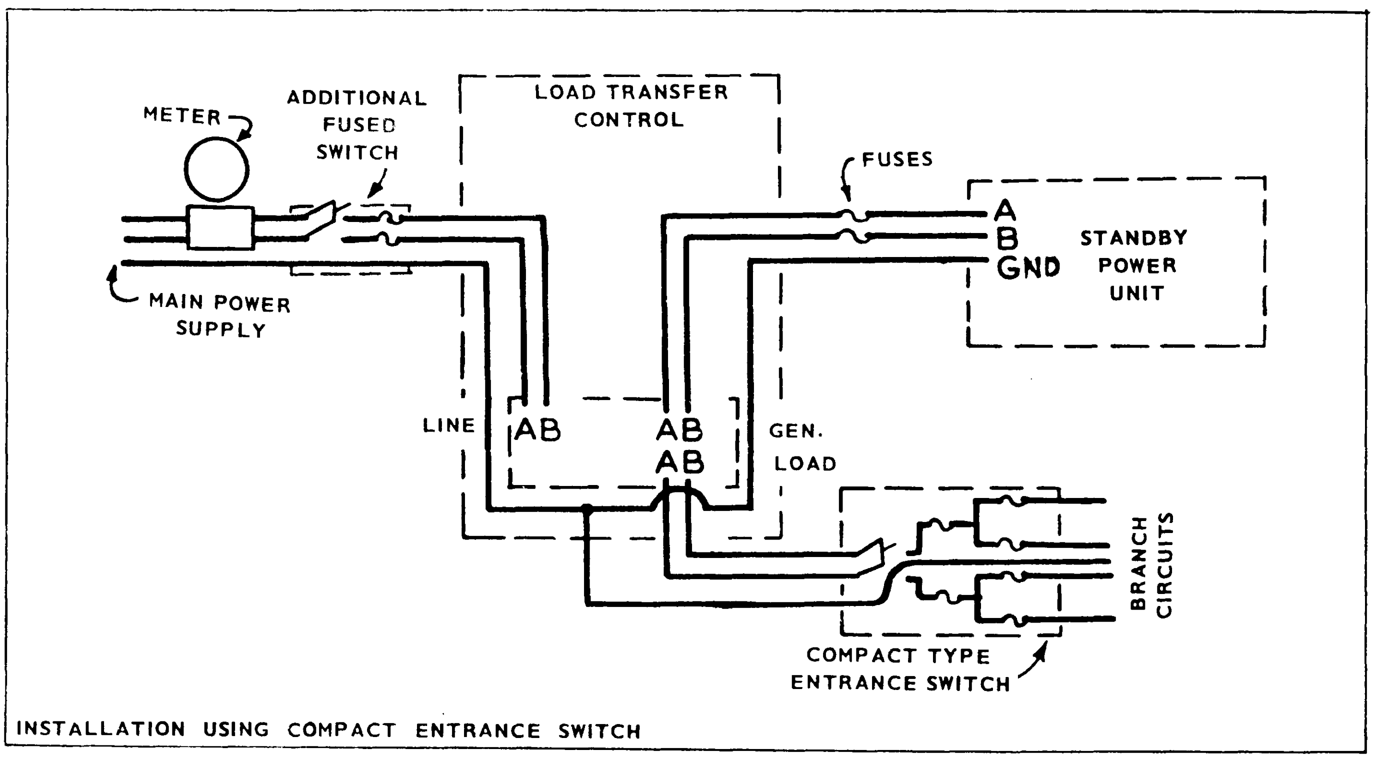


FIG. 6

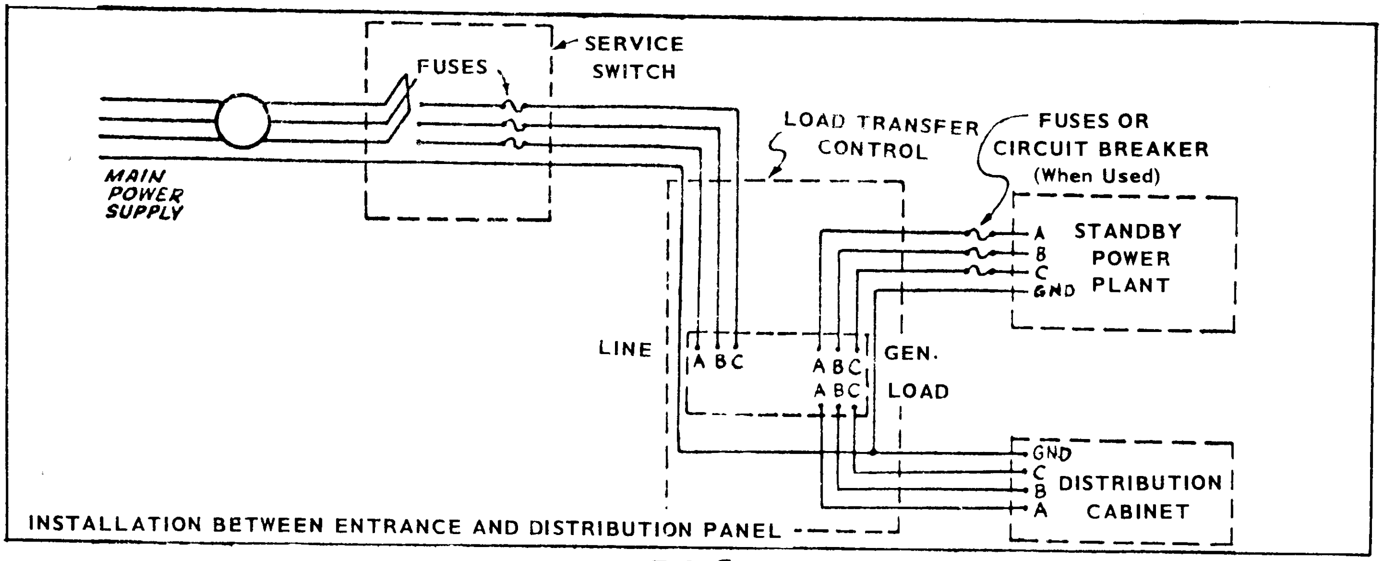


FIG. 7

The load selected for operation during emergency service might happen to be served by only one of the two *hot* line wires. In that case, half of a 120/240-volt generator would be 100% overloaded, the other half idle. This can be remedied by re-wiring the fuse box so the load to be operated during emergency is served equally by each of the two *hot* wires.

CONTROL MOUNTING

The load transfer control is normally supplied in a *NEMA Type 1* box for indoor wall mounting. It should be protected from excessive heat, moisture, dust, and dirt. Mount the control on a vertical wall, switchboard, or other permanent support where it will not be subjected to excessive vibration. Secure it with bolts or screws through the holes provided in the back of box (Fig. 5).

WIRING

Before wiring the control, provide the commercial power line with a suitable switch and fuses (or circuit breakers) ahead of the load transfer. All load circuits should also be properly fused. Install and operate the plant from its own controls before wiring the load transfer control. Load transfer control wiring can be accomplished in two steps:

1. Wire control between control and generator set.
2. Wire load from line, generator set, and load, to the control. If conduit is used, run the control (low voltage) and load wires in separate conduits.

Control Wiring: Three control wires connect the load transfer control and generator set *ground*, *B+*, and *remote*. For runs up to 100-feet, use #14 wire; for longer runs, use larger wire as specified in the plants manual. If possible, color-code the wires using the following color code for uniformity.

Control Circuit Color Code:
B+ ....Green
Ground......White
Remote.....Red

Connect the wires from the terminal block in the load transfer control to the remote terminal block in the plant control box, *B+* to *B+*, *ground-to-ground*, and *remote-to-remote* (Fig. 9).

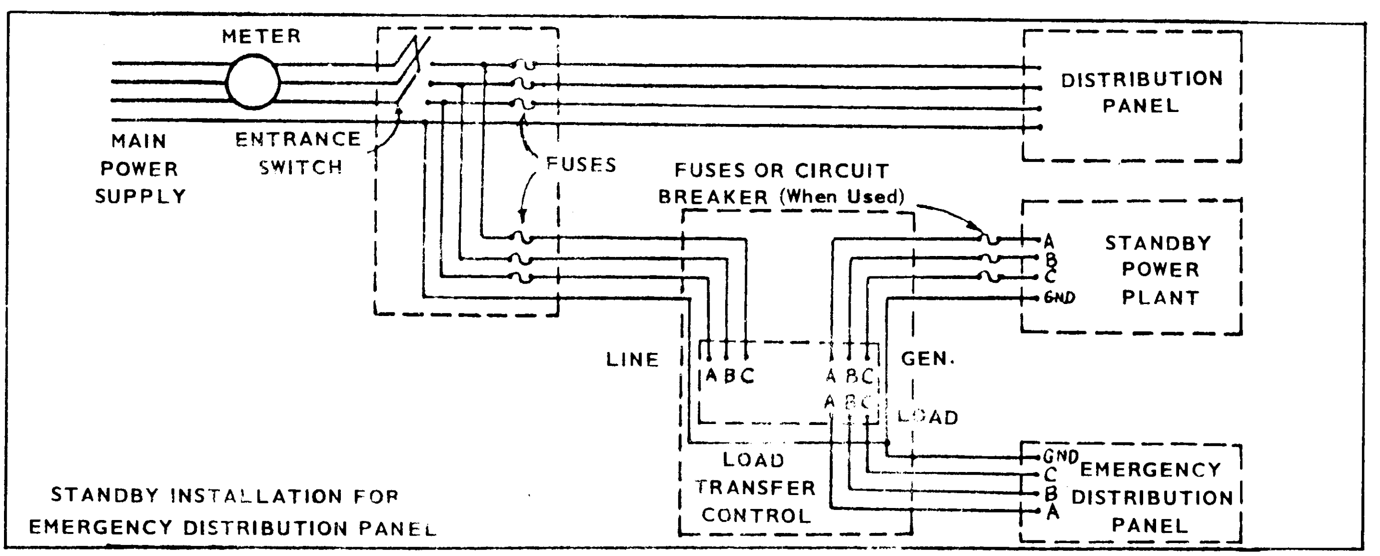


FIG. 8

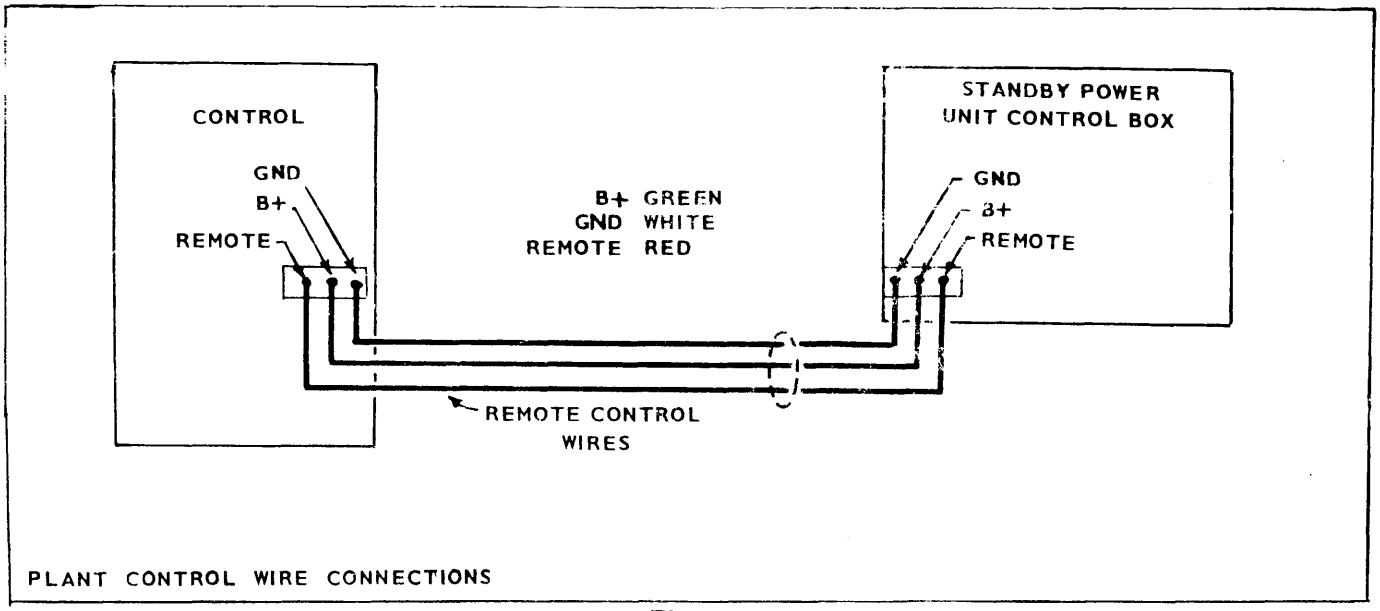


FIG. 9

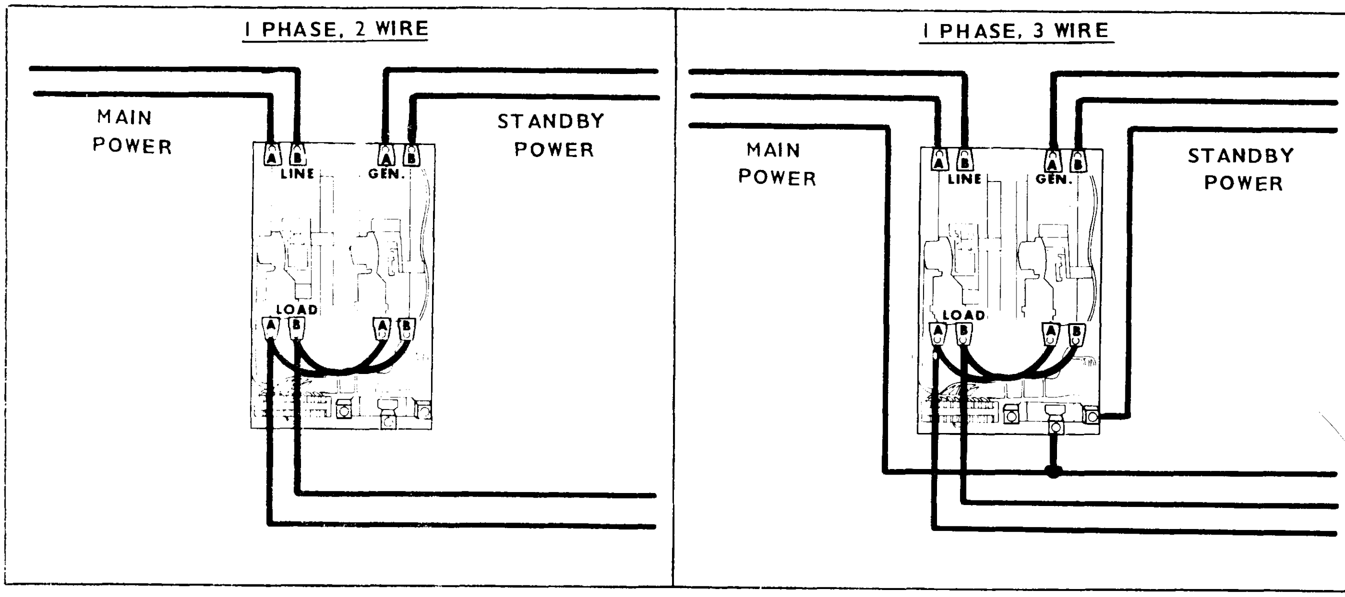


FIG. 10

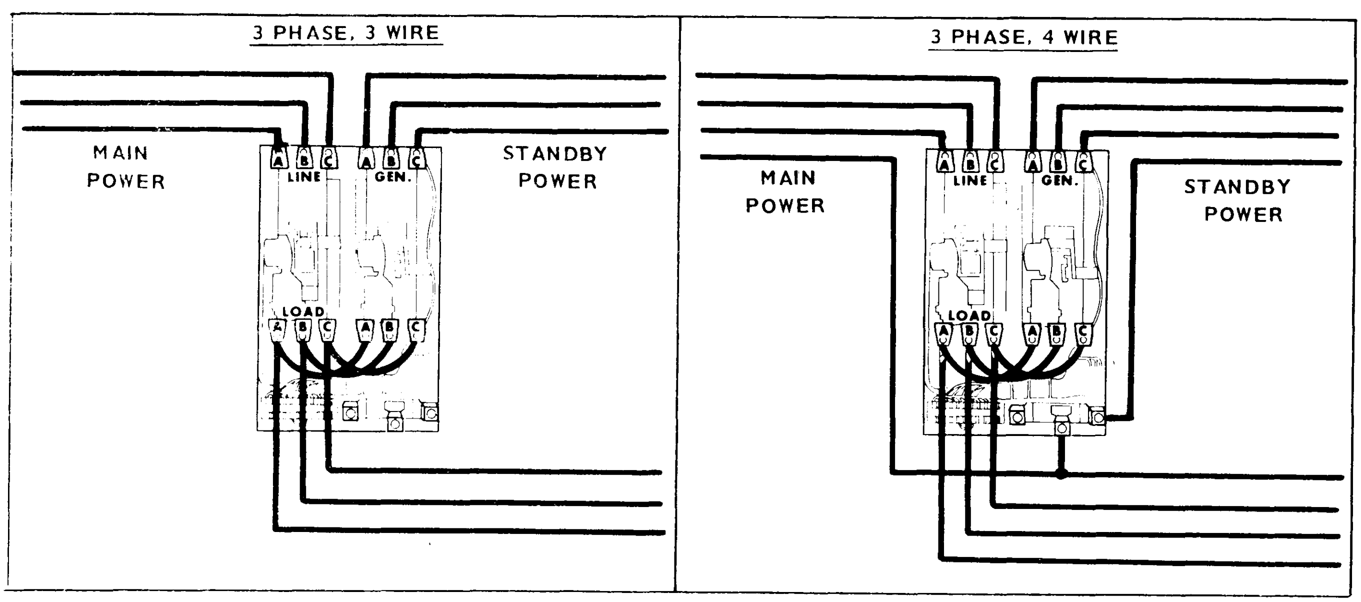


FIG. 11

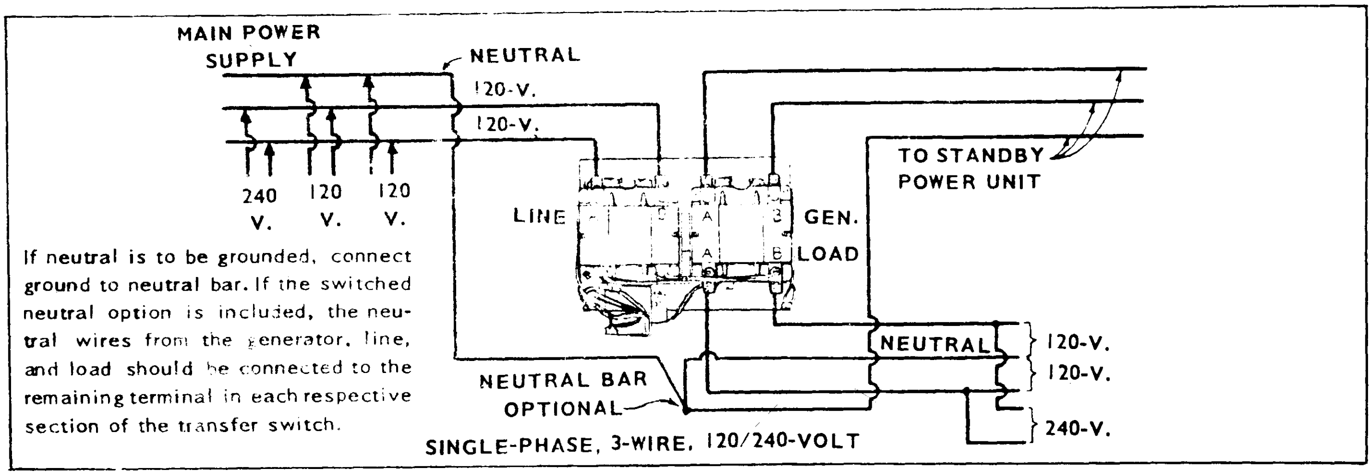


FIG. 12

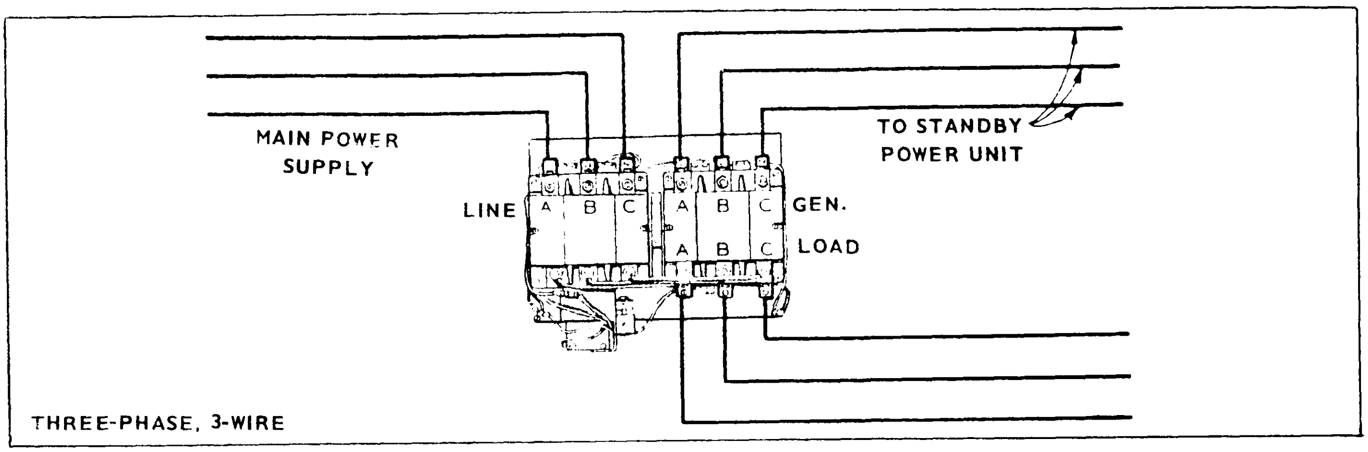


FIG. 13

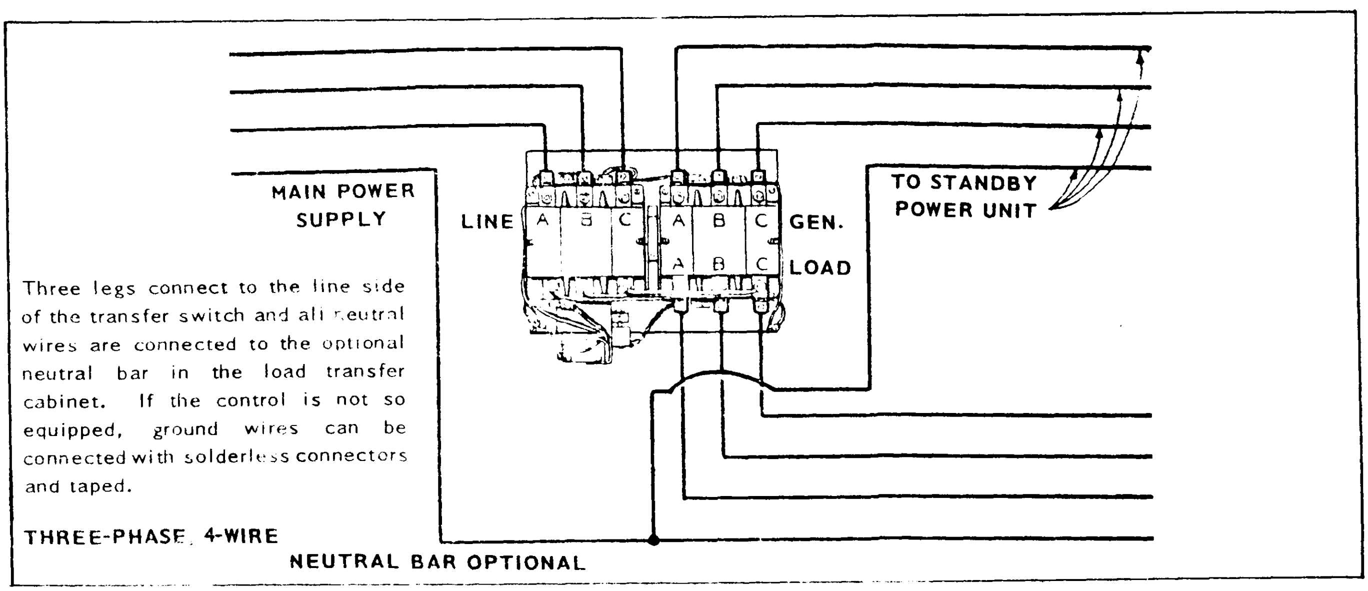


FIG. 14

CHECKING PHASE RELATIONS OF A 3-PHASE STANDBY

Phase relationships determine the direction of rotation of any 3-phase motor. Phase relations must be correct if motors are to rotate in the proper direction under both normal and emergency power. Always check phase relationship as follows before operating generator or connecting line to load.

Connect a 3-phase motor to the load terminals (and power to the line side of the transfer switch) and check motor rotation. If the direction of rotation is correct, the lines phase relationship is correct. If it rotates in the wrong direction, change the direction of rotation by reversing any two of the three main phase leads connected on the transfer switch line-side.

Next, turn off the main power, start the generator and check motor rotation when powered by the generator. If the direction of rotation is wrong, correct it by reversing any two of the three main phase leads on the generator (GEN) side of the transfer switch.

THREE-PHASE SERVICE AND A SINGLE-PHASE STANDBY

In some cases, emergency single-phase loads connected from one leg to ground of a 4-wire 3-phase service can be protected by a single-phase generating plant and load transfer control. This is often done in institutions where all emergency lights are connected from one leg of the 4-wire service to ground. The load transfer control used for this service should be wired to the generating plant with the leg of the commercial power to be protected by stand-by power connected to the line side of the transfer switch.

Wiring this type of control can become a complicated procedure, depending on the electrical service, the problems of 3-phase balance, and a knowledge of the loads to be operated during a power failure. It should be attempted only with a thorough knowledge of the buildings electrical service. If questions arise concerning the use or installation of a control in this type of service, contact *Onan* furnishing full information.

When the Operation Selector switch is used in conjunction with the plant control switch, the following points should be noted. The plant control switch predominates. When it is on *stop*, the plant stops and cannot be started from the load transfer. When it is on *run*, the plant cannot be stopped from the load transfer. To control the plant from the load transfer, set the plant switch on *remote*. The Operation Selector switch will then start and stop the plant.

Before setting the plant for remote operation, test it by setting the plant control switch on *run*. The plant should start (but not take over the load) unless the commercial line fails. With the commercial power connected to the control, set the plants switch at *remote*. The control is now ready for automatic operation and will start if commercial power fails. As a test, the entrance switch of commercial power can be opened. The plant should start and supply the load.

OPERATION SELECTOR SWITCH (Optional)

The operation selector switch allows the plant to be controlled from the load transfer control. It is a three position switch: In the *check* position, the plant starts and runs but does not assume the load unless a line failure occurs. Use this position for manual plant exercise. The *stop* position shuts down the plant and prevents it from starting. Use this position for plant repairs and service. The *automatic* position allows the plant to assume the load when a line failure occurs. This is the normal position for automatically starting and stopping the standby plant.

TIME DELAY RELAYS (Optional)

All time delay relays are set at the factory. Unless otherwise stated in the order specifications, relays are set as shown in Table 2 If necessary, these settings can be adjusted (see *Maintenance*).

TABLE 2 - TIME DELAY RELAY STANDARD SETTINGS

(Unless Otherwise Specified In Order)

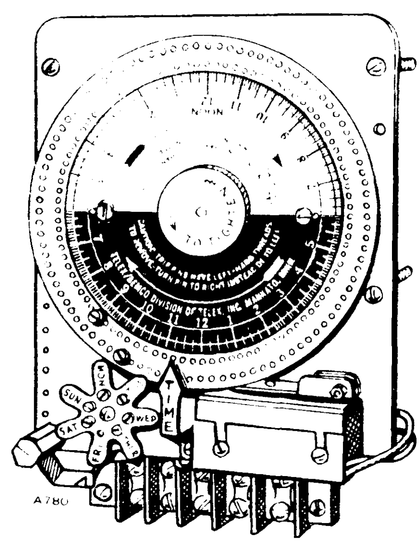
Delay in starting	8-10 Sec
Delay on load pickup	25-30 Sec
Delay on retransfer	7-10 Min - Agastat 10 Min - Hagen
Delay on plant stopping after retransfer	3 Min - Agastat 10 Min - Hagen

BATTERY CHARGING CIRCUIT

Set the trickle charger to maintain the plant batteries at full-charge. This can best be done by setting the battery charger and checking the battery condition for several weeks with a hydrometer. Adjust the charger for the minimum charge-rate that will maintain charge condition. Higher rates will shorten battery life. Large ambient temperature changes will probably require charger adjustment.

EXERCISER CLOCK

The exerciser clock requires setting to determine the number and length of exercise periods each week. It will operate the plant for any multiple of 15-minutes per day for as many days as is desired. *Onan* recommends running the plant for at least 30-minutes once a week. Running the plant for one long period each week is better than several short periods.



EXERCISE CLOCK SET TO START PLANT AT 9 P.M. EACH FRIDAY AND STOP IT AT 10 P.M.

FIG. 15

The clock is equipped with a 24-hour dial (light half for day hours, shaded half for night). Ten trip-pins are supplied with the clock for a maximum of five operations daily. An operation is set in the following manner: A trip-pin placed in the inside row of holes starts the plant; a pin in the outside row stops the plant.

The specific days the plant is to operate are set on the spoked wheel below the daily dial. Place a trip pin in each spoke for which *no exercise* period is desired. Example:

Fig. 15 shows the clock set to exercise the plant for 9:00 to 10:00 P.M. Friday night. With the pins in place, set the clock for the correct day and time. To set the day, turn the spoked wheel to align the correct day with the small day pointer on the spoke spring. To set the time, loosen the *left hand thread dial* lock-nut and turn the dial by hand to the correct time. After setting the correct time, tighten dial nut.

PERIODIC SERVICE

At regular intervals inspect inside the cabinet for dust. Clean as required. Always keep the cabinet clean. Dust and dirt can cause hum, irregular operation, or even a complete breakdown of the system. At the same time, inspect wiring for loose or dirty connections.

ONAN WIRING DIAGRAMS

The wiring diagram furnished with every load transfer control is your key to the control. *Keep it with the control.* Use the wiring diagram:

1. **To explain control operation**
2. **To obtain part numbers for ordering repair parts**
3. **To determine the function of all components**
4. **To aid in control repair**

Here are some hints on reading wiring diagrams. The Onan wiring diagram is a semi-pictorial. It shows all components in their approximate position and named by function, i.e., time delay on starting relay and the start-stop relay. The relative positions of the terminals on each component are the same as you see them in the control. All relays are shown *de-energized* unless otherwise noted. The outside enclosure metal is shown in dotted lines. Each view is labeled to indicate the direction of viewing and location. For example: Panel Rear View (inside panel as seen from the rear).

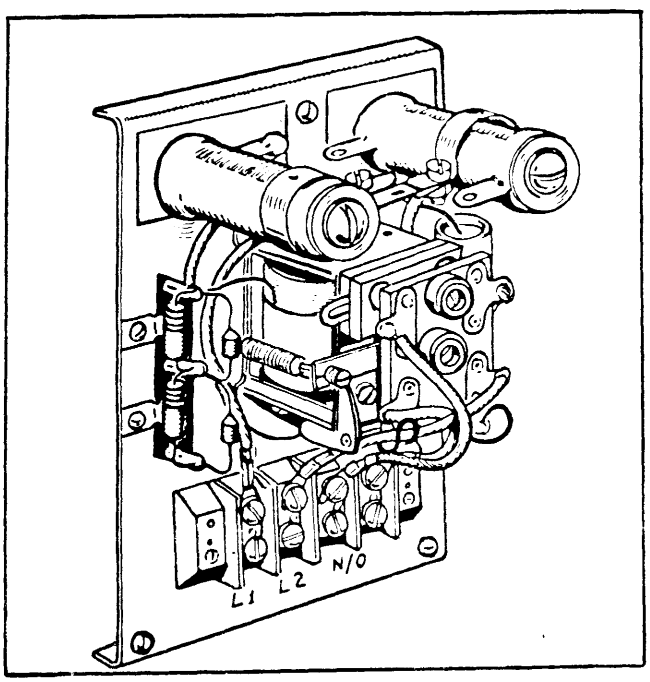


FIG. 16

ADJUSTMENT OF VOLTAGE SENSITIVF RELAY (Optional)

Under-Voltage Relay: Determines the voltage at which the the load transfer switches the load from line to generating plant and back again. This relay was accurately set at the factory. Settings are marked. *Do not change the adjustments* without taking the proper precautions.

NOTE: Some controls have a non-adjustable voltage sensitive relay (no cover or adjustment controls, Fig. 16). Do not attempt to adjust this relay. If the relay becomes inoperative, return it to the dealer or an ONAN service center.

Do not change the setting on adjustable relays until you are sure it requires re-adjustment. Undetected line voltage drops in the supply line may be causing the relay to operate, in which case, the relay is serving its purpose.

A record of line voltage readings (taken at times of suspected improper operation) may isolate the trouble in the supply line.

Following is the adjustment procedure:

1. Provide an accurate ac voltmeter (not less than 1000-ohms per volt) of 0 to 150-range. To simulate a line voltage drop, provide a 1000-ohm wire wound rheostat (2-watts or larger).
2. Install a temporary jumper wire from the relays N/O to C terminals (see Fig. 16).
3. Connect the voltmeter across the L1 and L2 terminals. Connect the rheostat in series with the L1 terminal and wire which normally connected to this terminal.
4. Turn the temporary rheostat to its minimum resistance position, giving a high reading on the temporary voltmeter.
5. Remove the protective caps from the two adjusting controls of the relay. Note the factory marking of the control adjustments.
6. Turn the *pickup* control to its clockwise limit. Turn the *dropout* control to its counterclockwise limit, then 1/4 turn clockwise.
7. Turn the *pickup* control slowly counterclockwise until a click is heard. The relay points have now closed.
8. Turn the temporary rheostat to drop the voltmeter reading until the relay contacts open.
9. Turn the temporary rheostat to raise the voltmeter reading slowly. Note the voltage at which the relay closes. This is the pickup voltage at which the load will transfer back to the normal source.
10. If the pickup does not occur at the desired simulated voltage, turn the relay pickup control in the proper

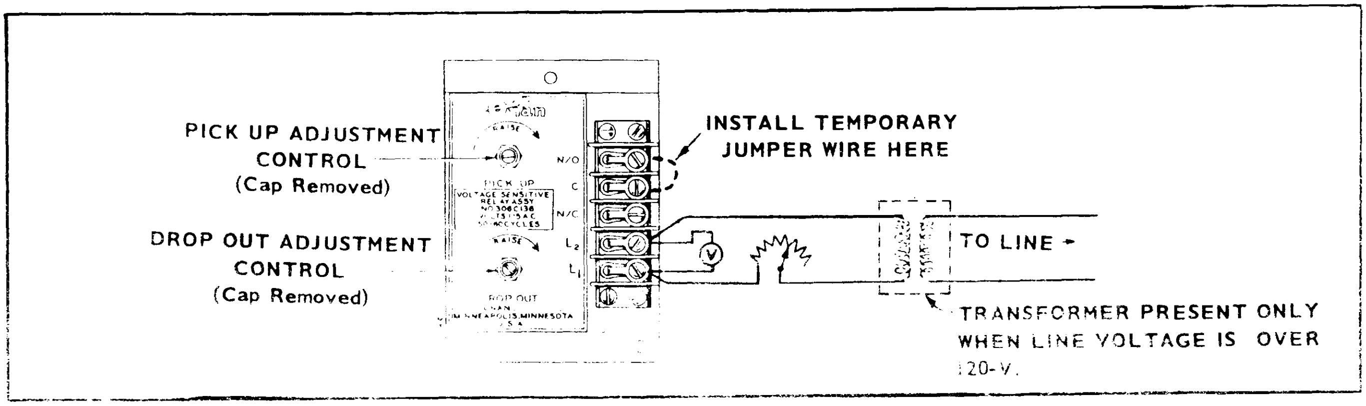


FIG. 17

direction. Repeat steps 8 and 9. Several such trials may be necessary to obtain the desired pickup point.

11. Turn the temporary rheostat to give the desired voltage for transfer of load from normal line to the generating plant.
12. Turn the *drop-out* control slowly clockwise until the relay contacts open. This will establish the point at which transfer is made from the line to the generator. The drop-out setting is adjustable from 5% to 17% below the pickup voltage.
13. Scribe a reference line to indicate the final adjustment of each adjusting screw for future reference in case of accidental change in the settings. Replace the protective caps on the adjusting screws without turning the screws.
14. Disconnect the temporary rheostat and voltmeter. Reconnect wire as in Step 3.
15. Remove jumper wire (installed in Step 2) from N/O and C terminals.

Over-Voltage Relay: Determines over-voltage required before the load transfer starts the generating plant and connects it to the load. Adjust by following the procedure for low voltage relays (*except* that a voltage source is required *equal* to the specified over-voltage condition). The relay should be adjusted to pickup at the specified over-voltage condition and drop out when the line voltage drops to about normal value. Plant starting is adjustable from 105% to 115% of normal.

TIME DELAY-RELAY

Two types of time delay-relays are used with *Onan* load transfer controls, depending on the length of delay and its function.

1. The Agastat Pneumatic Delay-Relay (Fig. 18) is adjustable from 1-second to 10-minutes. Time delay can be either on energization or de-energization depending on relay uses.
2. The Hagen Synchronous Clock Delay-Relay (Fig. 19). Delay occurs on energization and is adjustable from 2 to 60-minutes.

Agastat Relay Adjustment: This relay obtains its time delay by controlling the flow of air from an enclosed cylinder. To change the delay setting, turn the slotted screw (on top of relay) clockwise to increase delay, counterclockwise to decrease it. Adjustment requires only a small movement of the screw.

CAUTION: Do not force the screw too far to the right (clockwise). This damages the needle-and-seat assembly.

When time delay is adjusted, check the result by connecting to an ac power source of the proper voltage. Time the

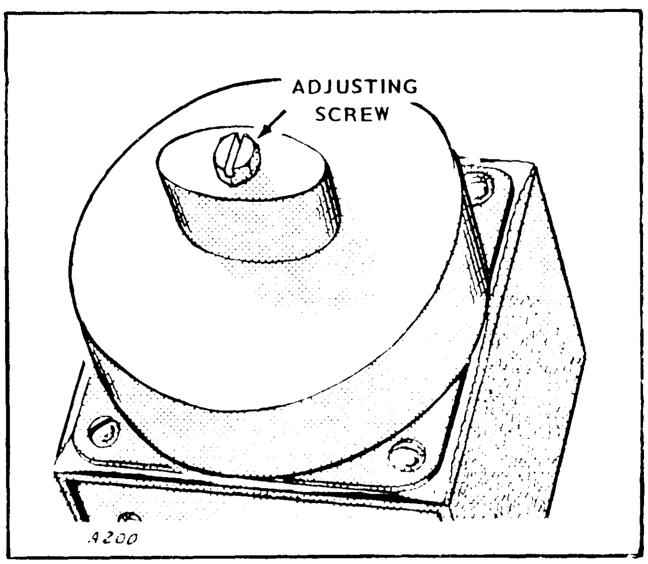


FIG. 18

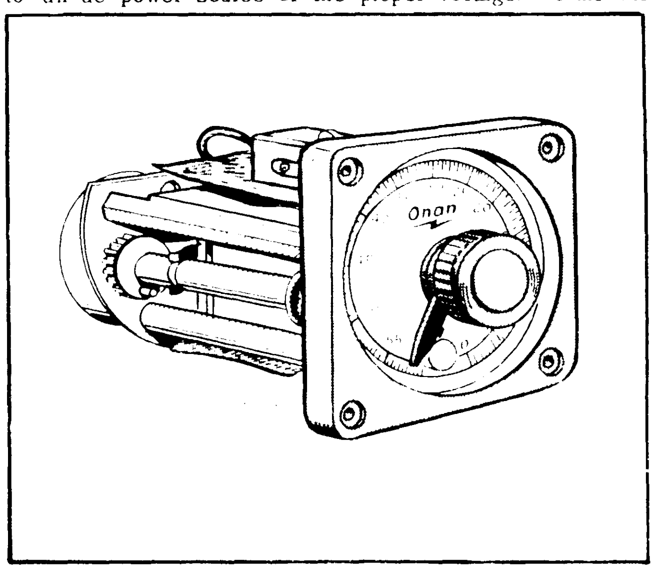


FIG. 19

operation. Two or three settings may be required to find the exact value.

Hagen Time Delay Relay Adjustment: This synchronous motor-driven time delay-relay (Fig. 19) has a dial on its face to aid in setting the correct time delay. A black pointer indicates the pre-set time delay; a red pointer indicates the time delay left in each operation. To set the relay, simply turn the adjusting knob in the center of the dial. Time delay can be changed with power *on* or *off*.

PILOT RELAY VARIABLE RESISTOR

This slide arm adjustable resistor determines the voltage at which the pilot relay pulls in as the generating plant builds up speed. It should not require adjustment unless it (or the relay) is replaced. It was factory adjusted to pull in at 80 to 85% of voltage as the generating plant builds up speed. For example, on a 240-volt generator, the relay should pull in when the voltage reaches 190 to 200-volts.

TROUBLE-SHOOTING AND REPAIR

Trouble-shooting (or repair) is a job for a competent electrician. ***High voltages*** are present throughout the control during *normal and standby* operation. Because the engine generator, load transfer control, commercial power and load, are all interdependent, trouble-shooting requires checking out the various systems. You must decide whether the load transfer, commercial power or generating plant, is causing the trouble.

Before doing anything, determine exactly what the trouble is. A troubleshooting chart at the end of this section gives typical causes of the most common control problems.

By checking out the systems, trouble often can be isolated. Operate the generating plant from its own controls. If the plant operates properly alone, the trouble is probably in the load transfer control. Next, determine which load transfer control component is at fault.

Observing relay action during operation is an important technique....it helps determine how far an operation gets before running into trouble. For instance, if the plant will not start when the line fails, watch voltage sensitive relays, time delay-relays, and the start-stop relay.

When optional equipment (time delays, voltage sensitive relays, etc.) is believed to be defective, they can often be checked by eliminating their contacts from the circuit with a jumper wire. Example: If a time delay on a stopping relay appears defective, short across the contact terminals to eliminate the relay from the circuit. When commercial

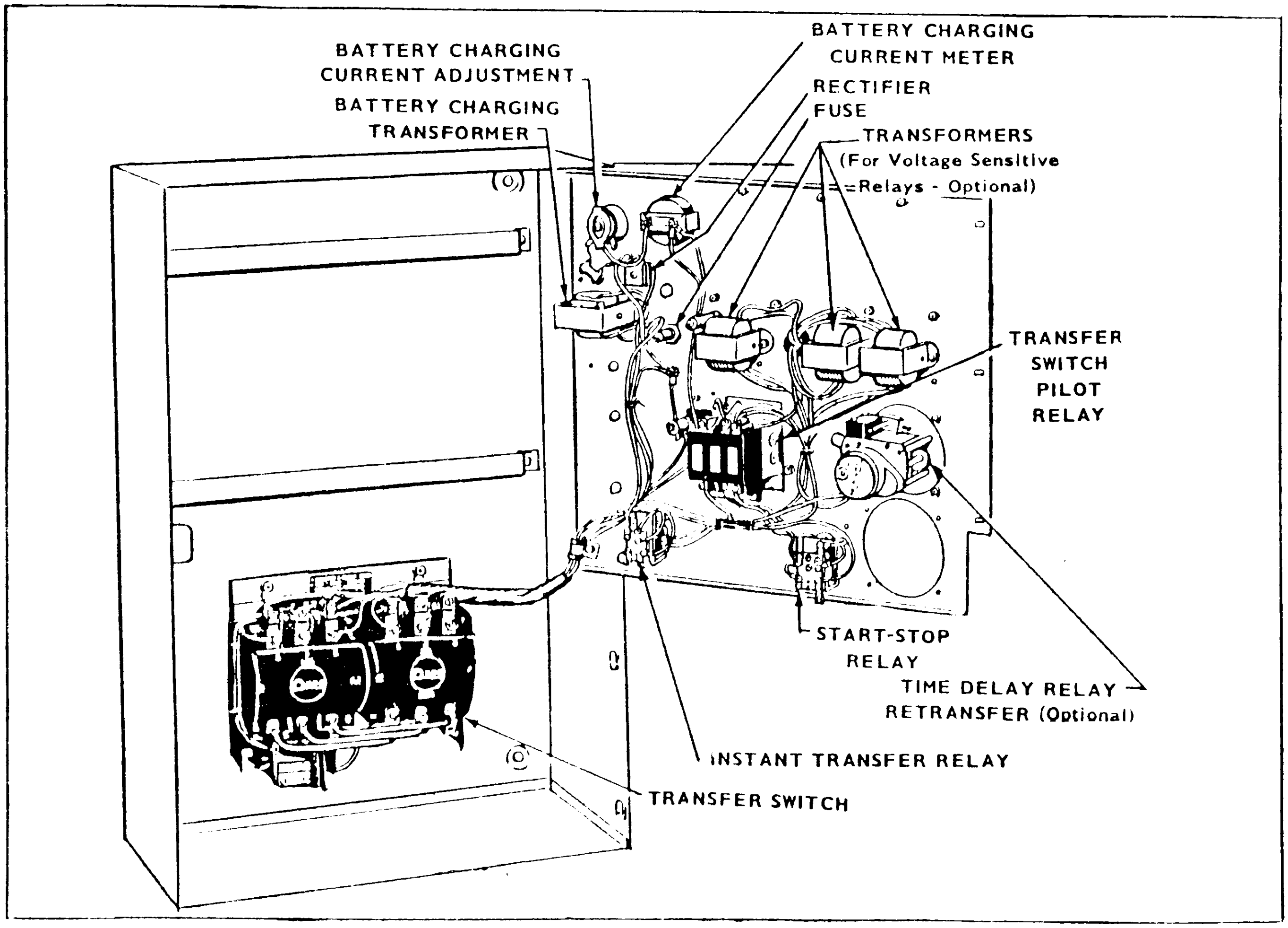


FIG. 20

power returns, the control should then operate in a normal manner (except without the time delay). If this happens, check the relay.

NOTE: The start time delay cannot be tested in this manner. When it is included in the circuit, the start-stop relay is eliminated and the time delay contacts control the plant directly.

RELAY REPAIR

Except for the transfer switch and transfer switch pilot-relay, *Onan* does not recommend repairing relays. If defective, replace them. However, relays with dirty contacts can be cleaned with hard paper or gauze tape soaked in carbon tetrachloride. If contacts are pitted, replace the relay.

TRANSFER SWITCH REPAIR

All transfer switches have replaceable contacts and coils.

CAUTION: Do not touch the transfer switch unless normal line power is off. Set the Operation Selector Switch (when used) to STOP position or disconnect starting batteries.

Transfer switch coils are rated according to voltage. Coils used at rated voltage (stamped on coil) should last indefinitely. If magnet does not close freely (as when dirty) the coil overheats and could burn up (coils can also burn from excessively high or low voltages). To remove coils see Table 3.

TABLE 3. COIL REMOVAL

MECHANICALLY HELD SWITCH 200-400 AMP (FIG. 22)
1. Disconnect coil lead wires.
2. Remove cap screws (4) mounting the coil and stationary magnet assembly to the case.
3. Pull out assembly
4. Remove coil from magnet assembly.
MECHANICALLY HELD SWITCH 100 AMP (FIG. 21)
1. Disconnect the coil lead wires.
2. Snap off the hairpin-shaped retaining clips holding the control rod and slide out the control rod.
3. Slide out the stationary armature and coil assembly.
4. Remove the coil from the stationary armature.

Contacts never require cleaning (or refacing) for the life of the equipment. Dis-colored silver contacts operate efficiently. Filing the contact faces destroys their mating surface. If contact points become badly burned or pitted, replace them as follows:

1. Remove plastic hood.
2. Remove spring and washer from each contact guide post.
3. Lift contacts from guide post. Curved silver contact surfaces face inward.
4. Take out stationary contacts by removing screws holding them to the transfer switch plastic body.

Transfer Switch Hum: When a *load* is connected to the *normal power* source, the switch may be mechanically held which eliminates hum. When the transfer switch connects the load to the *generating plant*, the switch is electrically held and a hum condition can occur. Hum may occur in mechanically-held switches because of incorrect adjustment of the coil-disconnect micro-switch. To minimize contact hum, magnet sealing faces were ground and polished (some switches include shading coils). Excessive hum can be caused by dirt between the magnet sealing faces. Clean them with carbon tetrachloride. Use medium-fine grade emery paper on rusted sealing faces. Remove all traces of emergy dust.

At some time, the transfer switch line-side latching mechanism may require adjustment. Transfer switch chattering can be caused by a latching mechanism that does not lock the contacts closed which causes the mechanism to pickup and drop out repeatedly.

Transfer switches featuring mechanically held line contacts or electrically held generator contacts, operate as follows:

The line contacts are closed and locked in the following manner (see Fig. 22). The line-side main coil pulls the contacts closed. While the contacts are closing, the mechanical latch engages the contact control rod and locks the contacts closed. At the same time, an arm on the mechanical latch actuates the coil disconnect switch (micro-switch) which opens the main coil circuit. The line contacts are now closed and locked in place and power is removed from the main coil simultaneously. Removal of power from the main coil eliminates any electrical noise (hum) from the transfer switch. To open the line contacts, the latching coil must be energized which disconnects the latching mechanism allowing the line contacts to open.

The latching mechanism and the coil disconnect switch must be adjusted to open the main circuit just as the contacts reach the closed position. If the main coil circuit is not broken, hum may result. If the coil disconnect switch opens the coil circuit before the contacts are seated, the contacts will chatter. Each transfer switch has several electrical interlock switches (see Fig. 21) which are operated by the mechanical movements of the line and generator contact control rods.

ADJUSTING MECHANICALLY HELD SWITCHES

To adjust the latching mechanism for positive locking, loosen the locking screws which secure the latching brackets.

Adjust the bracket for 1/16" clearance between the latching lever and the contact operating rod when the main coil armature is fully seated (Fig. 20). On units with roll pins locking the latching coil, remove the roll pins to make the adjustment. After the adjustment is complete, drill new holes and install new roll pins.

To adjust the coil disconnect switch, align the micro-switch actuating arm and the adjusting screw on the latching lever. Set the adjusting screw so the micro-switch opens just as the latching lever engages the contact operating rod. Operate the transfer switch several times to check switch adjustment. Adjust as required and seal the adjustment with paint. Check the operation of all electrical switches to assure that they operate properly according to the movements of the contact control rods. Check all electrical connections and hardware for tightness.

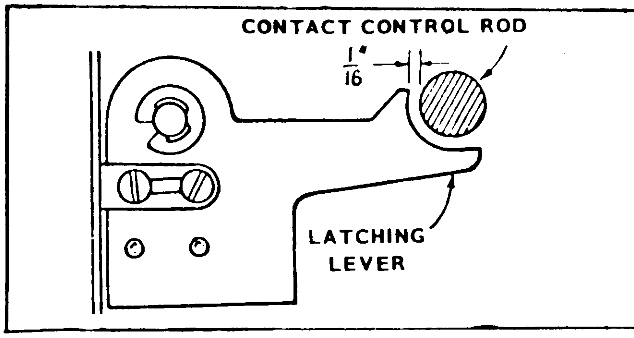


FIG. 20

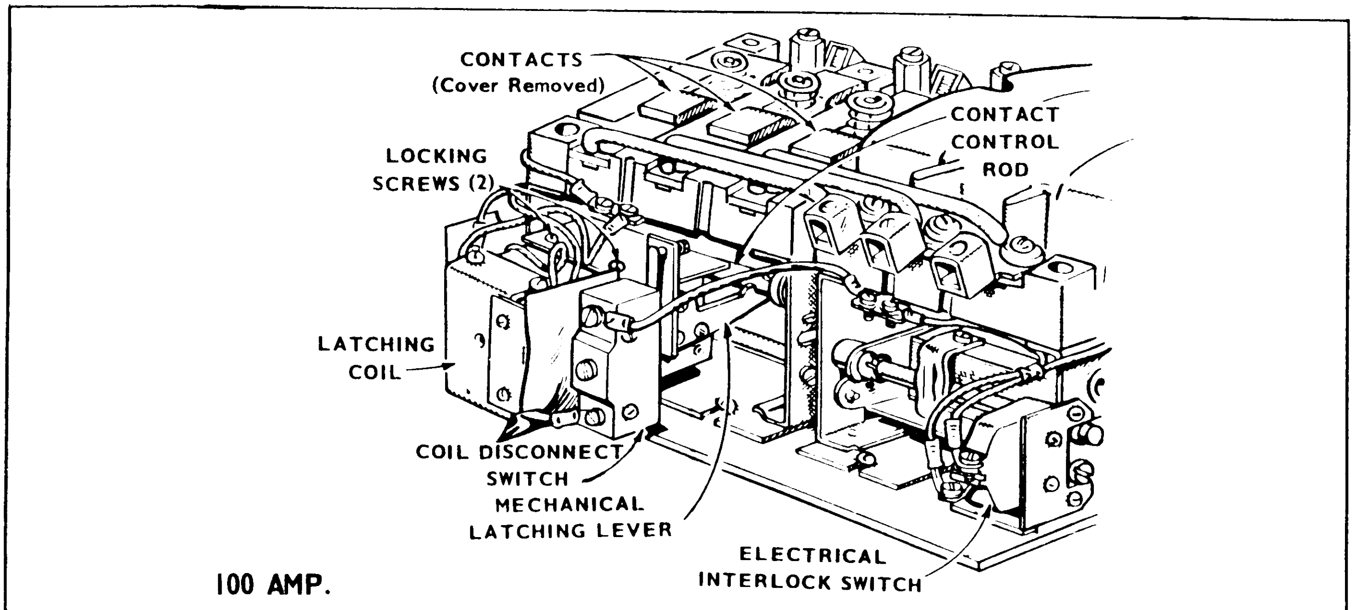
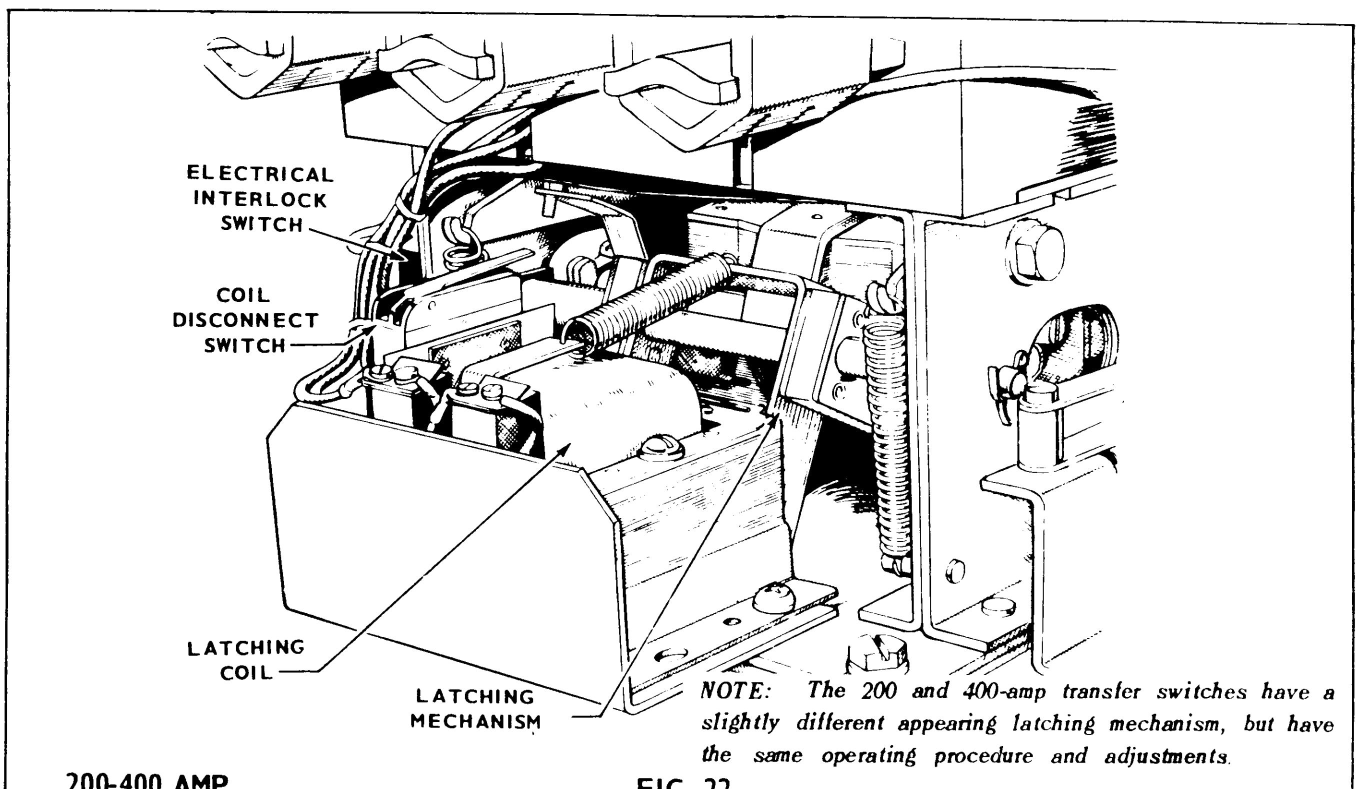


FIG. 21



NOTE: The 200 and 400-amp transfer switches have a slightly different appearing latching mechanism, but have the same operating procedure and adjustments.

FIG. 22

TROUBLE-SHOOTING CHART

TROUBLE	POSSIBLE CAUSE
Power fails, plant does not start.	1. If time delay on starting included, check to see that normal delay has occurred. 2. Defective time delay on starting relay. 3. Generating plant defective. 4. Start-stop relay sticking or dirty contacts.
Plant starts under no apparent power failure.	1. Equipped with voltage sensitive relays but no delay on starting. Momentary voltage dips will cause a control so equipped to start. 2. Defective voltage sensitive relays. 3. Defective start-stop relay.
No delay on starting.	1. Defective time delay on starting relay.
Plant does not react to low low voltage.	1. Defective voltage sensitive relays. 2. Voltage sensitive relay requires adjustment.
Plant does not stop when power returns - continues to supply power to load.	1. If time delay on stopping included, check to see that normal delay has occurred. 2. Time delay on retransfer relay defective. 3. Defective voltage sensitive relay (will not pickup).
No delay on stopping.	1. Defective time delay on stopping relay.
Plant continues to run after transfering load back to commercial power.	1. If time delay on stopping (after transfer) is included, be sure normal delay has passed. 2. Defective time delay on stopping relay. 3. Defective start-stop relay (will not energize). 4. Short in plant to load transfer control wires.
Will not exercise.	1. Defective exerciser.
Does not stop at end of exercise period.	1. Exerciser fails during period. 2. Power failure during exercise period.
No power to load during normal operation.	1. Dirty or pitted contacts on transfer switch. 2. Defective transfer switch line side coil. 3. Transfer switches electrical interlocking switches defective. 4. Instant transfer relay defective.
No power to load after generator start.	1. If time delay on load pickup included, check to see that normal delay has occurred. 2. No generator voltage build-up or low generator output voltage. 3. Defective transfer switch pilot relay. 4. Defective latch mechanism on transfer switch - line side not unlatching.
Line side of transfer switch does not pickup when power returns.	1. If time delay on retransfer is included, be sure normal delay period has passed. 2. Defective transfer switch coil. 3. Defective instant transfer relay 4. Transfer switch mechanical interlock defective or generator contacts not completely dropped out 5. Electrical interlock switches defective.
Transfer switch chatters when line power returns.	1. Transfer switch not latching into closed position - adjust. (See Trouble-shooting and Repair Section) Mechanically Held Only

TROUBLE	POSSIBLE CAUSE
No battery charging current.	1. Defective rectifiers. Measure resistance of each rectifier forward and backward. Resistance in one direction should be high, low in the other direction. 2. Defective milliammeter (open circuit). 3. Defective resistors. 4. Transformer (open circuit). 5. Fuse burned out.
Load transfer control hums.	1. During generator operation - dirty pole pieces causing vibration. (See Trouble-Shooting and Repair Section). 2. During time when line is on - defective coil cut-off switch or poorly adjusted latching mechanism. (See Trouble-Shooting and Repair Section). Mechanically Held Only.

PARTS INFORMATION

This control is custom engineered and specially constructed. Optional equipment and special requirements demand particular circuits and components to perform the automatic functions of this control. Because of the individuality of each control and the variations of circuits and components, a parts list is not printed in this manual. The wiring diagrams supplied with this control contain a listing and location of parts (excluding hardware and transfer switch parts).

For service or parts, contact the dealer from whom you purchased this equipment or refer to the company listed on the nameplate of your control.

Obtain part numbers and description of all repair parts from the Wiring Diagram furnished with the control. Be sure to state on your order the Model and the Serial No. of the control for which parts are required. Obtain these numbers directly from the identification plate. State transfer switch part number, shown on wiring diagram, when ordering transfer switch components.

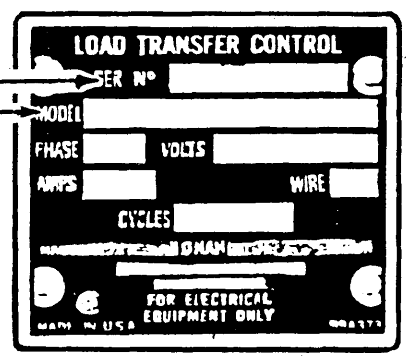
Order parts by part numbers with complete description as listed in the diagram. State the quantity of each part desired. If unable to identify the part required, return the old part to your nearest *authorized service station.* Print your name and address plainly on the package. Regardless of any previous correspondence, write a letter describing the part and stating reason for returning it.

Please do not order parts in a letter in which some other subject is treated. State definite shipping instructions when ordering parts.

All shipments are complete unless the packing list indicates items are back-ordered. Shipments are properly packed and in good order when delivered to the transportation company. Any claim for loss or damage in transit should be filed promptly against the transportation company making the delivery.

Always give these numbers when ordering repair parts or requesting service information.

WRITE IN NUMBERS SHOWN ON CONTROL NAMEPLATE



KEEP CONTROL WIRING DIAGRAM WITH THIS MANUAL.

REFER TO WIRING DIAGRAM FOR LISTING AND LOCATION OF PARTS.

900-129 (Revised 7-69)

SUPPLEMENTARY INSTRUCTIONS

Onan

These instructions apply to the motor operated circuit breaker transfer switches for the following load transfer controls: LTC 800, LTC 1200 through Spec C and LTC 2000 through Spec B (Manual #959-3); LTD 800 through Spec C (Manual #972-1).

The load transfer controls are housed in two separate cabinets, or cubicles. The larger cabinet contains the motor operated transfer switch mechanism and non-automatic circuit breakers. The small cabinet contains control components such as relays, battery charger, and other optional equipment which are all covered in the applicable Instruction Manual.

DESCRIPTION (800 & 1200 Amp Series)

The motor-operated circuit breakers, one on line side and one on generator side, are electrically operated to open or close. Each one is controlled by contact-making devices outside the breaker and motor mechanism, and performs its function by means of a motor moving the circuit breaker handle with the aid of worm gear, crank, operating rod and handle attachment.

The motor operated mechanism consists of a motor, single speed reduction means, a crank, a limit switch, a centrifugal brake, a housing for mounting the parts just mentioned, an operating arm, a breaker handle attachment, and an emergency handle. The speed reduction is made between the motor and the crank by a hardened steel worm coupled directly to the motor shaft and a bronze worm gear coupled to the crank shaft. The motor, gear and worm have packed ball bearings containing sufficient lubricant to last throughout the life of the apparatus. The operating rod is the mechanical link between the crank and the handle attachment. It is provided with a compression spring to absorb any variations between or in these two parts. The handle attachment is fastened to the breaker handle and has a clutch which either connects the operating rod mechanically to the breaker handle, or disconnects the operating rod when the emergency handle is inserted. On the 800 ampere series, the handle attachment is fastened to the breaker handle and has a clutch which either connects the operating rod mechanically to the breaker handle or disconnects the operating rod when the handle is pulled out. On the 1200 ampere series, the operating rod is also the mechanical link between the crank and the handle attachment.

The motor is of the series commutator type and operates on a.c.

The limit switch opens the motor circuit as soon as the breaker closes or opens in response to a corresponding contact in the control circuit. This switch is a rotary type with two segments, one for closing and one for opening.

The centrifugal brake, consisting of two weights spun against a brake band by the motor shaft, limits the speed of the motor and prevents overtravel of the motor mechanism.

Important: *This motor-operated breaker has been adjusted at the factory for proper operation. Do not dismantle or change the relative position of any of the parts, since this may affect the operation and reduce the life of the apparatus.*

Lugs on the neutral bar for the 800 series will accommodate two 3/0 to 500 MCM size wires. The other connecting lugs (one per pole) accommodate two 3/0 to 600 MCM size wires. The 1200 ampere series have lugs on the neutral bar for three 300 to 500 MCM size wires. Four 300 to 500 MCM size wires can be connected with the other lugs (one per pole).

Operation

Designed for intermittent operation, the high torque operating motor has the same direction of rotation for closing and opening, and should not be put through more than 10 complete closing and opening operations immediately following one another. The number of operations is not limited if the rate of operation is not greater than four per minute.

After the control contacts close, the circuit breaker motor is started and rotates the crank 180°. A motor cut-off switch then opens the circuit to stop the motor and closes a contact to rotate the crank another 180°. This opens the circuit breaker when the opening control contact is made.

MANUAL OPERATION (800 Amp)

Turn the single-pole toggle switch by the transfer switch to the open or off position. If the particular model doesn't have a toggle switch, disconnect the jumper between terminals 6 and 8. Then pull out the knurled handle to disconnect the motor mechanism from the breaker handle.

To change back to automatic operation, return the breakers to their original positions, latch handles and close the disconnect switch or connect the jumper.

MANUAL OPERATION (1200 Amp)

Turn the single-pole toggle switch by the transfer switch to the open or off position. If the particular model doesn't have a toggle switch, disconnect the jumper between terminals 6 and 8. Screw the emergency handle into the end of the operating lever until the handle can no longer be turned. This will lift a roller out of a notch in the lever which is operated by the motor crank and will disconnect the operating lever from the motor mechanism. The breaker can then be operated manually by means of the emergency handle.

To change back for automatic operation, return breakers to original positions, unscrew, remove the emergency handle and close the disconnect switch or connect the jumper.

Maintenance

CAUTION *Before performing the following, disconnect all electrical power!*

If it is necessary to remove the motor mechanism for inspection of the circuit breaker, proceed as follows: Remove the 1/2 inch nuts, pull off the motor mechanism and mounting plate as a unit. Remove the two 1/4 inch flat head screws that go through the handle. The operating handle assembly can now be pulled off and the circuit breaker cover removed. Assemble in the reverse order. Check the gap between the handle assembly and the crank. This should be 1/8 of an inch at all positions of the crank. If the gap is not correct, loosen the two 1/4 inch flat head screws that pass through the handle assembly and move the assembly toward or away from the crank as required. Then retighten the screws. The motor should be rotated manually to check the operation before electrical operation is attempted. This may be done by removing the spring clip and plate at the end of the motor housing and rotating the motor shaft in the direction shown by the arrow.

DESCRIPTION (2000 Amp)

The motor operator mechanism is a device designed to remotely control and operate a breaker to its "ON" and "OFF" positions. In times of necessity, it is possible to manually operate the breaker through the operator mechanism.

In operating the breaker "ON" or "OFF", the geared-motor's output shaft, which is reversing, moves through less than one-half revolution. The motor reverses by means of two separate windings which are controlled by limit switches. Motor control (energization and cut-out) is governed by means of drive cam adjusting the brackets and a toggle limit switch. Each motor provides maximum torque at initial starting. Thus the handle arm action is immediate.

Handle arm travel and drive cam brackets are factory adjusted. Tests are run on a breaker to insure proper motor operation.

The lugs on the neutral bar can take four 300 to 500 MCM size wires. Four 300 to 500 MCM size wires can be accommodated by the other lugs (two per pole).

OPERATION (2000 Amp)

The motor operator is an intermittent duty device. A safe duty cycle, i.e., "OFF" to "ON" again, should not exceed five per minute. At this rate the operator would far outlast the circuit breaker.

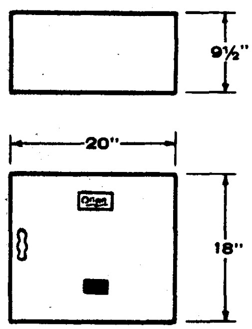
Manual Operation - Turn the toggle switch to the open or off position. If the particular model doesn't have a switch, disconnect the jumper on terminals 6 and 8. Insert the portable handle into the breaker's extension handle and open or close the breaker "ON" or "OFF". Operating the breaker manually through the motor operator actuates the limit switch. Thus the electrical circuit to the motor stays in step with the breaker's handle position. Close the switch or connect the jumper to return to automatic operation.

NOTE: *When throwing the breaker "OFF" manually, move the breaker's handle to the extreme "OFF" position in order to insure that the arm of the limit switch is toggled over completely from one position to the next.*

CABINETS

Use Table 1 as a reference for Cabinet "B" below.

CABINET "A"



CABINET "B"

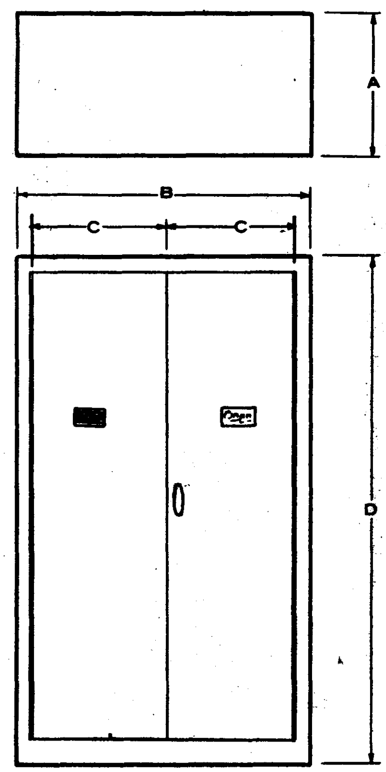


TABLE I

MODEL	DIMENSION A	B	C	D
LTC & LTD 800*	17½"	36"	18"	60"
LTC 1200*	18"	36"	18"	66"
LTC 2000**	25"	54"	22½"	90"

** - These models are wall mounted.*
*** - Free standing models only.*