

J86243A RECTIFIER UNIT

1. GENERAL

1.01 This section covers the operation of an automatically regulated metallic-type rectifier unit using a saturable transformer control for floating and charging 10-, 11-, or 12-cell batteries. It was designed originally for use in floating an 11-cell battery in the TD-2 radio relay system. The rectifier unit is rated 24 volts, 9 amperes direct current. Regulation should be within ± 2 per cent for power service voltage variations up to ± 8 per cent and load variations up to rated ampere output for battery voltages up to 24 volts. At higher battery voltages up to 28 volts, the regulated output is limited to about 7 amperes. At greater current outputs the voltage droops and the output is limited to about 14 amperes at 80 per cent of the regulated voltage. The unit is designed to operate on 115, 210, 220, 230, 240, or 250 volt 60-cycle single-phase power service with voltage variations within ± 8 per cent and frequency within ± 2 per cent. The unit is self-regulating and is suitable for use in room temperatures from 40 to 110F (4 to 43C).

Caution: Voltages inside the rectifier case are higher than those usually encountered in telephone power plants. Avoid all contact with terminals as high voltages are present. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur. Remove all A-C and D-C fuses for the rectifier unit before removing any protective guards behind the covers to work on the inside of the unit.

1.02 A metallic rectifier cell is an elementary rectifier having one positive electrode, one negative electrode, and one rectifying junction. A rectifying element is a circuit element which has the property of conducting current effectively in one direction only and may consist of a group of metallic rectifier cells connected in parallel or series arrangement or both. A rectifier unit is an assembly consisting of a rectifying element and associated auxiliaries such as transformers, filters, switches, etc. To avoid unbalance, only complete rectifying elements should be replaced. In no case should any attempt be made to replace part of the rectifier cells in a stack or bolt assembly or even to replace a complete bolt assembly which is part of a rectifying element.

1.03 Keeping the ventilating passages and rectifier cells clean is especially important to prevent excessive heating.

1.04 Routine checks are intended to detect defects particularly in infrequently operated parts of the equipment and, in so far as possible, guard against circuit failures liable to interfere with service. Tests and adjustments, other than those required by trouble conditions, should be made during a period when they will cause the least unfavorable reaction.

1.05 The instructions of this section are based on drawing SD-81093-01.

1.06 More detailed information on the operation and maintenance of individual pieces of apparatus, such as instruments, keys, relays, etc. is given in other sections and the attendant should of course be familiar with them. The relay is assumed to have been adjusted in accordance with these sections and the circuit requirements table of the circuit drawing. Refer also to Section A801.910, Artificial Loads.

1.07 Information in this section is arranged under the following headings:

1. GENERAL

2. OPERATION

- 2.01 How the Rectifier Unit Works
- 2.11 Preparing to Start
- 2.12 Initial Adjustments
- 2.14 Routine Adjustments (Normal Operation)

3. ROUTINE CHECKS

4. TROUBLES

5. POINT-TO-POINT VOLTAGES

- 1.08 List of Gauges
(Equivalents may be substituted)
Meter, M9B
Voltmilliammeter, KS-8039

2. OPERATION

How the Rectifier Unit Works
(See Fig. 1 Functional Schematic)

2.01 Single-phase 60-cycle 115-volt a-c power is connected to the rectifier unit either directly or by a step-down auto-transformer when the power supply is in the range 210 to 250 volts. The power supply is connected to a built-in line voltage regulator LR which minimizes line voltage variations and delivers to retard coil L1

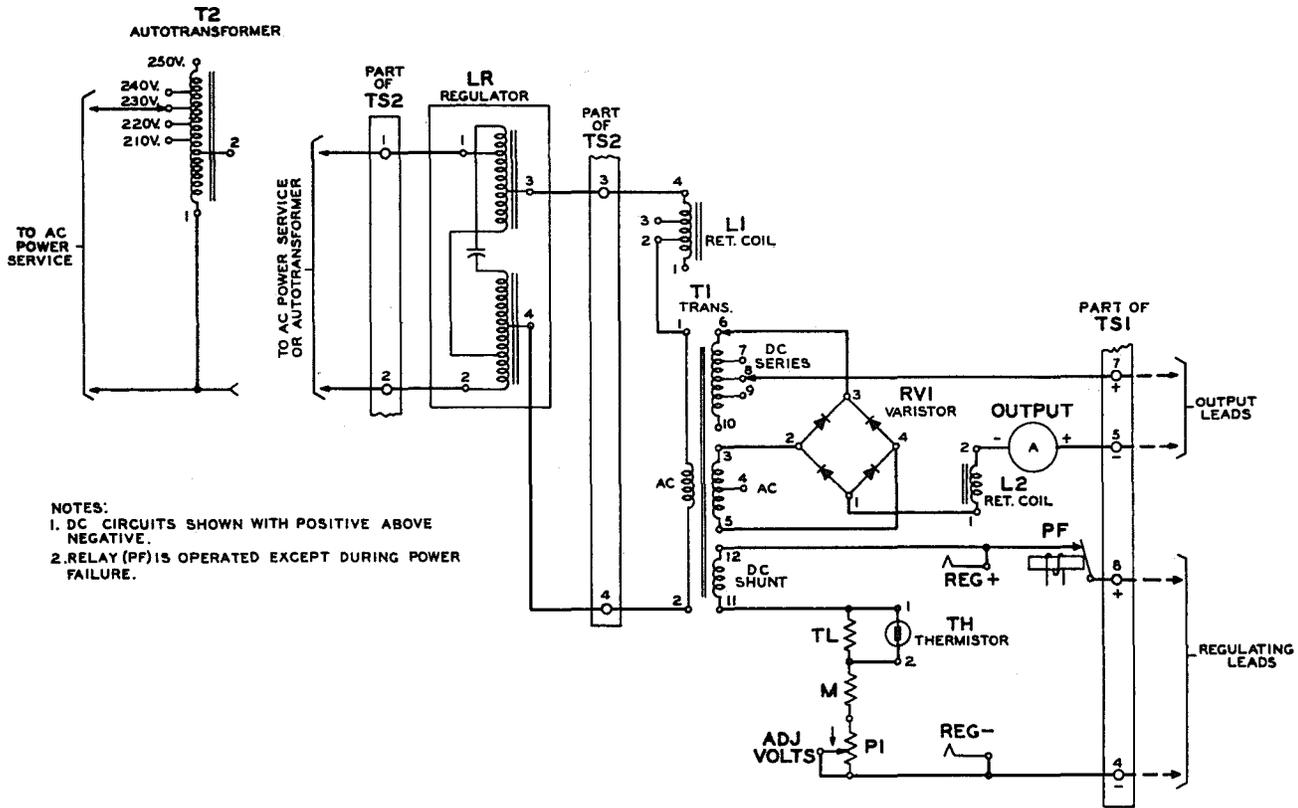


Fig. 1 - Functional Schematic

and the primary of transformer T1 in series substantially a constant voltage at a constant rectifier output current for line voltage variations up to + 8 per cent. The line voltage regulator output voltage varies some with load but this is overcome by the series coil of transformer T1.

2.02 Transformer T1 is a saturable-type transformer, the saturation being controlled by the d-c current through shunt and series coils. The effect of these two coils is opposing. As the saturation of the transformer core increases the voltage across the primary of transformer T1 decreases and that across retard coil L1 increases. Consequently the secondary output voltage decreases. The shunt coil introduces a practically constant magnetizing force on the transformer core, since the coil is connected to the regulated output of the rectifier unit.

2.03 At no load the effect of the shunt coil is to reduce the rectifier output voltage from that which would be developed if there were no shunt coil. The amount of this reduction is designed to be equal to the drop in voltage due to internal losses at full load. If the current in the shunt coil is reduced by rheostat ADJ VOLTS, it raises the output voltage

but reduces the output current for which regulation can be obtained as explained later.

2.04 As the output current increases from no load, the combined effect of the series and shunt coils produces less and less saturation, increasing the voltage applied to the rectifying element. This increase in voltage applied to the rectifying element is sufficient to make up for the increased internal losses in the rectifier and therefore a practically constant output voltage is secured. For full-load current of the rectifier unit, the magnetizing force of the series coil (compounding) on the transformer core is designed to be equal and opposite to the shunt coil, and thus one coil is neutralized by the other.

2.05 As the output current increases above rated full-load current, the saturation begins to increase thereby reducing the voltage applied to the rectifying element. This spoils the regulation but affords a means of limiting the output current when the battery voltage is low or overloads are connected.

2.06 If the output voltage is raised by reducing the current in the shunt coil with rheostat ADJ VOLTS, the opposing

magnetizing force of the series coil will equal that of the shunt coil at some value below rated full load current. Consequently at that point the output voltage will start to droop. This accounts for the lower rating of the rectifier unit at voltages from 24 to 28 volts.

2.07 Thermistor TH in the shunt coil circuit is a device whose resistance decreases with increase in temperature and automatically minimizes the effect of changes in temperature of the room and the equipment.

2.08 Rectifying element RV2 (not shown on the functional schematic) is connected across a part of the transformer secondary to secure a small d-c supply to operate relay PF. When power fails this relay releases and disconnects the battery from the transformer shunt coil avoiding battery drain and closes contacts connected to terminal 6 (not shown), which may be used to secure an alarm indicating power failure.

2.09 Output current ripple is reduced by retard coil L2 and the rectifier output current is indicated by ammeter OUTPUT. Nearly 3/4 of an ampere of this output is used in the shunt coil regulating leads.

2.10 The transformer series coil is provided with taps to permit adjustment for manufacturing variations and load regulation in the line voltage regulator. The proper tap will be selected by test at the time of manufacture. As the rectifying element ages, the forward resistance of the element increases and an increase in the a-c voltage applied to the rectifying element may be required to secure rated output. This effect will usually appear only after a period of years in operation and the need for adjustment will be indicated by excessive changes in the output voltage or even hunting with variations in load current. To increase the voltage for an aged rectifying element, increase the number of active turns on the series coil of T1.

Preparing to Start

2.11 When putting the rectifier unit into service initially, check against the circuit drawing to see that:

- (a) Rheostat ADJ VOLTS is turned completely counterclockwise.
- (b) If an autotransformer is used, connections have been made to the proper taps for the power service voltage.
- (c) Proper size a-c supply and d-c charge and regulation fuses have been provided.

- (d) A variable resistance load capable of carrying 12 amperes at 28 volts is available.
- (e) A suitable voltmeter having an accuracy within 1/2 of 1 per cent is available.

Initial Adjustments

2.12 After making the checks outlined in 2.11, put in the d-c fuses and then the a-c supply fuses. Relay PF should operate. With the voltmeter connected to jacks REG+ and REG-, turn rheostat ADJ VOLTS clockwise until the battery floating voltage is secured but do not force the output above eight amperes in trying to secure the floating voltage. Make the final adjustment after the battery is charged to the floating voltage and with the output between five and nine amperes but never over nine.

2.13 When a floating voltage adjustment has been secured, check the voltage at no load and full load. If the voltage is constant within ± 1 per cent as measured at jacks REG+ and REG-, the rectifier unit is in adjustment. If the voltage increases with increasing load (use artificial load to supplement the office load if necessary), the turns in use on the series coil of transformer T1 should be reduced in accordance with instructions on SD-81093-01. If the voltage decreases with increasing load, the number of turns in use should be increased. Usually this adjustment will be correct as received from the manufacturer.

Routine Adjustments (Normal Operation)

2.14 The rectifier unit has no disconnecting switches and is connected to both a-c power and the battery when the associated fuses are in place. If it is necessary to take a unit out of service, remove the a-c fuses first and then the d-c charge and regulation fuses. To restart, put in place first the d-c fuses and then the a-c fuses.

3. ROUTINE CHECKS

3.01 From time to time check the output voltage to be sure the battery is being properly floated. Occasionally remove the a-c fuses and observe that relay PF releases and then reoperates when the fuses are put in place again. After this check, be sure the proper output voltage is secured, with a load less than full load.

3.02 If the output voltage droops excessively with increasing load indicating an aged rectifying element, increase the number of turns in use in the series coil as indicated on drawing SD-81093-01 and check the performance.

4. TROUBLES

4.01 This rectifier unit should be practically trouble free. The rectifying element will of course, age with use and after a period of years may require readjustment of the series coil of transformer T1 to use more turns to overcome the increased forward resistance in the element. This adjustment will be indicated when floating voltage droops excessively with increasing load.

4.02 Rheostat ADJ VOLTS requires no maintenance. If operation indicates a defective sliding contact, turn the rheostat back and forth a few times to clean the surfaces. If the rheostat becomes defective, replace it.

4.03 The regulator LR requires no maintenance and is not adjustable. In case point-to-point voltage measurements indicate a defective regulator, replace the unit. This will require a check of the series coil adjustment to secure regulation within the limits with changes in load.

Trouble Chart

4.04 Should any of the following troubles develop, it is suggested that the possible causes be checked. If the trouble is not found, look for open or loose connections or short circuits due to foreign material lying across wiring terminals.

| <u>Trouble</u> | <u>Possible Cause</u> |
|------------------------|--|
| No d-c output current | Power failure Blown a-c supply fuse or charge fuse ADJ VOLTS rheostat out of adjustment |
| Low d-c output voltage | ADJ VOLTS rheostat out of adjustment Line voltage more than 8 per cent low Aged rectifying element |

High resistance at some contact in line circuit
Overload
Regulating lead open
Charge lead resistance high

High d-c output voltage ADJ VOLTS rheostat out of adjustment
Line voltage more than 8 per cent high
Regulating lead open
Aged thermistor TH

Hunting of current Rectifier over compounded, voltage rising with load

5. POINT-TO-POINT VOLTAGES

5.01 As long as the rectifier unit operates satisfactorily, point-to-point voltages are not needed and are not operating requirements to be checked in routine. In case the output cannot be secured, they may be useful in locating a defective condition.

Caution: When using any portable instrument the leads should be examined carefully to make sure the insulation is undamaged. The leads should be connected at the instrument before making contact with the circuit to be tested. If connections are to be changed from one instrument range to another, first disconnect the leads from the equipment under test.

5.02 The readings given in the table are approximate and typical for a rectifier unit adjusted as indicated in 5.03. The readings are measured with an M9B meter which is provided with test leads. Connecting the meter to observe readings does not affect the rectifier output. A defective rectifier unit may have quite different voltages than those shown. Therefore, it may be desirable to use a higher voltage jack in the meter than shown in the table until readings indicate the proper jack to use.

5.03 Table of Point-to-point Voltages

Rectifier adjusted to 23.7-volt 9-ampere output with 115-volt 60-cycle power supply connected to terminals 1 and 2.

| Voltage Across | Measurements Taken | | | | M9B Meter† | | |
|----------------|--------------------|-------|------|-------|------------|---------------|---------------|
| | From | | To* | | Jack | Toggle Switch | Reading Volts |
| | App. | Term. | App. | Term. | | | |
| LR | TS2 | 1 | TS2 | 2 | 150 | AC | 120 |
| | TS2 | 3 | TS2 | 4 | 150 | AC | 120 |
| L1 | T1 | 1 | L1 | 4 | 150 | AC | 42 |

| Voltage Across | Measurements Taken | | | | M9B Meter+ | | |
|-------------------|--------------------|------|-------|----|------------|------------------|------------------|
| | From | | To* | | Jack | Toggle Switch | Reading Volts |
| App. | Term. | App. | Term. | | | | |
| T1 | T1 | 1 | T1 | 2 | 150 | AC | 76 |
| | T1 | 3 | T1 | 5 | 150 | AC | 31.5 |
| | T1 | 3 | T1 | 4 | 15 | AC | 8.2 |
| | T1 | 6 | TS1 | 7 | 3 | DC | .26 |
| | T1 | 12 | T1 | 11 | 15 | DC | 7.3 |
| L2 | L2 | 2 | L2 | 1 | 15 | DC | 1.1 |
| Output | TS1 | 7 | TS1 | 5 | 30 | DC | 23.7 |
| | REG+ | - | REG- | - | 30 | DC | 23.6 |

*"To Term" should be connected to -V Jack of meter.

+The M9B meter has an accuracy ± 5 per cent on a-c and ± 2 per cent on d-c.

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