INSTRUCTION MANUAL

FOR

AUTOREG

COMMUNICATION BATTERY CHARGERS

C & D BATTERIES DIV.

Model No. ________________ Serial No. ____________________

A.C. Input D. C. Output

Volts ________ PH __________ Cells ____________ A. H. ________

Amps ________ CY __________ Volts ____________ Amps ________

Max. Amb. Temp. ________ °C Code ___________

C & D BATTERIES DIV.

THE ELECTRIC AUTOLITE COMPANY

CONSHOHOCKEN, PA.

RS-170

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INTRODUCTION

AutoReg chargers of the ARF series are designed exclusively for use with calcium grid lead acid batteries whereby the station load demand is relatively constant and the batteries can be maintained at 2.20 volts per cell while floating. Under these conditions, voltage adjustments are not required nor do the batteries require an equalizing charge. In general, the constant load is approximately 2/3 to 3/4 of the rating of the charger.

Beyond the full load rating of the charger (current limiting region) the output voltage while charging a discharged battery will always be above two volts per cell except during the initial surge prevalent with the restoration of AC power after a power outage.

The ampere hour capacity of the battery does not affect the operation of the charger, except to prolong the recharge time on a large battery and shorten the recharge time on a small battery. This primarily is a function of the original specifications and design of the over-all system. The charger automatically adjusts to the battery's requirements. In all cases the battery is the master while the charger is a slave responding to demands made by the dictating battery. Since the battery regulates the charge, it is evident that overcharging is practically impossible. This promotes longer life and less frequent water addition resulting in decreased maintenance for the entire system.

INSTALLATICN

Unpacking

The equipment should be carefully unpacked to avoid marring the enclosing case or damaging the apparatus. Particular care should be exercised that no small parts are mislaid or thrown away in the packing material. If the equipment is not to be used as soon as it is unpacked, it should be stored in a dry place and protected from accidental damage.

Location

The equipment should be installed in a convenient, dry place, where it will not be subjected to excessive vibration and where the ambient temperature does not exceed the limits of $-40^{\circ}C$ ($-40^{\circ}F$) minimum and $+60^{\circ}C$ ($+140^{\circ}F$) maximum. If these temperature limits are exceeded, it may be necessary to install additional ventiliation or heaters. Locations subject to excessive vibration should be avoided, or else the equipment insulated therefrom, because of the possible detrimental effect, or injury to the more delicate instrument mechanisms.

Power Source

It is very essential to the proper functioning of this equipment that the AC supply voltage and frequency be within the limits of plus and minus 10 percent of that voltage rating stamped on the nameplate, and plus and minus 1 percent of the frequency rating. If the source voltage is other than rated value, it will be necessary to reconnect the voltage taps on transformer primary. When the sustained voltage fluctuations are beyond the range of plus or minus 10 percent consult the nearest sales office of C & D Batteries Division of The Electric Autolite Company.

External Connections

The connection diagrams, furnished with each charger show the internal connections together with all the necessary external connections.

THEORY OF CPERATION

Construction

C & D AutoReg Chargers are of the regulated constant potential type designed around the ferro-resonant theory. This theory involves a combination of a resonant electrical circuit working in conjunction with primary, secondary and magnetic circuits. The diagram in Figure 1 below illustrates these circuits and are identified as follows: (1) Primary Winding, (2) Resonant Winding,(3) Secondary Winding, (4) Compensating Winding. The compensating winding (4) is connected in series with the secondary but is wound over the primary winding (1) on part "A" of the center leg of the core. Second Winding (3) is also layer wound over the resonant winding (2) on part "B" of the center leg. The resonant and secondary windings are isolated from the primary and compensating windings by the magnetic shunts.

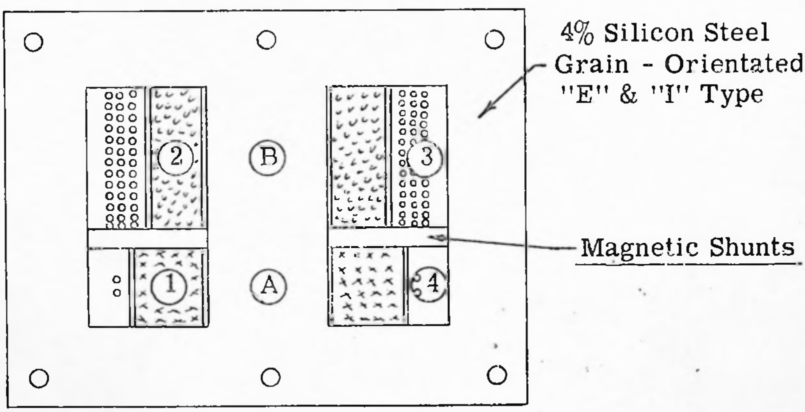


Figure No. 1, Construction Details

OPERATION

In a ferro resonant circuit, the core material of the inductance consists of 4% silicon magnetic steel which is operated in a highly saturated condition. Saturation of the core occurs when an increasing magnetizing current does not result in an increasing magnetic field strength. As the line voltage to the primary (1) is increased from zero, the input line current increases until the core material of the inductance begins to saturate and its increasing current is beginning to neutralize the current drawn by the capacitor "C" connected across the resonant winding (2). The flux density threading part "B" of the core structure now becomes such that the inductive reactance of the resonant winding (2) approaches the value of the capacitative reactance of the capacitor "C" at the frequency of the exciting voltage. (Point "W")

At this time the line current will diminish to a low relative value at which point the ferro-resonant circuit is in resonance. Fig. 2 delineates this characteristic (Point "Y"). As the line voltage is increased beyond this point the line current increases very rapidly due to the now highly saturated condition of the core material. The voltage appearing across the resonant winding (2) rises rapidly to a stable pre-determined value, which is higher than the calculated turns-ratio voltage. This has the effect of increasing the magnetic density in part B of the core and reducing the relative reluctance of the magnetic shunt circuit. Therefore, changes in flux due to variation in the primary are mostly absolved in the magnetic circuit (shunts) and the transformer will resist going out of resonance, resulting in a very stable output with wide variation (plus or minus 15%) in the AC input voltage. Actually the input voltage must drop to a value below the "jump in" point "W" before the circuit will "jump out" of resonance.

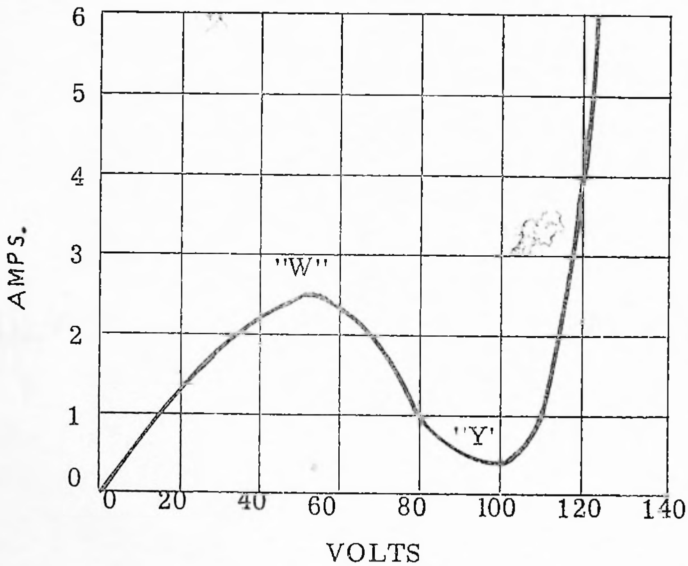


Figure No. 2

Volt Input VS Current Relation of The Ferro-Resonant Circuit.

The shunts serve to loosen the effective coupling between the resonant circuit and the primary winding so that once resonance is effected, the primary must supply only that energy necessary to overcome the core and copper losses to maintain equilibrium at no load. These shunts between the resonant winding and the primary winding permit magnetic fields of different strength to exist in the magnetic core passing through each coil. The difference in field strength is passed to the outer legs of the core. Thus, each coil has certain amount of freedom from the other and they are not as closely coupled as in ordinary transformers.

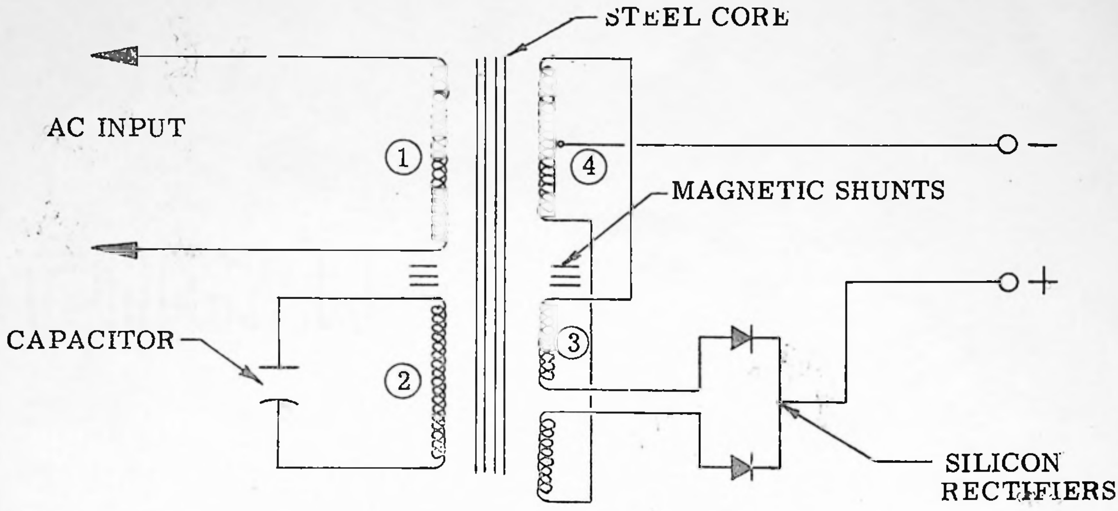


FIGURE NO. 3 CIRCUIT THEORY

Current Limiting

Normal operation at relatively high flux densities and the use of magnetic shunts combine to produce high leakage reactance at currents beyond rated full load. Should the DC load reach a point where the energy drained from the ferro-resonant does not leave enough energy in the circuit to maintain saturation of the core, the ferro-resonant circuit will collapse. When this circuit collapses, the DC output voltage falls to a low value protecting the charger from injury. These units can even be short circuited indefinitely without harm due to the collapse of the ferro-resonant circuit.

Simplicity of Construction

The simplicity of the ferro-resonant design permits the maximum freedom of operation with a minimum of components. The basic charger is composed of a transformer described previously and hermetically sealed silicon power rectifiers. Since silicon rectifier characteristics will not change with time in normal operating temperature, no ageing taps are necessary. Thus the only control necessary is a simple clock device to disengage the charger from the AC line upon the completion of the charging cycle. Pilot lights and meters (optional) are supplied to give visible indication of operation.

Since the charger is automatically self-protecting, it is possible to charge any size capacity battery of the same number of cells up to the rating of the charger in eight hours or less or during an overnight period if the charger is rated for this service on specific applications. The unit will charge a battery (same number of cells) many times larger than the nameplate rating -- it will just take a longer charging period. From this it should now be apparent that this charger is extremely versatile, self-protecting, and since it functions as demanded by the battery itself, the ultimate in battery charging is achieved. This can only result in longer battery life expectance and less maintenance.

Alignment

The simplicity of the ARF series of AutoReg Chargers practically eliminates all alignment procedures. In general, the charger should be energized before the battery and load are connected. This charges the capacitors in the filter circuit from the charger instead of exposing the capacitors to a surge of current from the battery if the battery is first connected. Actually no harm will occur to any component as the thermal fuses will absorb this current shock. However, any fast acting fuse (if use) in the DC circuit will probably open.

The charger is factory preset to give the rated voltage with a constant station load of 15% to 100% of full load rating. They can be factory set to any desired station load from 15% to full load. This is not advisable in the field.

Trouble Shooting

In the case of failure of the AutoReg charger to function correctly, a check of the following items should be made:

Power Source:

1. Has the power source to the AutoReg charger been turned on?

2. Is there voltage at the input terminals of the charger?

3. Is the supply voltage and frequency within the nameplate rating of the AutoReg charger?

4. Has the DC output of the AutoReg charger been connected to the battery bus?

Failure to Operate

A. General

1. Check to see if switches are closed.

2. Operate circuit breakers to ascertain proper closing of breaker contacts.

3. Make sure tap change links are all in proper location.

4. Be certain that the battery voltage is within the nameplate rating of the AutoReg charger.

5. BE SURE THAT THE BATTERY POLARITY HAS NOT BEEN REVERSED.

B. No Output Voltage, AC breaker closed and DC fuses open.

1. Check the DC voltmeter that it isn't open circuited or the pointer stuck, or reading backwards. Do this by connecting another voltmeter across its terminals.

2. Check the AC voltage across each half-section of the secondary of the anode transformer. If this voltage is zero, it indicates an open winding in the transformer.

3. Check the AC voltage across the AC winding of each saturable reactor. If this voltage is zero, then the winding is shorted, or the anode transformer is open circuited. A normal voltage may be as low as 10 volts.

No Output Voltage, DC breaker closed.

1. Check the DC voltmeter that it isn't open circuited or the pointer stuck, or reading backwards. Do this by connecting another voltmeter across its terminals.

2. Check for battery voltage on battery side of DC breaker.

3. Make sure DC breaker contacts are closed. Check with continuity meter.

C. Failure to deliver current to battery with AC and D C breakers closed.

1. Check DC ammeter to be sure that it is not open circuited or the pointer stuck. Do this by connecting another ammeter across its terminals.

2. Check DC breaker with breakers on the ON position and measure voltage across terminals of each breaker. A defective breaker is indicated if there is a voltage across the terminals.

3. Check power rectifiers for an open rectifier. This is done by disconnecting the anode connection of each rectifier and measuring the forward and reverse resistance. A good rectifier will have a very high reverse to forward resistance ratio. (1000 or more to 1).

D. Grounding Lights Fail to Function Properly

1. Both lights out.

(a) Check for a burned out bulb.

(b) Check voltage at the terminals of grounding light assemblies to which insulated wires are connected.

(1) If the voltages across the two lights are not equal, check for an open resistor in the light assembly.

(2) If no voltage is measured here, check the wiring and connections to the lamp assemblies.

(3) Battery voltage insufficient to light lamps.

2. One light out.

(a) Check for a ground in the system.

E. Alarm System

1. If alarm system fails to function with the AC input breaker open measure the voltage across the coil of the alarm relay. There should be no voltage present.

2. Check for DC voltage across the alarm terminals, no voltage should be present.

(a) If voltage is present, contacts of relay are not closing properly or interconnecting wiring is open.

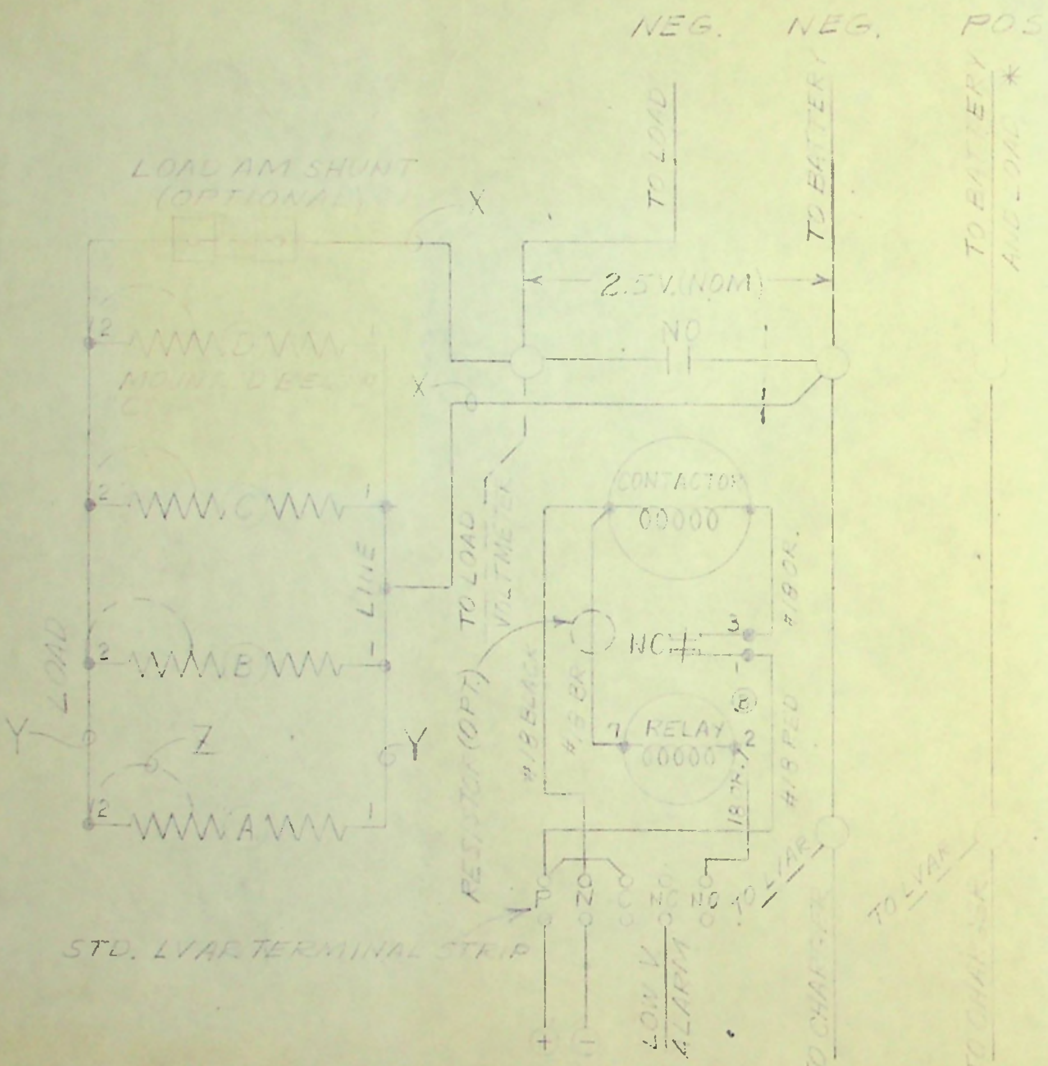
(b) If trouble is not found in 1 and 2 above, trouble is external to charger and alarm system should be checked.

3. If alarm sounds with proper input and output voltages, the trouble is alarm relay or internal connections to relay.

F. DC Trip Indicating Light

The DC trip indicating light, as supplied, provides a visual indication for those instances when the DC breaker trips or is open. The operating mechanism is a set of auxiliary contacts, normally open, which are closed in the trip or open position. The leads are brought out from internal connections in the DC breaker to a terminal board located on the rear of the breaker. Provision has been made for a normally closed contact should this be desired as an alternate. This would require one reconnection on the terminal block. Should the pilot light not function when the DC breaker is open or tripped, check the lamp or line supply.

* Load connection should be made at battery if possible.

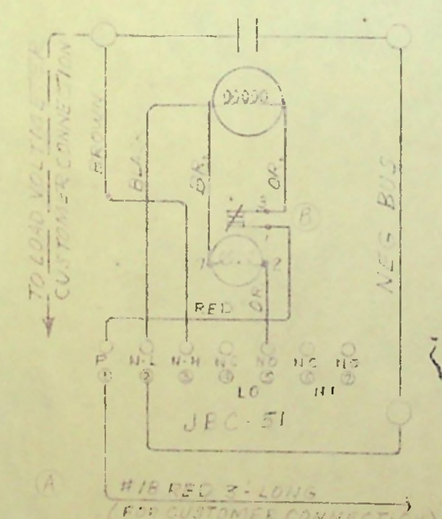


RATING	RESISTOR	CABLE SIZE	CONNECT AS SHOWN FOR APPROX. 2.5 V. DROP		
			For 15 A. to 29 A.	For 30 A. to 60 A.	
60 AMPS	A-.17 Ω B-.17 Ω	X- #4 Str. Y- 1/16 x 5/8 copper Z- #6 Str.	Series- Line to A1 Load to tap on A as Req'd.	Parallel- Line to A1 & B1 Load to equal taps on A & B as required	
100 AMPS	A-.17 Ω B-.17 Ω C-.17 Ω	X- #1 Str. Y- 1/16 x 5/8 copper Z- #6 Str.	For 30A. To 45A. Parallel (2) Line to A1 & B1 Load to equal taps on A & B as required	For 46A. to 100A. Parallel ( ) Line to A1, B1, C1 Load to equal Taps as req'd.	
150 AMPS	A-.045 Ω B- .17 Ω C-.045 Ω D- .17 Ω	X- #2 Str. Y- (2) 1/16 x 5/8 ** copper Z- #4 Str.	For 35A. to 80A. Series-Parallel Line to A1 & B1 A2 & B2 to C2 & D2, Load to taps on C&D as required	For 81A. to 125A Parallel (3) Line to B1,C1, and D1 Load to equal taps as req'd.	For 126A. to 150A. Parallel (4) Line to A1,B1,C1, and D1 Load to ends or tap B & D as required.

** Junction between B & C on line side.

INSTRUCTIONS AND NOTES:

1. Battery polarity is not shown as ballast may be used in either leg.
2. Output leads may be 1/8 x 1 copper bus bar or cable up to #4/0.
3. If the low voltage alarm unit is mounted externally, a terminal strip must be mounted and connected as shown.
4. The "NO" contact opens on low voltage, allowing the control relay to drop out. Its contacts close to complete the contactor coil circuit.
5. On a 24 volt system, the lvar operate point is usually set at 25.0 volts
6. On recharge, if it is desired that the contactor be kept closed above the operate voltage of the lvar, a series resistor (1000 Ω, 10w., adj.) can be added in series with the control relay coil to delay pickup.
7. If a load voltmeter is used, leads may be run from vrb unit but readings would not allow for voltage drop of load cables.



ALTERNATE CONNECTION FOR DUAL-NEG. LVAR (COL. GAS EXT.)

REF. DWG. MBC-203

NO	DATE	BY	REVISION
B	11-24-64		ADDED PIN NOS. FOR ENCL. RELAY
A	2-7-62		ADDED ALT. CONN. FOR COL. GAS

C & D BATTERIES of Conshohocken, Pa
DIV THE ELECTRIC AUTOLITE CO

SCHEMATIC - UNIVERSAL LOAD VOLTAGE REGULATOR VRB 24, 60, 100 and 150A.

DRAWN BS	APPROVED
CHECKED	DRAWING NO
DATE May 1 1962	KBC-479
SCALE	