MARATHON POWER TECHNOLOGIES COMPANY

CHRISTIE

A Division of MARATHON POWER TECHNOLOGIES COMPANY

OPERATOR'S MANUAL

FOR

AUTOMATIC REFLEX CHARGER / ANALYZER

MODEL RF80H

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TD-A6 Rev B
DCR #54769
Revised 11/2000

LIMITED WARRANTY

COVERING INDUSTRIAL CHARGERS AND POWER SUPPLIES

MANUFACTURED BY MARATHON POWERS TECHNOLOGIES

Marathon Power Technologies warrants the Charger/Analyzer to the extent of the parts necessary to correct any defect in workmanship or materials which may develop under proper and normal use for a period of one (1) year from date of receipt of the equipment by the customer, but not to exceed eighteen (18) months from the date of shipment from Marathon. This warranty also includes any labor necessary to effect such repair, if the Charger/Analyzer is returned to Marathon Power Technologies in Waco, Texas, USA, properly packaged and insured.

The above shall constitute fulfillment of all Marathon liabilities in respect to said equipment, and Marathon shall not be liable for any consequential damages nor for any damage in shipment. The Charger/Analyzer or faulty part must be returned to Marathon. The cost of any transportation and insurance is not included with this warranty.

The specifications contained in this manual are subject to change without notice. The contents are believed to be accurate, but no warranty is expressed or implied as to the suitability for specific applications. If errors are found, please notify Marathon Power Technologies at the address shown below.

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(The following applies to the Cell Reading described on page 3-6, Item 13)

Cell Reading # 1: Use this position only after flashing green bars appear during charging. The reading on the digital meter then stands for relative ampere-hours.

Cell Reading # 2: Use this position only before flashing green bars appear during charging (e.g., to detect low electrolyte or shorted cell at beginning of charge), and during discharge. The reading on the digital meter in this position is cell voltage. (Note: The voltage fluctuates due to the ReFLEX positive and negative pulses.)

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SECTION 1

GENERAL DESCRIPTION

1-1. PURPOSE OF CHARGER/ANALYZER

1-2. The Model RF80H Automatic ReFLEX Charger/Analyzer is the most efficient and sophisticated instrument available for rapid, automatic charging and analyzing of nickel-cadmium (ni-cad) batteries. Designed for 11, 19, 20 and 22-cell, sintered vented-type ni-cads, the charger/analyzer uses the patented ReFLEX charging principle to give rated or better-than-rated battery capacity in 1 hour. The charger/analyzer is shown in Figure 1-1.

WARNING - NEVER USE THE RF80H TO CHARGE SEALED (e.g.: cylindrical, non-vented, "flashlight-type") NI-CAD CELLS. THERE IS A DEFINITE EXPLOSION HAZARD IN THE CASE OF A FAULTY CELL WHEN CHARGING AT HIGH CURRENTS WITHOUT PROPER PROTECTIVE MEANS.

1-3. For battery condition analysis, a discharge test technique is used that accurately tests the fully charged ni-cad for rated capacity. This function gives the most practical comprehensive test of ni-cad capacity possible, consistent with the essentially constant specific gravity of the ni-cad electrolyte. The entire cycle, consisting of three stages, is automatic.

1-4. RATINGS AND SALIENT CHARACTERISTICS.

1-5. Useful information about ratings and salient characteristics of the charger/analyzer are tabulated in Table 1-1.

1-6. CHARGER/ANALYZER FUNCTIONS.

1-7. REFLEX CHARGING. The patented ReFLEX charging principle is unique in that it allows most vented-type aircraft ni-cad batteries to be fully recharged in 1 hour from an unknown state-of-charge. Using the ReFLEX charging method often will result in higher-than-rated capacity in the battery. The ReFLEX charging method provides a further benefit by the interjection of depolarization pulses during charging. This reduces battery heating during charging and results in greatly improved charging efficiency over conventional methods.

1-8. BATTERY ANALYZING. The battery analyzing function allows complete battery analysis automatically with a pre-programmed cycle, and the evaluation of battery condition both by GO/NO-GO indicator lights and by actual ampere-hour capacity readout. The charge-discharge-recharge cycle is preprogrammed to match each specific battery type and takes approximately 3 hours with most batteries. Charging is by the ReFLEX method and discharging is by regulated constant current. The GO/NO-GO point, which is also pre-programmed, can be set to any percentage of rated battery capacity. (Also see 1-37).

1-9. CELL SCANNING. This capability allows manual measurement of individual battery cell voltages at any time using the charger/analyzer digital panel meter (DPM) and supplied probes. (Also see 1-37.)

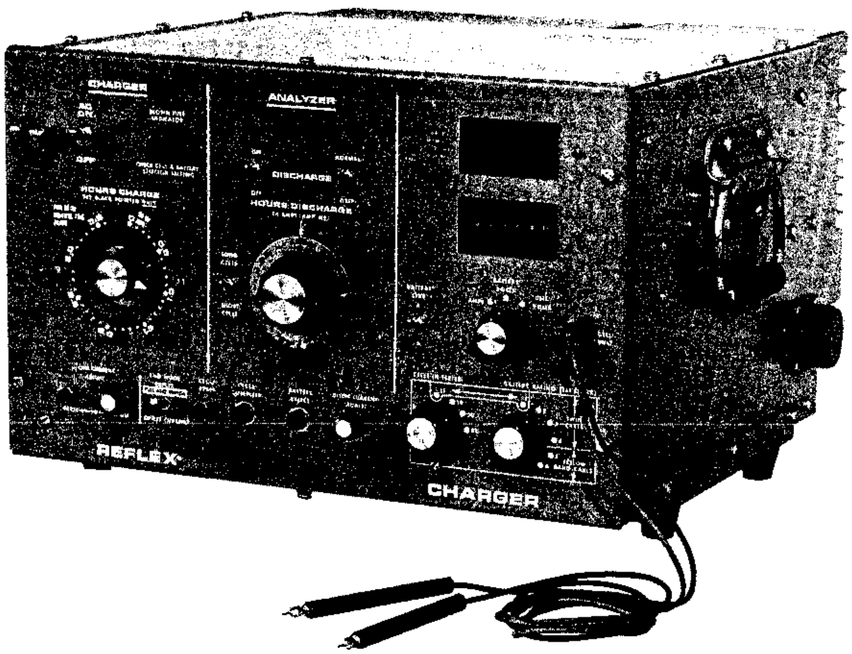


Figure 1-1. The Model RF80H ReFLEX Charger/Analyzer

Table 1-1. Ratings and Characteristics

RATINGS
INPUT POWER: 208/230V a-c, single-phase, 50/60 Hz, 23 amperes. (115V a-c, 26 amperes limited operation capability: only on certain models) CHARGE CURRENT OUTPUT IN REFLEX MODE: Adjustable, 5 to 80 amperes. CHARGE CURRENT OUTPUT IN CONSTANT CURRENT MODE: Adjustable, 2.5 to 65 amperes. DISCHARGE CONSTANT CURRENT: Adjustable, 5 to 50 amperes. NOMINAL DISCHARGED BATTERY VOLTAGE: Preset, 0.95 volt per cell, average (i.e., approximately 18 volts for 19 cell battery). BATTERY CELL RANGE: 11, 19, 20, and 22 cells in series. BATTERY AMPERE-HOURS (A-H) RANGE: 6 to 55 (except for 11 cell batteries which are 40 to 55 A-H).
CHARACTERISTICS
DIMENSIONS (Inches): 17-5/8 wide by 19-3/4 deep by 11-3/4 high. NET WEIGHT: 150 pounds CABLES PROVIDED: One input power cable without plug. Two battery connection cables; one with Elcon-type connector; and one yellow-band cable with lugs for smaller batteries. CHARGE TIME: 1 hour for most batteries up to 40 A-H; 1 hour 10 minutes or less between 40 to 55 A-H. Some ni-cads require additional time. DISCHARGE TIME: 1 hour for most batteries. Some ni-cads or battery shop procedures require 2 hours. A few additional minutes of discharge will occur if battery has more than rated "GO" capacity on long cycle. CHARGE-DISCHARGE-RECHARGE CYCLE TIME: 3 hours for most batteries. Some ni-cads or battery shop procedures may require up to 5.5 hours. A few additional minutes of discharge will occur if battery has more than rated "GO capacity on long cycle.

1-10. DEEP DISCHARGING. This feature allows deep discharge cell equalizing which discharges each cell to zero volts for cell reconditioning.

1-11. CONSTANT CURRENT CHARGING. This capability allows electrolyte level adjustment during constant current charging as required by some battery manufacturers. Constant current can also be used for slow charging of individual cells, and for cell balance and cell fatigue tests described below.

1-12. CELL VOLTAGE BALANCE TESTING. The charger/analyzer constant current charge mode allows performance of cell balance tests recommended by some battery manufacturers.

1-13. CELL FATIGUE TESTING. The charger/analyzer constant current charge mode allows performance of cell fatigue (cellophane barrier) tests recommended by some battery manufacturers.

1-14. PHYSICAL DESCRIPTION

1-15. The charger/analyzer is enclosed in a steel cabinet, fitted with mounting feet and two carrying handles. Figure 1-2 and 1-3 illustrate prominent features and components of the unit. The cabinet is finished with a blue coating resistant to the electrolyte of ni-cad batteries. Forced-air cooling is achieved by a fan at the rear of the unit which draws cooling air through openings on the left and underside of the cabinet. The top must always be closed during operation as the cabinet is designed with specific air flow patterns to assure proper cooling of all critical components. The heated air is exhausted by the cooling fan out the right rear of the cabinet. The unit is supplied with a red and black probe set for cell scanning, an input power cable, a twin-lead battery cable with Elcon-type connector, and an alternate yellow-band cable with lug-type connectors.

1-16. CONTROL PANEL ARRANGEMENT. The control panel is arranged into three functional divisions. The first, at the left section of the unit, contains all the controls and indicators for charging. The center portion of the panel contains the controls and indicators for discharge analysis and the right section of the panel contains a digital voltage and current readout meter (DPM), an LED Bar Display that shows approximate state-of-charge of the battery and cycle mode of the RF80H, connection for cell scanning probes, and setup controls for battery rating and type. A single connector on the right side of the cabinet provides connection for both types of battery cables. An electrical interlock prevents the use of the wrong cable.

1-17. INTERIOR COMPONENTS. As may be seen in the interior view of Figure 1-3, the major components of the unit consist of the primary power transformer T1, the filter reactor L1, the terminal board TB1 which mounts the high current a-c and d-c fuses F1 & F2, three control circuit cards A1, A3, and A4, and various control relays. The high current rectifying diodes are heatsink-mounted at the rear of the unit and the discharge resistors, diode assemblies, and filter capacitor are mounted inside protective covers on the outside rear of the cabinet. The input power cable is provided at the rear of the unit.

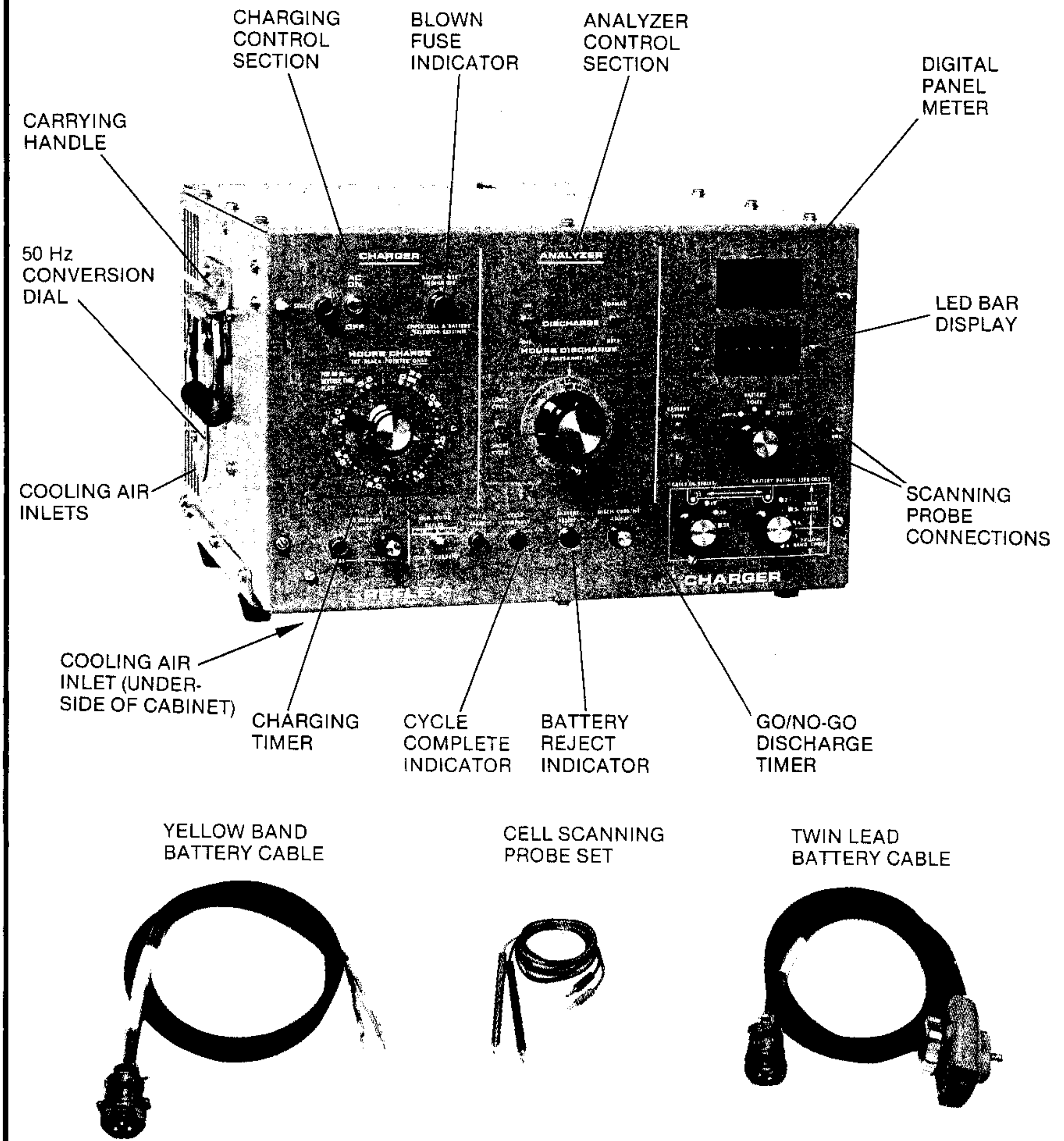


Figure 1-2. Location of External Components

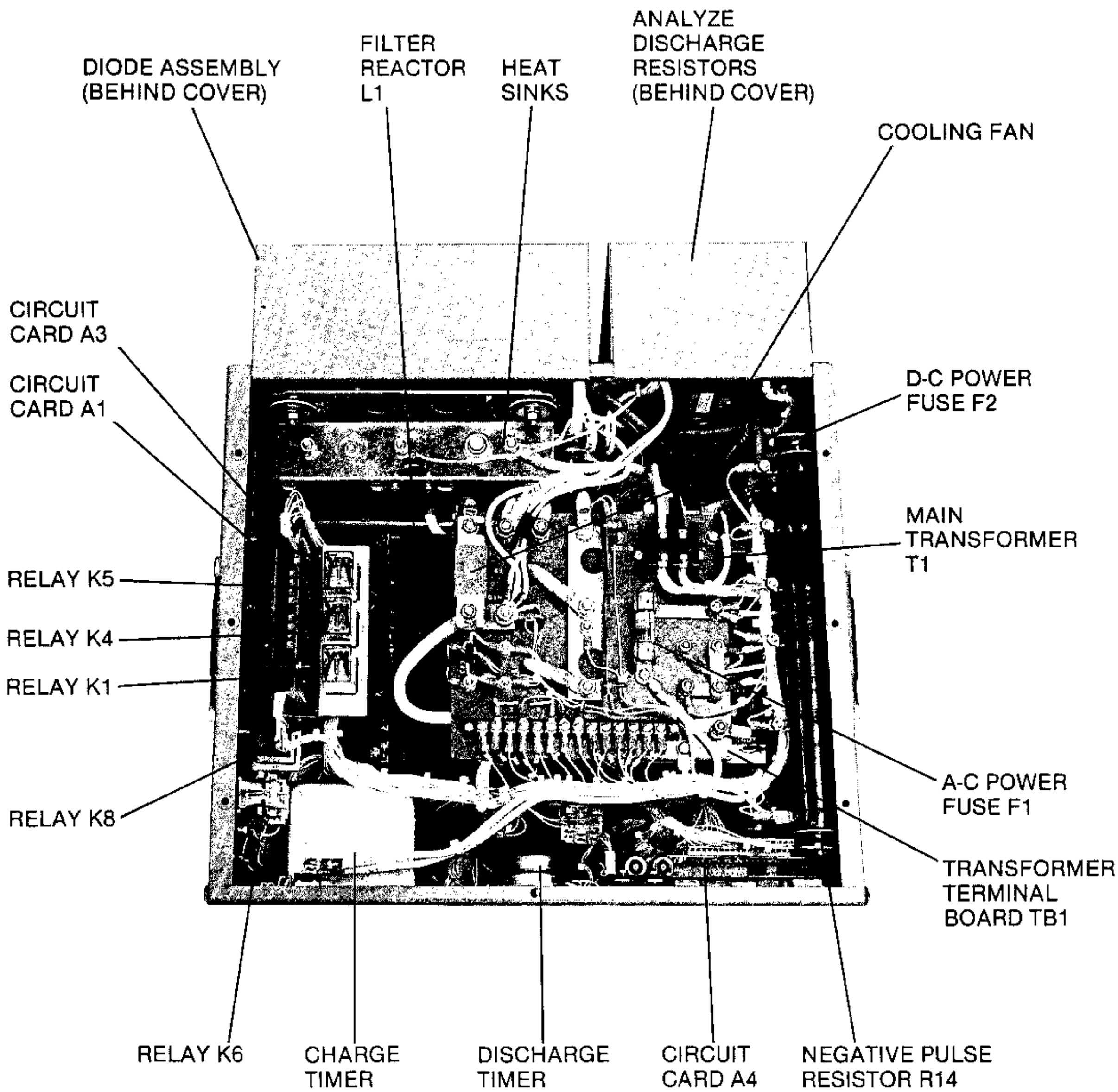


Figure 1-3. Location of Major Internal Components

1-18. THE NI-CAD BATTERY.

1-19. The ni-cad battery is particularly well suited for many uses as it provides high power in a small package. Other advantages of the ni-cad are: a constant voltage during 90 percent of its discharge; it performs well at low temperature; it can be relatively quickly charged; and it can usually be recharged well over a thousand times.

1-20. The electrolyte in the ni-cad battery is a solution of potassium hydroxide (KOH) and distilled water, a chemical opposite, in many ways, to the dilute sulphuric acid of the familiar lead-acid battery. For example, ni-cad batteries should never be touched by or exposed to battery acid; a possibility that might come about through the use of hydrometers, syringes, or thermometers contaminated by lead-acid batteries. Furthermore, the electrolyte in the ni-cad does not chemically react with the plates as does the sulphuric acid of the lead battery. Consequently, the ni-cad plates do not deteriorate nor does the specific gravity of the electrolyte change.

1-21. Ni-cad batteries also have certain disadvantages. The so-called "memory effect", for example, is a ni-cad defect through which a battery might lose a small portion of its capacity each time it is charged or even when it is "idling" in a charged condition. This hidden fading effect can cause the battery user to believe that the battery is charged to full capacity when, in fact, it will be unable to produce the required current

1-22. The fact that the electrolyte does not chemically react with the plates contributes to longer life of ni-cads. However, it constitutes a minor disadvantage as far as measuring the state-of-charge. Since the specific gravity of a ni-cad does not change during charge or discharge, it is not possible to determine that state-of-charge of a ni-cad battery by checking the electrolyte with a hydrometer. Neither is a voltage test too effective, since in ni-cads the voltage remains constant during 90 percent of the discharge cycle.

1-23. THE REFLEX CHARGING PRINCIPLE.

1-24. THE BURP. The ReFLEX charging principle should not be confused with conventional pulse chargers and is even further removed from constant potential and constant current (current limited) chargers. The "burp" in ReFLEX is what makes it all possible. It is what gives ReFLEX charging its name. The ReFLEX principle consists of an alternating series of high-power charge thrusts, each instantly followed by a unique, low-power discharge, or negative "burp". The duration of each discharge pulse automatically increases during the charging cycle, as it always lasts until sufficient battery depolarization has taken place before another large charge thrust is initiated. ReFLEX charging is not unlike a baby being alternately fed and burped at ultra-high speed. It is this burping effect that "cures" polarization voltage losses generated by all other charging methods. This process should not be confused with "pulse" charging which is an on-time off-time pattern during the charge period. As shown in Figure 1-4, the ReFLEX principle minimizes the memory effect. It also drastically reduces the charging time without causing undesirable battery heating (which occurs if the time is shortened with conventional

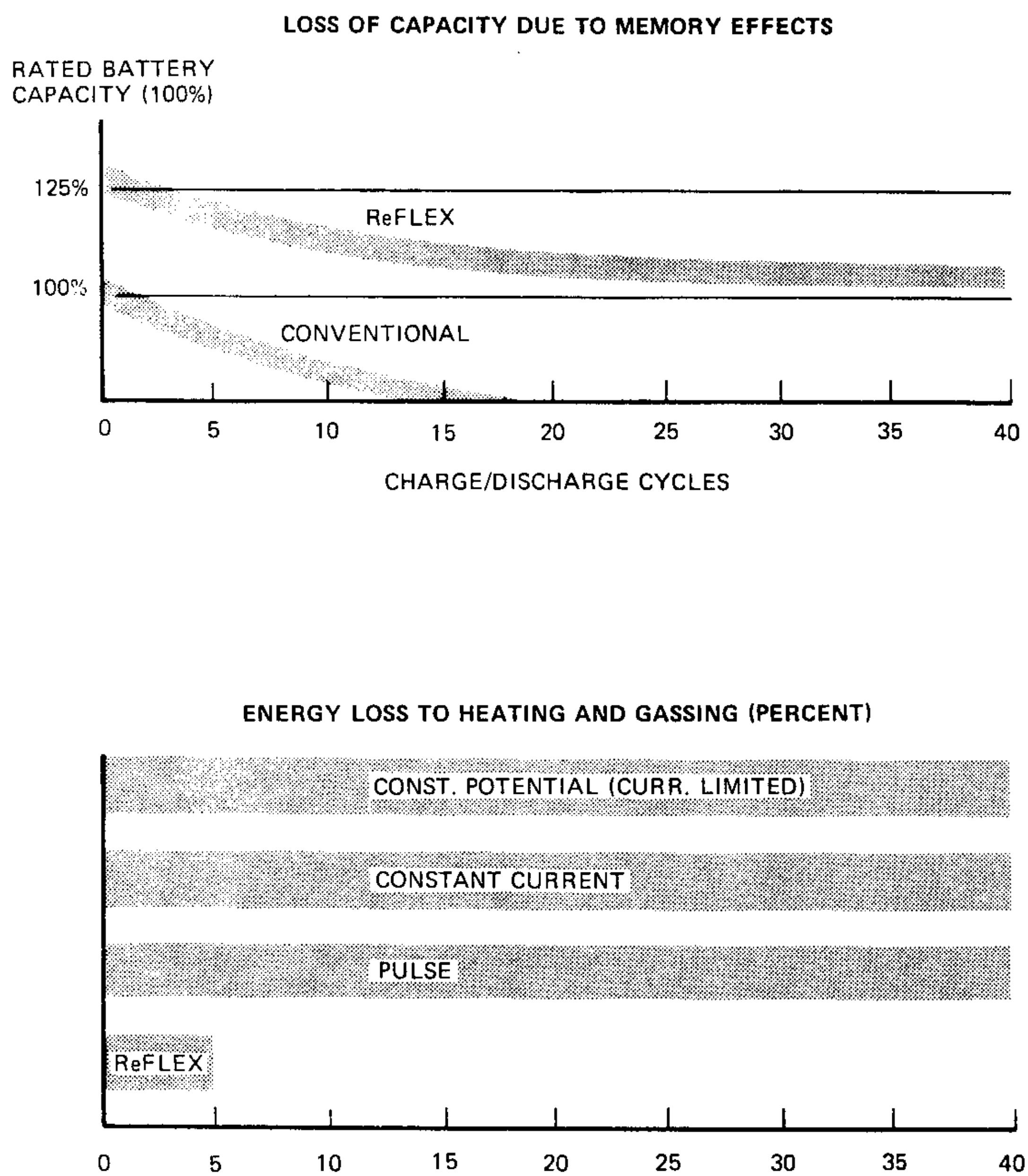


Figure 1-4. The Advantages of ReFLEX Charging

methods), because ReFLEX has a 85 to 95 percent charging efficiency compared to 70 percent for conventional chargers. Energy loss due to heating and gassing is greatly reduced.

1-25. This ReFLEX action (big charge/little burp) depolarizes the battery plates. and suppresses the electrolysis reaction to allow safe, high-speed charging up to 130 percent or more of capacity with minimum heating or gassing. Analysis has revealed that a 1 hour charge is the ideal rate for most vented aircraft type ni-cad batteries.

1-26. REFLEX IN ACTION. The ReFLEX principle is more sophisticated than a simple burp. The ReFLEX charge-thrusts are set to twice the ampere-hour battery capacity in amperes (2C) for high rate batteries. After each charge-thrust, a low-power, discharge-thrust is automatically applied until an accurate interrogator shows that depolarization has taken place. At that point, another charge-thrust occurs and the cycle is repeated. As the battery nears full capacity, the negative thrusts become longer, eventually reaching a point where the net charge (charge minus discharge becomes small.

1-27. An extra benefit of ReFLEXing is the approximate battery state-of-charge indication provided by the motion of the LED Bar Display. As the discharge thrusts become sufficiently long and the battery nears a full state-of-charge, the green pulses will extend further toward the right. At full charge, the green pulses may extend completely to the right. This provides a very helpful indication of battery state-of-charge. The ReFLEX operator can use this information to reduce the battery charging time even more.

1-28. HOW THE CHARGER ANALYZER WORKS.

1-29. The charger/analyzer functionally consists of control circuits, charging circuits, and discharging circuits. Actually, some of the circuits are used for both charging and discharging. However, to simplify the functional description, they will be described separately.

1-30 THE CHARGING CIRCUITS. Figure 1-5 is a block diagram of the basic ReFLEX charging circuits and Figure 1-6 illustrates how the circuits work during the positive and negative current pulses of the ReFLEX cycle. The basic a-c power is applied through the AC and START switches to an isolation/stepdown transformer. The basic output of this transformer is applied to Silicon Controlled Rectifiers (SCR's). Other transformer outputs are used by the control and other circuits. The SCR's provide amplification and rectification The d-c output from the SCR's is further filtered by a reactor and capacitor to reduce ripple. The output of the filter stage is passed through a current-sensing shunt to the battery being charged. A voltage sensing circuit is connected across the output. A multi-tapped resistor is also connected across the output. This is the negative pulse "burping" element used to discharge (depolarize) the battery during ReFLEX charging.

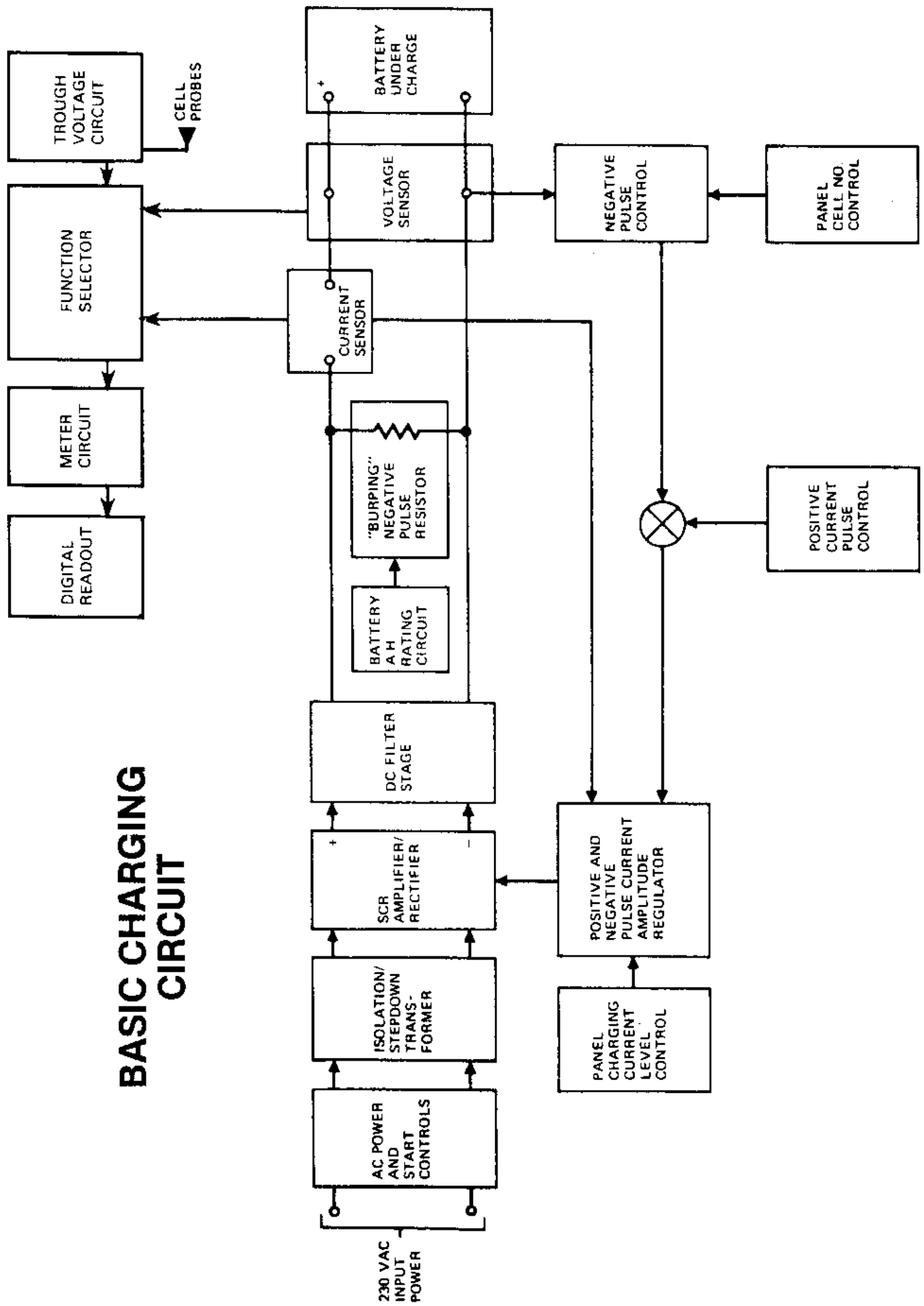


Figure 1-5. Charging Circuit Functional Block Diagram

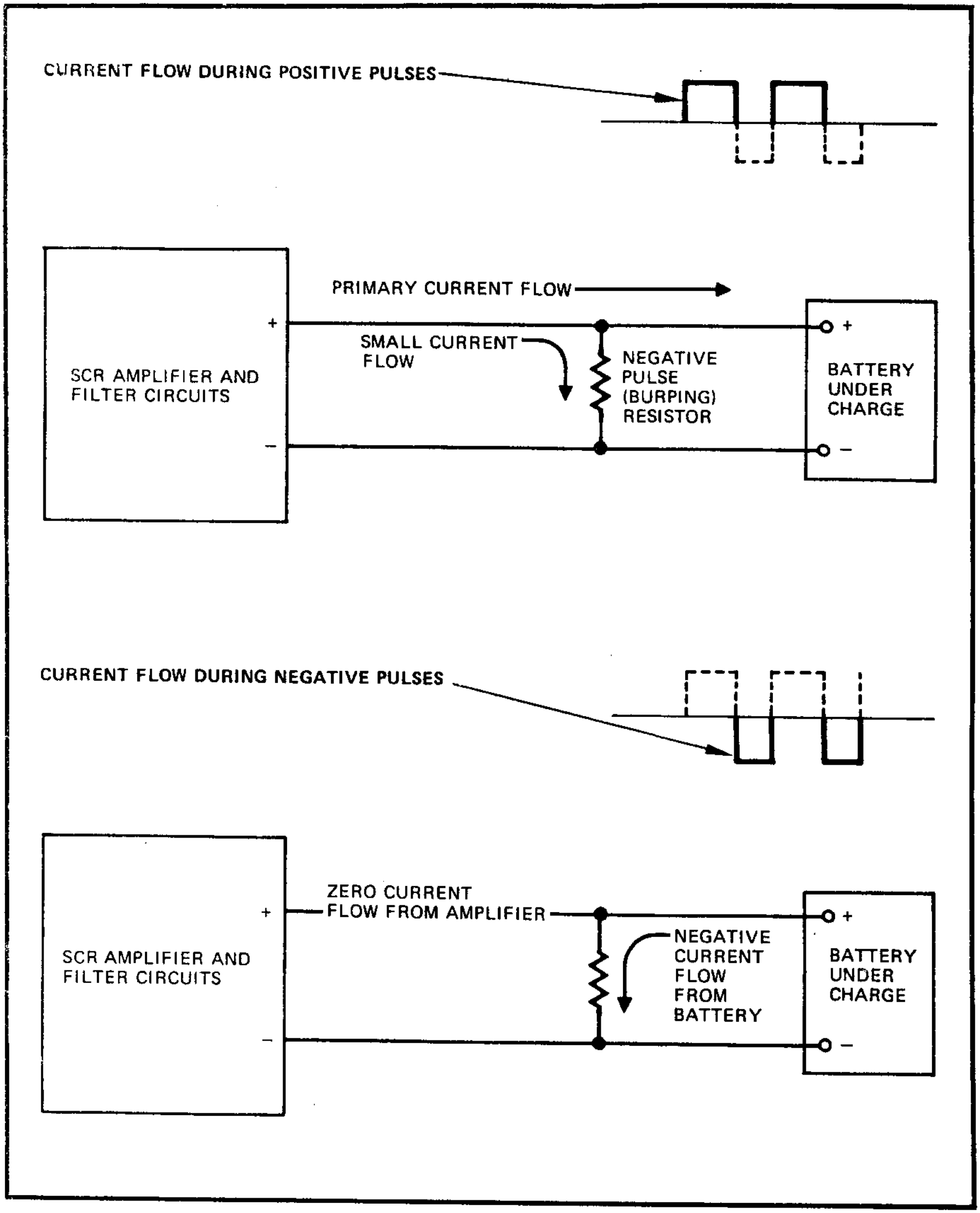


Figure 1-6. Circuit Function During ReFLEX Charging

1-31. Both the positive and negative charging pulses are controlled during operation. Basic control is provided by a current amplitude regulator circuit that senses output current to control the SCR amplifier. The amplitude of the positive pulse is set by the CHG CURRENT ADJUST control to match the requirements of the battery being charged. The duration and frequency of the positive pulse are controlled by a positive current pulse control circuit. The duration of the negative pulse is controlled by a negative pulse control circuit that senses the battery voltage during the negative pulse to provide a negative pulse duration command.

1-32. As shown in Figure 1-6, during the positive pulse portion of the charging cycle, current at the regulated level is applied to the battery and a small amount of current is also passed through the "burping" resistor. During the negative pulse portion of the charging cycle, however, the output of the SCR amplifier is shut off for the duration of the negative pulse and depolarizing current from the battery flows back through the "burping" resistor to discharge the battery. The discharge energy during the "burp" is determined by the duration of the negative pulse and the resistance of the "burping" resistor which takes into consideration the ampere-hour rating of the battery. As the battery becomes more fully charged, the duration of the negative pulse and the frequency, level, and duration of the positive pulse are automatically controlled to provide optimum ReFLEX charging. When the charging cycle reaches the time set into the HOURS CHARGE timer, the unit automatically switches to the analysis or discharge mode.

1-33. THE ANALYSIS AND DISCHARGE CIRCUITS. Operation of the analysis and discharge circuits is based upon a constant current discharge of the battery from full charge to complete discharge to evaluate the ampere-hour capacity of the battery. Figure 1-7 illustrates the discharge circuit. The constant discharge current is set by the DISCH CURRENT ADJUST control. Actual discharge of the battery is through a large, multi-section power resistor with the rate of discharge controlled by the SCR amplifier. As shown in Figure 1-7, the current through the discharge resistor (R) is made up of the filtered SCR amplifier d-c output (I_A) and the battery discharge current (I_B). This total current multiplied by the resistance (R) must at all times equal the battery voltage. Therefore, the selected battery discharge current (I_B), as sensed at the current shunt, can be held constant by automatically varying the SCR amplifier output (I_A) as the battery voltage (E) changes during discharge. Since $(I_A + I_B)R = E$, the battery discharge current is $I_B = E/R - I_A$. For example, if battery voltage (E) equals 22 volts and R equals 1 ohm, for the battery discharge current (I_B) to be 10 amperes the SCR amplifier output (I_A) must be 12 amperes. When, for example the battery discharges to a voltage of 19 volts, the SCR amplifier output must become 9 amperes to maintain the 10 ampere discharge rate of the battery.

1-34. In LONG CYCLE, analysis of the battery ampere-hour capacity is accomplished by discharging a fully charged battery at a constant rate until the battery voltage reaches a value equal to 0.95 volt average per cell. At this voltage the battery is considered to be discharged. The position of the CELLS IN SERIES switch assists in establishing this discharge voltage value.

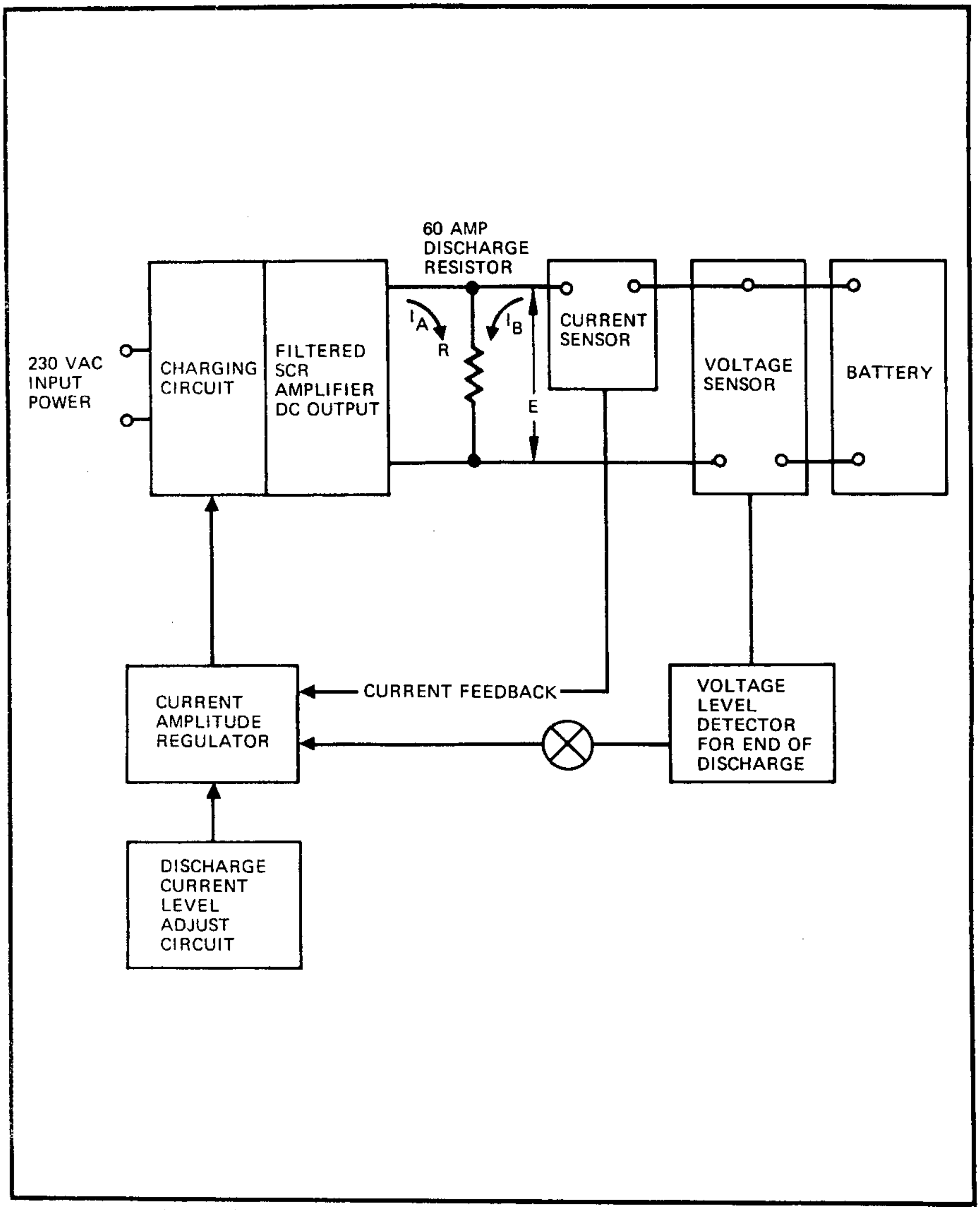


Figure 1-7. Analysis/Discharge Functional Block Diagram

1-35. When the battery reaches this discharge point, the analyzer circuits decide to either accept or reject the battery based on ampere-hour capacity. If "GO" capacity has not been attained (the HOURS DISCHARGE pointer is to the left of the white panel arrow), the battery will be rejected. In this case, the red BATTERY REJECT indicator will light and the battery will continue to discharge at approximately the 10 hour rate (C/10) for a time equal to the setting of the HOURS CHARGE timer black pointer. If the "GO" capacity has been attained (SHORT CYCLE) or exceeded (LONG CYCLE), the HOURS DISCHARGE pointer has moved past the white panel arrow and the control circuitry automatically switches the charger/analyzer to the final recharge mode.

1-36. FINAL RECHARGE MODE. This mode uses the same circuits as the initial charge cycle. The only difference is that the control circuitry automatically resets the HOURS CHARGE timer to the programmed period and when the battery has been charged for this period at the programmed charge rate, the green CYCLE COMPLETE indicator lights and the charger/analyzer automatically shuts off.

1-37. DigiFLEX

(a) The RF80H ReFLEX Charger/Analyzer contains DigiFLEX, a revolutionary new concept in aircraft ni-cad battery servicing. Detailed explanations of DigiFLEX and ReFLEX are provided in two publications located inside the back cover (See "DigiFLEX Battery Analysis" and "THE ReFLEX Charger/Analyzer with DigiFLEX Pre-Analyzer"). Read them after finishing this section.

(b) DigiFLEX may be a difficult concept to understand, but has proven to be beneficial in the battery shop whether or not you understand the theory.

(c) DigiFLEX provides not only a visual digital display of battery state of charge, but might also pinpoint low capacity cells and/or questionable batteries...all during the ½ to 1 hour ReFLEX charge. At times, the operator may therefore choose to dispense with the capacity discharge test (and subsequent recharge) altogether.

(d) Besides obtaining digital readouts, the DigiFLEX user may:

- continue with the RF80H charge-discharge-recharge routine to analyze the battery and cells, but double check the relative battery and cell capacity during ReFLEX charge with DigiFLEX; or

- dispense with the discharge altogether, using the relative battery and cell capacity indications during ReFLEX charge - thereby cutting the entire charge and analysis time to a total of ½ to 1 hour for most batteries.

(e) DigiFLEX provides the operator with the opportunity to service ni-cads even better and faster than with ReFLEX alone. To date, DigiFLEX is an optional procedure which has not yet been fully documented. However, since its introduction, battery shop operators around the world who have RF80H units have commented approvingly on the benefits of DigiFLEX.

SECTION 2

INSTALLATION

2-1. UNPACKING AND INSPECTION.

2-2. The charger/analyzer has been thoroughly inspected and tested prior to shipment, and packed in a sturdy container that is designed to protect the unit from damage during all normal conditions of shipment. After opening the shipping container, carefully examine the exterior of the unit for damage, paying special attention to damage indications such as dents in the cabinet, broken meter coverings, and looseness or damage of panel controls. In the event of damage, notify the transportation company at once for inspection and proper handling of claims. Check the items listed on the packing slip to make sure that the battery cables, electrical probes, and all other items normally supplied are present.

2-3. INSTALLATION.

2-4. The charger/analyzer, like all high quality equipment, must be properly installed if it is to provide the many years of trouble-free operation for which it was designed. The following paragraphs provide important installation instructions which should be carefully followed to ensure proper operation of the unit.

2-5. PLACEMENT. Proper placement is essential for proper operation as well as for ease of use. Cooling is an important consideration. For proper cooling, the charger is designed with two air intakes; one on the left side and one on the bottom (underside) of the cabinet. A blower at the rear of the cabinet draws air through the interior of the cabinet, and exhausts heated air out the rear of the cabinet. To ensure proper cooling, make sure that the conditions illustrated and outlined in Figure 2-1 are carefully observed during installation.

CAUTION

NEVER OPERATE THE CHARGER/ANALYZER WITH THE CABINET COVER OPEN OR REMOVED IN AN ATTEMPT TO IMPROVE COOLING. THE CHARGER IS DESIGNED FOR PROPER COOLING ONLY WITH THE CABINET COVER INSTALLED. REMOVAL OF THE COVER DURING USE WILL RESULT IN OVERHEATING AND POSSIBLE DAMAGE TO THE CHARGER.

2-6. POWER CONNECTION. The charger/analyzer is designed to use either 208 or 230V a-c ± 10%, single phase, 50 or 60 Hz power (see 2-10 for 115V a-c operation). The input power cord is provided without a connector so that the user can either provide a connector compatible with his facility outlet or wire directly into a circuit breaker. Conversion for 50 or 60 Hz operation, which requires no electrical changes, is covered in paragraph 2-7. Figure 2-2 illustrates electrical connection criteria. When connecting the charger make sure that the following steps are carefully observed:

WARNING

ALWAYS DISCONNECT THE POWER CONNECTOR OR SHUT OFF THE CIRCUIT BREAKER AHEAD OF THE CHARGER (FOR WIRED-IN TYPE CONNECTION) BEFORE OPENING THE CHARGER CABINET TOP. EXPOSED VOLTAGES DANGEROUS TO HUMAN LIFE ARE PRESENT IN THE CHARGER CIRCUITRY WHENEVER POWER IS APPLIED TO POWER CORD REGARDLESS OF CHARGER ANALYZER AC POWER POSITION.

a. Check that the current capacity of the voltage source to be used corresponds to the current rating on the nameplate marking (23 amperes nominal) and is equipped with a suitable circuit breaker. Refer to Figure 2-2 for connection instructions.

b. Measure the voltage of the voltage source to be used, at the outlet or circuit breaker, as applicable. The unit normally is set up at the factory for 230V a-c operation. If the source voltage is always between 215 and 250V a-c no internal wiring connection changes are required. If source voltage is always between 190 and 215V a-c, conversion is required. Refer to Figure 2-2 for conversion instructions. (If unit had been operated at 115V a-c, reconnect W172 to TB1-72.)

c. See 2-10 for 115V a-c operation.

WARNING

THE CHARGER CABINET MUST ALWAYS BE GROUNDED TO A SOLID, EXTERNAL GROUND TO ENSURE MAXIMUM OPERATOR SAFETY. USE 10 AWG WIRE.

2-7. CONVERSION FOR 50 OR 60 HZ POWER. The only conversion required for 50 Hz operation is in the HOURS CHARGE and HOURS DISCHARGE timer dials on the front panel. No electrical changes are required. The charger/analyzer is set at the factory for 60 Hz operation unless specifically ordered for 50 Hz. Figure 2-3 illustrates how to make the conversion.

2-8. PREPARATION FOR RESHIPMENT OR STORAGE.

2-9. Use standard procedures for preparing the charger/analyzer for reshipment or storage to ensure adequate protection of the unit. No special procedures are required.

2-10. OPERATION WITH 115V AC, 3 KW, POWER SOURCE
For charging 19 cell batteries with a 40 ampere maximum charging rate and 25 ampere minimum discharge rate.

a. On TB1 place one link between terminals TB1-15 and TB1-16, and the second link between TB1-17 and TB1-18. Tighten link nuts. Place W172 on terminal TB1-71.

b. Use the yellow band battery cable (step 4 of Table 3-3) and Battery Ratings #5 or 6 only (step 2 of Table 3-3). Otherwise follow the procedures of Figure 3-1.

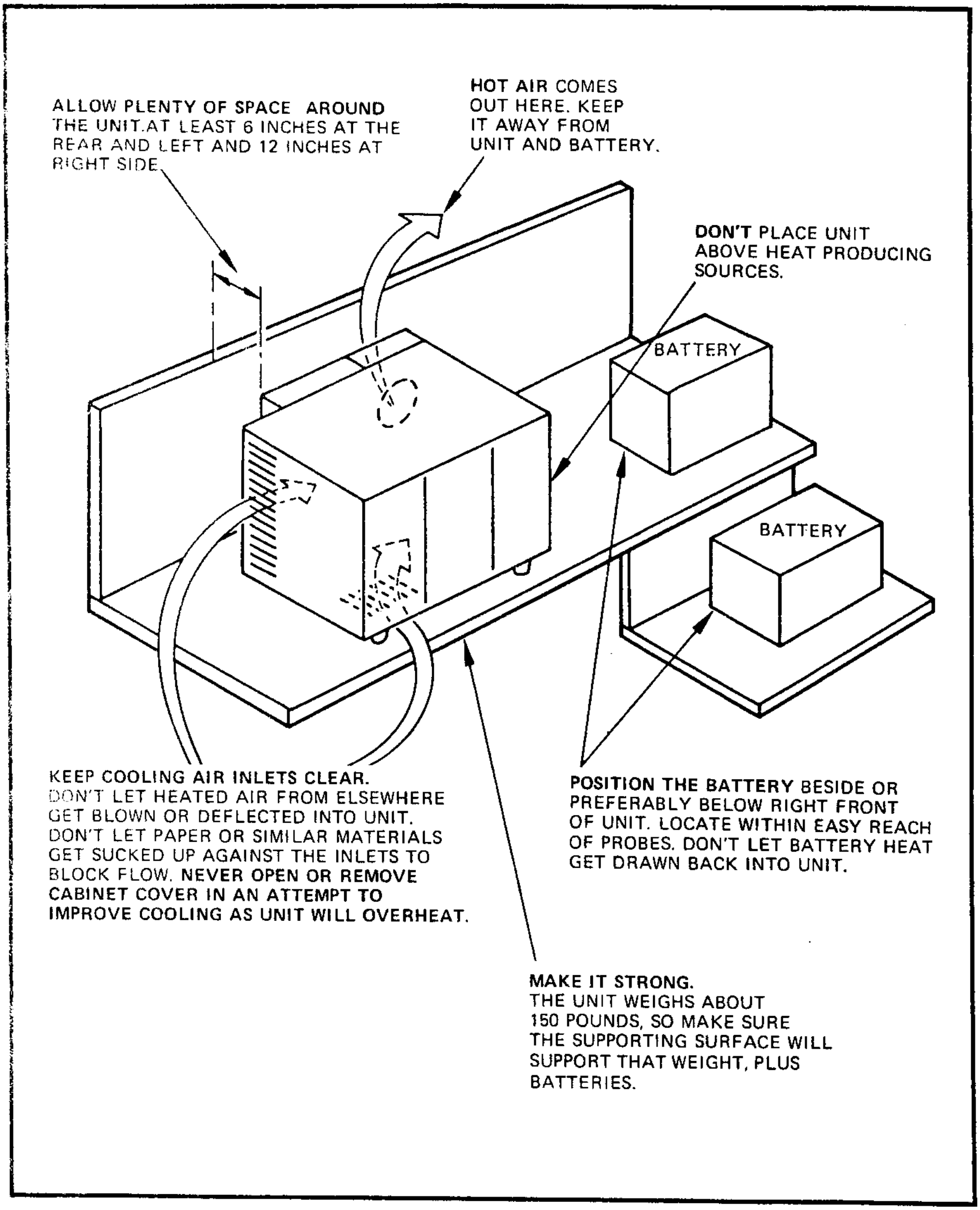
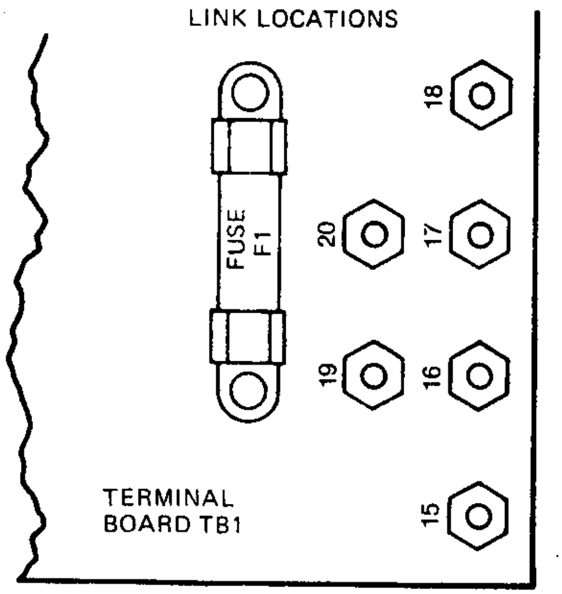


Figure 2-1. Placement Instructions



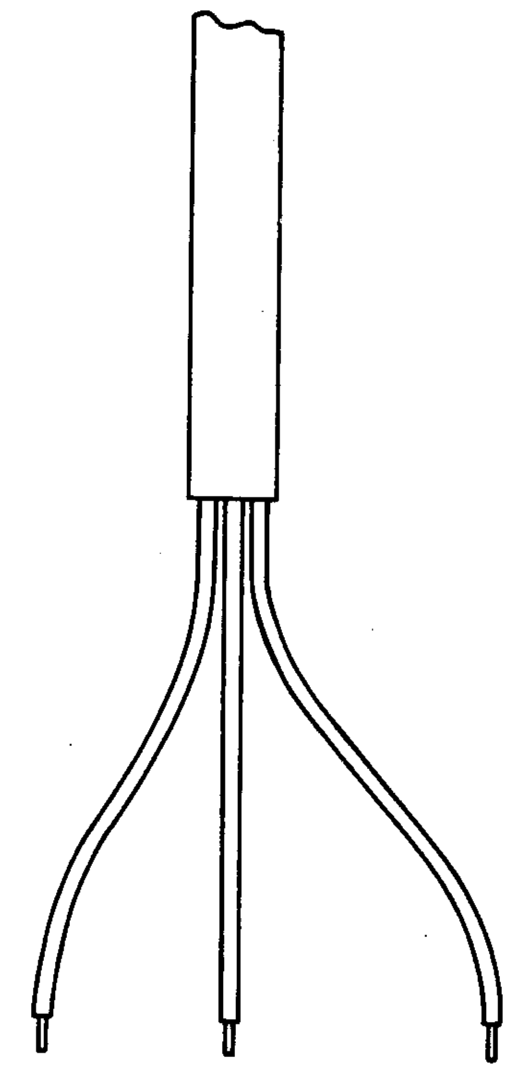
(TB1 IS LOCATED UNDER TOP COVER)

A. Of the three links joining studs on TB-1, the single link joining 16-19 is permanent. **DO NOT REMOVE.**

B. The other two links are moveable. Their locations permit three possible input voltages:

1. If the AC input voltage is always between 215 and 250 volts, place and tighten both links between 16 — 17.
2. If the AC input voltage is always between 190 and 215 volts, place and tighten both links between 19 —20.
3. 115 volt operation. (See paragraph 2 — 10).

POWER CABLE CONNECTIONS

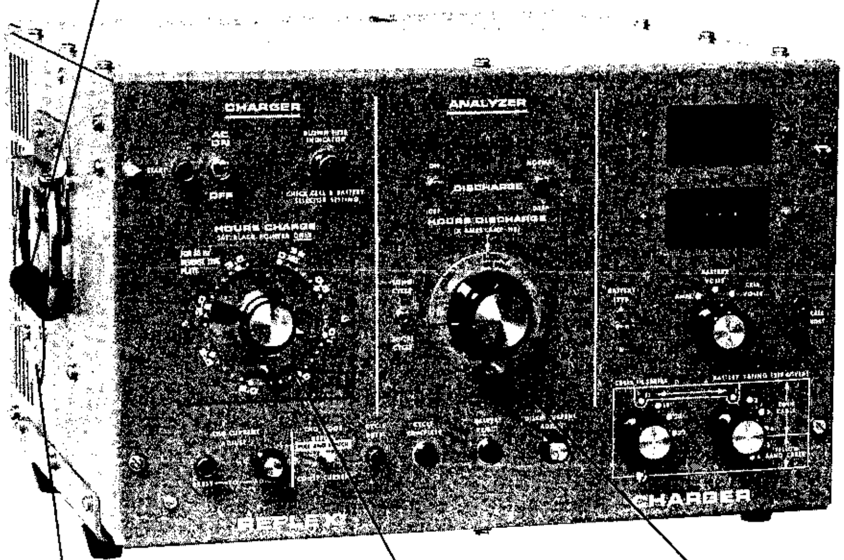


AC POWER CABLE 3-CONDUCTOR 12 GAUGE

Figure 2-2. Electrical Connection

STEP 1

REMOVE 50Hz DIAL FROM MOUNTING



STEP 2

LOOSEN SETSCREW RETAINING POINTER AND REMOVE POINTER. LOOSEN DIAL LOCKING KNOB. REMOVE DIAL RETAINING NUT AND SPACER. SLIDE FINGER-NAIL OR SCREWDRIVER BEHIND DIAL TO REMOVE. INSTALL 50Hz DIAL, FROM STEP 1, USING RE-TAINING NUT AND SPACER, WARNING: CHECK THAT TIMER INDEX KNOB IS IN THE PANEL INDEX HOLE BEFORE TIGHTENING NUT. REINSTALL POINTER AND TIGHTEN POINTER SETSCREW.

STEP 3

REMOVE TWO SCREWS RETAINING 60Hz PLATE. TURN PLATE OVER AND REINSTALL WITH 50Hz SIDE FACING OUTWARD.

STEP 4

REINSTALL 60Hz DISCHARGE TIMER DIAL, REMOVED IN STEP 2, FOR FUTURE USE

NOTE:

THE CHARGER/ANALYZER IS NORMALLY SET FOR 60Hz OPERATION AT THE FACTORY UNLESS SPECIFICALLY ORDERED FOR 50 Hz. CHECK INSTALLED DIALS BEFORE MAKING CONVERSION.

Figure 2-3. Conversion for 50 Hz Operation

SECTION 3

OPERATION

3-1. GENERAL.

3-2. The charger/analyzer allows simple, yet sophisticated, automatic rapid charging and analysis of ni-cad batteries. In addition to standard charging and analysis, many additional optional procedures, as recommended by some ni-cad manufacturers, can also be performed. Within this section are instructions for battery inspection prior to charging, standard charging and analysis procedures, and instructions for the various optional procedures.

3-3. BATTERY INSPECTION.

3-4. Carefully inspect the battery visually and electrically before starting to charge it. Always closely follow the battery manufacturer's recommended procedures for both inspection and any necessary corrections.

3-5. VISUAL INSPECTION. Examine the battery case and cover for damage and make sure that all hardware is present and secure. Remove the cover and inspect the cells for damage, deterioration, missing or broken vent caps, and similar problems. Verify that the cells are properly interconnected with positive (+) terminals connected to negative (-) terminals and interconnecting links properly installed and tightened. Check insulation, the electrical receptacle, and its connections for damage. Verify that the cells are all of the same type and manufacturer.

3-6. ELECTRICAL INSPECTION. Inspect the battery for cell-to-case current leakage. A simple method for this electrical leakage check is as follows:

a. Use an inexpensive 500 milliampere meter and a fuse for the leakage checks.

b. Carefully touch each positive and negative terminal only momentarily to avoid damage to the test meter in the event of excessive leakage. Measure current leakage between the battery case and the positive terminal, and the battery case and the negative terminal of each cell in the battery.

c. The individual cell-to-case leakage should be less than 1 milliampere per ampere-hour of battery rating. For example, the maximum single cell leakage current should be 34 milliamperes for a 34 ampere-hour battery.

3-7. STANDARD SETUP AND OPERATION.

3-8. Before starting operation, make sure that the charger/analyzer has been properly installed as described in Section 2, and that adequate cooling has been provided for both the charger/analyzer and the battery. Become fully familiar with the use of the operating controls which, for convenience, are illustrated and completely described by Figure 3-2.

WARNING

NEVER OPEN OR REMOVE THE CABINET TOP WITH POWER APPLIED TO THE POWER CORD. HIGH VOLTAGES DANGEROUS TO LIFE ARE PRESENT IN EXPOSED CIRCUITS EVEN WITH THE CHARGER/ANALYZER AC SWITCH IN OFF POSITION. ALSO, DAMAGE TO THE CHARGER/ANALYZER FROM OVERHEATING CAN RESULT FROM OPERATION WITH THE COVER OPEN OR REMOVED, AS A CLOSED CABINET IS ESSENTIAL FOR PROPER COOLING AIR FLOW THROUGH THE UNIT.

3-9. PRELIMINARY SETUP. Perform the following preliminary setup procedures:

a. Set the AC switch to OFF.

b. Verify that facility power has been turned on.

c. Plug the leads of the red (+) and black (-) probes into the corresponding red and black terminals next to the panel voltmeter.

d. Check that the sharp, pointed end of each probe tip extends from the probe. If the tip is blunt, loosen the tip retaining nut, withdraw the tip, and reinstall with the pointed end out. Tighten the retaining nut securely to ensure good electrical contact.

e. Position the battery for charging and check that cables for connection to the battery are available for use.

NOTE

IT IS BEST TO ESTABLISH A STANDARD LOCATION FOR THE BATTERY TO BE CHARGED. THIS LOCATION SHOULD BE CONVENIENT TO THE BATTERY INTERCONNECTING CABLE, PANEL-CONNECTED CELL VOLTAGE PROBES, AND TO FACILITIES FOR COOLING THE BATTERY, IF DESIRED.

f. Remove the battery cover.

WARNING

THE CHARGER MUST BE OFF WHILE IT IS BEING CONNECTED TO THE BATTERY.

g. To monitor electrolyte temperature, insert a clean alcohol-type thermometer into a cell physically located in the center of the battery.

WARNING

THE CHARGER MUST BE OFF WHILE IT IS BEING DISCONNECTED FROM THE BATTERY.

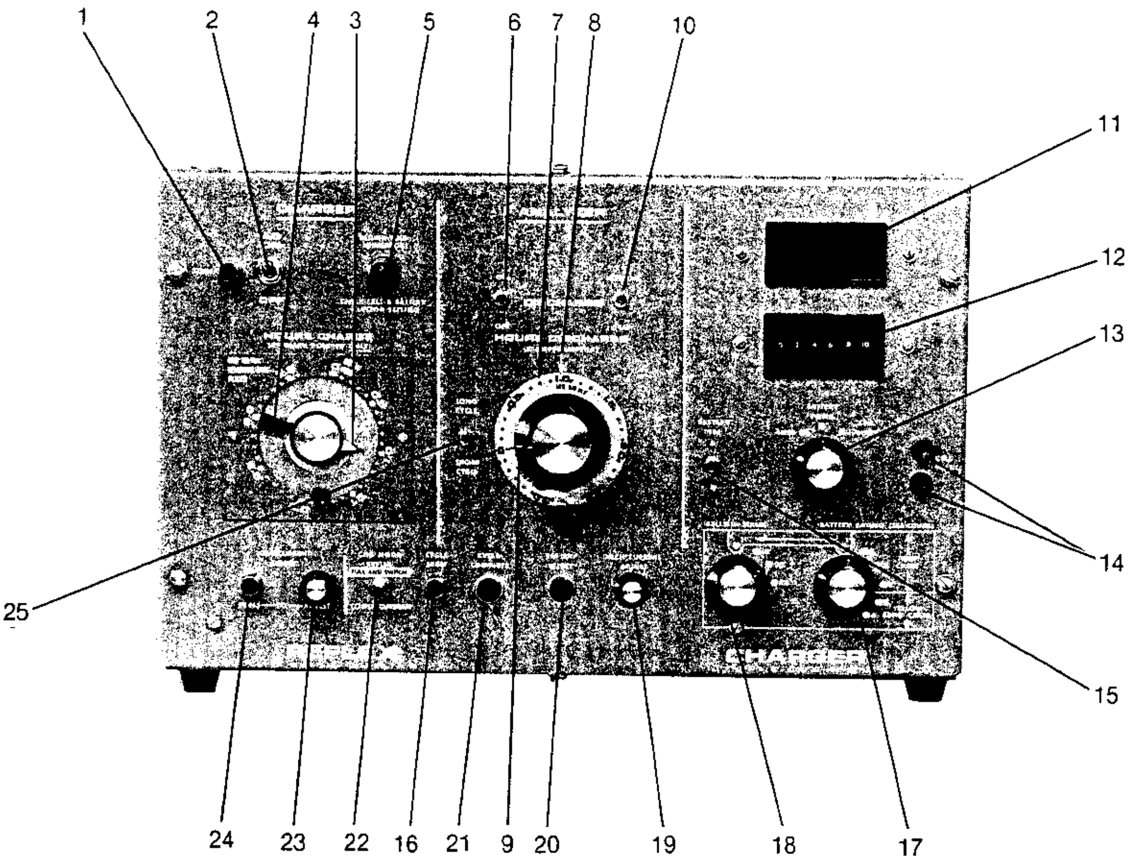


Figure 3-2. Controls and Indicators (Sheet 1 of 6)

Figure 3-2 Index No.	Nomenclature	Function
1	START Switch (momentary)	When momentarily operated, supplies power to control circuits and starts operation of unit. The BLOWN FUSE INDICATOR (5) will light as this switch is held down. This verifies that power is present to the unit and that the blown fuse indicator light is good. The switch may be operated at any time during operation to check the fuse.
2	AC Switch	Applies primary power to all circuits in the ON position. The OFF position removes power from the unit; however, certain internal circuits will still be at line voltage. Therefore, always remove power from the power cord before opening the cabinet.
3	HRS CHARGE White Pointer (center knob)	Indicates remaining charging time. The white pointer automatically moves counterclockwise from the black pointer position to zero, with the time indicated in 0.1 hour increments by the dial plate on the panel. This pointer automatically resets to the black pointer position when commanded in the automatic cycle and also whenever the CYCLE RESET switch (16) is operated. Rotation counterclockwise to the 0 position automatically places the unit in the discharge mode if the ANALYZER switch (6) is set to ON and the CHG MODE switch (22) is set to ReFLEX.
4	HRS CHARGE Black Pointer	Sets the total charge time. A range of zero to 3.0 hours (3.6 hours for 50 Hz operation) is provided with increments of 0.1 hour marked on panel dial plate.
5	BLOWN FUSE INDICATOR (Indicator and fuse-holder)	Lights if abnormal conditions cause panel-mounted 5 ampere fuse F4 to open. If lighted, no ReFLEX charging action takes place even though panel meters indicate charging. Also lights when

Figure 3-2. Controls and Indicators (Sheet 2 of 6)

Figure 3-2 Index No.	Nomenclature	Function
		START switch (1) is operated to verify power to unit and that indicator is good. Fuse F4 is replaced by setting AC switch (2) to OFF and unscrewing cover to indicator. The fuse may then be grasped with two fingers and withdrawn. Fuse F4 is installed by aligning the two fuse prongs with the holder holes and pushing into place.
6	ANALYZER Switch	Controls the analyzer (discharge) functions. The OFF position makes the automatic and manual discharge functions inoperative. The ON position enables all analyzer functions.
7	GO/NO-GO Dial	Moveable dial which sets the GO/NO-GO level for the battery under analysis and indicates discharge time in increments of 0.1 hour over a range of zero to 3.0 hours (3.6 hours for 50 Hz operation). The small knob at bottom of dial secures it in place. During use, this dial is set to a time specified by Table 3-3 for the particular battery by aligning the specified dial indication with the GO/NO GO arrow (8).
8	GO/NO-GO Arrow	This arrow is the GO/NO-GO point for battery analysis. If the discharge pointer (9) has passed the GO/NO-GO arrow at the time the battery reaches the discharged state, the automatic cycle continues. If the pointer has not reached the arrow at that time, the BATTERY REJECT indicator (20) lights and the charger/analyzer will not start automatic recharging.
9	HRS DISCHARGE Pointer	Timer pointer indicates elapsed discharge time. During use this pointer must be set to zero on GO/NO-GO dial (7) before unit is turned on. When discharge automatically begins, the pointer travels in a clockwise direction. When the battery reaches battery discharge voltage, the pointer movement stops. The elapsed discharge time multiplied by the discharge current

Figure 3-2. Controls and Indicators (Sheet 3 of 6)

Figure 3-2 Index No.	Nomenclature	Function
		equals the actual ampere-hour capacity of the battery in LONG CYCLE. SHORT CYCLE will indicate rated capacity, or less.
10	DISCHARGE Switch	Selects discharge mode for the battery under analysis. The NORMAL position provides a controlled, constant current discharge rate with programmed cycle. The DEEP position provides discharge until manually stopped.
11	Digital Meter Panel (DPM)	Provides value of parameter selected by Meter Switch (13).
12	Bar Display	The red display shows the magnitude of the charging current. When pulsing, the red display identifies the RF80H as being in the ReFLEX charging mode. The green display shows the approximate state-of-charge of the battery when ReFLEX charging. When not-pulsing, the green display identifies the discharge (analyze) mode. See Table #3-1 for additional details.
13	Meter Switch	Selects parameter to be displayed on DPM (11), e.g.: charge or discharge current (AMPS), battery voltage (BATTERY VOLTS), or cell voltage (CELL VOLTS). The BATTERY VOLT position automatically applies the overall voltage of the battery under test to the meter. The CELL VOLTS position applies the battery cell voltages monitored with the scanning probes connected to panel jacks (14). See 3-37.
14	CELLS VOLTS Jacks	Two panel jacks, one red (+) and one black (-), for connection to the cell voltage measurement probes. The signal monitored here is applied to the meter if the meter switch (13) is in the CELL VOLTS position.
15	BAT TYPE Switch	Selects proper ReFLEX charge for battery type under analysis. Proper setting for each battery type is listed in Table 3-3.

Figure 3-2. Controls and Indicators (Sheet 4 of 6)

Figure 3-2 Index No.	Nomenclature	Function
16	CYCLE RESET Switch	Momentary switch which resets the automatic cycle to the initial charge mode. This switch can be operated at any time to reset the unit to charge mode when CHG MODE switch (22) is in ReFLEX position.
17	BATTERY RATING Switch	Selects internal circuit functions compatible with six different battery ampere-hour capacity categories. The battery cable type (twin or yellow band) used with each position is also shown. This switch is set according to battery type to the position as provided in Table 3-3.
18	CELLS IN SERIES Switch	Selects internal circuit functions compatible with the number of cells (11, 19, 20, or 22) actually in the battery.
19	DISCH CURRENT ADJUST Control	Adjustable multi-turn control which sets the constant discharge current rate as indicated on meter (11).
20	BATTERY REJECT Indicator	Red indicator which lights if the battery under analysis fails to have rated ampere-hour capacity as indicated by HOURS DISCHARGE pointer failing to pass the GO arrow (8).
21	CYCLE COMPLETE Indicator	Green indicator which lights at the end of the full automatic cycle if the battery has at least "GO" capacity.
22	CHG MODE Switch	Selects charging mode of unit. The ReFLEX position provides normal ReFLEX charging and also allows full automatic operation. The CONST CURRENT position provides constant current charging, at greatly reduced rate, for use in certain types of special tests or applications. No automatic cycle is provided in this mode.
23	CHG CURRENT ADJUST Control	Adjustable multi-turn control which sets the charging current rate as indicated on meter (11).

Figure 3-2. Controls and Indicators. (Sheet 5 of 6)

Figure 3-2 Index No.	Nomenclature	Function
24	CHG CURRENT ADJUST Switch	Momentary switch which, when operated, places the unit in the constant current mode. This allows the adjustment of charging current in the ReFLEX mode by CHG CURRENT ADJUST control (23) to be read directly on DPM (11). See Figure 3-1 step 13A.
25	SHORT/LONG Discharge Cycle Selector	LONG CYCLE allows discharge to continue for actual capacity. SHORT CYCLE will stop discharge at 12 o'clock.

Figure 3-2. Control and Indicators (Sheet 6 of 6)

3-10. STANDARD AUTOMATIC OPERATION. The charger/analyzer provides an automatic three-cycle program for battery charging and analysis. During the first cycle the battery is ReFLEX charged for a specified time period, and then automatically switched to the second cycle. The second cycle is a constant-current discharge analysis cycle in which the actual ampere-hour capacity (LONG CYCLE) or the pre-programmed capacity (SHORT CYCLE) of the battery is established. If the battery fails this test, the red BATTERY REJECT indicator will light and the battery will not recharge. If the battery passes the analysis cycle tests, it is automatically switched to the final recharge cycle in which it is again ReFLEX charged to full capacity and the green CYCLE COMPLETE indicator will light. The only operator actions required are cell scanning at the beginning and during the last few minutes of the first cycle charging period, near the end of the second cycle discharge period, and during the last 10 minutes of the recharge cycle.

3-10A DigiFLEX OPERATION. The green bar display, during the last few minutes of CHARGE, gives an indication of relative state-of-charge and state-of-health of the battery connected to the RF80H. Green bars start to appear at about 90% of attainable battery capacity. Ni-cad battery characteristics differ by brand, type, service history, etc.. Thus, one battery may be fully charged when 8 green bars light up, yet another battery may produce 8 bars and not yet be fully charged. To maximize the benefits of DigiFLEX operation, experienced operators do the following:

(a) Connect a battery to the RF80H. Follow the procedure of 3-10 and 3-20. However, just before the beginning of the discharge cycle, observe and record the number of green bars.

(b) Perform the discharge and recharge cycles of 3-10. At the end of the discharge cycle, record the ampere-hour discharge capacity as described on page 3-5, index #9.

(c) The next time that particular battery is brought in for servicing, follow the same ReFLEX charging procedure described in (a). When you observe the same number of green bars as previously observed, that battery will most likely have approximately the same ampere-hour capacity as previously noted.

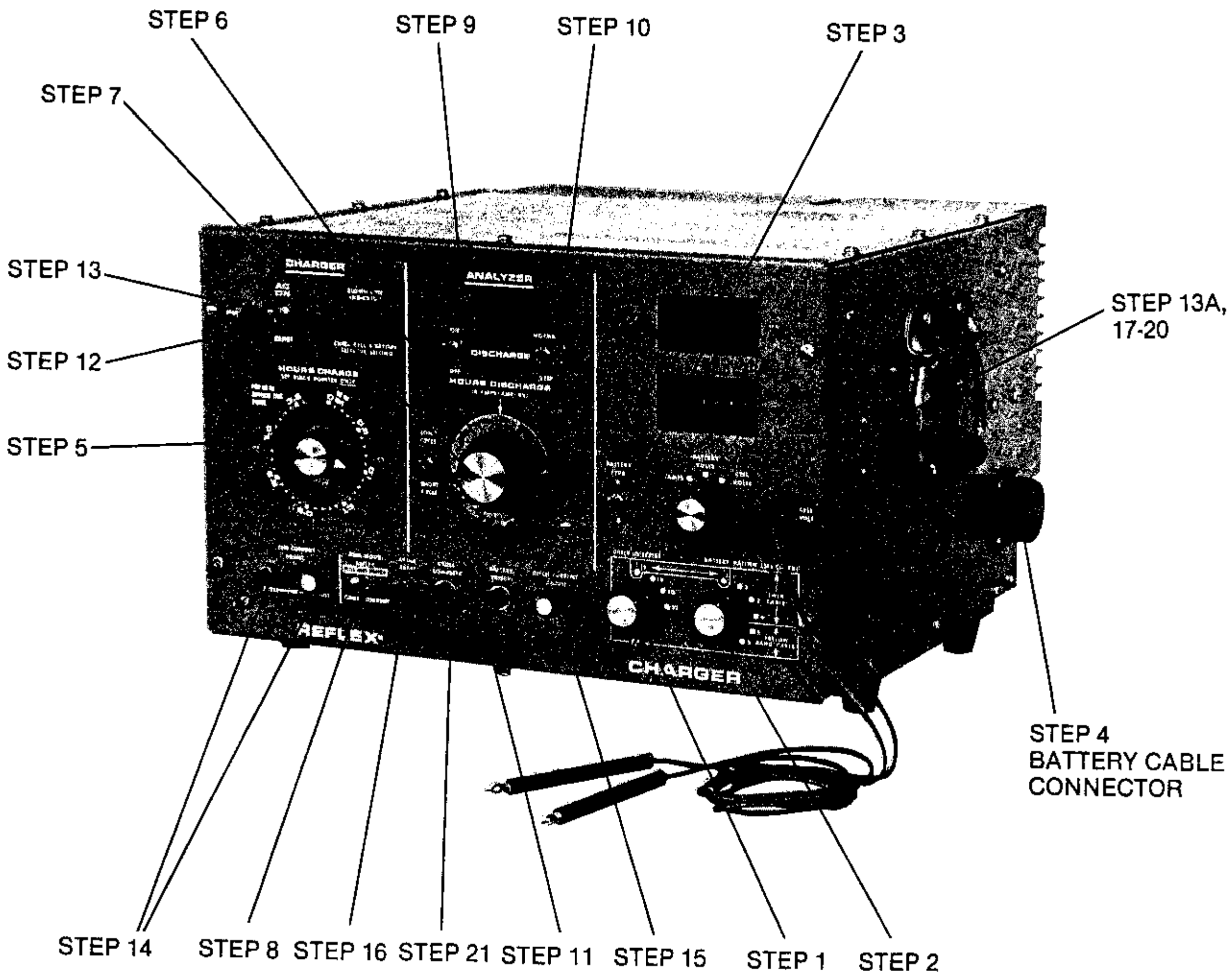


Figure 3-1. Standard Operating Procedure

3-11. A step-by step procedure for charging any ni-cad battery is given and illustrated in Figure 3-1. The specific parameters and control settings for most popular battery makes and types are provided in Table 3-3. Perform the procedure of Figure 3-1 while observing the following:

a. Read and understand the battery manufacturer's battery manual before starting.

b. IT IS GOOD PRACTICE to periodically monitor, as time allows, the battery and charger/analyzer throughout the automatic cycling.

CAUTION

NEVER OPERATE WITH THE CHG MODE SWITCH IN CONST CURRENT (CONSTANT CURRENT) POSITION WHILE USING THE ReFLEX CHARGING CURRENT LEVELS OF TABLE 3-2. SEVERE BATTERY DAMAGE WILL RESULT.

c. If at any time during operation the BLOWN FUSE INDICATOR LIGHTS (except briefly at turn-on) and remains lighted, fuse F4 has blown and ReFLEX charging action is not taking place regardless of seemingly correct charging action and meter indications. Stop operation immediately, correct the problem, and replace fuse F4.

3-12. BATTERY ANALYSIS AND ACCEPTANCE CRITERIA.

3-13. OBSERVATIONS. After you have set up and started the unit, you will observe the red pulses of the Bar Display. You may also observe its green pulses depending upon the battery's state-of-charge.

Red pulses show the magnitude of the charging current.

Green pulses show the approximate state-of-charge of the battery when ReFLEX charging. In addition, green pulses identify whether the RF80H is set to ReFLEX or Constant Current charging. A non-pulsing green display identifies the discharge (analyze) mode.

Table 3-1 describes how to interpret the bar display's red and green pulses.

Table 3-1

STATUS INDICATOR
(STATE-OF-CHARGE AND CYCLE MODE INDICATOR)

Red Indicators		Green Indicators		Battery		Charging		Discharging
Pulse	Steady	Pulse	Steady	Charged	Not Charged	ReFLEX	Constant Current	
x		small			x	x		
x		max.		x		x		
	x						x	
			x					x

Figure 3-1. Operating Procedures (Sheet 1 of 5)

INITIAL SETTINGS BEFORE TURN ON (AC SWITCH TO OFF)			
Step	Control or Function	Normal Setting	Comments
1	CELLS IN SERIES Switch	See Comments at right	COUNT THE ACTUAL NUMBER OF CELLS IN THE BATTERY. DO NOT RELY ON BATTERY PLATE as cells are sometimes added. Then set to position exactly equal to number of cells in battery. DO NOT, for example, operate a 20 cell battery at the 19 cell position.
2	BATTERY RATING Switch	Set per Step 2 Column of Table 3-3	The battery rating should be based on the 1 hour rating. If CELLS IN SERIES switch or BATTERY RATING switch are in wrong position when unit is turned on, fuse F4 in front panel may blow (amber BLOWN FUSE INDICATOR lighted or flashing) and prevent depolarizing reverse pulses from flowing. This results in increased battery heating and reduced battery capacity. Fuse F4 also may blow if unit is turned on with no battery connected.
3	BAT TYPE Switch	Set per Step 3 Column of Table 3-3	CAUTION: ALL CELLS MUST BE OF SAME TYPE AND MANUFACTURER. Refer to paragraph 3-20 for additional information.
4	BATTERY CABLE	Use Cable in Step 4 Column of Table 3-3	Be sure to remove the yellow covers from the Elcon connector when used. Connect and screw proper cable completely onto connector on right side of unit. Then connect to battery, (+) to (+) and (-) to (-). NOTE: A positive interlock system results in no charge output if wrong cable or wrong BATTERY RATING switch position is used.
5	HOURS CHARGE Timer	Set for Step 5 Column of Table 3-3	Set charging time by turning the black pointer on the charge timer. Also see Paragraphs 3-14 and 3-20. Use proper Hz dial.
6	GO/NO-GO HOURS DISCHARGE Dial	Set per Step 6 Column of Table 3-3	To make GO/NO-GO dial setting, loosen the small black locking knob retaining dial position and rotate dial until the required number lines up with the white arrow on panel. Then tighten the locking knob. Other

Figure 3-1. Operating Procedures (Sheet 2 of 5)

INITIAL SETTINGS BEFORE TURN ON (AC SWITCH TO OFF)			
Step	Control or Function	Normal Setting	Comments
			discharge rates between 5 and 50 amps can sometimes be used.
7	HOURS DISCHARGE Pointer	Set to 0 Position	This is at 8 'clock for 1 hour discharge, or 4 o'clock for 2 hour discharge, on 60 Hz dial. During discharge, the discharge pointer will move clockwise toward the white arrow, which is the "GO" capacity point. Use proper Hz dial.
8	CHG MODE Switch	REFLEX Position	Always set CHG MODE switch to REFLEX, except for the optional procedures described in paragraphs 3-25, 3-26, and 3-27. Observe special operating directions.
9	ANALYZER Switch	ON Position	Set to OFF if battery is to be charged only and not analyzed.
10	DISCHARGE Switch	NORMAL Position	See paragraphs 3-15 and 3-24 for use of DEEP discharge setting.
11	LONG CYCLE/ SHORT CYCLE Switch	LONG CYCLE SHORT CYCLE	See paragraph 3-19 (a-1 and a-2) for use of this switch

TURN-ON AND ADJUSTMENTS			
Step	Control or	Normal	Comments
12	AC Switch	ON	Nothing visible will occur.
13	START Switch	Press Momentarily	Fan should start. BLOWN FUSE INDICATOR should light up momentarily while switch is depressed If it does not come on, check the light again by depressing this switch 30 seconds after the charge current has been adjusted. If it still does not come on, replace light before proceeding. If light stays on after releasing switch, replace fuse. If the light stays on or continues to flash, check the BATTERY

Figure 3-1. Operating Procedures (Sheet 3 of 5)

TURN-ON AND ADJUSTMENTS			
Step	Control or Function	Normal Setting	Comments
			RATING and CELLS IN SERIES switch positions and replace fuse. The Status Indicator should show red pulses, unless cable is not connected to battery, wrong cable is used, CHG MODE switch is set to CONST CURRENT position, BATTERY RATING switch is set wrong, or CHG CURRENT ADJUST control is turned completely counterclockwise.
13A	Meter Selector Switch	AMPS	In order to obtain a display of current on the DPM, this switch must be set to AMPS. If ReFLEX charging, the CHG CURRENT ADJUST switch (Step 14) - which puts the RF80H into the constant current charging mode - must also be depressed. Otherwise an error signal indication will be displayed.
14	CHG CURRENT ADJUST Switch	Press	Simultaneously, press the CHG CURRENT ADJUST switch and set the charge current by turning the multi-turn CHG CURRENT ADJUST control.
	CHG CURRENT ADJUST Control	Set per Step 14 Column of Table 3-3	
15	DISCH CURRENT ADJUST Control	Set per Step 15 Column of Table 3-3	Start discharge by moving only the white pointer of the HOURS CHARGE timer gently counterclockwise back through zero. Then set the discharge current by turning the multi-turn DISCH CURRENT ADJUST control. In rare cases, mechanical movement of the white pointer may not result in termination of the charge cycle and initiation of the discharge cycle. The reason relates to the mechanical alignment of Charge Timer components. Should your repetitive gentle counterclockwise movement of the white pointer through zero not result in the discharge mode, then mechanically move the white pointer close to zero and let it move electrically the remaining few moments until the zero contact closure initiates the discharge cycle.

Figure 3-1. Operating Procedures (Sheet 4 of 5)

TURN-ON AND ADJUSTMENTS

Step	Control or Function	Normal Setting	Comments
16	CYCLE RESET Switch	Press Momentarily	Press CYCLE RESET switch to start the now fully-programmed automatic charge-discharge-recharge cycle.

BATTERY ACCEPTANCE OR REJECTION

Step	Control or Function	Normal Setting	Comments
17	Cell Voltage balance check at start of charge (Meter switch)	CELL VOLT Position	IMMEDIATELY AFTER START OF CHARGE: Use scanning probes to check voltage of each cell. Stop charging operation and reject battery if any cell is shorted, measures less than 1.0 volt, or has reversed polarity. Review paragraph 3-17. If any cell voltage is unusually high, check electrolyte level.
18	Cell Capacity balance check during charge	CELL VOLT Position	DURING CHARGE: At least during the last 10 minutes of charge, use scanning probes to check whether one or more cell readings are substantially higher or lower than the others. See paragraph 3-17 in case of abnormal readings.
19	Cell Voltage balance check during discharge (Meter switch)	CELL VOLT Position	DURING DISCHARGE: After 54 minutes of discharge if discharging at the 1 hour rate (or after 1 hour 48 minutes if discharging at the 2 hour rate), use scanning probes to check that each cell voltage is at least 1 volt.
20	Cell Capacity balance check during recharge (Meter switch)	CELL VOLT Position	DURING RECHARGE: At least during last 10 minutes of recharge, use scanning probes to check whether one or more cell readings are substantially higher or lower than the others. See paragraph 3-17 in the case of abnormal readings.
21	Acceptance or Rejection		FOR BATTERY TO BE ACCEPTABLE, THE FOLLOWING FOUR CONDITIONS MUST ALL HOLD TRUE AT END

Figure 3-1. Operating Procedures (Sheet 5 of 5)

BATTERY ACCEPTANCE OR REJECTION			
Step	Control or Function	Normal Setting	Comments
			OF RECHARGE: A. Green CYCLE COMPLETE indicator is lighted. B. There were no abnormal readings in Steps 18 and 20 for which corrections have not been made. C. There were no cells with less than 1 volt in Step 19. D. Electrolyte level satisfies battery manufacturer's requirements.

	BATTERY INFORMATION				CHARGER ANALYZER SETTINGS (See Set-Up Procedure)							
					Step No. 2	Step No. 3	Step No. 4	Step No. 5	Step No. 6		Step No. 14	Step No. 15	
	GE	MARATHON	SAFT	③ 1-hour amp-hr rating "C"	BATTERY RATING NO.	BATTERY TYPE	CABLE	HOURS CHARGE	GO/NO-GO HOURS DISCHARGE STD④	alt	CHG CURRENT (amp)	DISCHARGE CURRENT (amp) STD④	alt
① ANY BATTERY	ALL	② Any With N Cells	② Any With VP Cells	C:5-9	6	A	Yellow	1	1	2	2C	C	C/2
				C:10-19	5	A	Yellow	1	1	2	2C	C	C/2
				C:20-29	4	A	Twin	1	1	2	2C	C	C/2
				C:30-39	3	A	Twin	1	1	2	2C	C	C/2
				C:40-55	2	A	Twin	1¼	1	2	2C**	C***	C/2
		② Any With M Cells	② Any With VO Cells	C:5-19	6	B	Yellow	1¼	2		C	C/2	
				C:20-39	5	B	Yellow	1¾	2		C	C/2	
				C:40-55	4	B	Twin	1¾	2		C	C/2	
COMMON COMMERCIAL BATTERIES	—	CA7(12M220)	1201	12	6	B	Yellow	1¼	2		12	6	
	11RB18	—	1277	12	5	A	Yellow	1	1	2	24	12	6
	—	CA103(10H120)	—	13	5	A	Yellow	1	1	2	26	13	6½
	—	—	1656	15	5	A	Yellow	1	1	2	30	15	7½
	—	SP/CA1700(17H100)	1756	17	5	A	Yellow	1	1	2	34	17	8½
	—	CA21H(20H120)⑤	—	20	4	A	Twin	1	1	2	40	20	10
	20RB10	—	—	21	4	A	Twin	1	1	2	42	21	10½
	—	CA727(24M220)	2371	24	5	B	Yellow	1¾	2		24	12	
	—	CA9(24H120)	2376⑤	24	4	A	Twin	1	1	2	48	24	12
	22RB20	—	—	26	4	A	Twin	1	1	2	52	26	13
	34RB12	—	4076⑤	36	2	A	Twin	1	1	2	72	36	18
	—	—	4006	36	2	A	Twin	1	1	2	72	36	18
	—	CA5H(36H120)⑤	—	40	2	A	Twin	1	1	2	80	40	20
	—	CA5H(36H120)⑤	—	40	2	A	Twin	1	1	2	80	40	20
	—	CA5(36M220)	4071	40	4	B	Twin	1¾	2		40	20	
	—	SP/CA400(40H100)⑤	—	40	2	A	Twin	1	1	2	80	40	20
	—	—	5103	50	2	A	Twin	1¼	1	2	80	50	25
	50LB01	—	—	50	1	A	Twin	1¼	1	2	80	50	25
COMMON MILITARY BATTERIES	MA-500H			5	6	A	Yellow	1	1	2	10	5	2½
	BB-641 & BB-676			10	5	A	Yellow	1	1	2	20	10	5
	BB-649			20	4	A	Twin	1	1	2	40	20	10
	MA-9 & BB-434			20	4	A	Twin	1	1	2	40	20	10
	MA-5 & BB-433			30	3	A	Twin	1	1	2	60	30	15

① Use the settings shown in this horizontal band for *any* battery, especially those not listed in the two lower bands. Under your brand of battery, determine which type cell you have (refer to the battery manufacturer's manual). The line of your battery's C value (also in the battery manual) contains the settings to use.

② Listed in battery manufacturer's manuals.

③ "C" is the number equivalent to the ampere-hour rating of the battery when discharged at the one-hour rate. EXAMPLE: For a battery rated 20 A-H at the 1-hour rate: C equals 20; 2C equals 40. C values can be found in the battery manufacturer's manuals.

④ *Certain* batteries may heat up more than desired during *discharge*. A two hour (C/2) discharge rate (alt) should reduce their discharge temperature rise

⑤ Certain batteries are also available in slightly different cases. (e.g.; 4076 vs 40176, etc.)

NOTE: Read "WARNING" in #1-2 of RF80H manual.

**80 amp minimum
***50 amp maximum
N116936-Rev.F

BATTERY DATA IS BASED UPON BEST AVAILABLE INFORMATON
See Instruction Manual for alternate charger/analyzer settings.

3-14. SAVING CYCLE TIME. If approximate 1-second pulse action occurs during the first few minutes, the battery is at a relatively high level of charge. Cycle time can be saved by rotating only the white pointer counterclockwise on the HOURS CHARGE timer to the 0.2 to 0.5 hour point (leaving the black pointer undisturbed). Manual rotation clockwise with the power on can produce mis-positioning of the white pointer.

3-15. BATTERY ACCEPTANCE OR REJECTION CRITERIA. There are four points in the automatic cycle at which the battery is subjected to pass-fail tests. The first two consist of cell scanning during initial charge cycle, the third test is at the end of the discharge cycle, and the fourth is at the end of the recharge cycle. Paragraphs 3-16 through 3-20 discuss these criteria.

3-16. Cell Scanning Method. Cell scanning is performed using the red (+) and black (-) probes to measure individual cell voltages. Each cell should be measured across the positive (+) and negative (-) terminal using the following method:

a. Set DPM switch to the CELL VOLT position.

b. Start with the cell connected to the red positive (+) terminal of the battery. This is usually considered cell number 1. Measure across the cell terminals with the probes and observe the cell voltage on the DPM. It is good practice to record the voltage of each cell for future reference.

c. Repeat step b for each of the remaining cells.

3-17. Cell Scanning During Initial Charge Cycle and Recharge Cycle. Cell scanning is performed twice during the initial charge cycle and once during the final recharge cycle. The basic requirements are as follows:

a. Cell Voltage Scanning Upon Turn-On
Immediately after turning on the charger, measure the voltage of each cell. Reject the battery if any cell is shorted, measures less than 1.0 volt, or has reversed polarity. Also review (b).

b. Cell Capacity Scanning During Last 10 Minutes of Charge
At least during the last 10 minutes of the initial charge and the final recharge, use scanning probes to check whether one or more cell readings are substantially higher or lower than the others. See paragraph 3-17c in case of abnormal readings.

c. Cell Evaluation Scanning
If a cell voltage is at least 0.1 volt less than the average of all the individual cell voltages, it could be weak and should be monitored closely for signs of failure throughout the discharge cycle. If any minimum cell voltage is greater by at least 0.1 volt than the other cells, it could have too low an electrolyte level. Try adding one or two drops of distilled water to lower the voltage. If a cell is obviously defective, such as having a zero to 1.4 volts total charge, the battery is unsuitable and should be rejected without further testing.

3-18. Cell Voltage Scanning During Discharge Cycle. After 54 minutes (0.9 on HOURS DISCHARGE dial) of a 1 hour discharge cycle or after 1 hour and 48 minutes (1.8 on HOURS DISCHARGE dial) of a 2 hour discharge cycle, the individual cell voltage must be scanned a second time. If all cells measure over 1.0 volt, allow the discharge cycle to continue. If any cell measures less than 1.0 volt, battery (deep discharge) reconditioning is required as described in paragraph 3-24, regardless of whether the battery passes the battery capacity GO/NO-GO test described in paragraph 3-19.

3-19. GO/NO-GO Decision in Discharge Cycle. The charger/analyzer automatically makes a GO/NO-GO decision as to battery capacity at the end of the discharge cycle. This decision is predicated upon an average cell voltage of 0.95 volt defining the discharge state. For example, a decision would be made at approximately 18 volts for a 19-cell battery. The GO/NO-GO decisions are as follows:

a-1. In the LONG CYCLE, if the HOURS DISCHARGE pointer, which moves clockwise, is past the white GO arrow (at 12 o'clock on the panel) when the battery voltage reaches the discharge state decision point, the battery has demonstrated its rated amere-hour capacity. The charger/analyzer will automatically switch to the final recharge cycle but not until it reaches the voltage listed in 4-15 (D), and then will recharge the battery and shut off. The green CYCLE COMPLETE indicator will light. The battery is now fully charged and ready for its intended use. In summary, the operator is told not only whether the battery is good or bad, but also how good or how bad - i.e., total ampere-hour capacity. Since the battery is always fully discharged (to 0.95 volt average per cell) at the end of the LONG CYCLE, it takes, for example, 1 hour 15 minutes in lieu of 1 hour (or 2 hours 30 minutes in lieu of 2 hours) for a battery with 25% more than rated capacity.

a-2. In the SHORT CYCLE, the analyzer will automatically switch to the final recharge cycle when the ampere-hour capacity set by the operator is met (i.e.: the discharge timer reaches the 12 o'clock position). In summary, the SHORT CYCLE tells the operator whether the battery is good or bad, and how bad. It does not tell how good it is. The SHORT CYCLE never takes more than 1 hour if the 1-hour discharge rate is used, or 2 hours if the 2-hour rate is used. It can be used to save time if the operator merely wants to know if the battery has met his minimum ampere-hour discharge capacity.

NOTE

IF THE ELECTROLYTE TEMPERATURE OF A PARTICULAR TYPE BATTERY EXCEEDS 49°C AT THE END OF THE DISCHARGE CYCLE, SET THE AC SWITCH TO OFF AND ALLOW THE BATTERY TO COOL TO WITHIN 5°C OF AMBIENT TEMPERATURE BEFORE RECHARGING. IN SUCH CASES, FUTURE DISCHARGING OF THIS BATTERY SHOULD BE PERFORMED AT A 2 HOUR (C/2 DISCHARGE RATE.

b. If the HOURS DISCHARGE pointer has not passsed the white GO arrow when the battery voltage reaches the decision voltage, the battery has less than the rated ampere-hour capacity. When this occurs the programmed cycle will be interrupted. The red BATTERY REJECT indicator will light and the charger/analyzer will continue to discharge the battery at approximately the 10 hour rate (C/10) for the time set by the black HRS CHARGE pointer. This facilitates deep discharge battery reconditioning as described in paragraph 3-24.

NOTE

IN "LONG CYCLE" THE ACTUAL AMPERE-HOUR (AMPERES X HOURS) CAPACITY WILL BE DISPLAYED REGARDLESS OF WHETHER PREDIALED CAPACITY IS REACHED (GREEN LIGHT) OR NOT (RED LIGHT). READ AND RECORD TIME AND CURRENT. IN "SHORT CYCLE", ONLY PREDIALED CAPACITY (GREEN LIGHT) OR LESS (RED LIGHT) WILL BE DISPLAYED.

3-20. Attainable Capacity Greater Than Rated Capacity. If the time between pulses does not exceed 1 second at the end of charge with the BATTERY TYPE switch A setting, and the battery did not heat or gas excessively during the charger cycle, it may be an indication that the battery has a substantially greater attainable capacity than its rated capacity. In this case:

a. Continue charging for an additional 0.5 hour by operating the CYCLE RESET switch and advancing only the white HOURS CHARGE pointer on the charge timer to the 0.5 hour point (leaving the black pointer undisturbed). If the time between pulses exceeds 1 second toward the end of charge, continue using the BATTERY TYPE switch A setting. In subsequent battery tests, use this actually attainable ampere-hour value for C when setting the charging current.

b. For maximum life, maximum reliability, and minimum memory effect, the battery should be charged to the maximum attainable capacity whenever possible.

c. If the time between pulses with the BATTERY TYPE switch A setting fails to exceed 1 second just occasionally with a certain type battery, and the current setting is properly based on attainable capacity, it may be an indication of one or more weak cells, In this case, the cell voltages should be checked at regular intervals during the capacity test.

d. The B setting is used whenever the A position does not provide sufficient depolarization. Depolarization is usually sufficient when the battery temperature during charge rises less than 15° C and gassing is not excessive.

e. Some A batteries require B polarization only when new or immediately after reconditioning. In this case, the A setting should be used after one or more discharge cycles.

3-21. ELECTROLYTE LEVEL CHECK. Once the full charging program has been successfully completed, let the battery rest for 2 to 4 hours. Then check the electrolyte level of each cell and add pure distilled water if necessary. Refer to paragraph 3-25 for optional electrolyte level checking procedures for certain batteries.

3-22. OPTIONAL PROCEDURES.

3-23. The charger/analyzer has several capabilities in addition to the standard automatic charge and analysis operating mode. These capabilities assist in the reconditioning of batteries which have been rejected during analysis; they also allow the performance of special procedures required by some battery manufacturers. Optional procedures that can be performed are:

a. Deep discharge cell equalizing.

b. Electrolyte level check.

c. Cell balance check.

d. Cell fatigue (cellophane barrier) test.

e. Partial mode operations including charging only, lengthening of charge times, manual switching to discharge mode, and manual stop after discharge.

f. Constant current charging.

3-24. DEEP DISCHARGE CELL EQUALIZING. Deep discharge cell equalizing is a process which discharges each cell individually in a controlled manner to zero volts. This procedure should be used if equalizing is a user's routine reconditioning procedure; it may also be used to recondition batteries which have been rejected during the discharge analysis portion of the charger/analyzer automatic cycle. Perform this procedure as follows:

a. With the AC switch set to OFF, connect the battery to the charger/analyzer. Set the CELLS IN SERIES switch, BATTERY RATING switch, and BATTERY TYPE switch to the positions listed in Table 3-3 for the battery.

b. Set the HOURS DISCHARGE dial to the 2 hour position and the pointer to 0. Set the ANALYZER switch to ON, DISCHARGE switch to DEEP, and AC switch to ON.

c. Operate momentarily the START switch and the CYCLE reset switch. Rotate the white HOURS CHARGE pointer through zero (leaving black pointer undisturbed) to start discharging.

d. Refer to Table 3-3 and obtain the battery 1 hour ampere-hour rating (C) and divide this value in half (C/2) to obtain the 2 hour discharge current for the battery. Set the DISCH CURRENT ADJUST control to obtain the 2 hour discharge current on the panel meter.

e. Allow the battery to discharge and use the charger/analyzer probes (with meter switch at CELL VOLT position) to scan the cell voltages.

f. As the voltage of an individual cell drops below 0.50 volt, short out that cell individually by connecting a shorting strap between the (+) and the (-) terminals. Continue this process until the overall battery voltage drops below 10 volts.

g. Shut off the charger/analyzer and disconnect the battery. Connect individual shorting 5 watt 1/2 ohm resistors across all remaining battery cells.

h. Monitor cell voltage and allow the cells to remain shorted out for at least 3 hours (overnight is recommended if possible) after all cells have dropped to zero.

i. Remove the shorting straps and resistors and charge the battery using the full standard automatic charging and analysis cycle of the charger/analyzer.

3-25. ELECTROLYTE LEVEL CHECK DURING CHARGE. Some battery manufacturers (such as SAFT) require checking of electrolyte level during (not after) charge. This must be performed immediately after the battery has been fully analyzed and ReFLEX recharged as described in Figure 3-1. Perform the electrolyte level check as follows:

a. Refer to Table 3-3 and determine the 1 hour ampere-hour (C) rating of the battery. Divide this value by 10 to obtain the current value for 10 hour (C/10) constant current charging mode.

b. Set CHG MODE switch to CONST CURRENT. Momentarily operate the CYCLE RESET switch to start the charge cycle. IMMEDIATELY (within 10 seconds) adjust the CHG CURRENT ADJUST control for the C/10 current value, as indicated on panel meter, that was calculated in step (a).

c. Allow the battery to charge for 1 hour at the C/10 constant current rate. During the last 10 minutes of this charging period, check and adjust the electrolyte level in accordance with the battery manufacturer's instructions.

3-26. CELL VOLTAGE BALANCE TEST DURING CONSTANT CURRENT CHARGE. Some battery manufacturers (such as General Electric) recommend checking cell balance while the battery is being charged at a constant current. This must be performed immediately after the battery has been fully analyzed and ReFLEX recharged as described in Figure 3-1. Perform the cell balance test as follows:

NOTE

CHECK INDIVIDUAL BATTERY CELL TEMPERATURE. IF ANY CELL TEMPERATURE EXCEEDS 49°C, LET THE BATTERY CELLS COOL TO THAT TEMPERATURE BEFORE PROCEEDING.

a. Refer to Table 3-3 and determine the 1 hour ampere-hour (C) rating of the battery. Divide this value by 10 to obtain the current value for the 10 hour (C/10) for the constant current charging mode.

b. Set CHG MODE switch to CONST CURRENT. Momentarily operate the CYCLE RESET switch to start the charge cycle. IMMEDIATELY (within 10 seconds) adjust the CHG CURRENT ADJUST control for the C/10 current value, as indicated on the DPM, that was calculated in step (a).

c. Set the white HOURS CHARGE pointer for 30 minutes (0.5 on dial) of charging. During the last 10 minutes of the charging period, use the charger/analyzer probes (with meter switch set to CELL VOLT position) to measure individual cell voltage. Record each cell number and voltage for use during cell fatigue tests. Replace any cell in which the voltage is not within 0.05 volt of any other cell.

d. If the cell fatigue (cellophane barrier) test is to be performed, retain control settings and proceed directly to paragraph 3-27.

3-27. CELL FATIGUE (CELLOPHANE BARRIER) TEST. Some battery manufacturers (such as General Electric) recommend checking for separator gas barrier (cellophane) condition. This is accomplished directly after and essentially as part of the cell balance tests of paragraph 3-26. Perform the cell fatigue test by continuing the cell balance test as follows:

a. Retain the charger/analyzer control settings from the last step of paragraph 3-26 including the C/10 current adjustment.

b. Continue charging at a C/10 constant current for an additional 4 hours. To facilitate timing, the black HOURS CHARGE pointer can be set to the 2 hour position and then reset for a second 2 hour period. Operate the CYCLE RESET switch to start the charging cycle as needed. The total charge time including the cell balance test is 4.5 hours. The battery should be monitored, as time allows throughout the charging period.

c. During the last 10 minutes of the 4 hour charging, measure each individual cell voltage using the charger/analyzer probes. Replace any cell in which the voltage has decreased, in the 4 hour period, by 0.04 volt or more from the voltage measured and recorded in paragraph 3-26, step (c). Replace any cell in which the voltage measures below 1.50 volts. Measure individual cell electrolyte teumperature and replace any cell in which the electrolyte temperature exceeds 40°C.

3-28. CHARGING ONLY. Sometimes it is desired to only charge a battery without the discharge capacity test portion of the automatic cycle, or to stop the cycle after the initial charging to perform electrolyte level adjustment. In such cases proceed as follows:

a. Perform the procedures of Figure 3-1, except in step 9, set ANALYZER switch to OFF, and do not perform steps 6, 10, 11, 15, and 17 through 21.

b. The charger/analyzer will now charge the battery for the specified period and automatically stop. At the end of the charging period the green CYCLE COMPLETE indicator will light.

3-29. LENGTHENING CHARGE TIME. If it is desired to lengthen the charging time while charging is in progress, operate the CYCLE RESET switch and rotate the white HOURS CHARGE pointer (do not move the black pointer) to the position which provides the additional charging time required. To increase REcharging time, set ANALYZER switch to OFF before operating CYCLE RESET switch.

3-30. SHORTENING CHARGING TIME. If it is desired to shorten the charging time while charging is in progress, rotate the white HOURS CHARGE pointer (do not move the black pointer) to the position which provides the remaining charging time desired.

3-31. MANUAL SELECTION OF DISCHARGE MODE. The discharge mode can be manually selected at any time in the atuomatic cycle if the CHG MODE switch is at

REFLEX, the ANALYZER switch is at ON, and the HOURS DISCHARGE pointer is counterclockwise from the white GO/NO-GO arrow. To select the discharge mode while in a charge mode, gently rotate the white HOURS CHARGE pointer counterclockwise slightly past zero (without changing the black pointer position). The unit will then automatically switch to the discharge mode.

3-32. AUTOMATIC STOP AFTER DISCHARGE. The charger/analyzer can be set to automatically stop when discharged to the full discharge point and, therefore, not continue atuomatically into the recharge mode. This is easily accomplished by setting the HOURS DISCHARGE white GO/NO-GO dial to a higher discharge time setting than the ampere-hour capacity of the battery will allow it to attain. For example, a GO/NO-GO dial setting of 2.9, with the pointer set to zero, and the normal discharge rate will cause a battery to reach the discharge point before the GO arrow is reached. The high discharge will then automatically stop, dropping to the approximate battery 10 hour rate (C/10) for the additional time equal to the black pointer setting of the charge timer.

The red BATTERY REJECT indicator will light under these conditions, but will not be indicative of a rejected battery.

3-33. CONSTANT CURRENT CHARGING. If it becomes necessary to charge individual cells, or batteries up to 21 cells (other than 11, 19, 20, or 22 cells), this can be accomplished by operating in the constant current mode. In these cells, charge for 7 hours at the 5 hour (C/5) rate, or for 14 hours at the 10 hour (C/10) rate.

3-34. OPERATING PROCEDURES AFTER POWER FAILURE. As a safety feature, in case of power failure during any part of the cycle, the unit will turn off. The discharge timer pointer, however, will allow determination of the battery status at the time of power failure. There are three possible pointer positions:

a. If the discharge pointer is at zero, it means that the battery was still charging. Once power becomes available, operate the START switch, and the charge cycle will start and operate for the maximum time set at the charge timer. As soon as the time between pulses is approximately 1 second (10 pulses in 10 seconds), move the white HRS CHARGE pointer to the 0.25 to 0.5 hour point, leaving the black pointer undisturbed.

b. If the discharge pointer is between zero on the dial and the white GO arrow, that means that the battery was discharging. Once power becomes available, operate the START switch and then the CYCLE RESET switch. Then gently rotate the white pointer of the HOURS CHARGE timer counterclockwise lightly through zero (leaving black pointer undisturbed), and the discharge operation will continue from its status when the power failed.

c. If the discharge pointer is past the white GO arrow on LONG CYCLE or at 12 o'clock on SHORT CYCLE, it means that the battery has passed the GO point during discharge, and is conditionally acceptable for use when full recharged. Once power becomes available, operate the START switch to complete the recharge with ANALYZER switch OFF.

3-35. ALTERNATE BATTERY CAPACITY VALUE. Certain battery manufacturers permit acceptance at 85% instead of 100% of rated battery capacity. If your shop procedure is to accept as battery discharge capacity on 85% (instead of the 100% of rated battery capacity that is the basis of Model RF80H operation), rotate the discharge timer dial (step 6, page 3-11) to 85% of the time specified in Table 3-3.

3-36. NEW BATTERY UNBALANCE. Previously unused batteries, particularly those not in shorted condition, may initially exhibit cell unbalance that is larger than desired. To prevent under or overcharging (excessive heating), the following is recommended:

a. Deep discharge all new batteries per 3-24 before proceeding with the automatic cycles described in 3-10.

b. Repeat automatic cycles until capacity on two successive cycles is about unchanged. These cycles should consist of ReFLEX charge, NORMAL discharge at the two-hour rate, and ReFLEX recharge. Should cell electrolyte temperature exceed 40°C after discharge, it is recommended that the battery cool to below that temperature before recharging.

SECTION 4

MAINTENANCE

4-1. GENERAL.

4-2. This section provides instructions for inspection, preventive and corrective maintenance, adjustment, and trouble-shooting of the charger/analyzer. The contents of this section presuppose familiarity with the equipment by maintenance personnel.

4-3. PERIODIC INSPECTION AND PREVENTIVE MAINTENANCE.

4-4. GENERAL PREVENTIVE MAINTENANCE PROCEDURES. The following are general preventive maintenance procedures which should be performed on a 180-day inspection schedule, and detailed preventive maintenance procedures which should be performed on an as-required basis, except as otherwise noted.

4-5. WORK AREA. Keep the general work area clean on a daily basis. Do not allow dirt, metal dust, powder, and pieces of paper to collect in the area of the charger/analyzer as the built-in cabinet cooling fan can easily suck such items into the unit. Do not block air inlets.

4-6. MECHANICAL CONDITION. Conduct a general inspection of the unit for general mechanical condition. Tighten all bolts, screws, switches, etc., which may be loose. Make sure printed circuit boards and plug in relays are pushed all the way into the connector.

4-7. ELECTRICAL CONDITION. Check all switches and controls for proper operation. All units and circuit cards should be inspected for indications of overheating, burned resistors, intermittent connections, noisy potentiometers, and leaking capacitors.

4-8. WIRING. Check the wiring for loose or broken tie-wraps, and frayed or damaged insulation. Tighten or replace loose or broken tie-wraps. Repair damaged insulation. Tighten all loose mountings, connections, and fastenings.

4-9. CABLES AND CONNECTORS. Examine cables for cracked or deteriorated insulation and for frayed or cut insulation at the connecting and supporting points. Inspect for loose cable clamps and for loose or corroded connectors. Check cables and connectors for improper placement which might subject them to strain, kinks or improper supports. Tighten loose cable clamps, coupling rings, and connections.

4-10. PRINTED CIRCUIT CARDS. Remove the plug-in printed circuit cards from the unit, inspect each card for dirt, broken printed circuits, bad connections, deteriorated components, and the following general overall conditions:

<u>NOTE</u>

DISCOLORATION OF CONFORMAL COATING AROUND VARIOUS COMPONENTS HAS NOT DETRIMENTAL EFFECT UPON OPERATION OF CIRCUIT CARDS.

a. Capacitors for signs of dielectric leakage and for bulging of the cases. Check terminals for loose connections and corrosion.

b. Fixed resistors for blistering, discoloration, and other signs of overheating.

c. Variable resistors for defects and loose mountings.

4-11. CLEANING. Clean the components of the unit as follows:

WARNING

DISCONNECT THE POWER CORD OR SHUT OFF MAIN POWER CIRCUIT AHEAD OF UNIT BEFORE OPENING CABINET. DANGEROUS VOLTAGES ARE PRESENT IN EXPOSED CIRCUITS EVEN WITH AC SWITCH IN OFF POSITION.

WARNING

USE OF COMPRESSED AIR FOR CLEANING CAN CREATE AN ENVIRONMENT OF PROPELLED FOREIGN PARTICLES WHICH MAY ENTER THE EYES AND CAUSE SERIOUS INJURY. AIR PRESSURE FOR CLEANING SHALL NOT EXCEED 15 psig AND EYE PROTECTION IS REQUIRED.

a. Open cabinet top and remove any dust, dirt, or foreign particles from circuit cards, components, and cabinet, using clean, dry, filtered compressed air at 15 psig. Remove stubborn dirt from component side of circuit card assemblies using soft bristle brush in conjunction with compressed air. Make sure that all ventilation openings in the cabinet are clean and free of obstructions. However, never add air filters to unit.

WARNING

ISOPROPYL ALCOHOL IS TOXIC AND FLAMMABLE. USE CHEMICAL GOGGLES, FORCED VENTILATION OR RESPIRATORS, AND GLOVES. KEEP CONTAINER CLOSED, AND KEEP SPARKS, FLAMES, AND HEAT AWAY. KEEP LIQUID OFF SKIN, EYES, AND CLOTHES. DO NOT BREATHE VAPORS.

b. Clean printed wiring side of circuit card assemblies, connector contacts, and exposed switch contacts using a cloth or soft bristle brush moistened with isopropyl alcohol, Specification TT-I-735, or equivalent. Dry with compressed air at 15 psig.

c. Remove fingerprints, electrolyte (potassium hydroxide) splatters and dirt from cabinet parts, front panel, and meter faces using a soft cloth moistened with a solution of mild liquid soap and water. Rinse with cloth moistened with water only enough to remove all traces of soap and dry using soft cloth or compressed air at 15 psig.

4-12. LUBRICATION. No lubrication of the unit is required. However, should diode replacement be necessary, thermal compound such as GE G624 Silicone, or equal, should be used at the diode/heat sink interface.

4-13. FUSE COMPLEMENT. Table 4-1 provides a list of fuses used in the charger/analyzer.

Table 4-1. Fuse Complement

Fuse	Rating (Amperes)	Function	Reasons for fuse Operation
F1	30	Protects AC input power circuit	Shorted diode or SCRs
F2	100	Protects positive (+) circuit	Battery connected with reverse polarity
F4	5	Protects ReFLEX control circuits	a) battery not connected b) CELLS IN SERIES or BATTERY RATING switches set incorrectly.

4-14. CALIBRATION CHECK.

4-15. Every 12 months perform the following:

a. Using a fully-charged, known-good battery, check that the Status Indicator pulsing interval during ReFLEX charging at full charge is approximately one second with the BATTERY TYPE switch set to A position and slightly longer when set to the B position.

b. Using representative 11, 19, 20, and 22 cell batteries, fully discharge each battery using the automatic analyzer mode (DISCHARGE switch at NORMAL position) and the HOURS DISCHARGE control set for greater than rated battery capacity to ensure a NO-GO condition. Check on the meter the battery voltage at time high discharge stops and the red BATTERY REJECT indicator lights. The voltage for each battery type should be as follows:

1) 11-cell battery: 10.5V DC ± 2%.

2) 19-cell battery: 18.1V DC ± 2%.

3) 20-cell battery: 19.0V DC ± 2%.

4) 22-cell battery: 20.9V DC ± 2%.

c. Alternate Procedure Without Battery.

Procedure for checking end of discharge point without battery. Also, procedure for recalibration if required. See IIIB on page 4 - 5.

I. Equipment Required:

A. Adjustable DC power supply, 0-36V DC, 100 amp.
B. Electrolytic Capacitor, 60,000 UF, 45V DC
C. Two Resistors, 0.5 Ohm, 3500 W. each.

II. Parts Replacement

A. If R9 (Charge Current Adjust) is replaced and it is subsequently found that the maximum attainable current (using twin cable) is higher or lower than 80 amp, proceed as follows:

Connect the 60K UF capacitor and the two 0.5 ohm 3500 W. resistors (all in parallel) to the twin cable. Turn battery charger on, set to constant current and rotate the "current adjust" control R9 to maximum (fully clockwise). Now adjust R26 on A1 card to obtain 80 ampere on the meter.

B. Replacement of any other component off the P/C boards does not require recalibration.

III. Periodic Calibration Check

A. ReFLEX Charging (without Battery)

(1) Connect the 60,000 uf capacitor, one 0.5 ohm 3500 W resistor, the DC power supply and DC voltmeter (all in parallel) to the yellow band cable. (Observe polarities - all positive terminals together, and all negative terminals together.)

(2) Set Battery Rating switch to "6",
Set Battery Type switch to "A",
Charge Mode switch to ReFLEX,
Analyzer switch to "on"
Discharge switch to "normal",
Meter switch to "Bat" volts,
Charge timer to "3" hours,
Discharge timer dial so that 2.5 is at the arrow,
Discharge pointer to zero (0),
Charge current adjust fully counterclockwise,
Discharge current adjust fully counterclockwise, and cells in series switch to "11".

Power supply voltage control to zero volts.

(3) Turn AC switch on and press RF80H start switches. The fan will start, but yellow lamp will not light until power supply is turned up. Press the "press to adjust" switch and adjust the current to read 5 amp on the DPM. Set the DC power supply volts to 0.5V DC above value given below. Allow the charger to warm up 10 minutes. After the warm up, reduce the power supply voltage slowly and at the following values (± 2%) the charger should start ReFLEXing:

11 cells	17.6V DC
19 cells	30.4V DC
20 cells	32.0V DC
22 cells	35.2V DC

If any of the settings need recalibration, adjust the applicable potentiometer:

Cell Position	Potentiometer
11	R41
19	R42
20	R43
22	R44

(4) Set Battery Type switch to "B".

(5) Follow the procedure of (3) above. The charger should start ReFLEXing at the following voltages:

11 Cells	17.3V DC
19 Cells	29.8V DC
20 Cells	31.4V DC
22 Cells	34.6V DC

If these settings need recalibration first make sure all the "A" settings are correct. Then a single potentiometer (R58) on the A3 card will adjust all 4 cell positions simultaneously.

B. Discharging (without Battery)

(1) Check calibration in accordance with 4-15a except use items under A. (1) above in lieu of battery if desired. Set power supply voltage to 1 volt above values given in III. B. (2) and (3). With discharge current set to 5 amp and charger-analyzer warmed up, reduce power supply voltage slowly to the value given.

(2) If any of the settings need recalibration, adjust the applicable potentiometer:

Cell Position	Potentiometer
11	R71
19	R72
20	R73
22	R74

(3) If the GO/NO-GO decision is preferred to be predicated on the average cell voltage of 1 volt rather than 0.95 volt per cell on LONG CYCLE (see also section 3-19), the applicable voltages should of course be:

11 cell	11.0V DC
19 cell	19.0V DC
20 cell	20.0V DC
22 cell	22.0V DC

4-16. TROUBLESHOOTING.

4-17. The charger/analyzer is rugged, reliable equipment. Sometimes, however, things do go wrong. Experience has shown that most apparent malfunctions of the charger/analyzer are caused by unsuspected heat sources, improper input power, and operator error. Table 4-2 lists troubles that have been experienced in the field, along with the sometimes uncommon causes and remedies. Table 4-3 provides test points and voltages as an aid to fault isolation.

4-18. SPARE PARTS

4-19. Experienced operators prefer keeping a few replacement parts on hand. The following are suggested, although you may prefer to add other items listed in Section 5.

Item	Part Number
A1 printed circuit card	S113950-5
A3 printed circuit card	S116913-2
F1 fuse (30 amp)	546130-013
F2 fuse (100 amp)	546191-041
F4 fuse (5 amp)	546105-008
K1 (or K4, K5, K8) relay	571403-001

4-20. SCHEMATIC DIAGRAM.

4-21. Figure 4-1 provides the schematic wiring diagram for the charger/analyzer.

Table 4-2. Troubleshooting (sheet 1 of 5)

Trouble	Probable Cause and Remedy
No DC output to battery (no red dashes on Bar Display)	<u>CHG CURRENT ADJUST CONTROL NOT IN CORRECT POSITION</u>. The control must be at least 90 degrees from full counterclockwise. Check this as someone may have rotated it.
	<u>WRONG CELL SELECTION</u>. Count cells and use matching selector switch position.
	<u>BATTERY RATING SWITCH POSITION AND CABLE IN USE INCOMPATIBLE</u>. A protective interlock prevents DC output if the wrong cable is used with a specific BATTERY RATING switch position. Check both switch position and cable and correct as needed.
	<u>NO INPUT POWER TO UNIT</u>. Momentarily, with AC switch ON, press the START switch. The amber BLOWN FUSE INDICATOR should light. If it

Table 4-2. Troubleshooting (Sheet 2 of 5)

Trouble	Probable Cause and Remedy
	doesn't, check for proper voltage at the AC outlet or circuit breaker. Correct as needed.
	FAULTY CONNECTION TO BATTERY OR DEFECTIVE BATTERY. Check for bad connection to battery. If the twin cable is in use, make sure that the yellow covers with center openings often installed on Elcon-type terminals are removed, as physical but not electrical contact can be made.
	Check that battery cable connector is fully mated with the unit cabinet connector. Check for breaks or damage to the cable. Make sure the battery has proper internal connections and connections to its external terminals.
	CHARGER/ANALYZER FUSES BLOWN. Open the circuit ahead of the unit by unplugging power cord or opening circuit breaker. Remove cabinet cover and the internal fuses. Check the two fuses, F1 and F2 for open condition using a test light or ohmmeter. If F1 is blown, the cause may be a shorted diode or silicon controlled rectifier (SCR). If F2 is blown the cause may be reversed polarity connections to the battery.
BLOWN FUSE INDICATOR lights or blinks	INDICATOR REMAINS LIGHTED OR BLINKS DURING CHARGING. Fuse F4 is blown. Check that battery cable is connected to battery and makes good contact at both ends. Check that CELLS IN SERIES and BATTERY RATING switches are correctly set. AC switch must not be set to ON before connections and settings are correct. Replace fuse F4.
BLOWN FUSE INDICATOR does not light momentarily when START switch is operated (in ReFLEX only)	INDICATOR LAMP OR FUSEHOLDER ASSEMBLY MAY BE DEFECTIVE. If a completely-discharged battery is connected to the RF80H charge for at least 15 seconds. If the BLOWN FUSE INDICATOR still does not light, check indicator lamp DS4, fuse F4, and fuseholder assembly. Replace as needed.

Table 4-2. Troubleshooting (Sheet 3 of 5)

Trouble	Probable Cause and Remedy
AC power in unit shuts off and does not turn on again.	AC POWER FAILURE. Restart unit as described in paragraph 3-34.
	THERMAL PROTECTORS DEFECTIVE. Check the thermal protectors on the heatsink and in the discharge resistor box. Replace as required. Check the DC current and correct as needed.
Charger/Analyzer relays chatter during operation	AC INPUT VOLTAGE TOO LOW. Check the AC input voltage to the unit. If too low for the TB1 connection, the relays will chatter. Correct the low voltage condition. Ensure that the power connection on TB1 is correct as described in Section 2 and that the power source is adequate.
CYCLE COMPLETE indicator (green) lights after the first charge cycle; unit does not go to analyze cycle even with HOURS DISCHARGE control properly set.	ANALYZER SWITCH OFF. Check that the ANALYZER switch has not been inadvertantly set to OFF position. Correct the switch setting.
	CHG MODE SWITCH SET TO CONST CURRENT POSITION. Check that CHG MODE switch has not been inadvertantly set to CONST CURRENT position. Correct the switch setting.
	STEP 16 OF OPERATING PROCEDURE WAS SKIPPED. Operate the CYCLE RESET switch to start the automatic charge-discharge-recharge cycle.
Control functions incorrect	CIRCUIT CARDS MALFUNCTIONED. First check that all circuit cards are properly seated and have not lost contact due to vibration. Check that harness connectors are securely mated. Also check that other plug-in components (relays, fuses, etc.) are properly seated. If unexplainable performance continues, consider using a contact cleaner such as "SpraKleen #8666" (GC Electronics) or equal.
Unit does not cycle to recharge mode with good battery	DISCHARGE SWITCH SET TO DEEP POSITION. Check that discharge switch has not been inadvertantly set to DEEP position. Correct the switch setting

Table 4-2. Troubleshooting (Sheet 4 of 5)

Trouble	Probable Cause and Remedy
Known-good battery does not pass GO/NO-GO test. BATTERY REJECT (red) indicator lighted	HOURS DISCHARGE DIAL OR POINTER INCORRECTLY SET. Verify that the HOURS DISCHARGE dial or pointer has not been set for too great a discharge time for the rated discharge current. Also check that too great a discharge current has not been used for the GO/NO-GO dial setting.
Known-good battery overheats during charge	This condition occurs occasionally even with good batteries. Try the B setting of the BATTERY TYPE switch using the "C" charge rate for 1.75 hours. Use the yellow-band cable if required. The time between pulses at the end of charge should normally be one second with the A position and greater than one second with the B position
	The battery may have been too hot at start of charge or recharge. Discharge battery at the 2 hour rate (C/2) instead of the 1 hour rate. Cool the battery with a blower or other means during charge and discharge.
Bar Display and digital meter indicate properly during charge, but subsequent discharging discloses insufficient ampere-hour capacity	CELLS IN SERIES SWITCH POSITION IS INCORRECT OR KNOB HAS SLIPPED. Check switch setting. Check that knob of the CELLS IN SERIES switch is not loose or slipped in position, so that the switch is set to, for example, the 19 cell position while the knob pointer indicates 20 cells. Check this by loosening the knob set-screw and removing the knob. Then, using pliers, rotate the switch to full travel in one direction. Align the pointer of the knob with the indicator dot in that direction and tighten setscrew.
Unit shuts off for several minutes and then can be started again	This condition usually occurs when the protective thermal devices have sensed over-heating and have opened to protect the unit. Incorrect air flow to or through the unit is the most frequent cause. Typical conditions causing this problem are: a. The cabinet cover has been partially opened or removed in an attempt to improve cooling.

Table 4-2. Troubleshooting (Sheet 5 of 5)

Trouble	Probable Cause and Remedy
	This makes cooling worse as the unit requires the cabinet to be closed for proper air flow through the transformers and heat sinks. Close the cabinet cover. b. A sheet of paper or plastic has been placed under the unit and is sucked up against the air inlet on the underside of the unit to block proper air flow. Remove the paper. c. A nearby source of heat, either beside or under the unit, is being directed into the air inlets. Typical heat sources are other battery chargers, heaters, coffee pots, and heated air blown from a battery. d. Insufficient space has been provided for the unit during installation resulting in poor air flow to the unit or deflection of heated air from the unit back into the air inlets. Refer to the installation criteria of Section 2 to assure proper air flow. e. Ambient temperature is too high. ReFLEX charge at the C rate for 1.75 hours instead of the usual 2C rate for 1 hour.
Cannot adjust discharge current to more than 30 amps	Check relays under discharge resistor box (see page 5-5). Contacts on one may stay open.
Loud hum in transformer during charge	Check relays under discharge resistor box (see page 5-5). Contacts on one may be welded closed.
BATTERY REJECT indicator (red) lights and unit stops. If operator then turns unit OFF and later ON and presses START switch, the CYCLE COMPLETE indicator (green) lights after recharge completion.	When the operator turned the unit off, he simulated that which is described in 3-34 (b). If he does <u>not</u> operate the CYCLE RESET switch upon turning the unit on again, (or momentarily disconnect the battery), the preprogrammed internal circuitry will produce a green light that means <u>only</u> that charging time expired. Press CYCLE RESET whenever turning unit on unless you want to continue an incomplete cycle.

Table 4-3. Fault Isolation (Sheet 1 of 5)

WARNING

HIGH VOLTAGES INSIDE OF CABINET.
BATTERY MUST BE CONNECTED, CHARGER SET AND TURNED ON FOR FOLLOWING VOLTAGE TESTS OR CHECKS.

Step	Measurement Test Point	Acceptable Indication	Remarks
1	TB1-L1 to TB1-L2	115 or 230 (208)V AC ±10% (depending on input voltage)	No Voltage - Check power circuit to charger for blown fuses, tripped circuit breakers, open switches, etc.
2	TB1-15 to TB1-18 (for 115, 208, or 230V AC input)	115 or 230 (208)V AC ±10% (depending on input voltage)	No Voltage - Check for blown fuse F1. If replacement fuse blows, check for grounded AC power, shorted power semiconductors, or shorted transformer. If F1 is not blown, proceed to the following Links: verify links correct for input voltage. Switch S15 - Check that S15 closes. Relay K10. Press START switch and verify that relay K10 operates. If R10 does not operate, check for open K10 coil, or defective components S4, S8, S14A, or R17. Switches S4 and S8 open if components are overloaded or improperly cooled. Check switch settings, battery cell number and ampere-hour settings. Check unit ventilation for spacing and no feedback of hot air. Check that fan is operating and up to speed
3	TB1-17 to TB1-18	115V AC ±10% (230V AC links connected)	No Voltage - Transformer T1 primary circuit open. See step #2.

Table 4-3. Fault Isolation (Sheet 2 of 5)

Step	Measurement Test Point	Acceptable Indication	Remarks
4	TB1-1 to TB1-2	122V AC ± 10%	No Voltage. Open primary winding or broken lead between TB1-1 and TB1-2.
5	TB1-4, 7, 8 to TB1-5 or TB1-3	31.7V AC ± 10%	No Voltage - Open winding or leads to terminals.
6	TB1-3 to TB1-5	63.4V AC ± 10%	No Voltage - If reading of Step 5 is correct and voltage is zero, one winding is reversed.
7	TB6-1 to TB6-2	115V AC ± 10%	No Voltage - If Step 3 results are correct, check for open wiring.
8	TB6-3 to TB6-4, 5, 6, 7	115V AC ± 10%	No Voltage - Transformer T2 primary or secondary winding open.
9	M3-L1 to TB6-4, 5, 6, 7	115V AC ± 10%	No Voltage - Check for correct charging cable and battery rating switch settings. Check twin cable for continuity between pins E and F on male plug. Check yellow-band cable for continuity between pins D and F on male plug. Check S13C for problem (open condition). Check S3B, CYCLE RESET, for open condition.
10	TB6-3 to M3-L2 (CHG MODE switch at ReFLEX and ANALYZER	115V AC ± 10%	No Voltage - Defective printed circuit card A3. Replace A3 card and recheck. If this does not correct problem, proceed to the following.

Table 4-3. Fault Isolation (Sheet 3 of 5)

Step	Measurement Test Point	Acceptable Indication	Remarks
	switch to ON)		Set ANALYZER switch (S5) to OFF and remove circuit card A3. If voltage is not correct, check for open wires, defective switch S5, or defective circuit card A4. If voltage correct, proceed to following. Set CHG MODE SWITCH (S9) to CONSTANT CURRENT with circuit card A3 removed. If no voltage is present, check for open switch S9.
11	TB1 (-) to TB1 (+) (using twin cable)	Same voltage as across the battery terminals	Reversed Voltage - Check battery for correct polarity. Check cable connection to battery at Elcon-type plug. If reversed connection has occurred, check for blown fuse F2. No Voltage - Check that both battery cable connectors are seated completely.
12	TB1 (-) to TB1 (+) (using yellow-band cable)	Same voltage as across battery terminals	Reversed Voltage - Check battery polarity and cable connection at battery. If reversed connection has occurred, check for blown fuse F2. No Voltage - Check that both battery cable connectors are seated completely.

Unit Set to ReFLEX Charging with Analyzer On
Unless Otherwise Noted

13	XA1-T to XA1-V	121V AC ± 10%	No Voltage - Check Step 4. Check R20; should read 4.7 ohm. If R20 open or high resistance, replace A1 card and R20. If R20 ok, check for open circuit in harness.

Table 4-3. Fault Isolation (Sheet 4 of 5)

Step	Measurement Test Point	Acceptable Indication	Remarks
14	XA1-E to XA1-F	63.4V AC ± 10%	No Voltage - See Step 6. If Step 6 ok, check for open circuit in harness.
15	XA1-H to XA1-L	63V AC ± 10% (R9 FULL CCW) 41V AC ± 10% (R9 FULL CW)	No Voltage - See Step 14. Check R11 and R12 read 75 ohms ± 20%. Also check for open circuit in harness.
16	XA1-J or XA1-M to XA1-N	0.15V DC ± 10% (R9 FULL CCW) approaches 2.75V DC (R9 FULL CW)	No Voltage variation with R9, replace "A1" card. Voltage checks ok, but no output: check power SCR's.
17	XA1-P (+) to XA1-D (-)	27V DC ± 10%	No Voltage - See Step 5. If Step 5 ok, replace A1 card.
18	XA1-A (+) to XA1-Y (-)	0 to 100 MV DC	With no output current - "0" V DC. With 40 A (yellow) or 80 A (twin cable): 100 MV DC (proportionally less for lower currents). If no voltage with current output, check for open circuit back to R10 A and B. If there is no control with R9, replace A1 card (if K1 is ok).
19	XA1-Z (+) to XA1-Y (-)	100 MV DC ± 10% (factory set)	Reads high or low: check R9. If open, replace. If R9 ok, replace "A1" card.
20	XA1-C (-) to XA1-P (+)	2 ± 10% VDC 27V DC ± 10% VDC	Charger set for constant current and M3 zero. As above but M3 not on zero. If no voltage reading, replace A1 card. If VDC does not change with M3, check that K6 and M3 operate

Table 4-3. Fault Isolation (Sheet 5 of 5)

Step	Measurement Test Point	Acceptable Indication	Remarks
21	XA3-M (-) to XA3-A (+)	27V DC ± 10%	See Step 17. No Voltage - Check S3A - if open replace. Check W301, W302, W69, W601 for open circuit. If open, repair.
22	XA3-A to XA3-H	ZERO VAC in ReFLEX Charging 115V AC ± 10% In Analyze (testing)	If not, replace A3 card. If not, replace A3 card.
23	XA3-S to XA3-A (+)	115V AC ± 10% Only as indicated under remarks	1) Momentarily when M3 transfers from charge to discharge. 2) At end of charge cycle.
24	XA3-P (-) to XA3-A (+)	8.5V ± 20%	With charged battery if voltage incorrect, check cell selector switch setting. Otherwise replace A3 card.
25	XA3-U (-) to XA3-A (+)	80 MV DC ± 20%	If voltage not as specified, check R6. If open, replace. Otherwise replace A3 card.
26	XA3-K to XA3-A	7.8V DC ± 10%	VDC - read just before test cycle is terminated. If VDC not as indicated, replace A3 card.
27	XA3-V (-) to XA3-A	27V DC to 3V DC (approximately) 8V DC (approximately)	During ReFLEXing voltage will vary between these values. After charge completed, and M3 has not reset (white pointer at zero.)
28	XA3-D (+) to XA3-K (-)	7.8V DC	Read just before end of test cycle. If reading zero, check K1. If K1 ok, replace A3 card.
XA3	XA3-D (+) to XA3-K (-)	3.6V DC (approximately)	After test cycle completed and charge #2 started, if reading about 6V DC, replace A3 card

SECTION 5

REPLACEMENT PARTS

5-1. GENERAL.

5-2. This section provides a listing of replaceable parts which are significant to proper maintenance of the charger/analyzer. Figures 5-1 and 5-2 provide illustration of parts location keyed by index number to the accompanying parts lists. The parts lists show the figure index number, part number, circuit designations as applicable, a brief description, and quantity used.

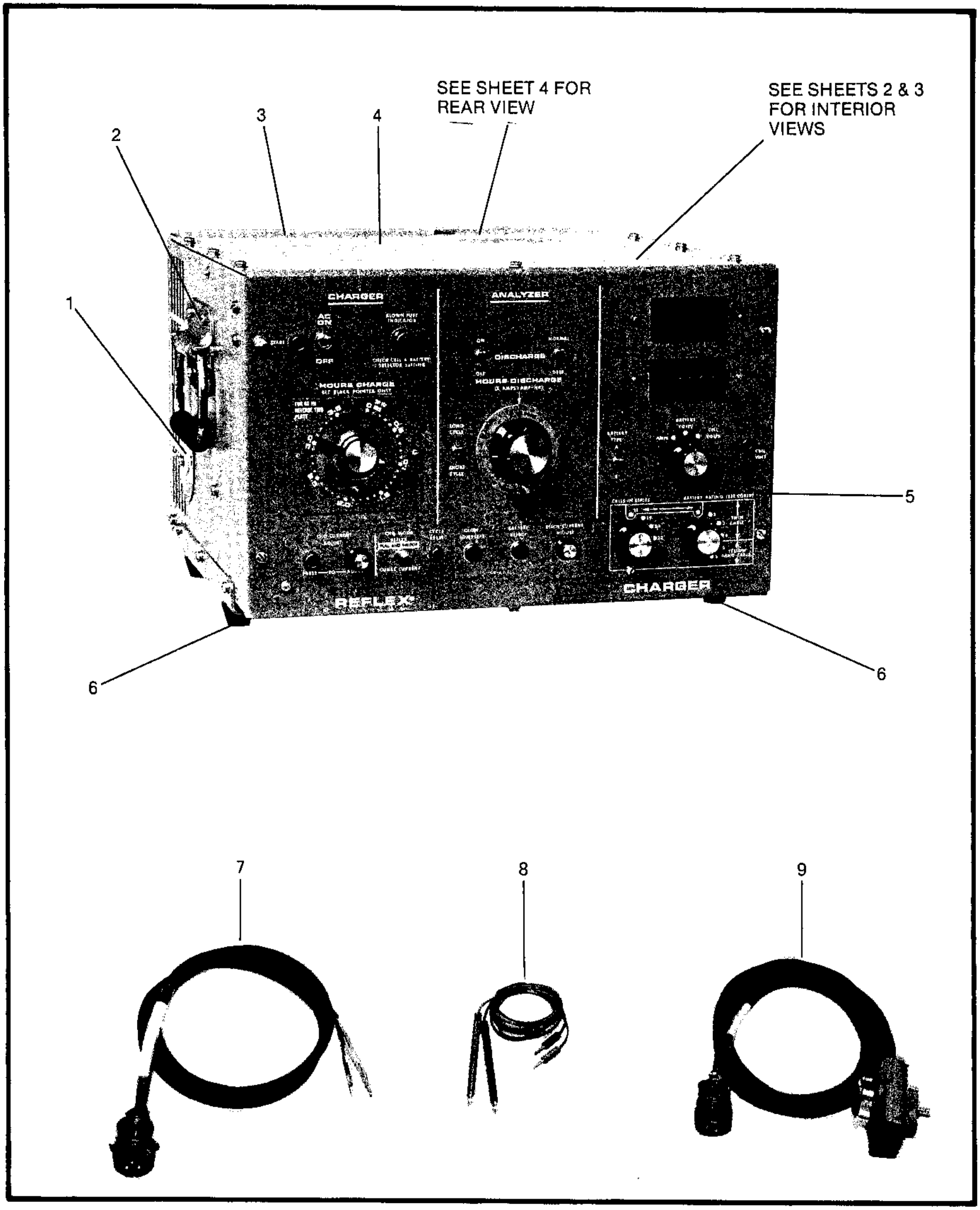
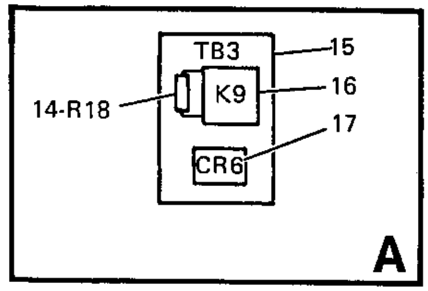


Figure 5-1. Replaceable Parts-Main Assembly (Sheet 1 of 4)



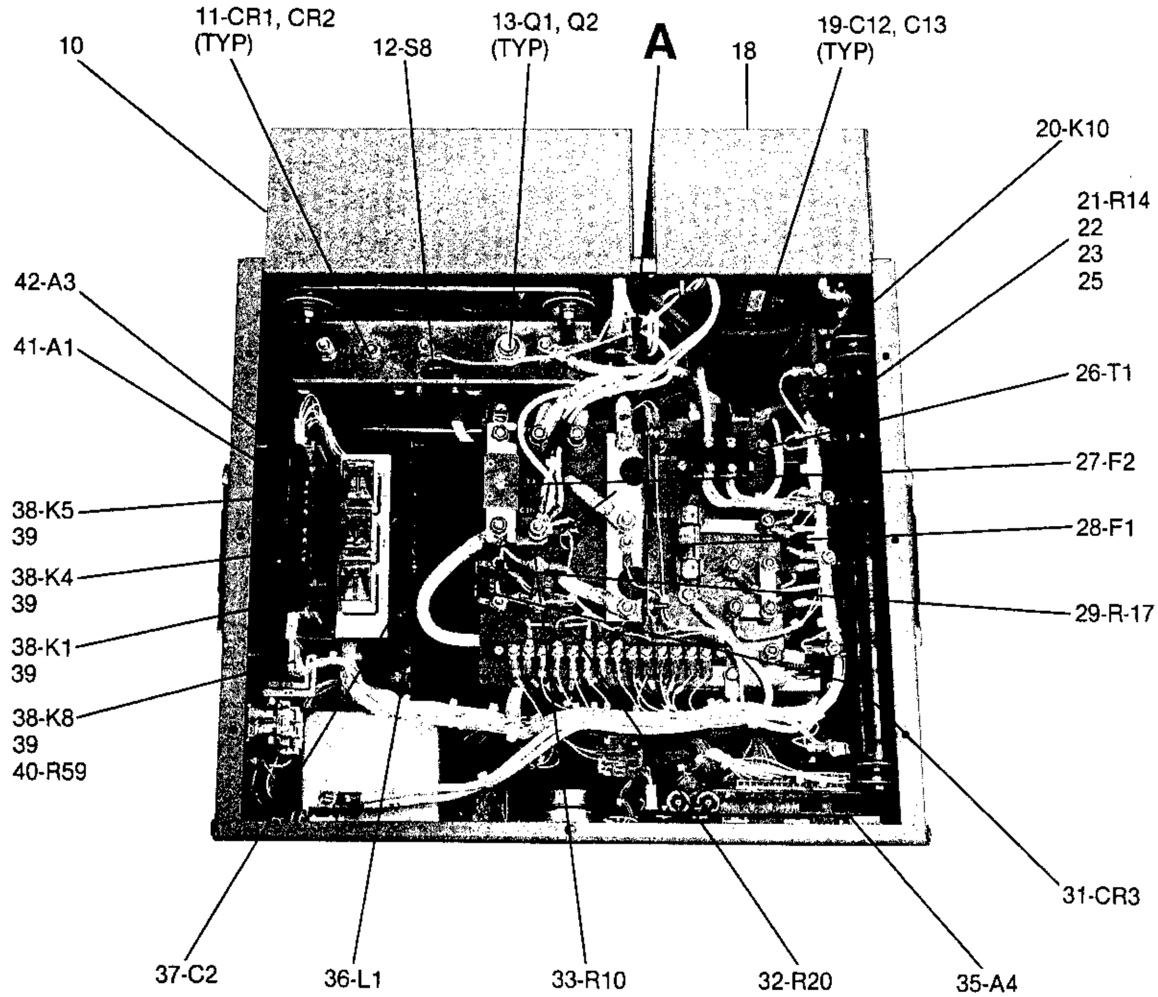


Figure 5-1. Replaceable Parts-Main Assembly (Sheet 2 of 4)

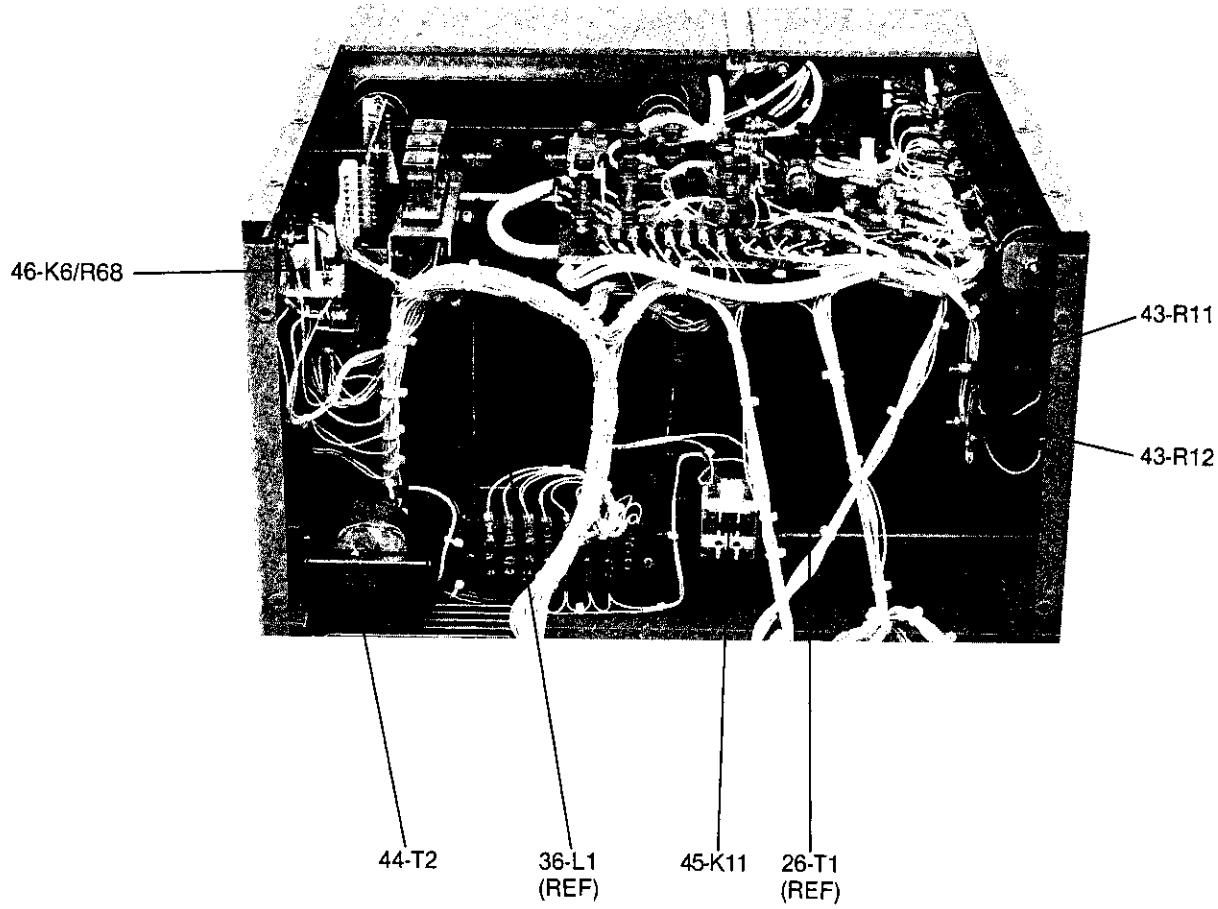


Figure 5-1. Replaceable Parts-Main Assembly (Sheet 3 of 4)

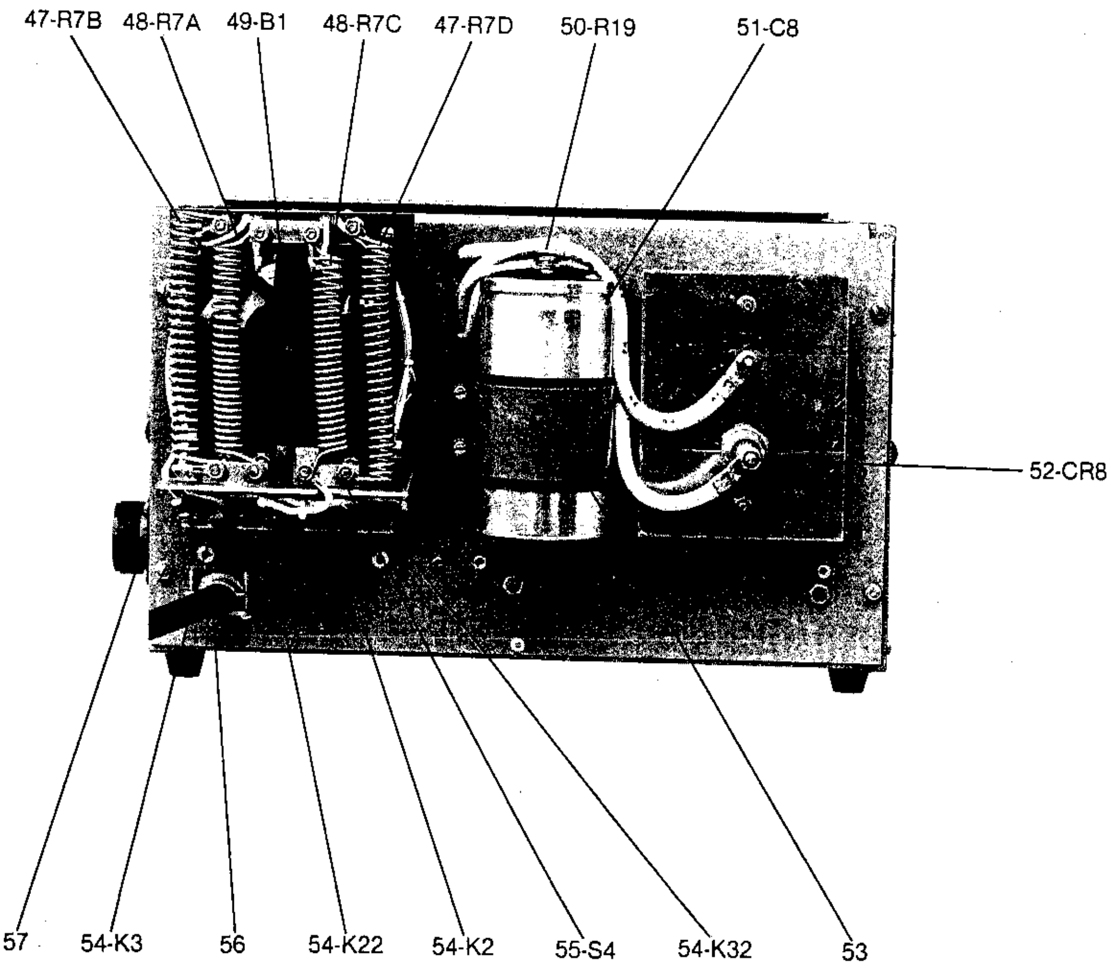


Figure 5-1. Replaceable Parts-Main Assembly (Sheet 4 of 4)

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-1	Model RF80H	CHARGER/ANALYZER, Battery, ReFLEX		Ref
-1	M114152-5	. DIAL, Timer, 50 Hz		1
-2	520510-007	. HANDLE		2
-3	C114209-1	. PANEL, Top		1
-4	116936-1	. INSTRUCTION SHEET, Operation		1
-5	S119598-1	. FRONT PANEL ASSEMBLY (See Figure 5-2 for detail breakdown)		1
-6	S117033-1	. LEG ASSEMBLY		2
-7	M116904-2	. CABLE ASSEMBLY, Battery, yellow-band		1
-8	526020-064	. PROBE SET, Cell-scanning, red and black lead		1
-9	M116905-2	. CABLE ASSEMBLY, Battery, twin-lead (Elcon-type connector)		1
-10	M116935-1	. HOUSING, Diode and capacitor		1
-11	541105-023	. DIODE, Silicon	CR1, CR2	2
-12	578800-041	. THERMOSTAT	S8	1
-13	541516-406	. SILICON CONTROLLED RECTIFIER	Q1, Q2	2
-14	555012-403	. RESISTOR	R18	1
-15	M117976-1	. TERMINAL BOARD	TB3	1

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-1				
-16	571150-004	. RELAY	K9	1
-17	541915-103	. PROTECTOR, Voltage surge	CR6	1
-18	M113737-1	. HOUSING, Discharge resistor		1
	S117034-1	. CAPACITOR ASSEMBLY		1
-19	530647-724	. . CAPACITOR	C12, C13	2
-20	571220-003	. RELAY	K10	1
-21	S119322-1	. RESISTOR ASSEMBLY	R14	1
-22	515810-501	. WASHER, Centering		2
-23	515811-902	. WASHER, Mica		2
-25	M100538-96	. ROD, Threaded		1
-26	W119525-1	. TRANSFORMER, Main	T1	1
	S119524-1	. TERMINAL BOARD ASSEMBLY, Transformer	TB1	1
-27	546191-041	. . FUSE, 100 Ampere	F2	1
-28	546130-013	. . FUSE, 30 Ampere	F1	1
-29	S117850-1	. . RESISTOR, Modified	R17	1
-31	S117029-1	. . DIODE, Modified	CR3	1
-32	S117028-1	. . RESISTOR, Modified	R20	1

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-1				
-33	119530-1	. . SHUNT	R10	2
-35	S116920-1	. CIRCUIT CARD ASSEMBLY	A4	1
-36	W116910-1	. REACTOR, Filter choke	L1	1
-37	530605-801	. CAPACITOR	C2	1
-38	571403-001	. RELAY	K1, K4, K5, K8	4
-39	524715-001	. SOCKET, Relay		4
-40	555152-103	. RESISTOR	R59	1
-41	S113950-5	. CIRCUIT CARD ASSEMBLY	A1	1
-42	S116913-2	. CIRCUIT CARD ASSEMBLY	A3	1
-43	555750-602	. RESISTOR	R11, R12	2
-44	587700-012	. TRANSFORMER	T2	1
-45	571210-019	. RELAY	K11	1
-46	S119323-1	. RELAY ASSEMBLY	R68, K6	1
-47	M114270-16	. RESISTOR, Discharge	R7B, R7D	2
-48	M114270-15	. RESISTOR, Discharge	R7A, R7C	2
-49	528010-007	. FAN ASSEMBLY	B1	1
-50	555013-204	. RESISTOR	R19	1
-51	530106-402	. CAPACITOR	C8	1

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-1				
-52	541106-013	. DIODE	CR8	1
-53	C116937-1	. CLAMP, Capacitor		1
-54	571150-004	. RELAY	K2, K3 K22, K32	4
-55	578800-041	. THERMOSTAT	S4	1
-56	M116980-1	. CABLE ASSEMBLY, AC Power		1
-57	M116979-1	. CONNECTOR		1

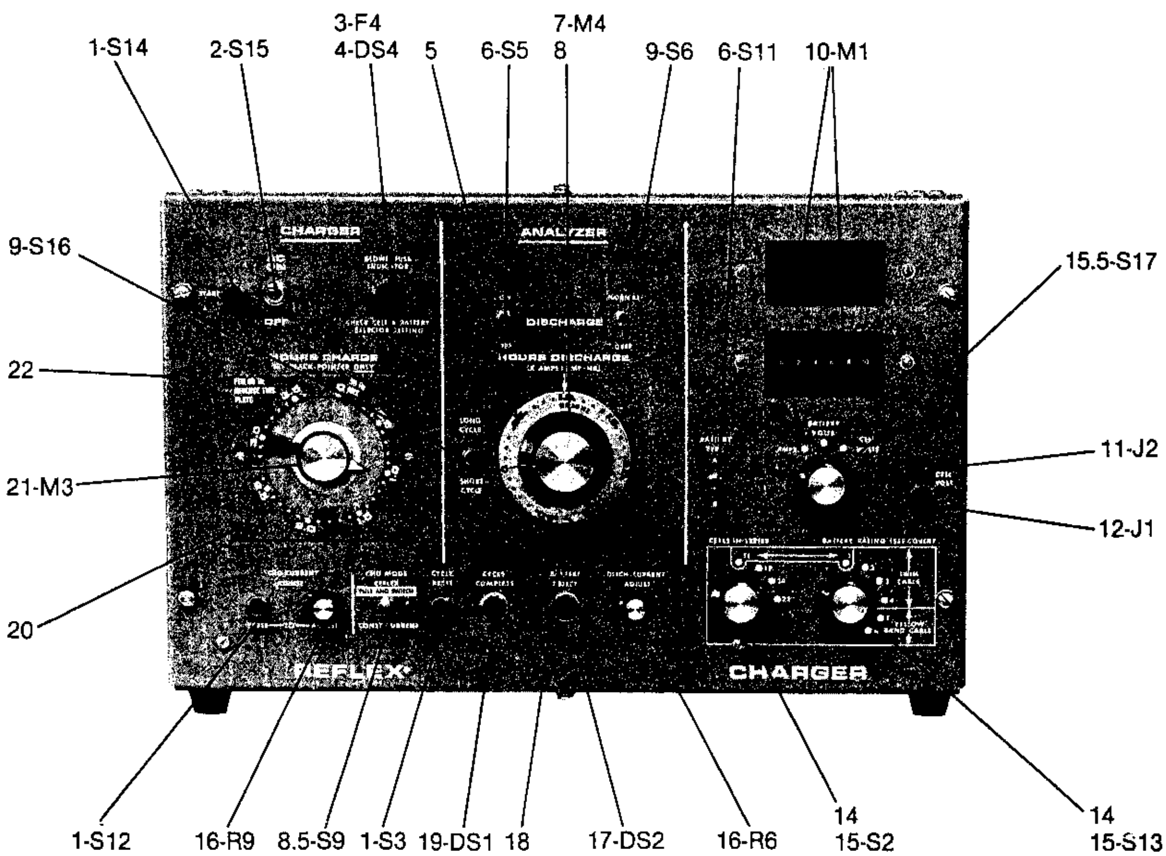


Figure 5-2. Replaceable Parts-Front Panel Assembly

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-2	S119598-1	FRONT PANEL ASSEMBLY (See Figure 5-2)		Ref
-1	578000-051	. SWITCH, momentary	S3, S12, S14	3
-1.5	578100-017	. BUTTON plus sleeve for "-1"	S3, S12, S14	1
-2	578711-017	. SWITCH, Toggle	S15	1
-3	546105-008	. FUSE, 5 Ampere	F4	1
-4	S116678-1	. FUSEHOLDER AND INDICATOR ASSEMBLY	DS4	1
-5	M114152-1	. DIAL, Timer, 60 Hz		1
-6	578712-008	. SWITCH, Toggle	S5, S11	2
-7	581130-005	. TIMER ASSEMBLY, Discharge, 3-hour	M4	1
-8	520570-045	. KNOB, Timer		1
-8.5	578742-008	. SWITCH	S9	1
-9	578732-007	. SWITCH, Toggle	S6, S16	2
-10	S119522-1	. DISPLAY ASSEMBLY	M1	1
-11	583100-025	. JACK, Test, Red	J2	1
-12	583100-024	. JACK, Test, Black	J1	1
-14	520570-046	. KNOB	S2, S13, S17	2
-15	578240-503	. SWITCH, Rotary	S2, S13	2
-15.5	S119600-1	. SWITCH, Rotary	S17	1

FIG. & INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REF DESIGNATION	QTY PER ASSY
5-2				
-16	565012-210	. RESISTOR, Variable	R6, R9	2
-17	546700-25	. INDICATOR, Assembly, Red	DS2	1
-18	515200-007	. CAP NUT, Nylon		1
-19	546700-034	. INDICATOR ASSEMBLY, Green	DS1	1
-20	C115902-2	. DIAL, Timer, 50/60 Hz		1
-21	581130-004	. TIMER ASSEMBLY, Charge, 3-hour	M3	1

MPTC - WACO

INDENTED BILL

DATE 11/28/01 TIME 14.13.56 PAGE 1 AMEF72
OPER CS

PARENT ITEM NO. 119443-001

DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000

QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
1	0010	TD-A6	OP MAN; RF80H	A B 54769	1.000	EA	2			.0	10/10/83	
.2	0010	000000-002	MISCELLANEOUS PAPER	A 2159	1.000	EA	4			.0	2/14/90	
1	0020	000000-001	HARDWARE		1.000	EA	4			.0	11/18/80	
1	0030	100126-014	SPACER	A C 5177	1.000	EA	4			.0	3/10/83	
1	0040	100126-064	SPACER	A C 5177	1.000	EA	2			.0	11/18/80	
.2	0030	507710-192	BAK BLK .1875		.170	FT	4			.0	10/12/90	
1	0050	100425-001	WASHER-SILASTIC	A D 5754	4.000	EA	4			.0	9/25/71	
1	0060	102404-001	BRKT MTG	1 8359(	2.000	EA	2			.0	5/21/76	
.2	0030	20196-023	STEEL CR .060 1008-1020	A R 52921	.020	SF	3			.0	10/12/90	
1	0070	102916-008	INSULATOR 8 POSN	E 2125	1.000	EA	2			.0	11/18/80	
.2	0010	102915-008	INSULATOR	D 2125	1.000	EA	2			.0	2/25/85	
..3	0010	507302-031	INSULATOR-1/32 GPO-2		.120	SF	4			.0	2/25/85	
1	0080	111820-001	NAMEPLATE UNIT	A H 23765	1.000	EA	4			.0	7/14/76	
1	0090	113950-005	A1 PCA (RF80-GT/H)	C J 23614	1.000	EA	2			.0	4/27/83	
.2	0010	113949-005	PRINTED WIRING BOARD (A1)	C G 23564	1.000	EA	4			.0	9/04/80	
.2	0020	518600-009	INSULATOR-PAD:TRANS;FLAT WAFER		7.000	EA	4			.0	9/04/80	
.2	0030	530101-215	CAP 100MF- 63V	A	2.000	EA	4			.0	9/04/80	
.2	0040	530601-616	CAP .1MF 100V	B 2221	3.000	EA	4			.0	1/01/76	
.2	0050	530602-003	CAP 2MF- 100V	. .	1.000	EA	4			.0	9/04/80	
.2	0060	530622-703	CAP.22MF-100V		2.000	EA	4			.0	9/04/80	
.2	0070	530622-801	CAP.022MF-100V 10% MYLAR		1.000	EA	4			.0	9/04/80	
.2	0080	541145-006	DIO BRDG 400V 2A	A	2.000	EA	4			.0	9/04/80	
.2	0090	541146-003	DIODE 400V-1A		5.000	EA	4			.0	9/04/80	
.2	0100	541210-048	IC- 741 OP-AMP		1.000	EA	4			.0	6/12/87	
.2	0110	541220-003	PHOTO TRANSISTOR	. .	1.000	EA	4			.0	9/04/80	
.2	0120	541336-701	TRANS-2N2905-60V-.60A	.	1.000	EA	4			.0	9/04/80	
.2	0130	541344-603	TRANS-2N1671B-30V-.05A-UNIJUNC		1.000	EA	4			.0	11/18/80	
.2	0140	541346-701	TRANS-2N2270-60V-1.OA		3.000	EA	4			.0	9/04/80	
.2	0150	541510-201	SCR-100V-1.0A-2N2324	A	2.000	EA	4			.0	9/04/80	
.2	0160	541706-204	DIODE-ZENER-6.2V-.4W-1N821		1.000	EA	4			.0	9/04/80	
.2	0170	541715-008	DIO ZNR 15V 2W	A	2.000	EA	4			.0	9/04/80	
.2	0180	541720-006	DIO 1N4747A ZENER	A	1.000	EA	4			.0	9/04/80	
.2	0190	541743-004	DIODE-1N4755-43V-1W	. .	1.000	EA	4			.0	9/04/80	
.2	0200	555001-001	RES 1/2W 5% 1 OHM		2.000	EA	4			.0	9/09/82	
.2	0210	555001-011	RES .5W 2.7 5%	.	1.000	EA	4			.0	9/09/82	
.2	0220	555001-042	RES .5W 51 5%	.	3.000	EA	4			.0	9/15/82	
.2	0230	555001-057	RES; 220- .5W- 5%	.	3.000	EA	4			.0	9/09/82	
.2	0240	555001-065	RES .5W 470 5%	.	1.000	EA	4			.0	9/15/82	
.2	0250	555001-069	RES .5W 680 5%	.	1.000	EA	4			.0	9/15/82	
.2	0260	555001-073	RES CF 1.0K OHM- 1/2W- 5%	.	7.000	EA	4			.0	8/17/82	
.2	0270	555001-075	RES .5W 1.2K 5%	.	1.000	EA	4			.0	8/24/82	
.2	0280	555001-081	RES- 2.2K 1/2W 5%	.	2.000	EA	4			.0	9/09/82	
.2	0290	555001-085	RES .5W 3.3K 5%	.	1.000	EA	4			.0	9/14/82	
.2	0300	555001-089	RES .5W 4.7K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0310	555001-097	RES .5W 10K 5%	.	6.000	EA	4			.0	8/17/82	
.2	0320	555001-121	RES- 100K OHM- 1/2W- 5%	.	1.000	EA	4			.0	8/17/82	
.2	0330	555001-161	RES- 4.7M 1/2W 5%	.	1.000	EA	4			.0	9/15/82	

PARENT ITEM NO. 119443-001 | DESCRIPTION RF80-H CHRISTIE | ENGR DRAW L 23552 | STANDARD BATCH QUANTITY 1.000 | QTY 1 | ITEM TYPE 1 | UNIT MEAS EA | LOW LEVEL 01

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0340	555013-207	RES 2W-1000 OHMS		1.000	EA	4			.0	9/04/80	
.2	0350	555332-402	RES 3.3KOHMS 6W	A	1.000	EA	4			.0	9/04/80	
.2	0360	555641-401	RES 649OHM 4W 1%	A	1.000	EA	4			.0	9/04/80	
.2	0370	565014-208	RES 10K VAR 15TURN	A	2.000	EA	4			.0	9/04/80	
.2	0380	565054-204	RES-VAR-50K-10%-15 TURN		1.000	EA	4			.0	9/04/80	
1	0100	114152-005	DIAL-TIMER 50HZ	B 1392	1.000	EA	2			.0	11/18/80	
.2	0010	114150-003	NAME PLATE	O RIGIN	1.000	EA	4			.0	1/01/70	
.2	0020	114151-001	KNOB		1.000	EA	4			.0	1/01/70	
1	0120	114926-001	GLASS WASHER	C 2025	1.000	EA	2			.0	11/18/80	
.2	0030	507302-091	POL GLASS3/32		.010	SF	4			.0	10/12/90	
1	0140	116686-001	STICKER WARNING		1.000	EA	4			.0	11/18/80	
1	0150	116904-002	CABLE ASSY	A E 23596	1.000	EA	2			.0	11/18/80	
.2	0020	507717-370	TUBING HT SHRINK	B 2221	.200	FT	4			.0	10/12/90	
.2	0030	507717-913	SLEEVE-HEAT SHRINKABLE;1	1265	.160	FT	4			.0	8/04/86	
.2	0040	511112-005	CABLE #12/2		6.000	FT	4			.0	9/11/80	
.2	0050	524206-006	CONN 6PIN MS3106	A	1.000	EA	4			.0	9/11/80	
.2	0060	524620-009	CABLE CLAMP	A	1.000	EA	4			.0	9/11/80	
.2	0080	583212-004	TRMNL-LUG:INS;RNG;TAP;12/10AW;		2.000	EA	4			.0	10/12/90	
.2	0090	511310-162	WIRE- #16 AWG- TEFLON- RED		.160	FT	4			.0	8/07/96	
.2	0100	511901-103	SOLDER RESIN		.050	LB	4			.0	8/07/96	
1	0160	116905-002	ASSY- DC CABLE	A F 23596	1.000	EA	2			.0	11/18/80	
.2	0010	106694-001	LABEL-NEG.	B 1929	1.000	EA	4			.0	9/11/80	
.2	0020	106695-001	LABEL-POS.	C 1929	1.000	EA	4			.0	9/11/80	
.2	0040	507717-502	SLV.BLK. .5 ID	B 2241	.250	FT	4			.0	10/12/90	
.2	0050	511104-005	CABLE #4 DUPLEX		6.000	FT	4			.0	9/11/80	
.2	0060	524102-010	PLUG-QIK DISC		1.000	EA	4			.0	9/11/80	
.2	0070	524206-006	CONN 6PIN MS3106	A	1.000	EA	4			.0	9/11/80	
.2	0080	524620-009	CABLE CLAMP	A	1.000	EA	4			.0	9/11/80	
.2	0090	583704-006	TRMNL-LUG:NINS;SDRLS;RING;BRZD		2.000	EA	4			.0	9/11/80	
.2	0100	511310-162	WIRE- #16 AWG- TEFLON- RED		.166	FT	4			.0	8/07/96	
.2	0110	507717-505	HEATSHRINK- .50 ID- BLK	23713	.166	FT	4			.0	8/07/96	
.2	0120	511901-103	SOLDER RESIN		.050	LB	4			.0	8/07/96	
1	0170	116910-001	CHOKE T3565-1 S145	D REDR	1.000	EA	2			.0	4/27/83	
.2	0010	101166-038	WEDGE,ALUM, 1"X4"X.25"	C R 20883	2.000	EA	4			.0	1/01/70	
.2	0020	105766-001	BRKT	B 813	4.000	EA	2			.0	1/01/70	
..3	0030	502213-051	HRS STR 3/16X 5/8 HRS PER		2.440	FT	4			.0	10/12/90	
.2	0040	112307-001	INSUL.	C 1956	4.000	EA	2			.0	1/01/76	
..3	0030	504640-632	.06 THICK ALUM.	2224	.120	SF	4			.0	10/12/90	
.2	0060	507302-062	MAT GLASS1/16		.400	SF	4			.0	10/12/90	
.2	0080	507319-014	NOMEX .010 THK		1.480	SF	4			.0	10/12/90	
.2	0100	507531-002	TAPE-GLASS CLOTH- 1		.050	RL	4			.0	10/12/90	
.2	0120	507540-601	TAPE 1/2W GLASS	A	.100	RL	4			.0	10/12/90	
.2	0140	507540-602	UNTR GLASS 1		.090	RL	4			.0	10/12/90	
.2	0160	509503-003	POLY VARNISH	O RIGIN	.100	GL	4			.0	10/12/90	
.2	0200	511506-051	MAG WIRE #5 SQ		9.600	LB	4			.0	10/12/90	
.2	0220	511901-101	SOLDER SILVER		.100	LB	4			.0	10/12/90	
.2	0240	583704-004	TRMNL-NINS;SDRLS;RING;4AWG;1/4		2.000	EA	4			.0	10/12/90	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1
ITEM TYPE 1
UNIT MEAS EA
LOW LEVEL 01

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0250	587312-301	XFMR-LAM:EI;2-1/4;M6;29 GA		20.600	LB	4			.0	1/01/70	
.2	0270	507704-382	RUBR GLSS .38		.750	FT	4			.0	10/12/90	
.2	0290	507510-104	UN GL EC9-4-U		.010	RL	4			.0	10/12/90	
1	0180	116913-002	A3 PCA (RF80-GT/H)	C K 23185	1.000	EA	2			.0	4/27/83	
.2	0010	116914-001	PR.WIRING BRD	J 2107	1.000	EA	4			.0	11/21/83	
.2	0020	507715-041	VNYL CLR .04		.540	FT	4			.0	6/12/87	
.2	0030	518600-009	INSULATOR-PAD:TRANS;FLAT WAFER		7.000	EA	4			.0	1/01/70	
.2	0040	520900-007	HEATSINK		1.000	EA	4			.0	1/01/70	
.2	0050	524709-003	PLUG BOARD		2.000	EA	4			.0	1/01/70	
.2	0060	530101-105	CAP 10MF- 50V		4.000	EA	4			.0	11/21/83	
.2	0070	530101-215	CAP 100MF- 63V	A	1.000	EA	4			.0	11/21/83	
.2	0080	530105-004	CAP 5MF- 150V	.	1.000	EA	4			.0	11/21/83	
.2	0090	530601-006	CAP 1MF- 100V	23543	1.000	EA	4			.0	11/21/83	
.2	0100	530601-610	CAP.10MF-200V		2.000	EA	4			.0	11/21/83	
.2	0110	530601-615	CAP .1MF-400V		1.000	EA	4			.0	7/30/79	
.2	0120	530633-801	CAP.033MF-100V		2.000	EA	4			.0	11/21/83	
.2	0130	530647-725	CAP.47MF-100V		1.000	EA	4			.0	11/21/83	
.2	0140	541146-003	DIODE 400V-1A		13.000	EA	4			.0	11/21/83	
.2	0150	541210-048	IC- 741 OP-AMP		2.000	EA	4			.0	6/12/87	
.2	0160	541336-701	TRANS-2N2905-60V-.60A	.	3.000	EA	4			.0	11/21/83	
.2	0170	541346-802	TRANS 75VOLTS		1.000	EA	4			.0	11/21/83	
.2	0180	541510-104	SCR 50V 1.6A	B 23544	2.000	EA	4			.0	11/21/83	
.2	0190	541530-801	TRIAC 400V 1.6 AMPERE,400VRMS	B 2132	1.000	EA	4			.0	11/21/83	
.2	0200	541706-204	DIODE-ZENER-6.2V-.4W-1N821		1.000	EA	4			.0	11/21/83	
.2	0210	541715-008	DIO ZNR 15V 2W	A	2.000	EA	4			.0	11/21/83	
.2	0220	555001-011	RES .5W 2.7 5%	.	1.000	EA	4			.0	9/09/82	
.2	0230	555001-042	RES .5W 51 5%	.	1.000	EA	4			.0	9/15/82	
.2	0240	555001-061	RES .5W 330 5%	.	3.000	EA	4			.0	9/14/82	
.2	0250	555001-067	RES .5W 560 5%	.	1.000	EA	4			.0	9/14/82	
.2	0260	555001-073	RES CF 1.0K OHM- 1/2W- 5%	.	7.000	EA	4			.0	9/14/82	
.2	0270	555001-077	RES .5W 1.5K 5%	.	6.000	EA	4			.0	9/09/82	
.2	0280	555001-087	RES .5W 3.9K 5%	.	2.000	EA	4			.0	9/14/82	
.2	0290	555001-089	RES .5W 4.7K 5%	.	2.000	EA	4			.0	9/15/82	
.2	0300	555001-092	RES .5W 6.2K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0310	555001-094	RES .5W 7.5K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0320	555001-097	RES .5W 10K 5%	.	6.000	EA	4			.0	8/17/82	
.2	0330	555001-101	RES .5W 15K 5%	.	1.000	EA	4			.0	9/09/82	
.2	0340	555001-103	RES .5W 18K 5%	.	2.000	EA	4			.0	9/09/82	
.2	0350	555001-104	RES .5W 20K 5%	.	1.000	EA	4			.0	8/24/82	
.2	0360	555001-105	RES .5W 22K 5%	.	2.000	EA	4			.0	9/09/82	
.2	0370	555001-109	RES .5W 33K 5%	.	1.000	EA	4			.0	9/14/82	
.2	0380	555001-114	RES CF 51K .5W 5%		1.000	EA	4			.0	7/12/83	
.2	0390	555001-117	RES .5W 68K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0400	555001-121	RES- 100K OHM- 1/2W- 5%	.	1.000	EA	4			.0	8/17/82	
.2	0410	555001-137	RES .5W 470K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0420	555001-145	RES- 1M OHM- 1/2W- 5%	.	1.000	EA	4			.0	8/17/82	
.2	0430	555013-301	RES 3W-1000 OHMS	A	1.000	EA	4			.0	11/21/83	

MPTC - WACO

INDENTED BILL

DATE 11/28/01 TIME 14.13.56 PAGE 4 AMEF72
OPER CS

PARENT ITEM NO.
119443-001

DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000

QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0440	555223-301	RES 4W-22000 OHMS		1.000	EA	4			.0	11/21/83	
.2	0450	555821-203	RES- 820 OHMS- 2W- 5%		1.000	EA	4			.0	11/21/83	
.2	0460	565013-208	RES-VAR-1K-20%-15 TURN	A	1.000	EA	4			.0	11/21/83	
.2	0470	565014-208	RES 10K VAR 15TURN	A	3.000	EA	4			.0	11/21/83	
.2	0480	565024-202	RES 1W 20K 10%		2.000	EA	4			.0	11/21/83	
.2	0490	565053-206	RES-VAR-5K-10%-	A	3.000	EA	4			.0	11/21/83	
.2	0500	565054-204	RES-VAR-50K-10%-15 TURN		1.000	EA	4			.0	11/21/83	
1	0190	116920-001	A4 PCA (RF80-GT/H)		1.000	EA	2			.0	4/27/83	
.2	0010	116919-001	PRINTED WIRING BOA		1.000	EA	4			.0	1/01/70	
.2	0020	524709-003	PLUG BOARD		4.000	EA	4			.0	1/01/70	
.2	0030	530122-102	CAP 220MF 63V	A	1.000	EA	4			.0	11/21/83	
.2	0040	530601-616	CAP .1MF 100V	B 2221	1.000	EA	4			.0	4/16/82	
.2	0050	530622-706	CAP.22MF-100V		1.000	EA	4			.0	11/21/83	
.2	0060	555001-080	RES .5W 2K 5%	.	1.000	EA	4			.0	8/24/82	
.2	0070	555001-087	RES .5W 3.9K 5%	.	1.000	EA	4			.0	9/14/82	
.2	0080	555001-109	RES .5W 33K 5%	.	1.000	EA	4			.0	9/14/82	
.2	0090	555001-117	RES .5W 68K 5%	.	1.000	EA	4			.0	9/15/82	
1	0200	116925-001	BRKT-FT COMPONENT		1.000	EA	2			.0	11/18/80	
.2	0030	502108-082	ANGLE 1X1X3/16		1.400	FT	4			.0	10/12/90	
1	0210	116926-001	BRKT-REAR COMP		1.000	EA	2			.0	11/18/80	
.2	0030	502108-082	ANGLE 1X1X3/16		1.400	FT	4			.0	10/12/90	
1	0220	116936-001	BATTERY LABEL (RF80-H)		1.000	EA	4			.0	2/19/72	
1	0230	116978-001	BRKT-SIDE	B 199	2.000	EA	2			.0	4/09/82	
.2	0040	502106-061	ANGLE 3/4X3/4X1/8		2.260	FT	4			.0	10/12/90	
1	0240	116979-001	RECEPT. ASSY	C 2043	1.000	EA	2			.0	11/18/80	
.2	0020	121348-001	WIRE HARNESS		1.000	EA	0			.0	10/12/90	
..3	0020	511311-061	WIRE #6 WHT- VINYL	23557	4.500	FT	4			.0	10/12/90	
..3	0040	583706-005	TRMNL-LUG:NINS;SDRLS;6AWG;1/4S	A	3.000	EA	4			.0	10/12/90	
.2	0040	507717-370	TUBING HT SHRINK	B 2221	.250	FT	4			.0	10/12/90	
.2	0060	507717-502	SLV.BLK. .5 ID	B 2241	.250	FT	4			.0	10/12/90	
.2	0070	524306-004	BOX MOUNT	A	1.000	EA	4			.0	1/01/70	
1	0250	116980-001	ASSY- AC INPUT CABLE- RF80-GT/ D	C 23678	1.000	EA	2			.0	11/18/80	
.2	0010	511112-004	CABLE, TYPE 500W, 12 AWG, 3		6.000	FT	4			.0	8/25/79	
.2	0040	583212-011	TRMNL-LUG:INS;12/10AWG;10STD;0		1.000	EA	4			.0	10/12/90	
.2	0060	583712-014	TRMNL-LUG:NINS;SDLS;PARA CON;B		2.000	EA	4			.0	10/12/90	
1	0260	117028-001	RESISTOR		1.000	EA	2			.0	10/14/71	
.2	0010	507706-031	TEFLN WHT #20		.210	FT	4			.0	7/13/76	
.2	0020	555001-017	RES .5W 4.7 5%	.	1.000	EA	4			.0	9/15/82	
.2	0040	583718-009	TRMNL-LUG:NINS;SDLS;RING;BRZD;		2.000	EA	4			.0	10/12/90	
1	0270	117029-001	DIODE (MOD)	B 1924	1.000	EA	2			.0	10/14/71	
.2	0010	541146-009	DIODE 400V-3A		1.000	EA	4			.0	4/13/80	
.2	0020	583718-001	TRMNL-LUG:NINS;SDLS;RING;BRZD;		2.000	EA	4			.0	7/13/76	
1	0280	117033-001	LEG-ASSEMBLY		2.000	EA	2			.0	11/18/80	
.2	0010	117013-001	BRACKET	A 83/2	2.000	EA	2			.0	1/01/70	
..3	0030	502611-192	HRS SHT .1196 11GA		.280	SF	4			.0	10/12/90	
.2	0020	520650-004	FEET-BLK-POLY-PLASTIC BMPR		4.000	EA	4			.0	1/01/70	
1	0290	117212-001	STICKER-CAUTION		1.000	EA	4			.0	11/18/80	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
1	0300	117373-001	DUST COVER	E 2253	1.000	EA	2			.0	3/10/83	
.2	0010	520300-042	DUST COVER	2253	1.000	EA	4			.0	7/30/79	
1	0310	117441-001	PANEL-TOP		1.000	EA	2			.0	11/18/80	
.2	0030	502620-481	SS SHT .048 18 GA		1.770	SF	4			.0	10/12/90	
1	0320	117442-001	PANEL-BOTTOM	E 199	1.000	EA	2			.0	11/18/80	
.2	0010	101368-003	RIVNUT S10-80		1.000	EA	4			.0	4/09/82	
.2	0020	117442-002	PANEL BOTTOM	E 199	1.000	EA	2			.0	4/09/82	
..3	0010	504640-632	.06 THICK ALUM.	2224	2.100	SF	4			.0	4/09/82	
1	0330	117445-001	STICKER-PATENT		1.000	EA	4			.0	11/18/80	
1	0340	117489-001	SIDE PANEL ASSY LT	A 2182	1.000	EA	2			.0	11/18/80	
.2	0010	116958-001	PLATE		1.000	EA	2			.0	1/01/70	
..3	0030	20196-022	STEEL CR .048 1008-1020	A R 52921	.130	SF	3			.0	10/12/90	
.2	0020	117463-001	PANEL SIDE LEFT	C C 23688	1.000	EA	2			.0	1/01/70	
..3	0010	101368-003	RIVNUT S10-80		7.000	EA	4			.0	4/09/82	
..3	0020	117463-002	PANEL-LEFT SIDE	B 199	1.000	EA	0			.0	4/09/82	
...4	0010	20196-022	STEEL CR .048 1008-1020	A R 52921	1.250	SF	3			.0	4/09/82	
.2	0030	520510-007	HANDLE		1.000	EA	4			.0	8/13/87	
1	0350	117822-001	REAR PNL ASSY	P 2277	1.000	EA	2			.0	11/18/80	
.2	0010	111947-001	HEATSINK	J 1876	2.000	EA	2			.0	1/01/70	
..3	0030	505511-291	COPPER .1294		.660	SF	4			.0	10/12/90	
.2	0020	111947-002	HEATSINK	J 1876	2.000	EA	2			.0	1/01/70	
..3	0030	505511-291	COPPER .1294		.660	SF	4			.0	10/12/90	
.2	0030	111957-002	SCREW SPLNE 1/4-2X1 1/4		1.000	EA	4			.0	9/22/86	
.2	0040	113128-001	STICKER-GRD GROUND	B 2287	1.000	EA	4			.0	9/15/83	
.2	0050	113736-001	INSULATOR MTG		1.000	EA	2			.0	1/01/70	
..3	0030	507302-130	1/8 GPO-2		.020	SF	4			.0	10/12/90	
.2	0060	114210-001	BRACKET		1.000	EA	2			.0	1/01/70	
..3	0030	20196-022	STEEL CR .048 1008-1020	A R 52921	.040	SF	3			.0	10/12/90	
.2	0070	114215-001	TIE BAR		1.000	EA	2			.0	1/01/70	
..3	0031	502620-252	SS SHT 0.025		.010	SF	4			.0	8/15/96	
.2	0080	114215-002	TIE BAR		2.000	EA	2			.0	1/01/70	
..3	0031	502620-252	SS SHT 0.025		.020	SF	4			.0	8/15/96	
.2	0090	114216-001	INSULATOR TOP		1.000	EA	2			.0	1/01/70	
..3	0030	507302-130	1/8 GPO-2		.030	SF	4			.0	10/12/90	
.2	0100	114218-001	INSULATOR		1.000	EA	2			.0	1/01/70	
..3	0030	507302-091	POL GLASS3/32		.130	SF	4			.0	10/12/90	
.2	0110	114270-015	DISCHARGE RESISTOR		2.000	EA	4			.0	1/01/70	
.2	0120	114270-016	DISCHARGE RESISTOR		2.000	EA	4			.0	1/01/70	
.2	0130	114326-001	INSULATOR MTG	B 83/3	8.000	EA	2			.0	1/01/70	
..3	0030	507302-061	INSULATOR-1/16 GPO-2		.160	SF	4			.0	10/12/90	
.2	0140	114467-001	BAFFLE		1.000	EA	2			.0	1/01/70	
..3	0031	502620-252	SS SHT 0.025		.010	SF	4			.0	8/15/96	
.2	0150	114926-001	GLASS WASHER	C 2025	4.000	EA	2			.0	1/01/70	
..3	0030	507302-091	POL GLASS3/32		.040	SF	4			.0	10/12/90	
.2	0160	116857-001	INSULATOR		1.000	EA	2			.0	1/01/70	
..3	0030	507302-031	INSULATOR-1/32 GPO-2		.010	SF	4			.0	10/12/90	
.2	0170	116937-001	CLAMP- CAPACITOR	A D 23579	1.000	EA	2			.0	1/01/70	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000

QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
..3	0010	20196-022	STEEL CR .048 1008-1020	A R 52921	.170	SF	3			.0	3/20/98	
.2	0180	116938-001	HEATSINK	B 2267	1.000	EA	2			.0	1/01/70	
..3	0030	504601-251	ALUM SHT .125		.200	SF	4			.0	10/12/90	
.2	0190	116940-001	REAR PNL ASSY	D 2080	1.000	EA	2			.0	1/01/70	
..3	0010	101368-005	RIVNUT S10-180		2.000	EA	4			.0	3/02/84	
..3	0020	116940-020	REAR PNL-FAB	D 2080	1.000	EA	0			.0	3/02/84	
...4	0010	504641-252	ALUM SHEET-0.125		1.200	SF	4			.0	3/02/84	
..3	0030	515200-030	NUTSERT #10-32		4.000	EA	4			.0	3/02/84	
.2	0200	116977-001	INSULATOR	A A ORGNL	1.000	EA	2			.0	1/01/70	
..3	0030	507304-012	INSULATION- SHEET		.190	SF	4			.0	10/12/90	
.2	0210	117976-001	INSULATOR TB3		1.000	EA	2			.0	1/01/70	
..3	0030	507302-191	GLASS POLY- 3/16 THK- GPO-2		.070	SF	4			.0	10/12/90	
.2	0220	118020-001	HARNESS	D 2090	1.000	EA	2			.0	1/01/70	
..3	0020	511328-201	WIRE #20 WHT		3.630	FT	4			.0	10/12/90	
..3	0040	511328-221	WIRE #22 WHT		19.710	FT	4			.0	10/12/90	
..3	0050	518900-009	CABLE TIE	A	20.000	EA	4			.0	1/01/76	
..3	0060	524640-028	HOUSING PLUG		1.000	EA	4			.0	4/27/83	
..3	0080	524900-041	MALE PIN		15.000	EA	4			.0	10/12/90	
..3	0090	583224-001	TRMNL-LUG:INS;RING;24/20WG;6ST	23719	4.000	EA	4			.0	5/02/84	
..3	0100	583224-003	TRMNL-LUG:INS;RING;24/20AWG;10	23719	1.000	EA	4			.0	12/15/80	
.2	0230	118020-002	WIRE SET	E 2271	1.000	EA	2			.0	12/16/80	
..3	0020	507701-201	SLV WHT .20ID		2.000	FT	4			.0	10/12/90	
..3	0040	511311-061	WIRE #6 WHT- VINYL	23557	2.170	FT	4			.0	10/12/90	
..3	0060	511311-101	WIRE #10 WHT VINYL,STRANDED		2.000	FT	4			.0	10/12/90	
..3	0080	511325-101	WIRE #10 WHT		1.710	FT	4			.0	10/12/90	
..3	0100	511325-141	WIRE #14 WHT		10.800	FT	4			.0	10/12/90	
..3	0120	583212-001	TRMNL-LUG:INS;RING;12AWG;6STD;		2.000	EA	4			.0	10/12/90	
..3	0140	583212-003	TRMNL-LUG:INS;RNG;TAP;10/12WG;		3.000	EA	4			.0	10/12/90	
..3	0160	583212-011	TRMNL-LUG:INS;12/10AWG;10STD;0		1.000	EA	4			.0	10/12/90	
..3	0170	583706-004	TRMNL-LUG:NINS;SDLS;RING;BRZD;		1.000	EA	4			.0	9/17/71	
..3	0190	583706-005	TRMNL-LUG:NINS;SDRLS;6AWG;1/4S	A	3.000	EA	4			.0	10/12/90	
..3	0210	583716-002	TRMNL-LUG:NINS;SDRLS;RING;BRZD		4.000	EA	4			.0	10/12/90	
.2	0240	515813-403	WASHER NYLON		4.000	EA	4			.0	1/01/70	
.2	0250	515900-036	FITTING- 3/4 IN- CABLE GRIP	A	1.000	EA	4			.0	1/01/70	
.2	0260	518506-081	CLAMP-GROMMET:1/2 GRV X 3/8 X		3.000	EA	4			.0	1/01/70	
.2	0270	518506-101	CLAMP-GROMMET:5/8 GRV X 1/2 X		2.000	EA	4			.0	1/01/70	
.2	0290	518900-008	CABLE TIE:TY-RAP;4.45 MIN LOC		3.000	EA	4			.0	10/12/90	
.2	0300	518900-009	CABLE TIE	A	15.000	EA	4			.0	1/30/81	
.2	0310	528010-007	FAN ASSY	A D 23421	1.000	EA	4			.0	1/01/70	
.2	0320	530106-402	530601-012- 45V	. .	1.000	EA	4			.0	1/01/70	
.2	0330	530601-617	CAP .1MF50VDC		2.000	EA	4			.0	8/12/86	
.2	0340	541106-013	DIODE 400V 125A	. .	1.000	EA	4			.0	1/12/83	
.2	0390	541108-004	DIODE-PWR-600V-70A	. .	2.000	EA	4			.0	10/10/90	
.2	0400	541516-406	SCR 200V- 80A	. .	2.000	EA	4			.0	1/01/70	
.2	0410	541915-103	PROTECTOR VOLTAGE SURGE		1.000	EA	4			.0	1/01/70	
.2	0420	555012-403	RES 100 OHM 5W 5%	A	1.000	EA	4			.0	3/30/80	
.2	0430	555013-204	RES:2W;1000 OHMS;10% TOL	A	1.000	EA	4			.0	3/30/80	

PARENT ITEM NO. 119443-001 DESCRIPTION RF80-H CHRISTIE QTY 1 ITEM TYPE 1 LOW LEVEL 01
ENGR DRAW L 23552 UNIT MEAS EA
STANDARD BATCH QUANTITY 1.000

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0440	571150-004	RELAY SPST 120V		5.000	EA	4			.0	1/01/70	
.2	0450	578800-041	SW-THRML:SPST NC;150F-130F;120	. .	2.000	EA	4			.0	1/01/70	
.2	0460	111957-001	SPLINE SCREW;1/4-20 X 1-1/4 LG		1.000	EA	4			.0	11/09/89	
.2	0470	518900-006	CABLE TIE:TY-RAP;5.5 MTG		4.000	EA	4			.0	11/09/89	
.2	0480	121539-001	AIR BAFFLE RF-80	B 2277	1.000	EA	2			.0	1/17/90	
..3	0010	000000-004	COST COMPONENT		1.000	EA	4			.0	1/01/89	
..3	0040	504640-503	ALUM SHT .050		.110	SF	4			.0	10/12/90	
1	0360	117823-001	SIDE PANEL ASSY RT	A 2182	1.000	EA	2			.0	11/18/80	
.2	0010	116958-001	PLATE		1.000	EA	2			.0	1/01/70	
..3	0030	20196-022	STEEL CR .048 1008-1020	A R 52921	.130	SF	3			.0	10/12/90	
.2	0020	117453-001	PNL-RITE SIDE-ASSY	B 199	1.000	EA	2			.0	1/01/70	
..3	0010	101368-003	RIVNUT S10-80		7.000	EA	4			.0	4/09/82	
..3	0020	117453-002	RIGHT PANEL	B 199	1.000	EA	0			.0	4/09/82	
...4	0010	20196-022	STEEL CR .048 1008-1020	A R 52921	1.250	SF	3			.0	4/09/82	
.2	0030	520510-007	HANDLE		1.000	EA	4			.0	8/13/87	
1	0370	117850-001	RESISTOR (MOD)		1.000	EA	2			.0	10/14/71	
.2	0010	507706-031	TEFLN WHT #20		.080	FT	4			.0	4/13/80	
.2	0020	555331-302	RES-3W;330 OHMS;5% TOL		1.000	EA	4			.0	4/13/80	
.2	0030	583718-013	TRMNL-LUG:NINS;SDLS;RING;BRZD;		2.000	EA	4			.0	4/13/80	
1	0380	118034-001	BRKT-RELAY		1.000	EA	2			.0	11/18/80	
.2	0030	20196-023	STEEL CR .060 1008-1020	A R 52921	.070	SF	3			.0	10/12/90	
1	0390	119322-001	RESISTOR (MOD)		1.000	EA	2			.0	4/27/83	
.2	0010	100538-096	ROD	A F 23688	1.000	EA	2			.0	4/13/80	
..3	0030	502549-043	THREADED ROD 10-32 ZINC-PLATED		1.000	FT	4			.0	10/12/90	
.2	0020	515810-501	WASHER STEEL		2.000	EA	4			.0	4/13/80	
.2	0030	515811-902	WASHER MICA	.	2.000	EA	4			.0	4/13/80	
.2	0040	555051-006	RES 225W- 50 OHMS		1.000	EA	4			.0	4/13/80	
1	0400	119323-001	ASSY RELAY (K6)	D 2231	1.000	EA	2			.0	4/27/83	
.2	0010	116883-001	INS MTG RELAY	C 1590	1.000	EA	2			.0	4/13/80	
..3	0010	116883-002	RELAY-FAB	C 1590	1.000	EA	0			.0	12/07/83	
...4	0010	507302-191	GLASS POLY- 3/16 THK- GPO-2		.030	SF	4			.0	12/07/83	
.2	0020	117031-001	RESISTOR MODIFIED	A	1.000	EA	2			.0	4/13/80	
..3	0010	555001-097	RES .5W 10K 5%	.	1.000	EA	4			.0	8/17/82	
..3	0020	583718-013	TRMNL-LUG:NINS;SDLS;RING;BRZD;		1.000	EA	4			.0	1/01/70	
..3	0030	507706-031	TEFLN WHT #20		.210	FT	4			.0	10/01/90	
.2	0030	571210-019	RLY DPDT 120VAC	A	1.000	EA	4			.0	6/12/87	
1	0410	119521-001	FRNT PNL ASSY	J 23604	1.000	EA	2			.0	11/18/80	
.2	0010	100126-064	SPACER	A C 5177	2.000	EA	2			.0	9/11/80	
..3	0030	507710-192	BAK BLK .1875		.340	FT	4			.0	10/12/90	
.2	0020	113969-001	TIMER DIAL	C 1658	1.000	EA	2			.0	9/11/80	
..3	0030	502620-121	SS SHT .012 30GA, 18-8 TYPE	D 83/2	.080	SF	4			.0	10/12/90	
.2	0030	114152-001	DIAL-TIMER 60HZ	B 1392	1.000	EA	2			.0	2/25/81	
..3	0010	114150-001	NAME PLATE		1.000	EA	4			.0	8/29/80	
..3	0020	114151-001	KNOB		1.000	EA	4			.0	2/03/81	
.2	0040	114154-001	SPACER	A B 23688	1.000	EA	2			.0	9/11/80	
..3	0030	20196-023	STEEL CR .060 1008-1020	A R 52921	.010	SF	3			.0	10/12/90	
.2	0050	114298-001	BRKT	J 2029	1.000	EA	2			.0	4/16/81	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
..3	0010	101368-003	RIVNUT S10-80		4.000	EA	4			.0	11/24/71	
..3	0020	114298-020	BRKT MTG FAB		1.000	EA	0			.0	11/24/71	
...4	0010	20196-022	STEEL CR .048 1008-1020	A R 52921	.540	SF	3			.0	4/12/83	
.2	0070	116265-001	BRACKET RELAY		1.000	EA	2			.0	4/16/81	
..3	0030	504640-632	.06 THICK ALUM.	2224	.020	SF	4			.0	10/12/90	
.2	0080	116678-001	BLOWN FUSE IND.	C 2239	1.000	EA	2			.0	9/11/80	
..3	0010	546300-034	FUSE HOLDER with indicator		1.000	EA	4			.0	1/01/70	
..3	0020	555001-061	RES .5W 330 5%	.	1.000	EA	4			.0	9/14/82	
.2	0090	118939-001	PANEL- RF80-H FRONT	D G 23492	1.000	EA	4			.0	2/25/81	
.2	0100	119600-001	SWITCH ASSY	B F 22572	1.000	EA	2			.0	12/15/80	
..3	0010	507706-031	TEFLN WHT #20		1.000	FT	4			.0	11/25/80	
..3	0030	511328-221	WIRE #22 WHT		6.880	FT	4			.0	10/12/90	
..3	0050	511602-220	BUS WIRE #22 GA		.070	FT	4			.0	10/12/90	
..3	0060	524717-001	CONN 17P W/LCK RMP	A	1.000	EA	4			.0	10/06/83	
..3	0080	524900-032	KEY-POLARIZING		2.000	EA	4			.0	10/12/90	
..3	0100	524900-038	TERMINAL- 18-24 AWG- CRIMP TYP		15.000	EA	4			.0	10/12/90	
..3	0110	555001-069	RES .5W 680 5%	.	1.000	EA	4			.0	9/15/82	
..3	0120	578260-601	SW-ROTARY:6P6T;NON-SHORT;115VA		1.000	EA	4			.0	11/25/80	
.2	0110	119601-001	HARNESS-MAIN	B K 22572	1.000	EA	2			.0	12/15/80	
..3	0010	114282-001	BRKT-MTG RELAY	E 2173	1.000	EA	2			.0	11/25/80	
...4	0030	504640-632	.06 THICK ALUM.	2224	.080	SF	4			.0	10/12/90	
..3	0030	507702-091	SLV CLEAR .09		2.000	FT	4			.0	10/12/90	
..3	0050	507702-131	SLV CLEAR .13		1.000	FT	4			.0	10/12/90	
..3	0060	507715-041	VNYL CLR .04		.250	FT	4			.0	5/18/87	
..3	0080	511328-201	WIRE #20 WHT		45.420	FT	4			.0	10/12/90	
..3	0100	511328-221	WIRE #22 WHT		308.000	FT	4			.0	10/12/90	
..3	0120	518900-008	CABLE TIE:TY-RAP;4.45 MIN LOC		6.000	EA	4			.0	10/12/90	
..3	0130	518900-009	CABLE TIE	A	227.000	EA	4			.0	8/23/82	
..3	0140	524600-037	RETAINER-SOCKET		3.000	EA	4			.0	4/24/84	
..3	0150	524640-029	HOUSING PLUG		1.000	EA	4			.0	4/27/83	
..3	0160	524709-004	CONNECTOR		4.000	EA	4			.0	5/31/83	
..3	0170	524711-001	CONNECTOR		2.000	EA	4			.0	5/31/83	
..3	0180	524714-003	CONN 14PIN		1.000	EA	4			.0	4/27/83	
..3	0190	524715-001	SOCKET RELAY		3.000	EA	4			.0	11/25/80	
..3	0200	524722-007	CONN EDG-CRD 44PIN	A .	2.000	EA	4			.0	11/25/80	
..3	0220	524900-032	KEY-POLARIZING		6.000	EA	4			.0	10/12/90	
..3	0240	524900-038	TERMINAL- 18-24 AWG- CRIMP TYP		56.000	EA	4			.0	10/12/90	
..3	0260	524900-042	FEMALE PIN		13.000	EA	4			.0	10/12/90	
..3	0270	530605-802	CAP .005MF 600V	A	1.000	EA	4			.0	9/15/71	
..3	0290	583218-005	TRMNL-LUG:INS;RING;TAPE;22/16A	A	6.000	EA	4			.0	10/12/90	
..3	0310	583218-012	TERMINAL- INSULATED- QUICK-CON		6.000	EA	4			.0	10/12/90	
..3	0320	583224-001	TRMNL-LUG:INS;RING;24/20WG;6ST	23719	25.000	EA	4			.0	4/27/83	
..3	0330	583224-002	TRMNL-LUG:INS;RING;24/20WG;8ST	23719	35.000	EA	4			.0	4/27/83	
..3	0340	583224-003	TRMNL-LUG:INS;RING;24/20AWG;10	23719	4.000	EA	4			.0	4/27/83	
.2	0120	119614-001	HARNESS-CELL PROBE	C 2049	1.000	EA	2			.0	12/16/80	
..3	0020	511328-221	WIRE #22 WHT		.670	FT	4			.0	10/12/90	
..3	0030	518900-009	CABLE TIE	A	1.000	EA	4			.0	11/25/80	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
..3	0040	524704-001	CONN 4PIN		1.000	EA	4			.0	3/22/83	
..3	0060	524900-032	KEY-POLARIZING		2.000	EA	4			.0	10/12/90	
..3	0080	524900-038	TERMINAL- 18-24 AWG- CRIMP TYP		2.000	EA	4			.0	10/12/90	
.2	0125	121877-001	CHARGER TIMER REPLACEMENT KIT	A D 23421	1.000	EA	2			.0	6/17/98	
..3	0010	TD-677	PROCEDURE REPLACING RF80-H/GT	A A ORIGN	1.000	EA	2			.0		
..3	0020	000000-001	HARDWARE		8.000	EA	4			.0		
..3	0030	115902-003	DIAL- 6 HR TIMER 50/60HZ	A E 23489	1.000	EA	2			.0		
...4	0010	20196-019	STEEL CR .030 1008-1020	A R 52921	.100	SF	3			.0		
..3	0040	581160-001	TIMER-ELC: 6HR- INTERVAL RESET	A	1.000	EA	4			.0		
.2	0140	507702-091	SLV CLEAR .09		.500	FT	4			.0	10/12/90	
.2	0150	507702-163	SLV CLEAR .16		.130	FT	4			.0	9/15/83	
.2	0170	507717-120	SLEEVE- HEATSHRINK- .125- BLAC		.500	FT	4			.0	10/12/90	
.2	0180	515200-007	CAP NUT 10-32		2.000	EA	4			.0	9/15/83	
.2	0190	515200-037	HEX 1/2 IN ACROSS		3.000	EA	4			.0	10/26/87	
.2	0210	518900-008	CABLE TIE:TY-RAP;4.45 MIN LOC		6.000	EA	4			.0	10/12/90	
.2	0220	518900-009	CABLE TIE	A	20.000	EA	4			.0	11/03/71	
.2	0230	520570-006	KNOB 1/4 SFT- POINTER TYPE	B 2145	2.000	EA	4			.0	11/10/86	
.2	0240	520570-036	KNOB BLACK 1/4		1.000	EA	4			.0	11/10/86	
.2	0250	520570-047	KNOB- 1/4 SFT- ROUND TYPE	A .	2.000	EA	4			.0	9/11/80	
.2	0260	524600-037	RETAINER-SOCKET		1.000	EA	4			.0	4/24/84	
.2	0270	524715-001	SOCKET RELAY		1.000	EA	4			.0	4/16/81	
.2	0280	524900-019	CIRCUITRAK		4.000	EA	4			.0	5/18/76	
.2	0300	524900-032	KEY-POLARIZING		2.000	EA	4			.0	10/12/90	
.2	0310	530605-802	CAP .005MF 600V	A	2.000	EA	4			.0	9/15/71	
.2	0320	538500-027	BEZEL	. .	2.000	EA	4			.0	9/11/80	
.2	0330	538500-028	FILTER GREY	. .	1.000	EA	4			.0	9/11/80	
.2	0340	538500-029	FILTER RED	O R.	1.000	EA	4			.0	9/11/80	
.2	0350	546700-025	INDICATOR-RED	A .	1.000	EA	4			.0	9/11/80	
.2	0360	546700-034	INDICATOR GRN		1.000	EA	4			.0	9/11/80	
.2	0370	555001-077	RES .5W 1.5K 5%	.	1.000	EA	4			.0	9/09/82	
.2	0380	565012-210	RES-VAR-100 OHM-2 W-10%-10 TUR	. .	2.000	EA	4			.0	9/11/80	
.2	0390	578000-051	SW-PUSH:DPDT;MOM;1/4-40 BUSHIN	A .	3.000	EA	4			.0	12/15/80	
.2	0400	578100-017	SW-PARTS:DRESS NUT&CAP FOR DPD		3.000	EA	4			.0	12/15/80	
.2	0410	578240-503	SW-RTRY:4P6T;1/4DX3/8 VERT FLT		2.000	EA	4			.0	9/11/80	
.2	0420	578712-008	SW-TOGGLE:SPDT;SOLDER;250AC/2A		2.000	EA	4			.0	9/11/80	
.2	0430	578722-015	SW-TOGGLE:DPDT;SOLDER;250VAC/2		2.000	EA	4			.0	2/06/89	
.2	0440	578742-008	SW-TGGL:4PDT;FORM C;LCKNG HNDL	A .	1.000	EA	4			.0	9/11/80	
.2	0490	581130-005	TIMER-ELECT:3HR;SPDT;CW ROT;12		1.000	EA	4			.0	9/11/80	
.2	0500	583100-024	TRMNL-PLUG:BNANA;BLK;PIERCD;7/	. .	1.000	EA	4			.0	9/11/80	
.2	0510	583100-025	TRMNL-PLUG:BNANA;RED;PIERCD;7/	. .	1.000	EA	4			.0	9/11/80	
.2	0520	586410-302	TERM-STRIP:NBARR;SOLDER;BAKELI		1.000	EA	4			.0	4/16/81	
.2	0530	518900-006	CABLE TIE:TY-RAP;5.5 MTG		3.000	EA	4			.0	11/09/89	
1	0420	119522-001	M1 PCA (RF80-H)	G 2292	1.000	EA	2			.0	3/10/83	
.2	0010	TD-409	M1 CARD ASSEMBLY	A A TD-409	1.000	EA	2			.0	8/06/82	
..3	0010	000000-002	MISCELLANEOUS PAPER	A 2159	1.000	EA	4			.0	2/14/90	
.2	0020	119568-001	PC BD	C 2081	1.000	EA	4			.0	11/20/80	
.2	0030	120725-001	MASK	A 2099	1.000	EA	4			.0	7/19/84	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0040	502962	SCH M1 DISPLAY PCB ASSY	D C 2081	1.000	EA	4			.0	10/16/87	
.2	0050	507531-201	TAPE 3/4W 1/32T	A	.010	RL	4			.0	6/09/86	
.2	0070	509101-013	RTV-3 OZ TUBE BLACK		.010	EA	4			.0	10/12/90	
.2	0080	509703-002	HUMISEAL- ACR		.030	EA	4			.0	9/22/83	
.2	0090	515900-061	STAND OFF		4.000	EA	4			.0	9/14/71	
.2	0100	515900-062	STAND OFF		2.000	EA	4			.0	9/14/71	
.2	0110	520900-015	HEATSINK TO-93		2.000	EA	4			.0	9/14/71	
.2	0120	524508-007	SOCKET- IC- 8 PIN DIP	. .	2.000	EA	4			.0	9/14/71	
.2	0130	524514-001	SOCKET- IC- 14 PIN DIP		1.000	EA	4			.0	9/11/80	
.2	0140	524520-002	SOCKET IC 20P		2.000	EA	4			.0	2/14/84	
.2	0150	524540-001	SOCKET- IC- 40 PIN DIP	. .	1.000	EA	4			.0	9/11/80	
.2	0160	524540-002	SOCKET- 40 PIN DIP	. .	1.000	EA	4			.0	9/11/80	
.2	0170	524702-001	CONNECTOR-WFR- 2-PIN MALE	. .	1.000	EA	4			.0	11/25/80	
.2	0180	524712-003	CONNECTOR-WFR-12-PIN MALE		1.000	EA	4			.0	9/14/71	
.2	0190	524715-008	CONNECTOR-WFR-15-PIN MALE		1.000	EA	4			.0	9/14/71	
.2	0200	530101-313	CAP 1000MF-16V	. .	2.000	EA	4			.0	9/11/80	
.2	0210	530105-005	CAP 5MF- 50V		1.000	EA	4			.0	11/28/83	
.2	0220	530110-001	CAP 10 MF 25V		1.000	EA	4			.0	11/28/83	
.2	0230	530110-101	CAP 100MF 25V		1.000	EA	4			.0	11/28/83	
.2	0240	530122-001	CAP 22MF- 50V		6.000	EA	4			.0	11/28/83	
.2	0250	530122-002	CAP 22 MF 16V		3.000	EA	4			.0	11/28/83	
.2	0260	530133-001	CAP 33MF 10V		1.000	EA	4			.0	11/28/83	
.2	0270	530601-615	CAP .1MF-400V		1.000	EA	4			.0	9/11/80	
.2	0280	530601-616	CAP .1MF 100V	B 2221	1.000	EA	4			.0	12/16/80	
.2	0300	530601-708	CAP- .01MF 63V- FILM 10%		1.000	EA	4			.0	5/10/91	
.2	0310	530622-708	CAP- .22UF	. .	1.000	EA	4			.0	9/11/80	
.2	0320	530647-727	CAP .47MF, 160V 5% METAL POLYP	. .	1.000	EA	4			.0	9/11/80	
.2	0330	530801-901	CAP MICA, RAD 100PF 300V 10	. .	1.000	EA	4			.0	9/11/80	
.2	0340	541146-003	DIODE 400V-1A		13.000	EA	4			.0	11/28/83	
.2	0350	541210-008	IC VOLT REG- +5V- 1A	. .	2.000	EA	4			.0	9/11/80	
.2	0360	541210-009	IC VOLT REG- -5V- 100MA	A .	2.000	EA	4			.0	9/11/80	
.2	0370	541210-010	IC OP AMP, BIMOS 8-PIN DIP	J 2182	1.000	EA	4			.0	9/11/80	
.2	0380	541210-011	IC 1458 DBL OP AMP	A .	1.000	EA	4			.0	9/11/80	
.2	0390	541210-012	IC DIGITAL CONVERTER	. .	1.000	EA	4			.0	9/11/80	
.2	0400	541210-013	IC LINEAR OPERATED LED DRIVER	. .	1.000	EA	4			.0	9/11/80	
.2	0410	541210-014	IC LED DRIVER	. .	1.000	EA	4			.0	9/11/80	
.2	0420	541220-002	IC 4N31 OPTO COUP	A	1.000	EA	4			.0	9/11/80	
.2	0430	541703-301	DIODE - ZENER	. .	2.000	EA	4			.0	9/11/80	
.2	0440	547100-001	LED DISPLAY	B 2132	1.000	EA	4			.0	9/11/80	
.2	0450	547100-002	LED DISPLAY	B 2132	1.000	EA	4			.0	9/11/80	
.2	0460	547500-003	LED-RED- BAR GRAPH- 10-SEGMENT		1.000	EA	4			.0	9/11/80	
.2	0470	547500-004	LED-GREEN- BAR GRAPH- 10-SEGME		1.000	EA	4			.0	2/14/84	
.2	0480	555001-049	RES CF .5W 100 5%	.	1.000	EA	4			.0	8/17/82	
.2	0490	555001-056	RES .5W 200 5%	.	1.000	EA	4			.0	8/24/82	
.2	0500	555001-063	RES .5W 390 5%	.	1.000	EA	4			.0	9/14/82	
.2	0510	555001-073	RES CF 1.0K OHM- 1/2W- 5%	.	2.000	EA	4			.0	8/17/82	
.2	0520	555001-074	RES .5W 1.1K 5%	.	1.000	EA	4			.0	8/24/82	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0530	555001-075	RES .5W 1.2K 5%	.	1.000	EA	4			.0	8/24/82	
.2	0540	555001-079	RES .5W 1.8K 5%	.	1.000	EA	4			.0	9/09/82	
.2	0550	555001-083	RES .5W 2.7K 5%	.	1.000	EA	4			.0	9/09/82	
.2	0560	555001-096	RES .5W 9.1K 5%	.	1.000	EA	4			.0	11/28/83	
.2	0570	555001-106	RES .5W 24K 5%	.	1.000	EA	4			.0	9/09/82	
.2	0580	555001-113	RES .5W 47K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0590	555001-121	RES- 100K OHM- 1/2W- 5%	.	4.000	EA	4			.0	8/17/82	
.2	0600	555001-133	RES .5W 330K 5%	.	1.000	EA	4			.0	9/14/82	
.2	0610	555001-137	RES .5W 470K 5%	.	1.000	EA	4			.0	9/15/82	
.2	0620	555001-145	RES- 1M OHM- 1/2W- 5%	.	1.000	EA	4			.0	6/17/86	
.2	0630	555052-304	RES 500OHMS 3W	A .	2.000	EA	4			.0	11/28/83	
.2	0640	555333-103	RES 33.2K 1/2W 1%	A .	2.000	EA	4			.0	11/21/83	
.2	0650	565013-208	RES-VAR-1K-20%-15 TURN	A	1.000	EA	4			.0	6/09/86	
.2	0660	565022-204	RES-VAR-200-10%-15 TURN		1.000	EA	4			.0	9/11/80	
.2	0670	565023-203	RES-VAR-2K-15 TURN	A	1.000	EA	4			.0	12/17/80	
.2	0680	565053-206	RES-VAR-5K-10%-	A	1.000	EA	4			.0	6/09/86	
.2	0690	565054-204	RES-VAR-50K-10%-15 TURN		2.000	EA	4			.0	9/11/80	
.2	0700	571100-004	RELAY SPST 5V	. .	1.000	EA	4			.0	9/11/80	
1	0430	119523-001	XFMR ASSY	C 84/1	1.000	EA	2			.0	4/27/83	
.2	0010	101126-012	SPACER BAKELITE	A A ORGNL	4.000	EA	2			.0	5/09/84	
..3	0030	507710-251	BAK BLK .25ID		.160	FT	4			.0	10/12/90	
.2	0020	107917-001	LINK-DUAL V.	G 2105	2.000	EA	2			.0	5/09/84	
..3	0030	505510-643	COPPER .0647		.020	SF	4			.0	10/12/90	
.2	0030	117034-001	CAPACITOR ASSY	F 2270	1.000	EA	2			.0	9/11/80	
..3	0020	507706-041	TEFLN WHT #18		.210	FT	4			.0	10/12/90	
..3	0040	507717-250	TUB INS .25ID HS	A	.170	FT	4			.0	10/12/90	
..3	0060	511311-142	WIRE #14 GRN		.830	FT	4			.0	10/12/90	
..3	0070	511311-182	WIRE #18 WHT,VINYL,STRANDED,		.830	FT	4			.0	3/30/80	
..3	0080	530647-724	CAP .47MF-600V		2.000	EA	4			.0	3/30/80	
..3	0090	583216-013	TRMNL-LUG:INS-RNG;TAP;16/14AW;	B 2130	1.000	EA	4			.0	3/30/80	
..3	0110	583712-014	TRMNL-LUG:NINS;SDLS;PARA CON;B		1.000	EA	4			.0	10/12/90	
..3	0120	583716-010	TRMNL-LUG:NINS;SDRLS;PARA CON;		2.000	EA	4			.0	3/30/80	
..3	0130	583718-023	TRMNL-LUG:NINS;SDRLS;PARA CON;		2.000	EA	4			.0	3/30/80	
..3	0150	507717-181	SLV VLK .187		.170	FT	4			.0	10/12/90	
..3	0160	518900-006	CABLE TIE:TY-RAP;5.5 MTG		1.000	EA	4			.0	11/09/89	
.2	0040	119524-001	T. BOARD ASSY	C 2270	1.000	EA	2			.0	9/11/80	
..3	0010	100415-001	SCREW SPLINE 10-32X1 ROUND HD		6.000	EA	4			.0	9/11/80	
..3	0020	101455-002	BUS BAR	A F 15227	1.000	EA	2			.0	9/11/80	
...4	0030	505510-643	COPPER .0647		.010	SF	4			.0	10/12/90	
..3	0030	101635-012	SCREW 8-32X7/8 SPL	O RIGIN	4.000	EA	4			.0	11/17/82	
..3	0040	111957-002	SCREW SPLNE 1/4-2X1 1/4		8.000	EA	4			.0	9/11/80	
..3	0050	117818-001	BUS BAR FUSE	A 83/2	1.000	EA	2			.0	9/11/80	
...4	0030	505510-643	COPPER .0647		.010	SF	4			.0	10/12/90	
..3	0060	118117-001	LINK		1.000	EA	2			.0	9/11/80	
...4	0030	505510-643	COPPER .0647		.010	SF	4			.0	10/12/90	
..3	0070	119530-001	RESISTOR (MOD)	B E 54794	1.000	EA	2			.0	1/23/81	
...4	0030	511820-301	COPEL .025X2.0		.420	FT	4			.0	10/12/90	

PARENT ITEM NO. 119443-001
DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000
QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

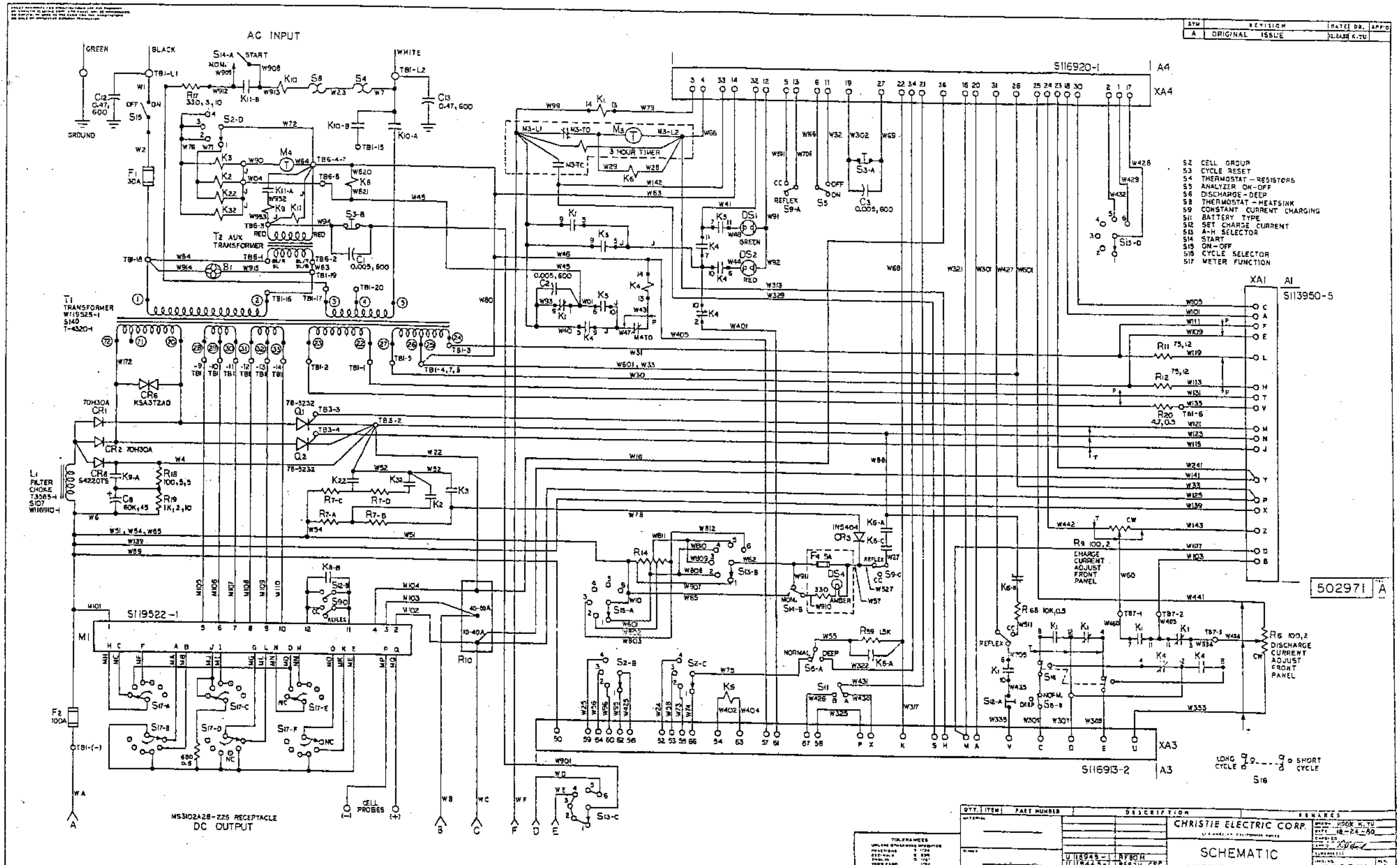
RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	ITEM UM	TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
..3	0080	119534-001	TERM. BOARD	B 2107	1.000	EA	2			.0	11/01/80	
...4	0030	507302-191	GLASS POLY- 3/16 THK- GPO-2		.380	SF	4			.0	10/12/90	
..3	0090	546300-032	CLIP W/SCREWS		2.000	EA	4			.0	9/11/80	
..3	0100	585217-601	TERMBD-BARR SCRW:DBL RW;PHENOL	A	2.000	EA	4			.0	9/11/80	
..3	0110	585999-001	TERMBD-ACCESSRY:END PC;PHENOL;		1.000	EA	4			.0	9/11/80	
..3	0120	586251-402	TERMBD-BARR SCRW:SGL RW;PHENOL	. .	1.000	EA	4			.0	11/01/80	
.2	0050	119525-001	XFORM T4320-1 S140	E 2220	1.000	EA	2			.0	9/11/80	
..3	0010	101166-016	WEDGE, ALUM, 1"X4"X".1875	C R 20883	2.000	EA	4			.0	9/09/85	
..3	0020	111173-001	BRKT MTG XFMR	F 2266	2.000	EA	4			.0	1/01/70	
..3	0030	120921-001	BRKT MTG XFMR	A 2132	2.000	EA	2			.0	12/04/87	
...4	0030	502213-051	HRS STR 3/16X 5/8 HRS PER		2.020	FT	4			.0	10/12/90	
..3	0050	507302-062	MAT GLASS1/16		.310	SF	4			.0	10/12/90	
..3	0070	507319-014	NOMEX .010 THK		2.650	SF	4			.0	10/12/90	
..3	0090	507510-103	CORD-UNTREATED GLASS (EC9-3-U)		.010	RL	4			.0	10/12/90	
..3	0110	507510-105	UN GL EC9-10U		.060	RL	4			.0	10/12/90	
..3	0130	507530-401	TAPE INS THERM WHT	A	.200	RL	4			.0	10/12/90	
..3	0150	507530-404	TAPE WHT 1/2W THRM	B	.050	RL	4			.0	10/12/90	
..3	0170	507540-601	TAPE 1/2W GLASS	A	.200	RL	4			.0	10/12/90	
..3	0190	507540-602	UNTR GLASS 1		.110	RL	4			.0	10/12/90	
..3	0220	509503-004	POLY- VARNISH	A	.100	GL	4			.0	9/25/90	
..3	0260	511325-141	WIRE #14 WHT		6.250	FT	4			.0	10/12/90	
..3	0280	511506-061	MAG WIRE #6 SQ		4.400	LB	4			.0	10/12/90	
..3	0300	511506-221	MAG WIRE #22 RD		.100	LB	4			.0	10/12/90	
..3	0320	511509-102	MAG WIRE #10 ROUND	. .	3.600	LB	4			.0	10/12/90	
..3	0340	511901-101	SOLDER SILVER		.100	LB	4			.0	10/12/90	
..3	0360	583212-011	TRMNL-LUG:INS;12/10AWG;10STD;0		3.000	EA	4			.0	10/12/90	
..3	0380	583218-004	TRMNL-LUG:INS;RING;RED;22/16AW	A	5.000	EA	4			.0	10/12/90	
..3	0390	587312-301	XFMR-LAM:EI;2-1/4;M6;29 GA		42.700	LB	4			.0	1/01/70	
..3	0430	507704-182	RUBR GLSS .18		1.500	FT	4			.0	10/12/90	
..3	0440	511325-081	WIRE #8 WHT		3.500	FT	4			.0		
..3	0450	511310-202	WIRE #20 RED TEFLON, TYPE EE		27.000	FT	4			.0		
..3	0460	507704-332	RUBR GLSS .33		1.250	FT	4			.0		
.2	0070	507510-103	CORD-UNTREATED GLASS (EC9-3-U)		.010	RL	4			.0	10/12/90	
.2	0090	507530-401	TAPE INS THERM WHT	A	.200	RL	4			.0	10/12/90	
.2	0110	507530-404	TAPE WHT 1/2W THRM	B	.050	RL	4			.0	10/12/90	
.2	0130	511325-141	WIRE #14 WHT		8.330	FT	4			.0	10/12/90	
.2	0150	583216-011	TRMNL-LUG:INS;RNG;TAP;16/14AW;	A	1.000	EA	4			.0	10/12/90	
.2	0160	583216-013	TRMNL-LUG:INS-RNG;TAP;16/14AW;	B 2130	4.000	EA	4			.0	7/13/76	
.2	0180	583218-002	TRMNL-LUG:INS;RNG;TAP;22/16WG;	A	12.000	EA	4			.0	10/12/90	
.2	0190	583708-006	TRMNL-LUG:NINS;SDLS;RING;BRZD;		3.000	EA	4			.0	9/11/71	
1	0450	119601-002	JMPR WIRE RF80H	B L 22713	1.000	EA	2			.0	12/21/83	
.2	0020	511311-061	WIRE #6 WHT- VINYL	23557	2.100	FT	4			.0	10/12/90	
.2	0030	511311-182	WIRE #18 WHT,VINYL,STRANDED,		.750	FT	4			.0	12/15/80	
.2	0050	511325-101	WIRE #10 WHT		5.250	FT	4			.0	10/12/90	
.2	0070	511328-221	WIRE #22 WHT		1.000	FT	4			.0	10/12/90	
.2	0080	583212-002	TRMNL-LUG:INS;RING;10/12AWG;8S		5.000	EA	4			.0	12/15/80	
.2	0100	583212-011	TRMNL-LUG:INS;12/10AWG;10STD;0		2.000	EA	4			.0	10/12/90	

PARENT ITEM NO. 119443-001

DESCRIPTION RF80-H CHRISTIE
ENGR DRAW L 23552
STANDARD BATCH QUANTITY 1.000

QTY 1 ITEM TYPE 1 LOW LEVEL 01
UNIT MEAS EA

RELATIVE LEVEL	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	ENGINEERING DRAWING NUMBER	QUANTITY PER	UM	ITEM TYP	OPT NO.	FIRST OP SEQ	LT ADJ	EFFECTIVE DATES FROM	TO
.2	0120	583218-002	TRMNL-LUG:INS;RNG;TAP;22/16WG;	A	1.000	EA	4			.0	10/12/90	
.2	0140	583218-004	TRMNL-LUG:INS;RING;RED;22/16AW	A	1.000	EA	4			.0	10/12/90	
.2	0160	583218-009	TRMNL-LUG:INS;RNG;RD;22/16WG;8		1.000	EA	4			.0	10/12/90	
.2	0170	583218-016	TRMNL-LUG:INS;MINI-SPR SPAD;22	A	10.000	EA	4			.0	12/15/80	
.2	0190	583706-005	TRMNL-LUG:NINS;SDRLS;6AWG;1/4S	A	4.000	EA	4			.0	10/12/90	
.2	0200	583712-005	TRMNL-LUG:NINS;SDLS;RING;BRZD;		1.000	EA	4			.0	8/07/87	
.2	0220	583712-014	TRMNL-LUG:NINS;SDLS;PARA CON;B		2.000	EA	4			.0	10/12/90	
1	0460	515200-007	CAP NUT 10-32		3.000	EA	4			.0	3/10/83	
1	0470	515816-001	WASHER STEEL		1.000	EA	4			.0	9/15/83	
1	0480	515819-003	WASHER NYLON		1.000	EA	4			.0	7/14/76	
1	0490	520570-006	KNOB 1/4 SFT- POINTER TYPE	B 2145	1.000	EA	4			.0	11/10/86	
1	0520	526020-064	TEST LEAD SET		1.000	EA	4			.0	11/18/80	
1	0530	546105-008	FUSE 5 AMPS		3.000	EA	4			.0	11/18/80	
1	0540	546130-013	FUSE 30 AMPS	A .	1.000	EA	4			.0	10/14/71	
1	0550	546191-041	FUSE 100AMPS	A .	1.000	EA	4			.0	10/14/71	
1	0560	555750-602	RES 12W- 75 OHMS	A	2.000	EA	4			.0	4/27/83	
1	0570	571210-019	RLY DPDT 120VAC	A	1.000	EA	4			.0	4/27/83	
1	0580	571220-003	RELAY DPST 115V		1.000	EA	4			.0	4/27/83	
1	0590	571403-001	RELAY 4PDT 120V		4.000	EA	4			.0	4/27/83	
1	0600	578711-017	SW-TOGGLE:SPST;LUG TERM;250VAC		1.000	EA	4			.0	3/10/83	
1	0610	585214-408	TERMBD-BARR SCRW:DBL RW;PHENOL		1.000	EA	4			.0	11/18/80	
1	0620	587700-012	XFMR-ISLN:115/230 P;115/30 S;6	A	1.000	EA	4			.0	11/18/80	
1	0630	596000-093	CRATE-SHIPPING-RF80		1.000	EA	4			.0	6/09/82	
1	0640	518900-009	CABLE TIE	A	25.000	EA	4			.0	11/09/89	
1	0660	518900-008	CABLE TIE:TY-RAP;4.45 MIN LOC		10.000	EA	4			.0	10/12/90	
1	0670	121538-001	COVER REAR RF-80	C 2287	1.000	EA	2			.0	1/17/90	
.2	0040	20196-022	STEEL CR .048 1008-1020	A R 52921	2.540	SF	3			.0	10/12/90	
1	0680	596000-180	INSERT SET- 2 PC.- FOR RF80H	A	1.000	EA	4			.0	11/08/93	


AC INPUT
GREEN
BLACK
WHITE
GROUND
T1 TRANSFORMER W119525-1 S140 T-4320-1
T2 AUX TRANSFORMER
L1 FILTER CHOKE T3385-4 S107 W116910-1
3 HOUR TIMER
S116920-1
A4
XA4
S113950-5
A1
XA1
S116913-2
A3
XA3
S119522-1
M1
MS3102A28-22S RECEPTACLE
DC OUTPUT
CELL PROBES
R9 100,2 CHARGE CURRENT ADJUST FRONT PANEL
R6 100,2 DISCHARGE CURRENT ADJUST FRONT PANEL
LONG CYCLE
SHORT CYCLE
S16
S2 CELL GROUP
S3 CYCLE RESET
S4 THERMOSTAT - RESISTORS
S5 ANALYZER ON-OFF
S6 DISCHARGE - DEEP
S8 THERMOSTAT - HEATSINK
S9 CONSTANT CURRENT CHARGING
S11 BATTERY TYPE
S12 SET CHARGE CURRENT
S13 A-H SELECTOR
S14 START
S15 ON-OFF
S16 CYCLE SELECTOR
S17 METER FUNCTION
A ORIGINAL ISSUE
502971 A
CHRISTIE ELECTRIC CORP.
SCHEMATIC
WIRING DIAGRAM
502971 A
SHEET 1 OF 1

Featuring DigiFLEX®

CHARGER/ANALYZER FOR AIRCRAFT BATTERIES

1 HOUR CHARGE — 1 HOUR DISCHARGE

BULLETIN R-

DigiFLEX®

- is a new concept in aircraft nickel-cadmium battery servicing. Together with REFLEX charging, it provides DURING CHARGE the type of information heretofore only available during a subsequent **discharge** (which also requires a **recharge**).
- comes standard as part of the RF80H REFLEX charger/analyzer.
- has a green bar display which, during the last few minutes of CHARGE, gives an indication of relative battery state-of-charge and battery state-of-health.
- has a digital display which, during the last few minutes of CHARGE, gives readings of relative cell ampere-hour capacities (as the cells are manually scanned).
- provides a digital readout for average battery voltage and constant current amps during REFLEX or constant current charge, as well as battery voltage, cell voltages and current during discharge.
- shows by means of the red and green bar displays whether the charger/analyzer is in REFLEX charge, constant current charge or discharge.

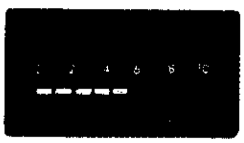
The RF80H includes the novel DigiFLEX circuit which brings a major advance to ni-cad battery **analyzing** — just as REFLEX brought a major advance to ni-cad battery **charging.**

In other words, DigiFLEX provides relative ampere-hour **discharge capacity** readings for each cell and the battery **DURING CHARGE.** This is accomplished through unique data analysis during the negative pulses (which are interjected between the positive charging pulses).

On the other hand, a conventional digital voltmeter reads **only voltage during charge.** *Unfortunately, there is no correlation between battery charging voltage and discharge capacity.*

HOW DigiFLEX IS USED

Battery State-Of-Charge and Capacity



Assume that it had **previously** been determined (or the unit set such) that with a particular battery① all 10 greenbars light up when that battery is at normal charging temperature, is fully REFLEX charged, and has just 100% rated capacity. If **now,** after 30 minutes of REFLEX charge, only 5 bars light up, the battery apparently is not yet charged. If after 40 minutes all bars light up, the battery is most likely fully charged and apparently still has its full capacity.

On the other hand, if after 60 minutes of charge — and, to make sure, after an additional 10 minutes of charge — only 6,7,8, or 9 green bars light up, that battery is most likely no longer capable of 100% rated capacity, at least without further maintenance such as deep discharge equalizing.

Regardless of whether a battery can still reach 100% rated capacity, the operator can usually tell when the battery will no longer accept additional charge by observing when the number of green bars starts to decrease.

Relative Cell Capacity

When the individual cells are quickly scanned with the probes during the last few minutes of REFLEX charging, or are scanned whenever the maximum number of green bars appropriate for that battery light up, any **cell** that reads 1.60② has approximately the same ampere-hour capacity as the **battery.** Any cell that reads higher has a higher capacity; any cell that reads lower has a lower capacity. If any cell reads appreciably lower, the battery should be rejected, pending further maintenance such as deep discharge equalizing.

DigiFLEX Analysis						=	A revolutionary concept of battery and cell **ANALYSIS DURING CHARGE**
REFLEX® Charge						=	Full charge in ½ to 1 hour
REFLEX Charge	+	**Discharge** Analysis				=	Charge-Discharge Analysis-Recharge in 2½ to 3 hours.
REFLEX Charge	+	**DigiFLEX** Pre-Analysis	+	**Discharge** Analysis		=	*Better battery quality* with battery and cell analysis **DURING CHARGE** as a double check on analysis during discharge. Takes 2½ to 3 hours.
REFLEX Charge	+	**DigiFLEX** Analysis				=	*Still greater productivity* through full charge + battery and cell analysis — **all in just ½ to 1 hour of Charge**

① Ni-cad battery characteristics differ by brand, type, service history, etc.

② 1.57 if the charger/analyzer is set to battery type "B" rather than "A".

SINCE 1929
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ELECTRIC CORP.
18120 South Broadway, Gardena, California 90248 U.S.A.
(213) 715-1402, TWX 910-349-6260, FAX (213) 618-8368

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- Rectodyne DC Power Carts for Starting & Service
- High Current D-C Power Supplies for Calibration and Checkout
- Chargers and Testers for lead acid batteries

Printed in U.S.A.

The REFLEX®(1) Charger/Analyzer With DigiFLEX™(2) Pre-Analyzer

A Revolution in Aircraft Nickel-Cadmium Battery Maintenance

by Fred Benjamin(3)

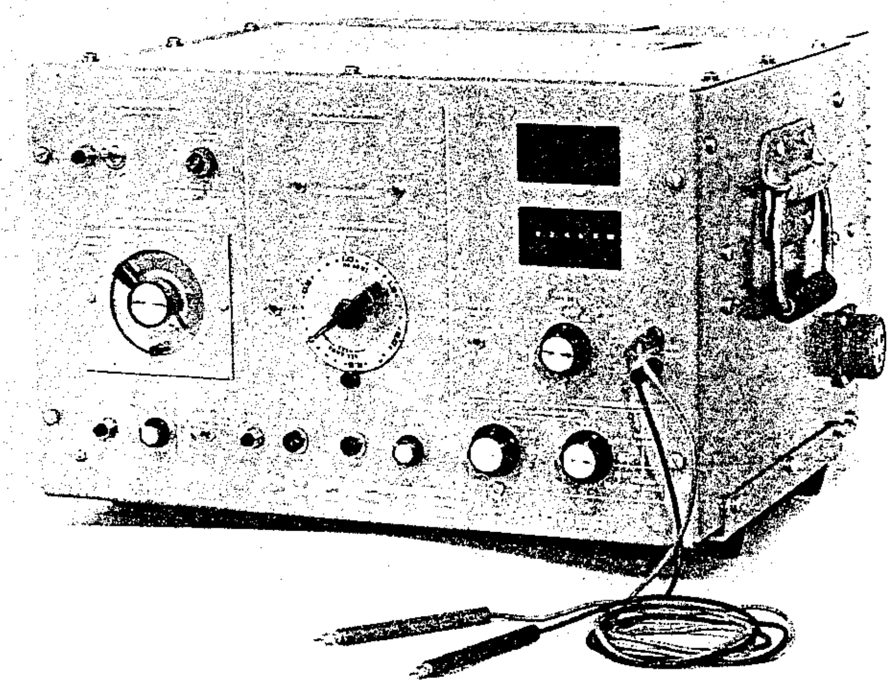


Fig. 1 RF80H Charger/Analyzer

It was not too long ago that it took as much as 2 to 3 *days* to check out the flightworthiness of a nickel-cadmium battery. REFLEX charging cut this to 2 to 3 *hours.* Now, a revolutionary charger/analyzer concept — Pre-Analysis — has been added to REFLEX to provide a more foolproof battery analysis without adding any additional time.

But even the 2 to 3 hours for charge and analysis might be cut to 1/2 to 1 hour with the RF80H charger/analyzer. Through the addition of DigiFLEX Pre-Analysis — which is unique and quite sophisticated, yet easy to perform — the operator may at times choose to dispense with the capacity discharge test altogether.

Ni-Cad Charger/Analyzers

Every so many flight hours, an aircraft ni-cad is brought to the battery shop to see whether it is still flightworthy, should be overhauled or scrapped. Whether the battery is still capable of delivering 100%, or some other acceptable percentage, of rated ampere-hour capacity, plays a major part in this investigation.

For this purpose, the battery shop operator usually employs a charger/analyzer. With a typical unit, he first charges the battery, then runs it through a discharge test cycle and finally recharges it again. (With some units, he needs to also discharge the battery prior to the first charge). A charger/analyzer like the RF80H (Fig. 1) performs these 3 cycles automatically in succession and provides GO/NO-GO commands and indicators as well as ampere-hour readouts.

But all was not well with charger/analyzers in former days. Typically, the analyzing process took many hours or even days. On some occasions it resulted in the acceptance of batteries that should have been rejected. On other occasions it resulted in the rejection of batteries that should have been accepted.

REFLEX Charging

To overcome some of these objections, Christie(4) introduced REFLEX charging(5) to aircraft battery charger/analyzers. The same concept which brings 20 minute charging of flashlight type ni-cads in portable video cameras, video tape recorders and paramedic equipment under the name of REFLEX-20(6), has brought innumerable benefits to the aircraft battery shop.

REFLEX has cut the aircraft battery charging time to 1 hour or less, a fraction of other methods. It has resulted in greater battery capacity, longer battery life, and has frequently rejuvenated batteries which had been rejected after conventional charging.

Besides cutting charging time, REFLEX has substantially overcome the cell imbalance problem associated with constant potential charging, which results in reduced battery capacity. It has also significantly reduced the so-called ni-cad "memory" effect associated, in various degrees, with constant potential, constant current and pulse charging. This "memory" effect results not only in reduction of battery capacity, but also in reduced reliability because the fading of capacity can come without warning.

When charging ni-cads, the most important part is the last 15% of the battery's maximum capacity. During that part, low currents and heat are the ni-cad battery's enemy. Low currents are a major cause of memory and sometimes also cell imbalance; on the other hand, high currents without REFLEX cause heating, resulting in reduced charge acceptance. REFLEX can overcome this apparent Catch-22 by providing, during this last 15% of charge, what ni-cads really like — high currents, with only a small battery temperature rise. The typically 95% net charging efficiency of REFLEX, compared to the typical 70% for other methods, makes that possible.

The Secret is in the Burp

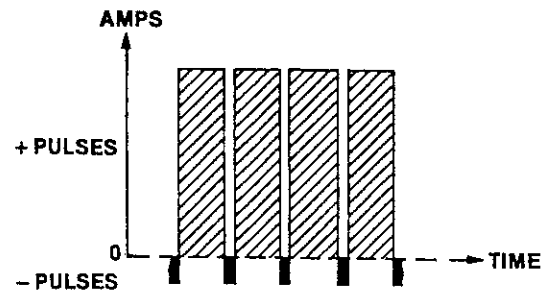
The secret to this high charging efficiency of REFLEX, and in turn all the other benefits, is in the negative pulses during charge, which can be compared to the burping of a baby. A battery, just like a baby, accumulates more and more internal gases when it is being "fed" or charged. These gases ordinarily cause increasingly higher current densities on the battery cell plates during charge, which result in heating. By "burping" the battery with negative pulses, which vary in accordance with its state-of-charge (Fig. 2), high currents cause little heat even at full charge.

DigiFLEX Pre-Analysis

DigiFLEX means to ni-cad battery analyzing what REFLEX means to ni-cad battery charging. They both improve battery quality and battery shop productivity.

REFLEX provides increased battery quality in the form of higher capacity, greater

(1) Protected by over 50 patents worldwide.
(2) Patents pending.
(3) Senior Vice President, Christie Electric Corp.
(4) Christie Electric Corp., 20665 Manhattan Place, Torrance, CA 90501.
(5) *The ReFLEX Principle of Charging Nickel Cadmium and Other Batteries* by Fred Benjamin, presented at the IEEE Power Processing & Electronics Specialists Conference May 22, 1972. *ReFLEX Charging for Nickel-Cadmium Batteries or Put Some in, Take Some Out, and End up With a Better Charge,* Aviation Mechanics Journal, October 1975.
(6) *System for 20-Min Recharging of Sealed Nickel-Cadmium Batteries* by Fred Benjamin, from the Journal of the Society of Motion Picture and Television Engineers, April 1977.



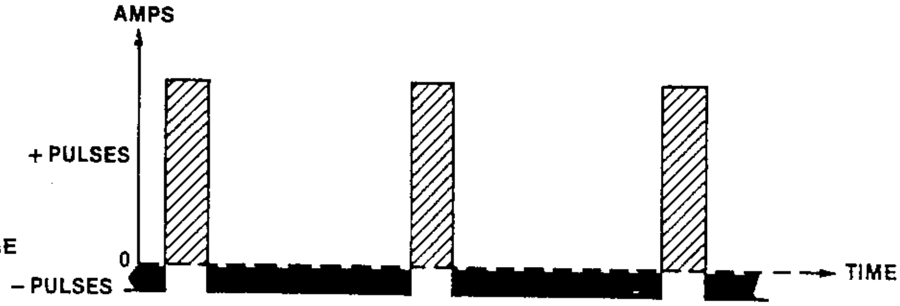


Fig. 2A — Positive and negative pulses near start of charge 2B — Positive and negative pulses near end of charge

reliability, longer life. It also provides increased battery shop productivity, since it requires less charging time per battery. DigiFLEX, on the other hand, provides increased battery quality by providing additional test data which heretofore were not available. Conversely, it increases productivity whenever battery and cell Pre-Analysis — which does not involve a time-consuming discharge and recharge — is considered satisfactory by itself.

What makes these improvements in analyzing possible are 3 key pieces of DigiFLEX information which are available during the last 10 minutes of REFLEX charge, prior to or without conventional discharge altogether:

Battery state-of-charge
Battery state-of-health
Relative cell capacities

In other words, DigiFLEX provides not only a visual display of battery state-of-charge, but might also pinpoint low capacity cells and/or questionable batteries — all during the 1/2 to 1 hour REFLEX charge. At times, the operator may therefore choose to dispense with the capacity discharge test altogether.

Battery Capacity/State-of-Charge

Fig. 3 shows the voltage of three 20-cell, 40 ampere-hour ni-cad batteries during a typical 1-hour REFLEX charge and during the subsequent battery capacity discharge at the 1-hour (40 ampere) rate.

If we assume, as battery manufacturers usually do, that full discharge corresponds to an average of 1 volt per cell, then 20 volts is the discharge reference level for a 20-cell battery. This reference level is indicated by the dashed horizontal line in Fig. 3. Since battery "A" reaches this reference level in less than 1 hour, it has less than rated 40 ampere-hour capacity. Battery "B" is apparently able to deliver exactly 40 ampere-hours and battery "C" more than rated capacity. Since discharge current is constant, (40 amps in this case), a timer (Fig. 4) gives readings corresponding to ampere-hours or percent of rated capacity (e.g., 1.1 corresponds to 44 ampere-hours or 110% rated capacity).

Just as Fig. 3 shows the battery voltage rising during charge and then falling during discharge, so Fig. 5 shows battery voltage

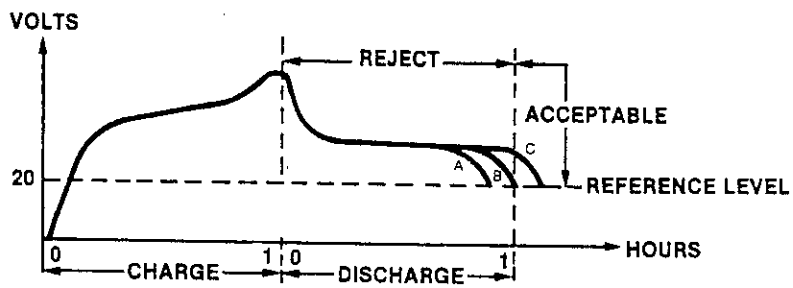


Fig. 3 Battery capacity by conventional charge-discharge

Fig. 4 Battery capacities are read with a timer.

rising during the REFLEX charge (positive) pulse and then falling during the discharge (negative) pulse.

Just as the voltage for a battery with higher capacity took longer to fall to the reference level in Fig. 3, so the voltages in Fig. 5 take successively longer to fall to their fixed reference level. Therefore, the battery in Fig. 5C has more capacity than Fig. 5B, which has more capacity than Fig. 5A. Since in this case "5A," "B" and "C" are one and the same battery, "C" must have a higher state-of-charge than "B," which has a higher state-of-charge than "A." In fact, "5A" occured

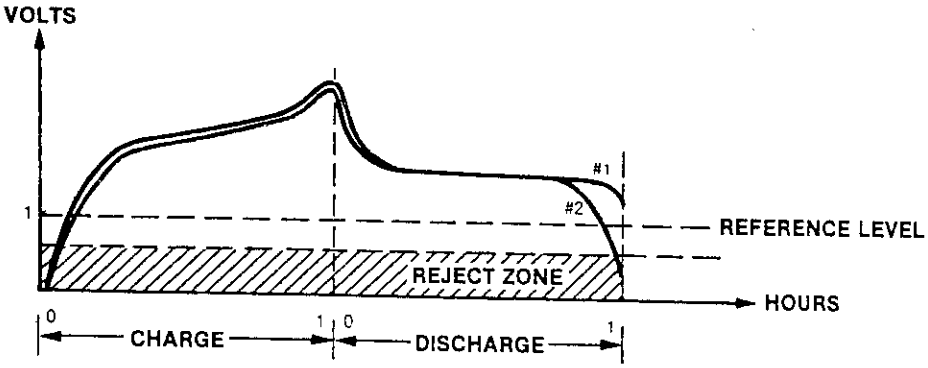


Fig. 8 Cell capacities by conventional charge-discharge

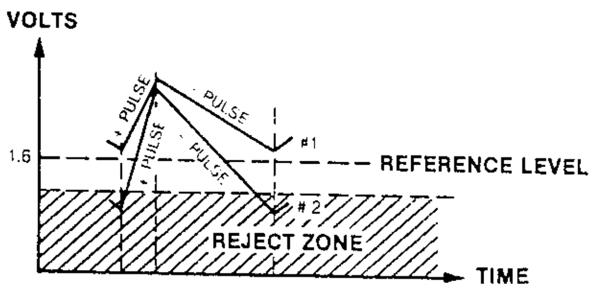


Fig. 9 Cell capacities with DigiFLEX under charge

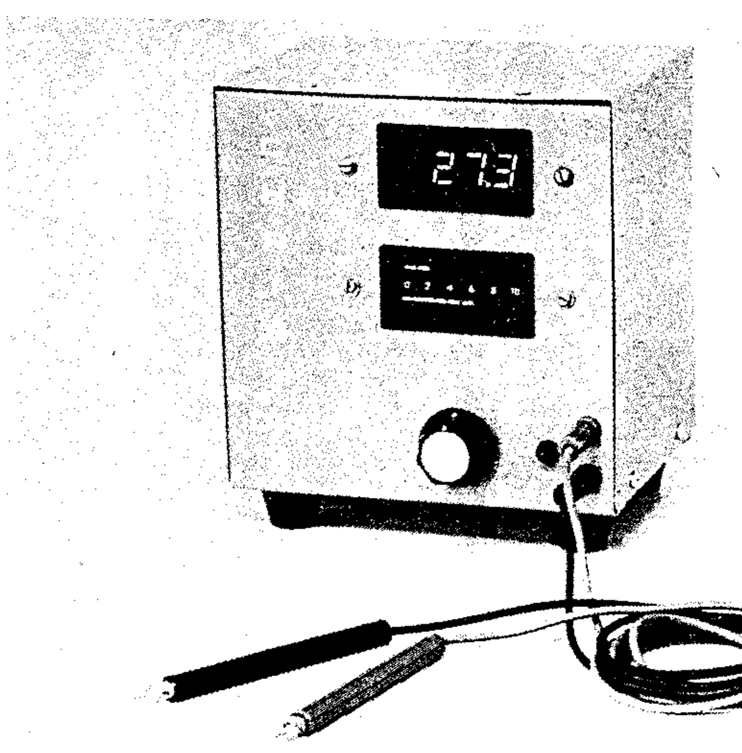


Fig. 10 The DF-1 DigiFLEX module

as the voltage of cell #1 at the end of discharge is still above the fixed reference level and therefore better than average in Fig. 8, so it is at the end of the discharge pulse in Fig. 9. Similarly, cell #2 is the reject zone in both cases.

Just as the voltage of cell #1 and #2 during the conventional battery discharge, as shown in Fig. 8, is read with a voltmeter near the end of discharge, so are these cell voltages read at the end of the discharge pulse in Fig. 9. Only in this case the DigiFLEX circuitry must sample, read and hold each cell voltage reading always at the same point, near the end of the discharge pulse. As in the case of the battery capacity test, this cell capacity information is repeated at least every second during the last 10 minutes of REFLEX charge.

Remember, the cell reference voltage levels do not change. They are 1 volt during the conventional discharge test and 1.6 volts during REFLEX charging with DigiFLEX. Any cell with voltage significantly below 1 volt and 1.6 volts, respectively, has a relatively low capacity and may have to be rejected.

Conclusion

DigiFLEX Pre-Analysis — being able to analyze a battery charge, prior to and sometimes even in lieu of a capacity discharge test — is now a reality. Heretofore, the only ni-cad battery capacity test available during charge has been the cell voltage balance test. As pointed out, even that test is of limited value.

DigiFLEX Pre-Analysis is not a superficial, but a very sophisticated analysis. Yet it is easy to perform and simple to interpret. It provides information about not one but the same two battery characteristics normally investigated during the capacity discharge test — i.e., battery state-of-health and relative cell capacities. DigiFLEX also offers a novel battery state-of-charge readout.

At first sight this new RF80H REFLEX charger/analyzer looks like the previous RF80GT REFLEX charger/analyzer, plus a digital meter and a few extra lights. Far from it. A digital meter and LED displays without the newly invented DigiFLEX concept and circuitry gives none of this valuable information. For this reason, a DF-1 DigiFLEX module (Fig. 10) is now available. By simply connecting this module to any RF80GT, present owners can enjoy all the same Pre-Analysis benefits of the new RF80H charger/analyzer.

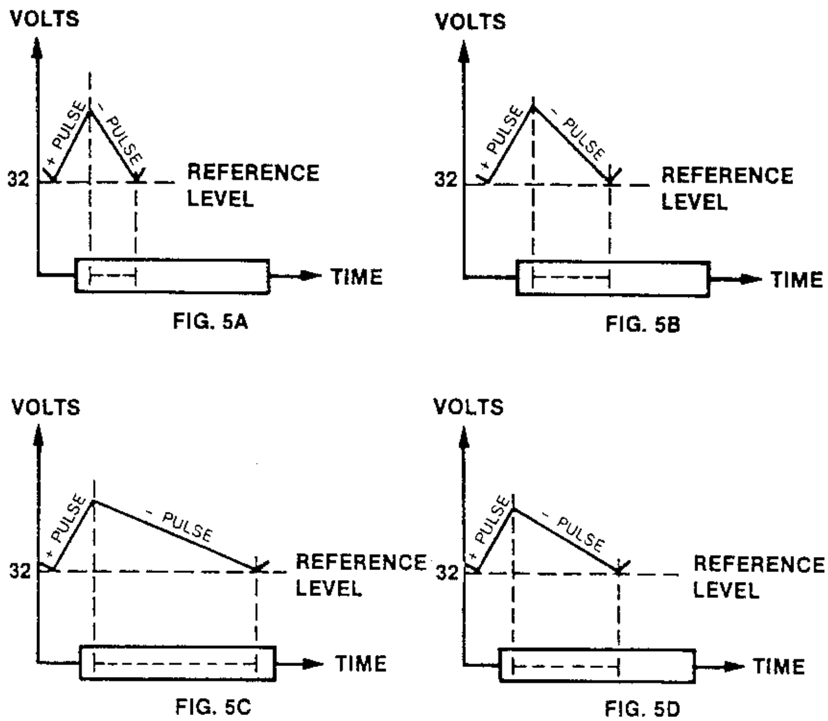


Fig. 5A, B, C, and D Battery capacity with DigiFLEX under charge

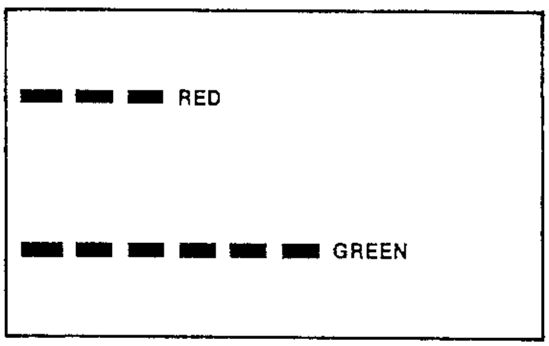


Fig. 6 Bar display

after 50 minutes, "5B" after 55 minutes and "5C" after 60 minutes of charge.

Just as the Fig. 3 battery capacities are read with a timer (Fig. 4), so the Fig. 5 capacities are read with a timer. Only in this case the timer is a special green LED bar display which goes from one to ten bars (Fig. 6). But while the charge-discharge of Fig. 3, plus recharge, takes 3 *hours*, the charge-discharge of Fig. 5, plus recharge, is repeated at least every *second* during the last 10 minutes of charge.

With most good low impedance aircraft ni-cads, all 10 green bars will light every second just prior to the conclusion of 60 minutes REFLEX charge, as in Fig. 5C. If, on the other hand, only 6 bars (as in Fig. 5D) light after 1 hour of REFLEX charge, such a battery may not be fully charged. It might be a battery which actually is capable of 130% rated capacity and may therefore require additional charge. However, if additional bars do not light after a few minutes extra charge — and it is a relatively cool low impedance battery — then it is a battery which probably will fail the conventional capacity discharge test.

Relative Cell Capacities

As shown in Fig. 5, special DigiFLEX circuitry and the green bar display provide an indication of battery state-of-charge and battery state-of-health *during charge.* Now let us see how DigiFLEX circuitry together with the digital voltmeter can provide relative cell capacities, *all during charge.* But first a word about conventional cell voltage tests during charge.

Conventional cell voltage tests under charge — except to check on cell separator fatigue and electrolyte levels — are of limited value. Voltages of cells under charge, or when idle, can seem normal; but if you want to actually run something with them, the cells might poop out. Have you ever had a battery-operated calculator or transistor radio which worked for a few seconds after turn-on (i.e., cell voltages were normal), and then died? Do seemingly fully charged cells with higher voltages under charge really have higher capacities and vice versa?

The automobile industry found out 30 years ago that there is only one meaningful way to check the health of battery cells, and that is *under load.* Fig. 7 shows such a tester then being used. DigiFLEX offers something better — *a cell voltage test under load and under charge at the same time.* But that is only half of it. The cell voltages displayed on the RF8OH digital voltmeter, thanks to special DigiFLEX circuitry, truly are an indication of relative cell capacities (unless they indicate incorrect electrolyte levels, or insufficient cell forming in new batteries).

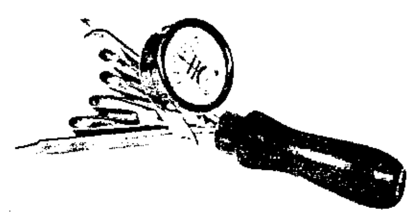


Fig. 7 Automotive cell tester

Fig. 8 shows the voltage of 2 cells in a 20-cell, 40 ampere-hour ni-cad battery during a typical 1 hour REFLEX charge and during the subsequent battery capacity discharge at the 1 hour (40 ampere) rate. As before, full discharge has occurred when the battery reaches the 20 volt fixed reference level. This corresponds to an average cell voltage of 1 volt, as shown by the horizontal dashed line in Fig. 8. Since cell #1 is still above the 1 volt reference level at the end of battery discharge, it has a higher than average cell capacity. But the voltage of cell #2 has fallen significantly below the reference level. Cell #2 therefore is suspect, and may have to be rejected.

Fig. 9 shows the DigiFLEX voltages of the same 2 cells, but during the *charge* cycle. Just as Fig. 8 shows the cell voltages rising during charge and then falling during discharge, so Fig. 9 shows the cell voltages rising during the REFLEX charge (positive) pulse, and then falling during discharge (negative) pulse. Just