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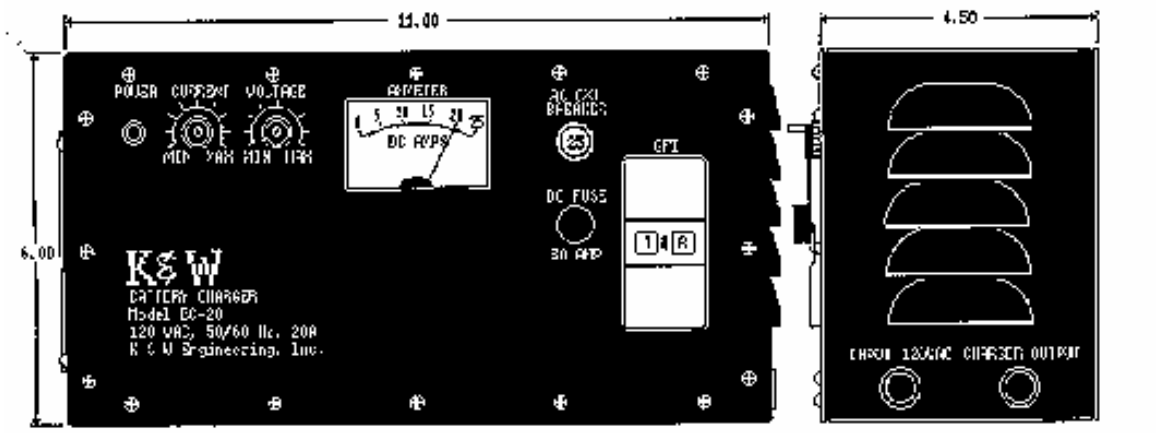
APPLICATION AND INSTALLATION OF THE K & W ENG. BC-20 BATTERY CHARGER

For years, EV hobbyists and manufacturers have been doing one of two things: designing and building their own battery chargers or purchasing and using any of several chargers manufactured by Lester Electrical. Lester chargers that are (or were) manufactured for on-road EV usage are dedicated battery voltage models from 72 through 144 volts, and come with or without an auxiliary output to charge a 12-volt accessory battery. Weights vary from 70 through 150 lbs., and prices range from $500 to $1500. A typical Lester unit for on-road EV applications is 12" H. x 9" W x 15" D., has 96 and 12-volt outputs, weighs 80 lbs., and sells for $800. What the on-road EV community has needed is a lightweight onboard charger that is smaller, less expensive, universal to several battery pack voltages, plugs into the 120 VAC socket, reliable more efficient, and automatic. The K & N Engineering model BC-20 has all of the previously mentioned features.

The BC-20 weighs only 9.9 lbs., costs less than a Lester charger, and will charge any lead-acid battery pack of 48 through 108 volts from a 120 VAC/20 amp outlet faster than a comparable Lester unit. The BC-20 is 98% efficient (compared to a Lester's 70%) and has plenty of other nice features too. While the BC-20 is transformerless, it has a safety ground fault Interrupter (GFI) to guard against line shock hazards. Because of the GFI feature, **the propulsion battery pack must be isolated from the vehicle frame** - an ideal safety requirement for all EV's. An accessory Line Boosting Unit (LB-20) is offered to enable the BC-20 to charge a 114 or 120-volt battery pack from a 120 VAC outlet at reduced output current. The BC-20 and the LB-20 are both warranted for 1 year.



K & W Engineering Model BC-20 Battery Charger (for 48-108 volt lead-acid battery packs) (See price list)
K & W Engineering Model LB-20 Line Boosting Unit (needed for BC-20 to charge 114 or 120 volt battery pack)

BC-20 Specifications:

Configuration:	2 KW transformerless, triac phase-controlled for lead acid batteries
Charging method:	Constant current to gassing point, then constant voltage to finish
Dimensions:	6.00" H. x 11.00" W. x 4.50" D
Weight:	9.9 Pounds
Input:	105-125 VAC, 50-60 Hz, 20 Amps
Output:	48 through 108 volt battery systems, selectable in 6-volt increments by means of furnished programming resistors
Regulation:	+/- 1.0 Amp output current for +/- 10% change in line voltage
Pot Adjustments:	Constant current, fully adjustable from 0-20 Amps Constant voltage, adjustable from 2.0 to 2.5 volts per-cell
Meter:	0-25 Amps DC, displays true output current +/- 10%
Safeties:	Ground fault interrupter (5-6mA trip), 30 Amp AC circuit breaker, 30 Amp output fuse
Surge Protection:	Soft-start circuitry to eliminate inrush current surges when power is applied (also eliminates need for input power switch)
Thermal Features:	Internal fan, overtemperature shutdown, charging voltage corrected for ambient temperature
Noise Filtering:	Reduces peak current, AC harmonics, and generation of EMI/RFI
Case:	Heavy-gauge sheet metal, textured black paint, white silk-screened lettering
Connections:	To internal barrier terminal strip with #10 or #12 AWG wire
Mounting:	Rear or bottom of case with 4 ea. ¼-20 bolts (hardware furnished)

LB-20 Specifications.

Configuration:	Line-boosting transformer, interconnects to BC-20 terminal strip
Dimensions:	6.00" H. x 7.50" W. x 4.50" D.
Weight:	8 pounds
Safeties:	30 Amp circuit breaker
Case:	Heavy-gauge sheet metal, textured black paint, white silk-screened lettering
Mounting:	Rear or bottom of case with 4 ea. ¼-20 bolts (hardware furnished)

APPLICATION NOTE:
The BC-20 is a single-output device, and does not furnish a 12-volt output for charging an auxiliary battery. If your vehicle application requires a 12-volt battery, a separate economy-type charger can be purchased and installed for charging it. Ideally, the BC-20 offers a multiple advantage over the Lester dual-voltage charger when used in conjunction with a Sevcon DC-DC converter (#622-11014 or 4622-11015) which replaces the auxiliary battery. The cost of a Lester charger and a deep-discharge auxiliary battery are only slightly less than the cost of a BC-20 and a Sevcon unit. The advantages of using a Sevcon with a BC-20 are that you wont need to charge or replace a 12-volt battery, and, the weight savings in your EV can amount to 100 lbs. or more.

MOUNTING LOCATION:
The BC-2O (and LB-20, if applicable) should be fastened to a clean: flat surface with the 4 bolts and 8 washers furnished with each unit. Ideally, the BC-20 (and LB-20, if applicable) will be mounted close to the batteries it will be charging, and will share the same ambient air as the battery pack for automatic temperature compensation. It should be installed so that it wont be exposed to moisture drip or splash. The ventilation louvers/slots and fan intake grille of the unit

should not be blocked so as to allow free air circulation. The 4 each ¼" holes at the rear or at the bottom of the BC-20 (and LB-20 if applicable) are to be used for mounting. The mounting holes have threaded inserts.

PRELIMINARY:
Verify that the EV propulsion battery is isolated from the vehicle frame.

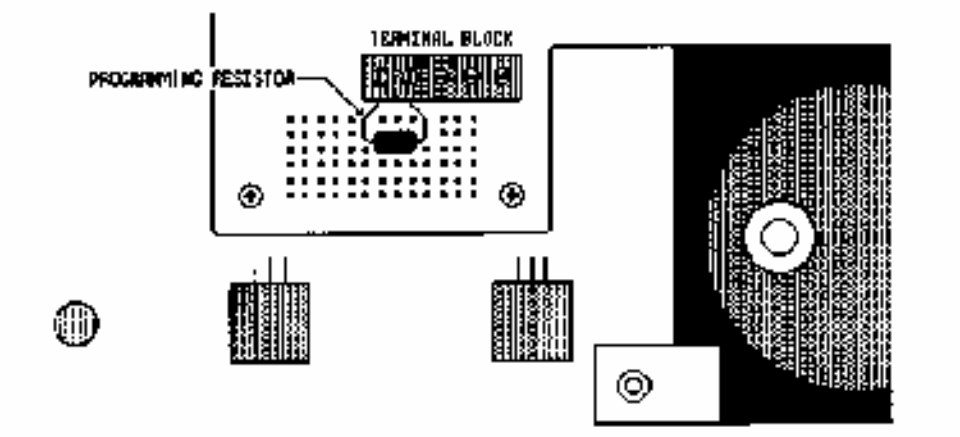
CONFIGURING THE CHARGER TO MATCH YOU BATTERY PACK:
The BC-20 is capable of charging battery packs from 48 through 120 volts by installing the proper internal programming resistor. A card of resistors is furnished with each unit that allow charger programming at 6-volt increments. The following table lists those values:

BATTERY VOLTAGE	RESISTOR VALUE	RESISTOR IDENTIFIER	BATTERY VOLTAGE	RESISTOR VALUE	RESISTOR IDENTIFIER
48	36.5 K ohm	3652F -or- Org-Blu-Grn-Red-Brn	90	71.5 K ohm	7152F -or- Vio-Brn-Grn-Red-Brn
54	41.2 K ohm	4122F -or- Yel-Brn-Red-Red-Brn	96	76.8 K ohm	7682F -or- Vio-Blu-Gry-Red-Brn
60	46.4 K ohm	4642F -or- Yel-Blu-Yel-Red-Brn	102	82.5 K ohm	8252F -or- Gry-Red-Grn-Red-Brn
66	51.1 K ohm	5112F -or- Grn-Brn-Brn-Red-Brn	108	86.6 K ohm	8662F -or- Gry-Blu-Blu-Red-Brn
72	56.2 K ohm	5622F -or- Grn-Blu-Red-Red-Brn	114	93.1 K ohm	9312F -or- Wht-Org-Brn-Red-Brn
78	61.9 K ohm	6192 -or- Blu-Brn-Grn-Red-Brn	120	97.6 K ohm	9762F -or- Wht-Vio-Blu-Red-Brn
84	66.5 K ohm	6652F -or- Blu-Blu-Grn-Red-Brn			

1) Lay the BC-20 down on its rear surface and remove the 16 screws from the front panel. Set the BC-20 onto its bottom surface, slowly pull the front panel outward and downward, being careful not to scratch the paint or damage any interconnecting wires.

2) With the BC-20 front panel now resting flat on its face, observe the printed circuit board mounted to the rear of the front panel. In the lower left region of the board, locate the small 5-position TERMINAL BLOCK. The PROGRAMMING RESISTOR will be installed on this TERMINAL BLOCK as shown below. Unless otherwise specified, factory-installed resistor will be for a 96-volt battery system.

3) If your battery system application is 96 volts, refer to the cable above and verify that the correct PROGRAMMING RESISTOR is installed for your application.



4) If your battery system application is for a voltage that does not correspond to the factory-installed resistor, loosen the TERMINAL BLOCK screws 2 or 3 turns and remove the resistor. Return it to the resistor card. Locate the correct resistor for your application; verify its value with a digital V.O.M. if you have difficulty identifying its value. Cut the resistors wire leads to ¾" length from resistor body to end. Bend and form the resistor leads approximately as shown in the figure above. Install the resistor and retighten the 2 TERMINAL BLOCK screws.

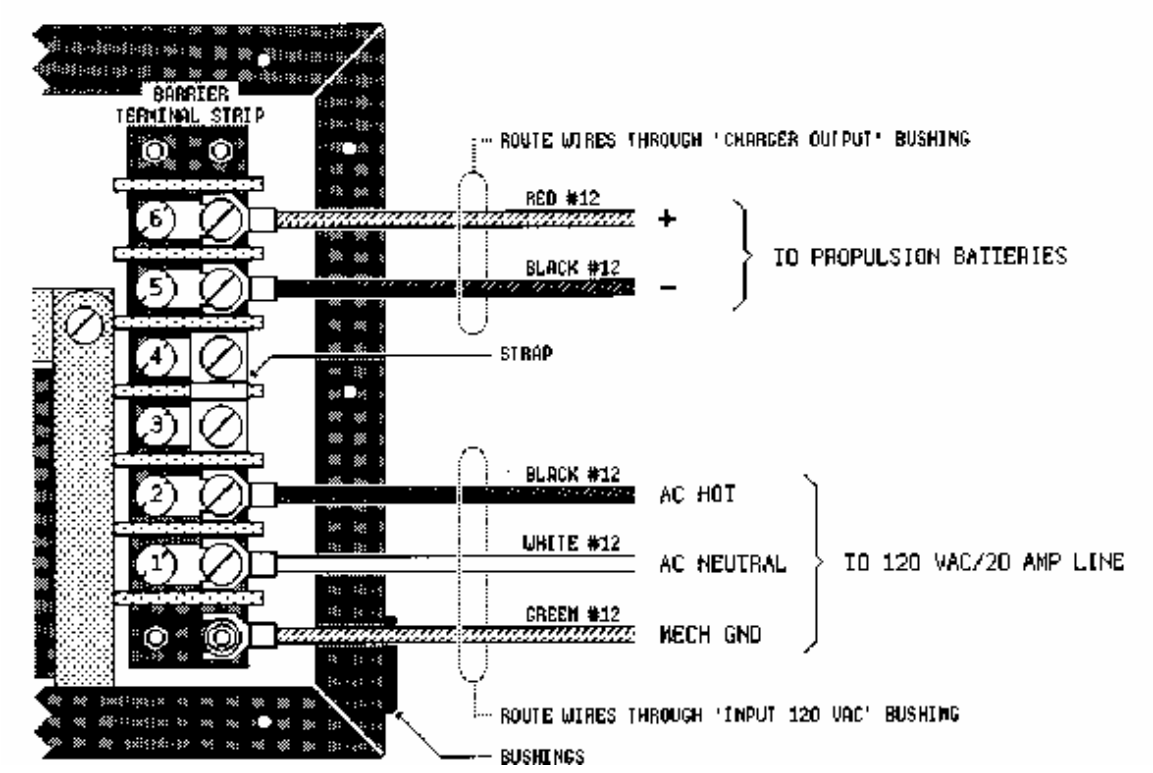
5) Place the BC-20 front panel back into position on the charger unit, being careful not to scratch the paint or damage any interconnecting wires. Hold the panel in place by temporarily installing 4 of the screws - one at each corner.

6) Mount the BC-20 (and LB-20 it applicable) into your EV per the MOUNTING LOCATION criteria of page 2. 5/16" clearance holes may be drilled through the mounting surface. Mounting hardware is furnished with each unit, and there are corresponding threaded inserts in the BC-20 case. When installing the 4 bolts (8 bolts, if applicable), place a split-lock washer and then a flat washer in that order, under each bolt head.

7) Remove the screws temporarily holding the BC-20 front panel. Slowly pull the front panel outward and downward, being careful not to scratch the paint or damage any interconnecting wires. NOTE: STEPS (8) THROUGH (11) APPLY TO 48 THROUGH 108-VOLT BATTERY SYSTEMS. FOR 114 OR 120-VOLT BATTERY SYSTEMS, SKIP TO STEP (12).

8) Locate the BARRIER TERMINAL STRIP inside the right portion of the BC-20. Refer to the figure below, Plan your wiring runs from the BC-20 BARRIER STRIP, through the appropriate BUSHING on the case and to the respective destination. The (+) wire should connect to the highest positive terminal in the propulsion battery pack, while the {-) wire should connect to the lowest negative. The AC HOT and AC NEUTRAL should connect to the vehicle's AC power input connector (120 VAC), normally installed in what formerly was the vehicle's gas tank filler. The MECH GND wire can connect to convenient bolt or screw that is common to the vehicle frame.

   NOTE: Hardware stores or electrical supply houses should carry the wire, terminal lugs and terminal crimping tool required for your installation.



9) By using stranded wire no smaller than 12 AWG, connect the wires to the BARRIER TERMINAL STRIP positions as shown in the illustration on page 4. The wires should first be routed through the appropriate BUSHING as shown, then crimp either insulated of non-insulated lugs onto the wire ends. The crimp lugs can be spade or ring type, and should be appropriately sized to the wire gauge used.

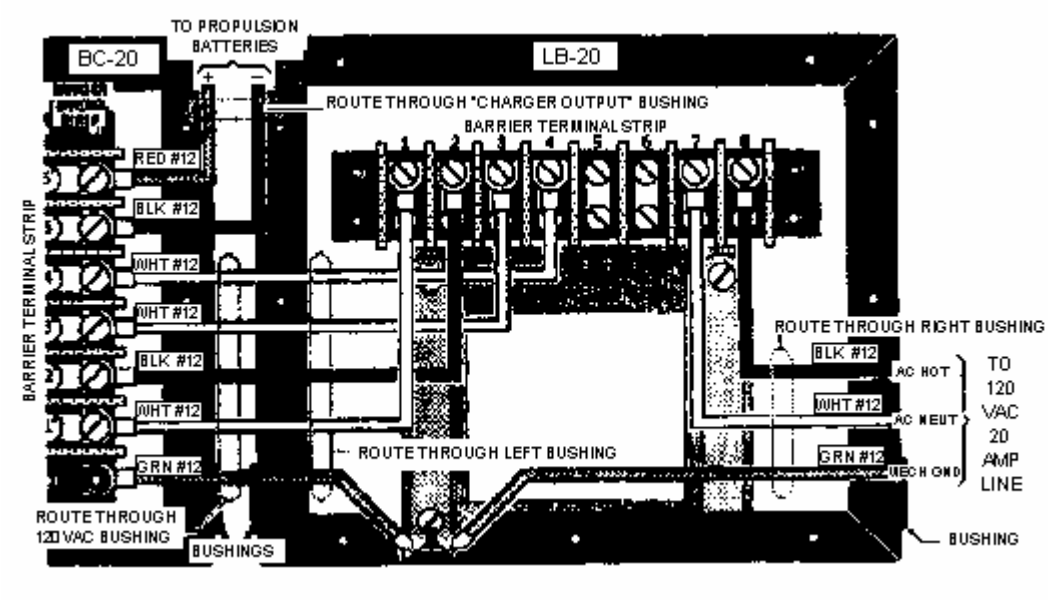
10) Screw the attached crimp lugs down tight onto the BARRIER TERMINAL STRIP. Check to see that there are no shorts from any of the wires to adjacent terminals or to the case (except for the GREEN MECH GND wire). DOUBLE-CHECK YOUR WORK FOR ACCURACY, AS MISWIRING CAN DAMAGE THE CHARGER.

11) Skip to step (18).

12) Remove the 12 screws from the front panel of the LB-20. Slowly pull the front panel outward and downward, being careful not to scratch the paint or damage any interconnecting wires.

13) Locate the BARRIER TERMINAL STRIPS inside the right portion of the BC-20 and the upper central portion of the LB-20. Refer to the figure below. Plan your wiring runs from the BC-20 and LB-20 BARRIER STRIPS, through the appropriate BUSHINGS on the cases, and to the respective destinations. The (+) wire should connect to the highest positive terminal in the propulsion battery pack, while the (-) wire should connect to the lowest negative. The BC-20's terminals #1-4 should connect one-for-one to the LB-20's terminals #1-4. The AC HOT and AC NEUTRAL should connect to the vehicle's AC power input connector (120 VAC), normally installed in what formerly was the vehicle's gas tank filler. The MECH GND wire should connect as shown to the screw in the LB-20, and then to the MECH GND of the 120 VAC input connector.

NOTE: Hardware stores or electrical supply houses should carry the wire, terminal lugs and terminal crimping tool required for your installation.



14) Refer to the illustration on page 4. At the BC-20 BARRIER TERMINAL STRIP, remove the STRAP between terminals #3 and #4.

15) By using stranded wire no smaller than #12 AWG connect wires to the BARRIER TERMINAL STRIP positions as shown in the illustration above. The wires should first be routed through the appropriate BUSHING as shown; then, crimp either insulated or non-insulated lugs onto the wire ends. The crimp lugs can be spade or ring type, and should be appropriately sized to the wire gauge used.

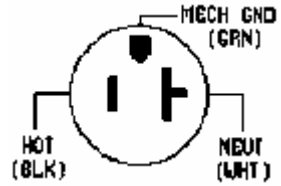
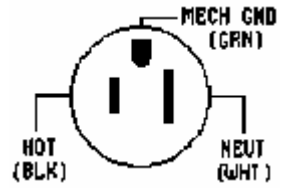
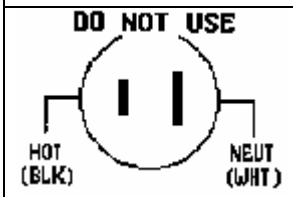
16) Screw the attached crimp lugs down tight onto the BARRIER TERMINAL STRIPS. Check to see that there are no shorts from any of the wires to adjacent terminals or to the case except for the GREEN MECH GND wire). DOUBLE-CHECK YOUR WORK FOR ACCURACY, AS MISWIRING CAN DAMAGE THE CHARGER.

17) Place the LB-20 front panel back into position on the booster unit, being careful not to scratch the paint or damage any interconnecting wires. Secure the panel by installing and tightening all 12 screws.

18) Place the BC-20 front panel back into position on the charger unit, being careful not to scratch the paint or damage any interconnecting wires. Secure the panel by installing and tightening all 6 screws.

19) Determine the type of 120 VAC service that you'll be taking power from to charge your vehicle. First choice would be 20 Amp service, second choice would be 15 amp. 20 amp service will enable the RC-20 current setting to be adjusted higher resulting in a 20-25% faster charge than can be provided by using 15 Amp service. If wired per electrical code you'll be able to distinguish the difference between the types. Since the Ground Fault Interrupter plays a major safety role in the BC-20, DO NOT ATTEMPT TO USE ANY CONNECTOR OR SERVICE THAT DOES NOT PROVIDE A MECHANICAL GROUND

WIRE TO THE VEHICLE FRAME. ALSO, DO NOT ATTEMPT TO USE ANY 120 VAC SERVICE THAT IS IMPROPERLY WIRED OR HAS AN IMPROPERLY SIZED CIRCUIT BREAKER OR WIRE.

CONNECTOR CONFIGURATION	POWER RATING	CONNECTOR NEMA TYPE	CIRCUIT BREAKER RATING INSTALLED	HOUSE WIRING INSTALLED
	125 VAC 20 AMPS	2-POLE/3 WIRE W/GND NEMA 5-20R	20 OR 25 AMP	#10 OR #12 AWG
	125 VAC 15 AMPS	2-POLE/3 WIRE W/GND NEMA 5-15R	15 OR 20 AMP	#12 AWG
	125 VAC 15 AMPS	2-POLE/2 WIRE NEMA 1-15R	15 OR 20 AMP	#12 OR #14 AWG

20) Purchase the 120 VAC line receptacle for the vehicle according to the service used. The connector on the vehicle should be a MALE FLANGED INLET type such as the Arrow Hart #5778C (20 Amp) or #5278C (15 Amp). Electrical supply houses or hardware stores should be able to provide either connector, or equivalent.

21) Mount the Male Flanged Inlet connector on the vehicle. An ideal place is behind the fuel filler door- The location chosen for the connector should be accessible to the outside of the EV, yet protected from water drip or splash.

22) Connect the 3 LINE INPUT WIRES from the BC-20 (or LB-20, as applicable) to the Male Flanged Inlet. Use the preceding illustrations as a wiring guide.

SETTING UP THE CHARGER.

23) Partially discharge the propulsion battery pack in the vehicle, This can be accomplished by driving it for 5 to 10 minutes on the road or by running the motor with vehicle in ‘neutral’ for about 15 minutes. If the batteries are already somewhat discharged, skip this step.

24) On the BC-20 front panel, set the CURRENT control adjustment to MIN (C.C.W.) position, and the VOLTAGE control to its 50% point.

25) Connect the vehicle's input power to the 120 VAC service with a power extension cord- THIS CORD SHOULD NOT BE LONGER THAN 25 FEET, NOR SHOULD IT BE SMALLER IN WIRE GAUGE SIZE THAN #12 AWG FOR SAFETY REASONS and to minimize power loss. The extension cord connectors should match the type and rating of service used.

26) The green POWER light should be on. If not, reset CFI by depressing and releasing its 'R' button. If problems continue see steps (31) & (32).

27) Refer to the following table while adjusting the CURRENT and VOLTAGE controls to their desired set points. These points are for flooded-cell (liquid electrolyte) lead acid batteries only. Consult with KTA Services for set points on gelled-call and other types of batteries.

NOMINAL BATTERY PACK VOLTAGE	MAXIMUM AMMETER SETTING (AMPS)		BATTERY PACK VOLTAGE UNDER CHARGE	
	FROM 20 AMP SERVICE	FROM 15 AMP SERVICE	@ 2.35 VOLTS/CELL	@ 2.50 VOLTS/CELL
48	8	7	56.4	60.0
54	9	8	63.5	67.5
60	10	8	70.5	75.0
66	10	8	77.6	82.5
72	11	8.5	84.6	90.0
78	12	9	91.7	97.5
84	13	10	98.7	105
90	14	10.5	106	113
96	15	11	113	120
102	16	12	120	128
108	18	13.5	127	135
114	15	11.3	134	143
120	12	9	141	150

28) Slowly rotate the CURRENT control toward the MAX (C.W.) position while observing the BC-20 AMMETER. Depending on which 120 VAC service you are charging from, set the AMMTETER current to the maximum value in step (27) for your battery pack voltage. This sets up the chargers CONSTANT CURRENT MODE, The BC-20 AMMETER should

remain steady at the current value set until the CONSTANT VOLTAGE MODE (CURRENT TAPERING) begins.

29) With a digital V.O.M., verify that the AC line voltage at the BC-20 (LB-20, if applicable) input is between 105 and 125 VAC while charging. If other than 105-125 VAC, specified performance cannot be guaranteed. Correct the 120 VAC service problem before proceeding. (NOTE: If the input voltage is lower than 105 VAC under charge, this usually can be corrected by using a shorter and/or heavier wire gauge extension cord. Seldom will the voltage he above 125 VAC.)

30) With a digital V.O.M., monitor the battery pack voltage under charge. It shall be gradually increasing with time as the AMMETER current remains steady.

31) NOTE: If, under charge, the green POWER light goes off, it may indicate that the main circuit breaker supplying your 120 VAC service or the 30 amp circuit breaker on the BC-20 or LB-20, if applicable) has tripped. (No circuit breaker is a precision device.) If so, reset the circuit breaker and readjust the AMMETER current as required to a slightly lower value until the circuit breaker(s) hold the current setting.

32) NOTE: If, under charge, the green POWER light goes off, but the GFI trips (as indicated by its small red pilot light), depress and release the R' button to reset the GFI. If the GFI continues to trip, this could be due to: (A) Dirty propulsion batteries and/or (B) A low resistance path between any part of the propulsion battery system and vehicle frame. In either case, correct the condition before proceeding.

33) Continuing from step (30) periodically check the BC-20 AMMETER and the battery pack voltage in the course of charging. At some point the BC-20 will switch into CONSTANT VOLTAGE MODE, characterized by a gradual decrease in charging current. When this point is observed, note the battery pack voltage under charge and compare it to the table in step (27). Ideally, the CONSTANT VOLTAGE MODE will start at the battery pack value listed for 2.35 volts/cell.

34) If the CONSTANT VOLTAGE MODE occurs below 2.35 volts/cell, readjust the BC-20 VOLTAGE control slightly in the C.W. direction until the ideal value is achieved.

35) If the CONSTANT VOLTAGE MODE occurs above 2.35 volts/cell, readjust the BC-20 VOLTAGE control slightly in the C.C.W. direction. Then, discharge the batteries slightly and repeat the procedure from step (33).

36) When the ideal mode switchover point is achieved, the CONSTANT VOLTAGE MODE will have been set whereby the BC-20 will charge up the battery pack automatically. The ideal end of charge will occur at the 2.50 volts/cell voltage listed for your battery pack in the table of step (27) at which time the current will have tapered off to about 1 Amp or less.

CHARGER AND BATTERY RECOMMENDATIONS.

Keep your batteries clean, and check them periodically for correct specific gravity as specified by the battery manufacturer. Also, TEST THE BC-20 GFI AT LEAST ONCE PER MONTH. WITH THE CHARGER PLUGGED INTO INPUT POWER, PRESS THE ‘T’ BUTTON TO TRIP IT, AND THE ‘R’ BUTTON TO RESET IT. IF THE GFI DOESN’T TRIP AND RESET, CONTACT KTA SERVICES PROMPTLY.

Finally, if you are driving and stop to ‘opportunity’ charge from a remote outlet, its ability to deliver current may be different from the outlet you normally charge from. This may necessitate a reduction in charging current in order to keep from blowing the remote outlets circuit breaker, Simply reduce current by adjusting the BC-20 CURRENT control slightly C.C.W. While performing this adjustment, however, do not readjust the BC-20 VOLTAGE control. Reset the CURRENT control higher when charging again from the normal outlet.