INSTRUCTION MANUAL

FOR

Onan®

Instapac®

VA

SERIES

ONAN 2515 UNIVERSITY AVE. S.E. • MINNEAPOLIS, MINN. 55414
A DIVISION OF STUDEBAKER CORPORATION
IN CANADA: ONAN GENERATORS CANADA LTD., P.O. BOX 652, GUELPH, ONTARIO

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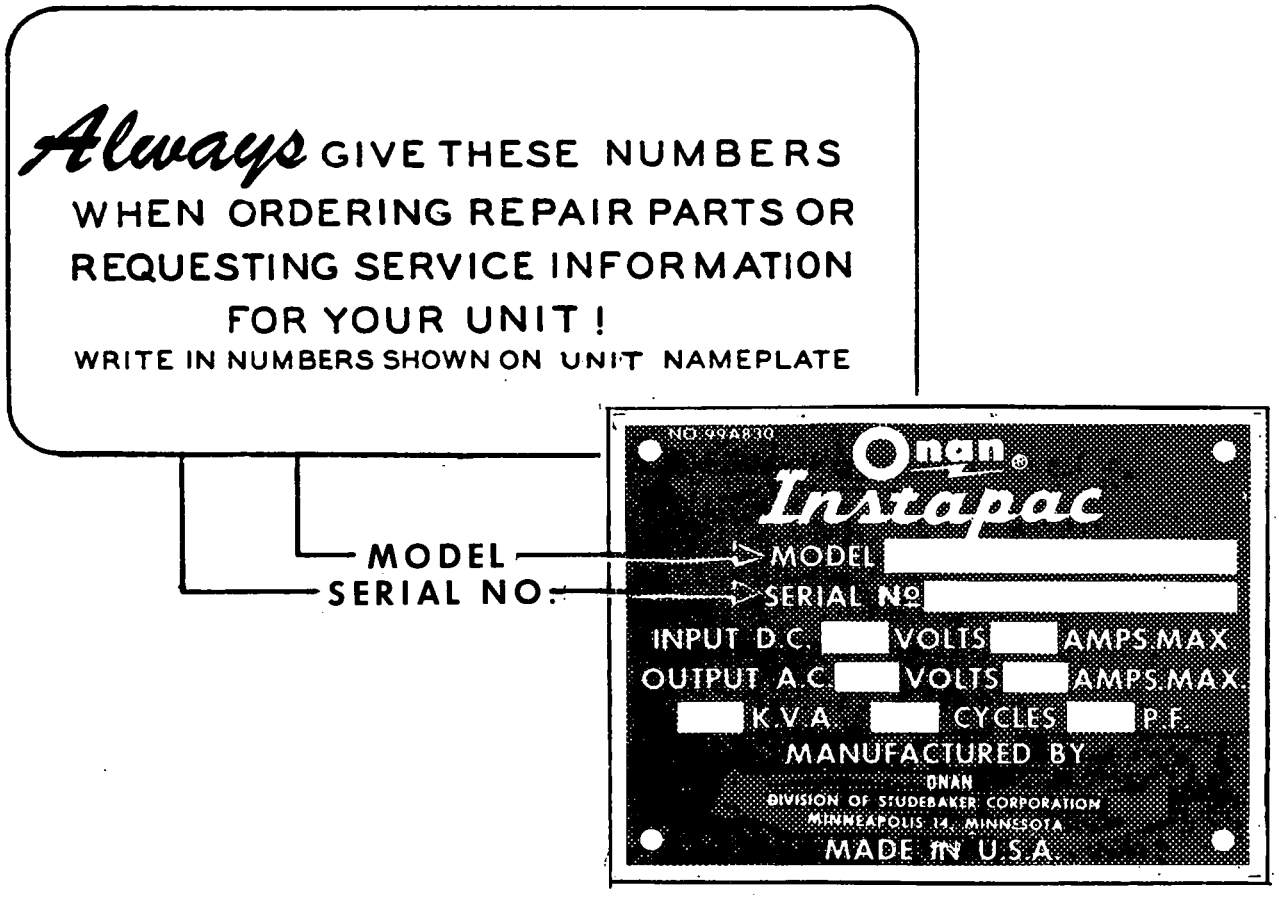
FOR SERVICE OR PARTS, CONTACT THE DEALER FROM WHOM YOU PURCHASED THIS FQUIPMENT OR REFER TO THE COMPANY LISTED ON THE NAMEPLATE OF THE UNIT.

Be sure to state on your parts order or service request the Model and the Serial No. of the unit involved. Obtain these numbers directly from the unit nameplate.

Order parts by description. State the quantity of each part desired. If unable to identify the part required, return the old part to the address shown on the nameplate. Print your name and address plainly on the package. Regardless of any previous correspondence, write a letter to the same address describing the part and stating the reason for its return.

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 promply against the transportation company making the delivery.



GENERAL INFORMATION

This instruction book contains information for the proper installation, operation, and maintenance of your equipment. We suggest that this book be kept handy so that it can be referred to when necessary.

This equipment is the result of proven engineering design, highest quality materials, and expert workmanship. Thorough inspection and testing assures you that this equipment will perform as expected.

If you wish to contact your dealer or the factory regarding this equipment, be sure to supply the complete MODEL and SPEC. NO., and the full serial number of the equipment as shown on the nameplate. This information is necessary to identify the equipment among the many basic and special optional types manufactured.

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 other 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

IMPORTANT

RETURN WARRANTY CARD ATTACHED TO UNIT

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GENERAL INFORMATION

Fill in blanks below for future reference.

Model of Instapac _____

Serial No. _____

Wiring Diagrams
furnished separately _____

_____

_____

_____

_____

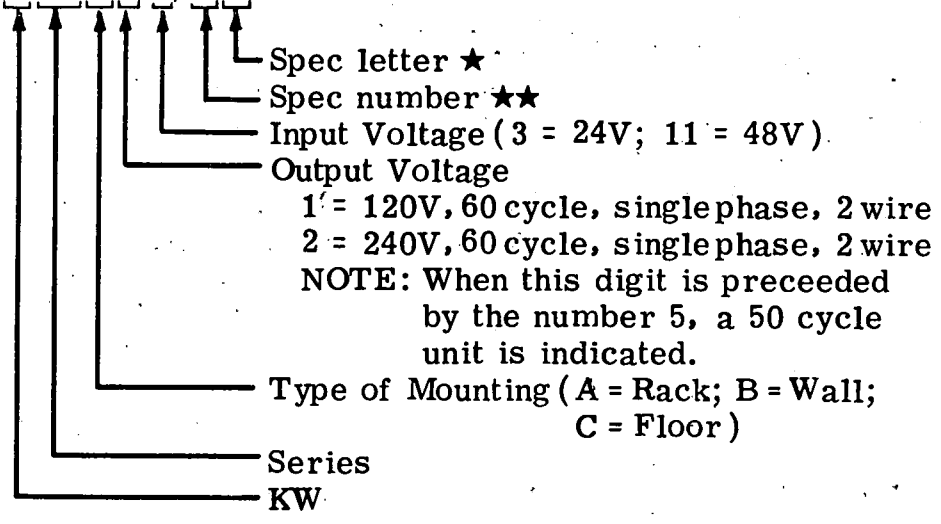
_____

DESCRIPTION

GENERAL. - The ONAN Instapac is a power generator that converts battery direct current (dc) to line voltage alternating current (ac). Comprised of a Transistor Inverter and Load Transfer control, Instapac can detect loss of normal power and switch itself on almost instataneously to feed the load. The delay for Instapac starting is small enough that most equipment cannot detect the power loss. Where equipment cannot tolerate any interruption of power, Instapac can be used as a continuous power source.

In operation, Instapac normally connects the electrical load lines to the normal source of power. When power fails, the control portion of the Instapac senses the power loss, starts the inverter, and transfers the load from the dead line to the inverter. When power returns (either normal or emergency engine-generator) the Instapac returns to standby. For loads greater than 1 kw, specially designed Instapacs can be wired in parallel to provide the desired output.

MODEL NUMBER. A complete description of any Instapac unit can be obtained from the model number. For example, model number 1VAA1-3/1A is a:



★ The model shown on the nameplate ends with a SPEC letter. This letter is advanced (A to B, B to C, etc.) with a factory change which results in noninterchangeable parts.

★★ Basic models (with no optional equipment) are identified as SPEC 1. An advanced SPEC number represents one or more options requested by the customer.

DESCRIPTION

USES. - Most Instapac installations have a large number of electrical devices in addition to critical equipment. This additional power requirement may total many KVA, but for emergency purposes, the capacity of Instapac is generally sufficient for the critical equipment only.

1. EMERGENCY POWER WITH A STANDBY ENGINE-GENERATOR POWER SOURCE. With this installation, the Instapac supplies power during the transition period until the engine-generator plant can provide power. Thus, any hesitation of power during transition is negligible. With a single 1 kw Instapac there is a time lapse of .017 seconds between line power interruption and full Instapac operation.

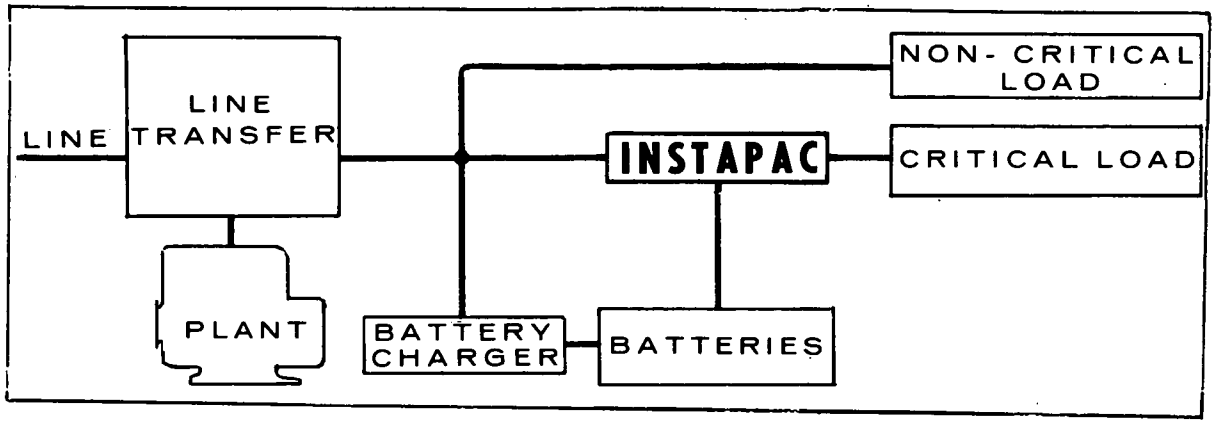


FIG. 1 EMERGENCY USE WITH STANDBY ELECTRIC PLANT

2. EMERGENCY POWER WITH NO PLANT. Fig. 2 illustrates how Instapac can be used when the commercial power is never off for long periods of time. In this case, an Instapac unit without an emergency plant can be used to supply the critical load power needed. The length of this operating interval is determined by the capacity of the battery used. Instapac models using 24 volt battery rated at 120 Amp/Hrs. will supply full load power for about one hour. Models using 48 volt battery (also rated 120 Amp/Hrs.) will supply full load power for about two hours. Battery capacity is directly proportioned to operating time.

3. CONTINUOUS POWER SOURCE. Where even a .017 sec power lapse cannot be tolerated, Instapac can be installed and operated as a continuous power supply (Fig. 1 or Fig. 2). This requires a special Instapac without a start-stop relay and not interchangeable with the standard model. In this operation, the batteries are floated on a battery charger which, in turn, operates from the normal power line or generating plant. Instapac supplies power to the load continuously, eliminating any delay. If batteries, battery charger or Instapac fail, the automatic by-pass relay transfers the load to the line or plant.

   Determine battery size for this installation by the maximum length of time power would be interrupted.

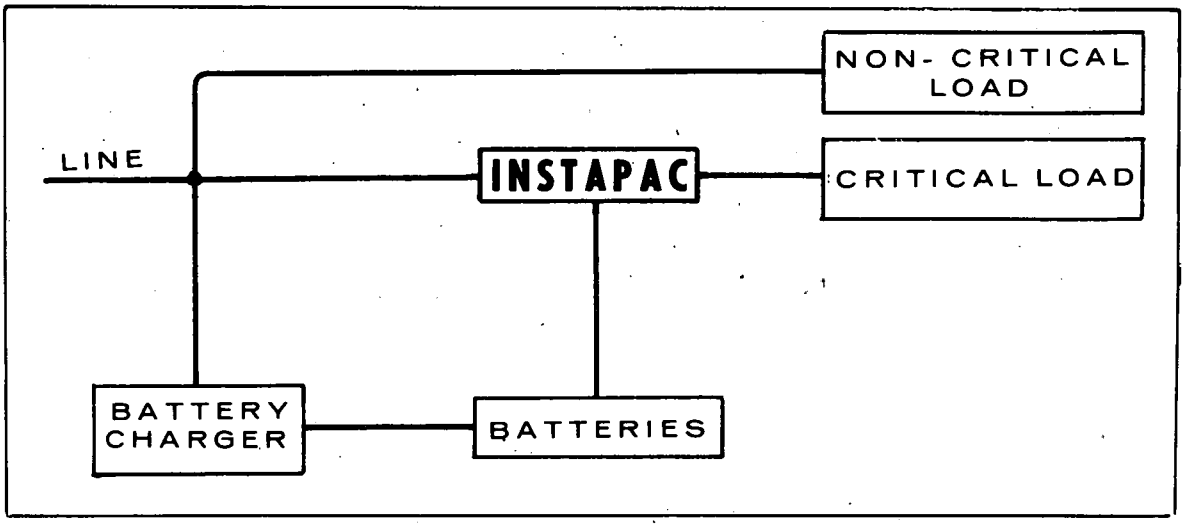


FIG. 2 EMERGENCY POWER USE WITH NO PLANT OR CONTINUOUS POWER SOURCE

STANDARD EQUIPMENT. Standard models are available with input voltages of 24 and 48 volts in both rack or wall mounted housings. No battery charger or meters are included.

1. Rack Mounted Housing - 19 inches wide, 10-1/2 inches high, 10-1/2 inches deep.

2. Wall Mounted Housing - 19 inches wide, 30 inches high, 11-1/2 inches deep.

3. Floor Mounted - Special to customer specifications

OPTIONAL EQUIPMENT. Several optional items are available for use with Intapac and, when used, are usually installed at time of factory assembly.

Provisions have been made to mount Voltage Sensitive, Time Delay, and Alarm Relays in Rack and Wall Mount Models.

Rack mounted Instapac units require a larger mounting panel for optional meters. However, wall mounted units have space for optional meters and battery charger in the cabinet.

NOTE: The voltage supplied by Instapac is Square Wave Voltage rather than Sine Wave Voltage, therefore rectifier type ac meters (if used) will not read accurately but are rather to be used as relative reading instruments during test or operation. Use vane or dynamometer type ac meters to obtain reasonably accurate readings.

1. BATTERY CHARGER - 4 AMP HIGH RATE - ADJUSTABLE LOW RATE - This charger keeps the batteries in a fully charged condition. Has an Exide T.V.R. (Temperature Voltage Regulated) Relay that cuts off the "high" charge rate at a predetermined voltage and connects the "low" rate. A charge rate rheostat adjusts the "low" rate. The milliammeter indicates the battery charge rate as adjusted by the rheostat.

   The T.V.R. Relay itself will not return the charger to the high rate charge, but when there is an interruption of power, a line relay resets the T.V.R. Relay to "high" rate charge. When power is restored, the charger will begin charging at the "high" rate.

2. VOLTAGE SENSITIVE RELAY - This relay is used to determine the voltage at which the Control Unit operates to switch from Line to Instapac and back again. Normal factory adjustment is: "drop out" 100 volts - "pull in" 110 volts. See Maintenance Section for adjustment. On continuous operation models the voltage sensitive relay can be wired to switch the load to the line if Instapac output voltage drops below the predetermined voltage. This protects the batteries from complete discharge.

3. SINE WAVE FILTER - The Sine Wave filter converts Instapac's square wave output to a sine wave. With the filter, the maximum power output is 80 percent of the Instapac rating. For installation and wiring instructions, see the wiring diagram accompaning the filter and ONAN Specification Sheet A-525.

4. TIME DELAY RELAY - The Time Delay Relay delays the normal action of the Control Unit and is adjustable. Consult the Maintenance Section for adjustment instructions.

5. REMOTE TEST RELAY - Wired in series with the Instapac test switch, the Remote Test Relay provides a means of testing the Instapac operation from a remote location. It is actuated by a normally open switch at the remote location. When operated, the relay starts the Instapac and switches the load. If the Remote Test Relay is used in conjunction with the alarm relay (No. 6). Instapac tests can be performed and checked from any distance.

6. ALARM RELAY - This relay actuates the alarm contacts in the event Instapac becomes operative.

7. AC VOLTMETER - To read "Load" voltage.

8. AC AMMETER - To read "Load" current.

9. DC VOLTMETER - To read "Input" voltage.

10. DC AMMETER - To read "Input" current.

INSTALLATION AND TESTING

GENERAL. - Instapac is designed to operate between ambient temperatures of 0°C (+32°F) and +60°C (+140°F). Do not install this unit where heat from other equipment will exceed ambient temperature ratings.

Don't connect Instapac to a load that exceeds the rating of the unit. Because it is self protecting, the Instapac won't operate over the rated load, but will shut down.

MOUNTING. - Mount Instapac within 30° of the vertical position. If it is tipped more than 30°, the mercury wetted contacts of the start-stop relay won't operate.

When installing a wall mounted model, mount it on a vertical wall, switch board, or other permanent support where it won't receive excessive vibration. Use the keyhole mounting holes in the top flange to hang the box on bolts previously screwed into the wall. Secure with bolts through the holes near the cabinet bottom.

When mounting Instapac units for parallel operation, mount the B units below the A unit for easier wiring.

WIRING. - All wiring should meet the specifications of any applicable electrical codes and use wires large enough to handle the maximum rated output and battery currents of the Instapac. To determine maximum battery current see Fig. 8.

Cut into the circuit serving the critical load (load requiring standby service) after the circuit fuse or circuit breaker. A fuse or circuit breaker located ahead of the Instapac unit protects ac circuit wiring.

The Battery and Output Terminals are insulated from the mounting box or panel. Therefore, either negative (—) or positive (+) (see caution page 6) battery terminals may be grounded. The neutral terminal of the output side of TB1 may be grounded if desired.

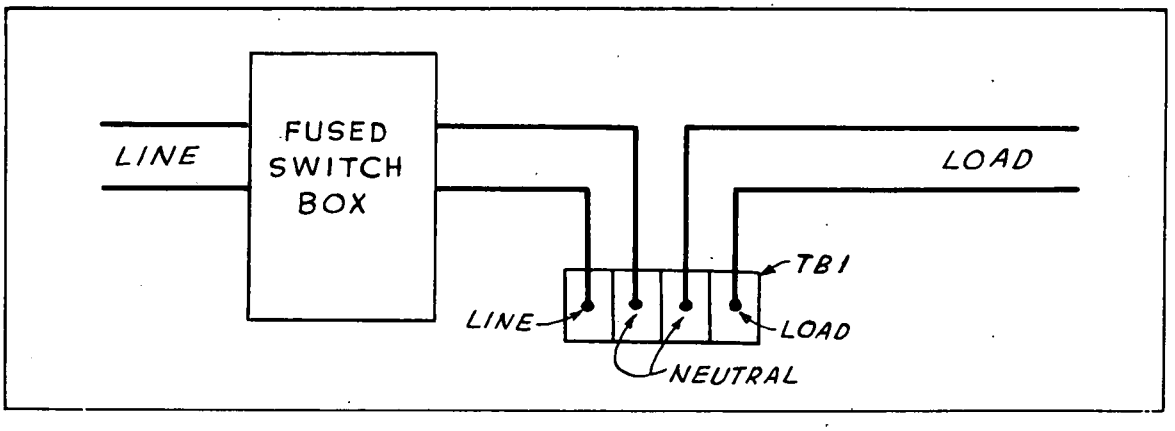


FIG. 3 - LINE AND LOAD CONNECTIONS

CAUTION !!
FOR POSITIVE GROUND BATTERY

The Instapac is shipped with the fuse connected in the positive battery lead. Some installations require that the battery be grounded. If the battery is negative ground, the fuse in the Instapac will protect the battery and wiring from accidental short circuits. If the battery is positive ground, the fuse in the Instapac MUST be changed to the negative lead.

The procedure for changing the fuse to negative lead is as follows:

1. Remove the four screws holding panel on which battery input terminal blocks and fuse are mounted.
2. On rear of this panel a jumper wire connects one end of fuse holder to the battery positive terminal block. Disconnect this wire at the positive terminal block only.
3. Disconnect wire at the other end of fuse holder and connect to the positive battery terminal block.
4. Disconnect wire from the negative battery terminal block and connect to fuse holder.
5. Connect jumper wire removed in step 2, to the negative battery terminal block.
6. Reinstall panel.

INSTAPAC NOMINAL OUTPUT	BATTERY WIRE SIZE		LOAD WIRE SIZE
	24 V	48 V	
1KW	#2	#4	#16
2KW	#00	#2	#14
3KW	#0000	#0	#12
4KW	—	#000	#10
5KW	—	#0000	#8

FIG. 4 - MINIMUM WIRE SIZES

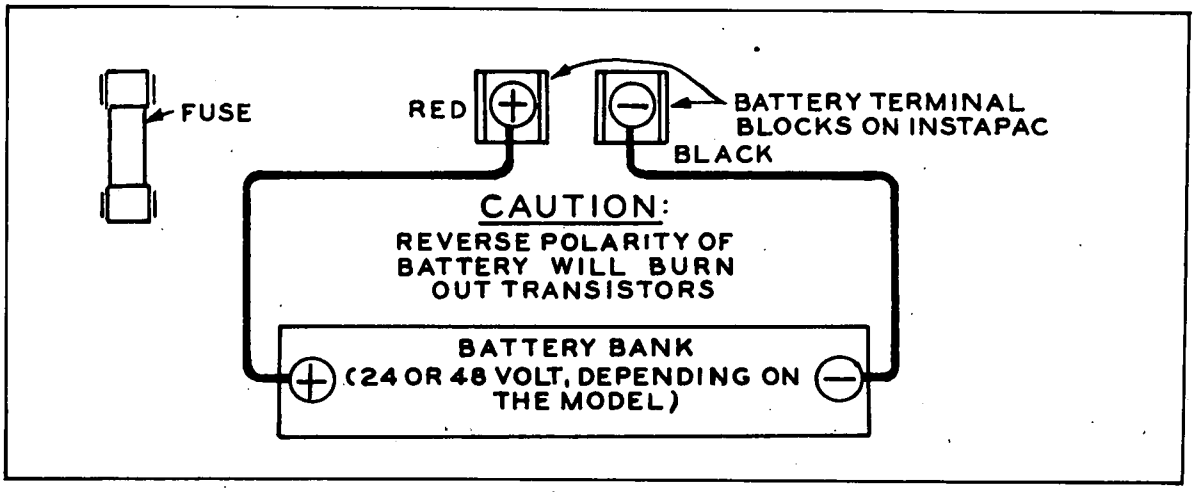


FIG. 5 - BATTERY CONNECTIONS

WARNING! PROPER POLARITY OF BATTERY AND AC LINE-LOAD CONNECTIONS MUST BE OBSERVED OR TRANSISTOR INVERTER WILL BE INSTANTLY DESTROYED.

1. Connect ac lines and load to proper terminals on TB1. The 10-32 screw terminals will accept lugs up to 7/16" wide. BE CERTAIN they are correctly installed.

2. Check normal operation by applying line ac power to regular load.

3. Connect batteries MAKING CERTAIN the positive lead (+) is connected to the red (+) terminal and the negative lead (–) is connected to the black (–) terminal (Fig. 5). The 1/4-20 terminal studs will accept lugs up to 1-1/2" wide.

WIRING, PARALLEL OPERATION. - To obtain more than 1 kw output from Instapac, specially designed single units are operated in parallel. One "A" unit (with transfer relay built for the combined power output) is used with 1 or more "B" units (without transfer relay).

NOTE: Don't attempt to use standard Instapacs for parallel operation without special modification instructions from the factory.

1. Connect 4 wire harness included with "B" unit to TB2 in each unit. The harness is numbered with metal tabs for proper wiring.

2. Install line and load wires to "A" unit (Fig. 3).

3. Install N and AC wires from "A" unit to "B" units. See wiring diagram for "A" and "B" units packed with shipment.

4. Check normal operation by applying AC power to regular load.

5. Install input jumper leads included with "B" units to connect all + and – leads in parallel.

6. Connect the battery leads (Fig. 7). Connect battery positive (+) lead to red (+) terminal of unit "A". Connect battery negative (–) lead to black (–) terminal of unit "B" which is last in the series of Instapacs. NOTE: These leads must be at opposite ends of the series of units so that the voltage at each unit will be identical despite the voltage drops in the connecting cables.

TESTING. - When installation is completed, push the test switch (off-on switch on continuous operation models) and watch the indicator light on the front panel. The light indicates that the Instapac is operating.

NOTE: To test Instapac operation without switching the load, open the control unit door. This releases the by-pass switch so the transfer relay won't feed inverter power to the load. Be sure this door is closed for normal operation. There is no by-pass switch on continuous operation models.

Test complete Instapac operation by removing the line fuse or tripping the circuit breaker ahead of the unit to simulate a power failure.

NOTE: This check can't be used on models designed for continuous operation. They are built without a start-stop relay and so can be started only by the off-on switch.

ADJUSTMENT. - Both the output voltage and the output frequency can be adjusted for correct operation.

Determine the line voltage of the normal source of power and if necessary, reconnect the black lead in the control box to supply the proper voltage (Fig. 6). When adjusting Instapacs in parallel operation, all units must be on the same tap.

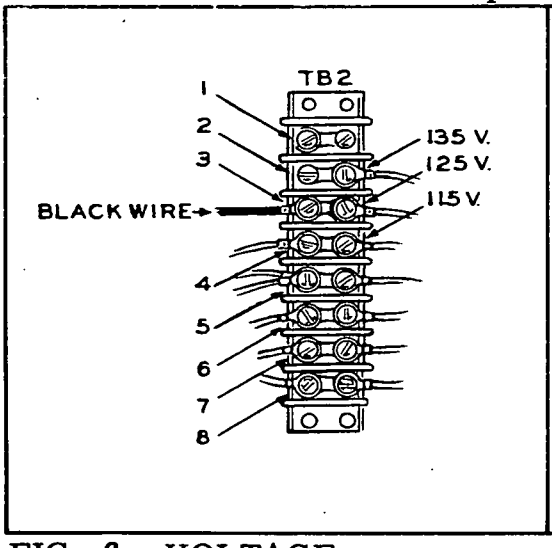


FIG. 6 - VOLTAGE ADJUSTMENT

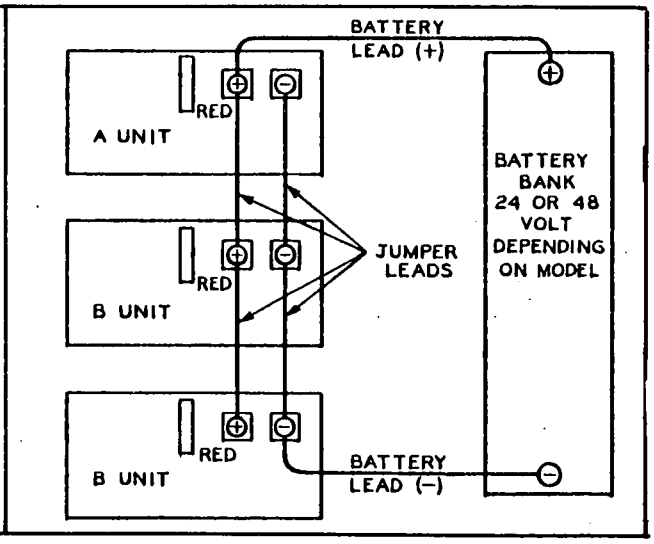


FIG. 7 - BATTERY CONNECTIONS, PARALLEL OPERATION

If frequency is critical, adjust it by moving the slider on the frequency adjusting resistor located in the inverter (**Fig. 13**). To reach the frequency adjusting resistor, disconnect the battery cables, and remove the back panel from the inverter unit.

On parallel operation units, adjust the output frequency by adjusting the frequency adjusting resistor in each inverter unit to the same position.

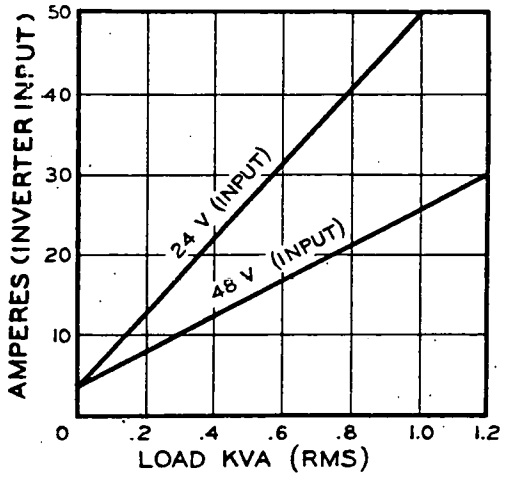


FIG. 8 - BATTERY CURRENT

BATTERIES. - Don't operate Instapac on a rectifier type battery charger or motor generator only. A BATTERY MUST BE USED in the input circuit to provide a low impedance reverse current path.

To calculate the necessary battery capacity for a particular installation, using lead-acid (automotive) batteries, obtain the inverter input current from Fig. 8. The formula below gives the battery capacity in ampere hours to a 10% voltage drop.

$$\text{Input Current} \times 2 \times \text{Operating time in Hours} = \text{Battery Capacity, AH (Ampere Hours, 8 hour rate)}$$

EXAMPLE: Find battery capacity necessary to operate a 48-volt Instapac at .8 KVA for 3 hours to 10% voltage drop.

Fig. 8 shows 21-ampere input for .8 KVA output. Applying the formula; 21 amps x 2 x 3 hours = 126 AH capacity (8 hour rate). Therefore, 4 12-volt, 130 AH, automotive batteries connected in series would provide the necessary power and voltage.

MAINTENANCE

When properly installed, Instapac requires a minimum of service. However, if service or repair is necessary it should be done by an experience technician.

ADJUSTMENTS

VOLTAGE SENSITIVE RELAY (optional). - The voltage sensitive relay adjustments determine the voltage at which the control unit switches the load from line to instapac and back again. This relay was accurately set at the factory and the setting marked. DO NOT CHANGE THE ADJUSTMENTS without taking the proper precautions.

Before changing the setting, be sure that it actually requires readjustment. Unsuspected voltage drops in the line supply 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 0-150 volt range. To simulate a line voltage drop, provide a 1000 ohm wire wound rheostat (2 watts or larger).

CAUTION — THE CONTROL IS HOT

2. Install temporary jumper wire from N/O to C terminals (Fig. 9).

3. Connect the voltmeter across the L_1 and L_2 terminals as shown. Connect the rheostat in series with the L_1 terminal and the wire which normally connects to this terminal.

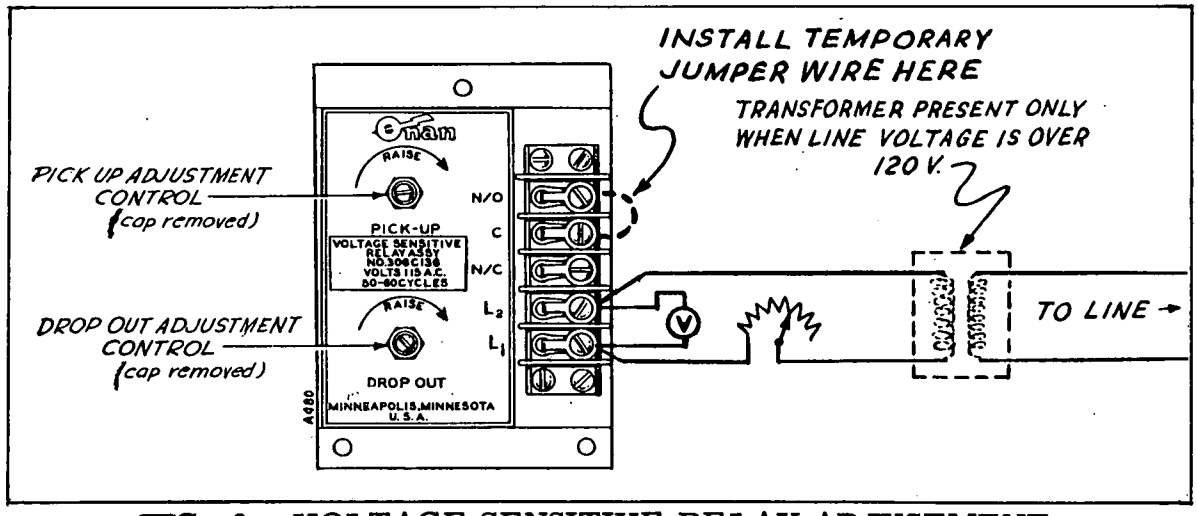


FIG. 9 - VOLTAGE SENSITIVE RELAY ADJUSTMENT

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 "drop-out" control go its counterclockwise limit, then 1/4 turn clockwise.

7. Turn the "pickup" control slowly counterclockwise to just the point where a click is heard, indicating that the relay points have 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 from Instapac to normal source.

10. If the pickup does not occur at the desired simulated voltage turn the relay pickup control in the proper 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 Instapac.

12. Turn the "drop out" control slowly clockwise to just the point where the relay contacts open. This will establish the point at which transfer is made from Line source to Instapac. The drop out setting is adjustable from 5% to 17% below the pickup voltage.

13. Scratch or paint 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, taking care not to turn the screws in doing so.

14. Disconnect the temporary rheostat and voltmeter and reconnect wire removed in step 3.

15. Remove jumper wire from N/O and C terminals installed in step 2.

AGASTAT TIME DELAY RELAY (optional). - This relay is used to delay the normal action of the control unit. Its delay is adjustable from .1 seconds to 10 minutes. It delays the transfer of load back to the normal power source.

If the original setting is to be changed turn the slotted center-top screw clockwise to increase the delay or counterclockwise to decrease the de-

lay. Adjustment requires only a small movement of the screw.

CAUTION: When adjusting the Agastat relay, don't force the screw too far to the right (clockwise). This will damage the needle and seat assembly.

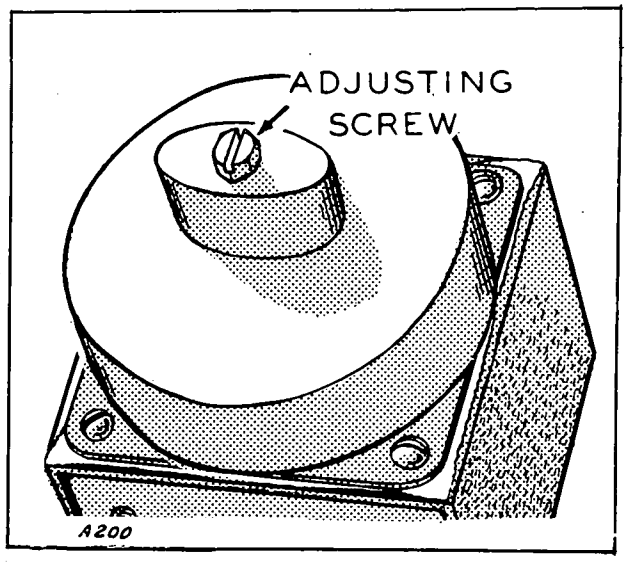


FIG. 10 - AGASTAT TIME DELAY RELAY

TROUBLE-SHOOTING

When trouble-shooting Instapac, always study the symptoms and remedies thoroughly before removing or replacing any components. When diagnosing trouble, remember, the trouble is usually a simple one rather than something mysterious and complicated.

If the unit won't operate, perform the complete trouble-shooting procedure (page15) to find the defective component.

In case of any other defective operation, see the trouble-shooting chart (page 13). The remedy references in this chart refer to steps of the troubleshooting procedure. Each step covers tests and results about a component or system within Instapac and each step can be used as a test for that component. For example; to test the start-stop relay, see step 12.

All Instapac trouble-shooting and servicing can be performed with an ohmmeter and voltmeter. But use only R x 1 or R x 10 scale on ohmmeter. Higher scales will give false readings. Most trouble-shooting and repair work, except for the control unit, can be performed without disconnecting power from the load. Disconnect the commercial power ahead of Instapac only when it becomes necessary in the testing procedure.

For disassembly and assembly instructions see page 25. Whenever removing or replacing transistors, follow the transistor replacement procedure, page 26.

TROUBLE-SHOOTING CHART

(All references to steps in this chart refer to the Trouble-Shooting Procedure page 15).

Probable Cause	Remedy
INSTAPAC WON'T START	
See the trouble-shooting procedure (Page 15). Perform all steps until defect found.	
INSTAPAC WON'T STOP	
(Stand-by models) Defective test switch	See step 8
Defective start-stop relay	See step 11
(Continuous operation models) Defective on-off switch	See step 7
INSTAPAC WON'T OPERATE WITH LOAD (output collapses when load connected)	
Overloaded or short in load	As self-protection Instapac output collapses under overload. See step 2.
Load contains a device that draws more than Instapac's maximum instantaneous current rating. (15 amps for 24 volt models) (18 amps for 48 volt models) For example, motors with high starting current, magnetic amplifiers and some transformers.	If peak current exceeds maximum rating, the inverter shuts down until the load is removed. Remove the questionable load and restart Instapac. NOTE: Many times, motor running current is within Instapac's rating while starting current isn't. The motor can be started on another source and switched to Instapac while running.
LOW INVERTER OUTPUT POWER	
Defective or discharged battery (in this case frequency is also low)	See step 2.
1 or more transistors defective	See step 4.

TROUBLE-SHOOTING CHART (Cont.)

Probable Cause.	Remedy
HIGH FREQUENCY ON OUTPUT	
High battery voltage	Output frequency is directly proportional to battery voltage - increases with higher than specified voltage. Reduce battery voltage, adjust battery charger.
Overload (accompanied by low output voltage)	When Instapac is overloaded, frequency increases and output voltage decreases until eventually output collapses. Reduce the load.
INSTAPAC OPERATES AND LINE TRANSFER RELAY SWITCHES BUT IT WON'T FEED THE LOAD	
(Stand-by models) Defective line transfer relay contacts	See step 9
(Continuous operation models) Defective automatic by-pass relay	See step 6
IMMEDIATE DESTRUCTION OF TRANSISTORS WHENEVER INSTAPAC STARTED	
No batteries on input or loose connection in battery circuit	Batteries must always be used. Check for high voltage drops across any battery circuit connection. See step 1
CYCLING (alternate starting and stopping)	
(Continuous operation models) Overload	Reduce load
CHATTERING LINE TRANSFER RELAY	
Defective diodes in start-stop relay supply	See step 10 and 12

TROUBLE-SHOOTING CHART (Cont.)

Probable Cause	Remedy
TRANSISTOR FAILURE (Although most transistor failures will be due to defects in the transistors check for the following especially if more than 1 transistor has failed or transistors fail repeatedly)	
No battery on input or high resistance in the battery circuit	See step 2
Defective 1000 mfd capacitor across input terminals	Check capacitor for leakage or open circuit
Ambient temperature in inverter cabinet above 140F	Reduce temperature
Start-stop relay removed without first disconnecting battery	See step 12
IMMEDIATE DESTRUCTION OF TRANSISTORS WHEN LINE CONNECTIONS ARE INSTALLED TO INSTAPAC	
"Hot" line connected to Instapac neutral terminals	See installation section
Line and load wires reversed — line feeding into Instapac output	Reverse line and load

TROUBLE-SHOOTING PROCEDURE

Use this procedure for testing each component and also as a complete procedure to trouble-shoot the inverter if it won't operate. Be sure to perform the tests in the order given below and follow all procedures. When you find the trouble, and the procedure doesn't indicate another test, reassemble and test the **Instapac.**

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
1. BATTERY Only with correct battery voltage on its input will the inverter operate properly	A. Check inverter fuse with an ohmmeter	I. A blown fuse may indicate that at least 2 transistors have short circuited. Test transistors, step 4 and 5 II. Defective mica insulation on transistors. Test from T_1

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
1. BATTERY (Cont.)		and T_2 to the inverter chassis. If short is indicated, proceed to page 27 step 4
		III. 1000 mfd capacitor shorted, or short in wiring
		IV. Fuse OK proceed to step B
	B. Measure voltage on input, start Instapac and remeasure. Check voltage drop across all input and battery connections with inverter on	I. Instapac input terminal voltage within 10% of battery voltage under both conditions. Battery system OK proceed to step 2
		II. Input voltage low under both conditions check battery with hydrometer. Recharge or replace if necessary
		III. Input voltage low only when inverter operating. Check battery with hydrometer. Clean and tighten any connections showing a voltage drop
2. LOAD Check for overload or short	Check inverter operation without load by opening the control door and pushing the test switch. (On continuous operation models, turn the switch off and remove wire from TB_2 of each	I. Indicator lights without load but not with load. Short or overload, collapsing Instapac output. Correct load.

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
2. LOAD (Cont.)	unit to remove load and then start the unit)	II. Indicator doesn't light. Check with voltmeter across terminals 4 and 5 of TB_2. Voltage here indicates defective bulb. If no voltage proceed to step 3 or 4
		III. Indicator lights under both conditions but no output. Proceed to step 6 or 9
3. PARALLELED UNITS ONLY If 1 unit of a paralleled package fails, all units stop. Use this test to detect the defective unit (s)	A. Disconnect all control and load wires interconnecting the units. Operate the control unit	I. Control unit operates, proceed to 3B
		II. Control unit doesn't operate. Proceed to step 4 and continue troubleshooting procedure until control unit repaired. Then return to step 3B
	B. Connect control and load wires from 1 slave unit to control unit and operate both	I. Combination operates. Proceed to step 3C
		II. Combination doesn't operate. Slave unit connected to master is defective. Proceed to step 4 and continue procedure until slave unit repaired. Then return to step 3C
	C. Repeat step B adding another slave unit. Repeat this procedure un-	

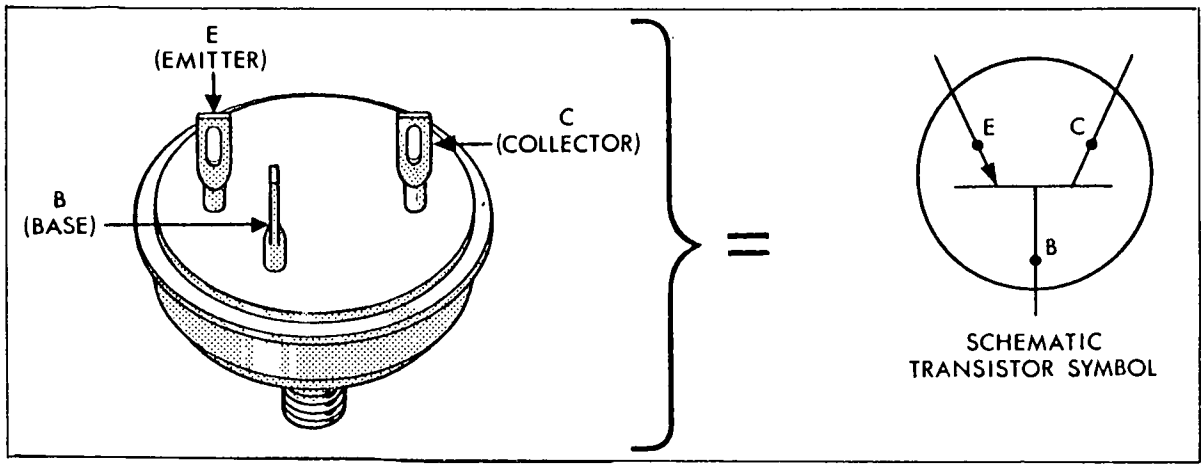


FIG. 11 - TRANSITOR AND SCHEMATIC SYMBOL. Note: In the Instapac circuit, each transistor acts as a switch between its E and C terminals. Voltage between the B and E terminals controls switching.

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
3. PARALLELED UNITS ONLY (Cont.)	til all slave units have been added and are working	
4. TRANSISTORS This test indicates transistors and diodes shorted. Test 4C will also indicate a transistor with open circuit. Perform step 5 to complete the check for open circuited transistors If transistors require replacement see page 26	A. Disconnect batteries and remove the inverter back panel. With an ohmmeter, check resistance between input negative (—) and T_1 or T_2. Reverse the ohmmeter probes and remeasure the resistance B. Repeat test A between the input positive (+) terminal and T_1 or T_2. Be sure fuse is in place	In both tests A and B, resistance reading in one direction about 10 times higher than the other direction indicates that transistors are good. Otherwise 1 or more transistors defective. If "A" indicates defective transistor it is on heat sink connected to negative (—) terminal If test "B" indicates a defective transistor it is on heat sink connected to battery positive (+) terminal If transistors test OK proceed to step 5 If either test indicates a defective transistor, proceed to step 4C

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
4. TRANSISTORS (Cont.)	C. Remove heat sink showing defective transistor and isolate all transistors by disconnecting the B (base) and E (emitter) leads from their terminal blocks To test EACH transistor, measure the resistance from C (collector) to E then, with the ohmmeter connected to C and E, connect B to E	I. Resistance increases when B connected to E. Transistor good. Proceed to step 4E II. Resistance goes down when B connected to E. Proceed to 4D III. Ohmmeter indicates open circuit or short circuit between C and E, proceed to 4D
	D. Reverse ohmmeter probes on C and E and measure resistance. With the ohmmeter probes connected to C and E connect B to E	I. Resistance increases when B connected to E. Transistor good. Proceed to step E II. Resistance goes down when B connected to E. Transistor defective, Replace, Then proceed to 4E III. Ohmmeter indicates open circuit or short circuit between C and E, Transistor defective, Replace. Then proceed to 4E
	E. Check all diodes by isolating one lead and measuring resistance in one direction, then reversing the probes and remeasuring	Replace diodes that indicate same resistance in both directions or indicate open circuit between terminals, then proceed to step 5

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
5. BASE CURRENT LIMITING RESISTORS A defective base current limiting resistor indicates that the transistor connected to it may be defective	A. Measure resistance of all current limiting resistors without removing them from the circuit. Reverse the probes and remeasure. On paralleled units, check resistors in all units	If resistance is over 1 ohm in either diretion, isolate the resistor and recheck resistance. Replace any found open circuited or shorted and proceed to step 5B
	B. If any resistors are defective return to step 4C and recheck transistor with base connected to defective resistor, unless that transistor was already replaced	
6. (Continuous Operation Models Only) AUTOMATIC BYPASS RELAY Check voltage to relay, coil continuity, and contact operation	A. Push the off-on switch to on and watch the relay and indicator light	I. Relay energizes but no voltage to load. Clean contacts II. Indicator lights, relay won't pull-in. Proceed to step 6B III. Indicator doesn't light, proceed to step 7
	B. If relay won't energize measure voltage across the relay coil	I. No voltage. Defective wiring to the relay coil II. Equal to output voltage at transformer. Wiring OK proceed to step 6C
	C. Isolate the coil and measure resistance; check for sticking contacts etc.	Coil resistance should be from 100 to 300 ohms. If coil or contacts are defective, replace the relay

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULTS AND CONCLUSIONS
7. (Continuous Operation Models Only) OFF-ON SWITCH CIRCUIT	Disconnect wires to off-on switch at TB_2 and check continuity of switch	I. Shows continuity between all wires in ON position only, switch OK
		II. Shows continuity in both positions or no continuity. Switch defective, replace
8. (Stand-By Models Only) TEST SWITCH CIRCUIT AND START-STOP RELAY COIL	Measure voltage between terminals 6 and 7 of TB_2. Push test switch and again measure voltage	I. No voltage at either time. Defective test switch or wiring to line terminals. Disconnect line voltage and test with ohmmeter
		II. Voltage under both conditions. Defective test switch or short circuit around test switch
		III. 120 volts with switch closed no voltage when switch pushed. Circuit OK
9. (Stand-by Models Only) TRANSFER RELAY	With normal power on relay should be energized	I. If relay energized, but no power to load, check contacts Clean dirty contacts with paper, don't file
		II. Relay doesn't energize, proceed to 9B
	B. Relay de-energized. Check voltage across terminals 7 and 8 of TB_2	I. No voltage indicates that possibly transfer relay coil shorted and the by-pass

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULT AND CONCLUSIONS
9. (Stand-by Models Only) TRANSFER RELAY (Cont.)		switch and start-stop relay defective. Proceed to 9C and steps 10 and 12 before testing operation
	C. If test B shows a defect, isolate the coil and measure its resistance	I. Resistance between 100 and 300 ohms. Coil OK. Check wiring
		II. Coil short or open. Replace relay. NOTE: On some larger contactors for paralleled units, the coil is available separately
10. (Stand-by Models Only) BY-PASS SWITCH AND START-STOP RELAY CIRCUIT	A. With ac power on, push the by-pass switch on control cabinet door	I. No change in operation proceed to step 10B
		II. Line relay chatters. Defective diodes in start-stop relay supply proceed to step 12
		III. Line relay drops out. Start-stop relay defective proceed to step 12
	B. Push test switch, then push by-pass switch.	I. Line relay drops out when by-pass switch pushed. Switch OK
		II. Line relay drops out when test switch pushed. By-pass switch open circuited. Replace

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULT AND CONCLUSIONS
10. (Stand-by Models Only) BY PASS SWITCH AND START-STOP RELAY CIRCUIT (cont.)		III. Line relay doesn't drop out. By-pass switch shorted or contacts welded. Replace
11. VOLTAGE SENSITIVE RELAY AND TIME DELAY (optional equipment)	A. Connect a jumper between terminals N/O and C of voltage sensitive relay. This shorts relay contacts. Operate the inverter	I. Inverter operates. Repair or replace relay as necessary (see adjustments)
		II. Instapac doesn't operate. Proceed to 11B
To test these relays, eliminate them from the circuit and check operation without them.	B. Connect a jumper across the time delay relay contact terminals	I. Instapac operates properly but with no delay on stopping. Remove and repair as necessary.
		II. No change in operation. Proceed to step 12

DISCONNECT THE BATTERY CABLES FROM THE INVERTER UNIT. ALL FURTHER TESTS WILL BE MADE WITHOUT BATTERIES

12. (Stand-by Models Only)
START-STOP RELAY WARNING: If the start-stop relay were removed with the batteries connected, it could burn out the transistors.

Open the control unit door so the by-pass switch will prevent the transfer relay from operating	A. Remove the inverter unit back cover with ac voltage connected. Remove the start-stop relay and check dc voltage across terminals 7 and 8 of relay socket (Fig. 12)	I. Approximately 100 volts dc. Voltage to relay coil OK, proceed to step 6B
		II. Less than 100 volts. Relay current limiting resistor or

TROUBLE-SHOOTING PROCEDURE (Cont.)

COMPONENTS AND TESTS	HOW TO PERFORM TESTS	RESULT AND CONCLUSIONS
12. (Stand-by Models Only) START-STOP RELAY (Cont.)		diodes defective. To check diodes, measure resitance one direction, then reverse the probes and remeasure. One reading should be at least 10 times highes than other
	Check coil resistance, pins 7 and 8; shake the relay	I. Relay OK if coil resistance is about 4000 ohms and the relay makes splashing sound
		II. Relay defective if it sounds like sand particles on the inside. Replace

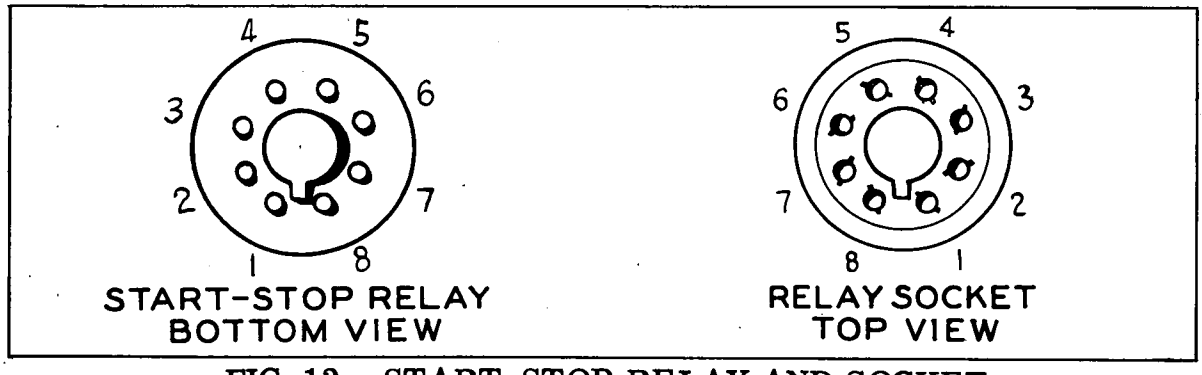


FIG. 12 - START-STOP RELAY AND SOCKET

13. INVERTER FEED BACK CIRCUIT	Measure resistance of feed back resistor and drive transformer primary (See Fig. 13)	I. Resistances OK. Recheck all steps
		II. Resistances incorrect. Replace components as required

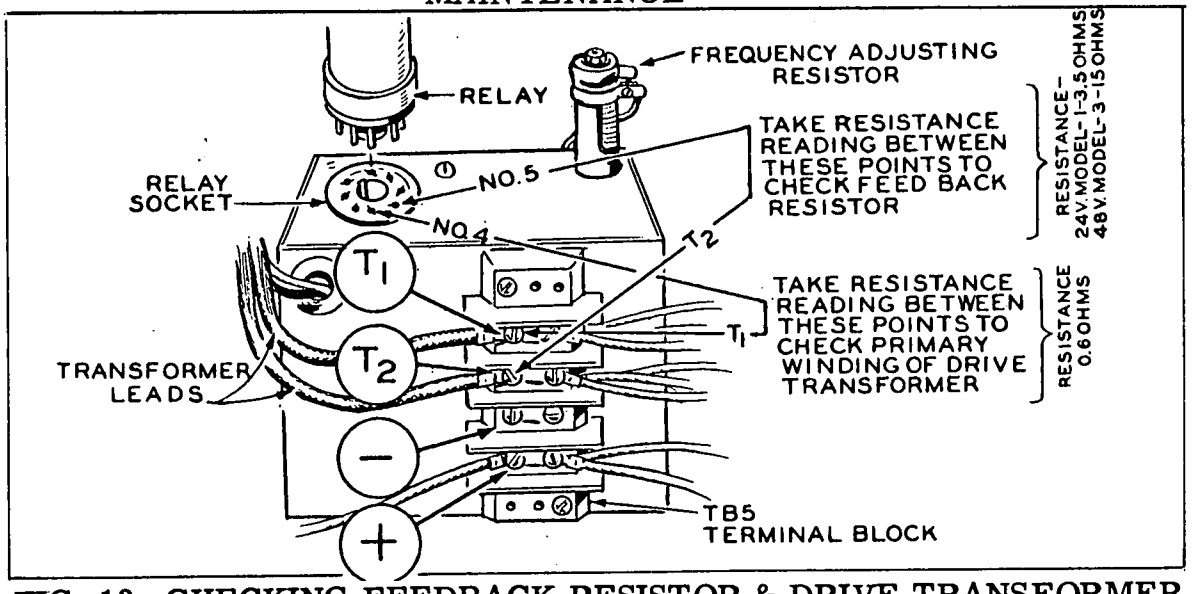


FIG. 13 - CHECKING FEEDBACK RESISTOR & DRIVE TRANSFORMER

INVERTER DISASSEMBLY. - The inverter and control units are individually assembled and attached to a common mount. They are designed to permit maintenance on the inverter unit without distrubing line ac power to the normal load. Only a 7/16" socket wrench with extension and a screw driver are required for disassembly and assembly.

1. Remove battery cables.

2. Remove inverter unit backplate and top cover screen.

3. Disconnect the inverter unit wires from terminals 6, 7, 8, 9, and 10 of TB2 in control box. Pull wires through rubber grommet into inverter unit.
   CAUTION: Except for continuous operation models, terminal 7 is hot. Operate and hold the test switch on the front panel to eliminate this voltage while disconnecting the wire.

4. Disconnect the two heavy wires to T_1 and T_2 on TB_5; then pull them through the rubber grommet into the control box.

5. LOOSEN the four 7/16" nuts securing the inverter unit to the front plate.

6. Lift the inverter unit up 1/2" and pull it away from the mounting plate.

7. to remove the heat sinks, unscrew the 4 machine screws holding each to the case and pull them out through the bottom. Remove any necessary wires at the terminal blocks.

CONTROL DISASSEMBLY

1. DISCONNECT NORMAL AC POWER SOURCE AHEAD OF INSTAPAC.

2. Remove wires from Line-Load terminals on TB_1.

3. Remove all remaining wires connected to the right side of TB_2 and wires on left side to terminals 4, 5, and 6.

4. Remove 4 screws securing control box to output transformer, then remove control box. NOTE: Carefully guide wires through rubber grommets in box to avoid kinks or breakage.

5. Remove four 7/16" nuts securing output transformer to front plate, then remove transformer.

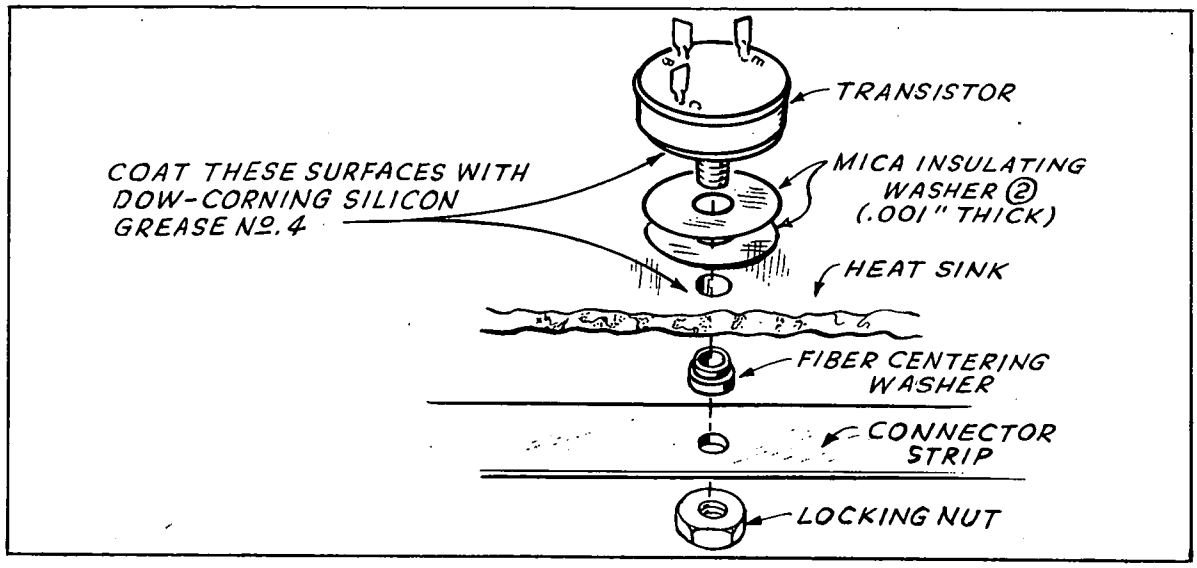


FIG. 14 - TRANSISTOR INSTALLATION

TRANSISTOR AND DIODE REPLACEMENT

1. Remove the defective transistor and thin (.001) mica insulating washers (Fig. 14).

   NOTE: When removing wires from transistors, be certain not to change their length.

2. If available, lightly coat the copper base of the transistor and heat sink as shown in Fig. 14 with Dow Corning Silicon grease #4 or Dow Corning Silicon Oil #200.

TRANSISTOR AND DIODE REPLACEMENT (Cont.)

3. See Fig. 14 for replacing transistors. Tighten nut to a maximum of 20 inch pounds. CAUTION: Use only enough force to provide a snug tightness. DO NOT OVER TIGHTEN. Do not allow the transistor to turn while tightening. Turning damages the insulating washers.

4. Check to see transistor is not shorted to heat sink. Use highest scale on ohmmeter between "C" and heat sink. A high reading is necessary to assure isolation between the heat sink and the transistor.

5. When soldering leads do not overheat. Use a very hot iron and do not hold it to the connection for more than 5 seconds. Allow to cool before soldering another connection.

6. Make sure of proper polarity when replacing diodes. When soldering, use a long nose plier to absorb heat from the lead.

ASSEMBLY - To assembly Instapac, reverse the disassembly procedures.

SINE WAVE FILTER

Instapac's output is a square wave. An optional sine wave filter converts the square wave output to a sine wave. The filter, however, reduces the maximum power output of the package by 20 percent.

INSTALLATION. - The filter should be located near the Instapac so the 3 interconnecting wires may be conveniently run. Be sure the ambient temperature is below 140°F. Higher temperatures could destroy the filter.

To wire the filter to Instapac, the black wire in the Instapac control box should be removed and #16 or larger wire installed as follows - -

-- From terminal 2, 3, or 4 of TB_2 to the filter IN terminal

-- From the transfer relay or automatic by-pass relay (terminal from which black wire was removed) to filter OUT terminal

-- From Neutral on TB_1 to the filter C terminal

TROUBLE-SHOOTING. - If you suspect that the sine wave filter isn't operating properly, check the output wave from with an oscilloscope.

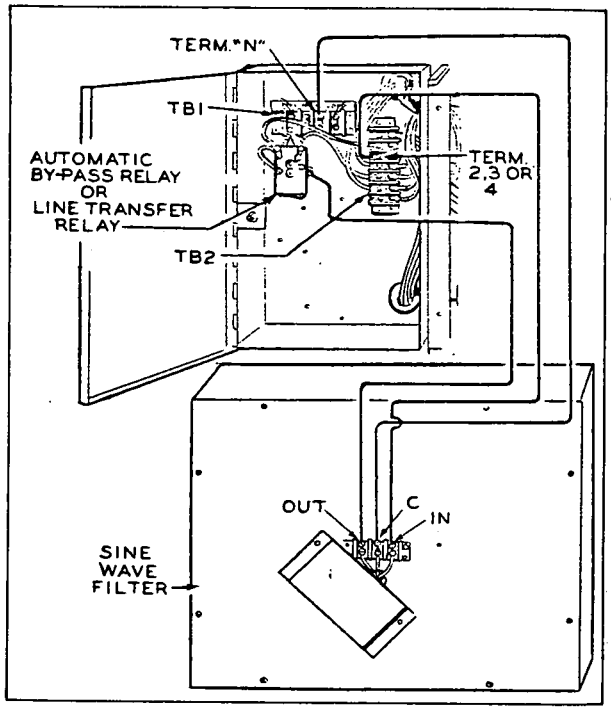


FIG. 15 - SINE WAVE FILTER INSTALLATION

As a further test, remove all connections from the filter and check the following with an ohmmeter--

-- Measure resistance between terminals IN and C. After the capacitors charge, and reading should be at least 1 megohm

-- Measure the resistance between terminals OUT and C. Correct resistance is about 0.6 ohms.

-- Measure the resistance from C and IN to the chassis. If either shows a reading, it indicates a short to the chassis.

If any of the above tests indicate that the filter is defective, return it to the factory for repair.

NOTE: DON'T ATTEMPT TO DISASSEMBLE THE FILTER - ALL COMPONENTS MUST BE REPLACED IN MATCHED SETS.

BATTERY CHARGER

The battery charger has a 4 amp high charge rate and adjustable (0.40 to 0.200 Amp) low charge rate. Regulated by a Exide T.V.R. (Temperature Voltage Regulated) relay that cuts off the high charge rate at a predetermined voltage and connects the low charge rate. A charge rate rheostat adjusts the low rate and should be adjusted to give the lowest charge rate that will keep the batteries fully charged. The milliameter indicates the battery charge rate as adjusted by the rheostat.

The T.V.R. relay itself will not return the charger to the high rate charge, but when there is an interruption of power, a line relay resets the T.V.R. relay to "high" charge rate. When power is restored, the charger will begin charging at the "high" rate.

BATTERY CHARGER (Cont.)

ADJUSTMENT. - When the battery charger is put into operation adjust for minimum charge rate. (NOTE: New battery operating at 70°F require approximately 50 milliamperes per 100 ampere hours capacity) Check the batteries weekly, and if the charge condition drops even slightly, increase the charge rate 20 milliamperes. Repeat the weekly check and increase in 20 milliampers steps until the charge condition stabilizes. NOTE: The above procedures is for lead-acid batteries only.