POWER SYSTEMS
REGULATED TUBE RECTIFIER CKT.
MAGNITUDE CONTROL
120/230 VOLTS 50-60 CYCLES A-C
24/34 VOLTS 8 AMPS. CONT., 10 AMPS. INTR D-C
J86207M

CHANGES

B. CHANGES IN APPARATUS

B.1 Replaced	Replaced By
23A Varistor	KS-15657, L7 Rectifier Stock
Rheostat KS-5563, L5 or Potentiometer KS-13650, L1	KS-13790, L1

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The codes of the meters were removed from the drawing, per Circuit Note 110.

D.2 In Circuit Note 101, KS-13385 solid wire was formerly "AM" wire. Leads marked "G" were formerly marked "D". The sentence "Leads marked "A" shall be as short as possible" was deleted from the note.

D.3 Leads marked "D" and "D1" were formerly marked "A".

D.4 In CD, under 9, Miscellaneous - delete first sentence about grid battery.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5750-HMK-DET-H1

POWER SYSTEMS
REGULATED TUBE RECTIFIER CKT.
MAGNITUDE CONTROL
120/230 VOLTS 50-60 CYCLES A-C
24/34 VOLTS 8 AMPS. CONT 10 AMPS INTR. D-C
J86207M

CHANGES

B. CHANGES IN APPARATUS

B.1 Superseded	Superseded by	Remarks
(TD) time delay relay per Power Data; Sect. 14.19 Item 811	KS-5596 L01	This is merely a change in the method of indicating the Weston Model 613 Relay
(R) Rheostat KS-5563 List 5	KS-5563 List 5 or KS-13650 List 1	
(H1), (H2), and (D) 310A .01 mf	310B, .02 mf	
Type ESCB wire	Type AM wire	

B.2 Prior to drawing Issue 3-D, KS numbers were indicated in place of wattage and tolerance at (E), (F), and (S), and the description of the input cord and plug was covered. This information is shown on the equipment drawing.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The capacity of condensers (D), (H1) and (H2) were increased from .01 to .02 mf to improve the r.f. filtering.

D.2 Note 109 was added.

D.3 The meter code numbers were added at (A) and (V).

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3250-FWA-CHA-UX

K 67730 (D) F
NO BACK

POWER SYSTEMS
REGULATED TUBE RECTIFIER CKT.
MAGNITUDE CONTROL
120/230 VOLTS 50-60 CYCLES A-C
24/34 VOLTS 8 AMPS. CONT., 10 AMPS. INTR. D-C
J86207H

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 This drawing was reissued primarily to rate it A. T. & T. Co. Standard.

B. CHANGES IN APPARATUS

B.1 The (S) resistance was added.

C. CHANGES IN CIRCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS

C.1 None.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The (S) resistance was added to by pass the current picked up by the tube grids around the grid battery.

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3250

DET)
RdeK) VY

POWER SYSTEMS
REGULATED RECTIFIER CIRCUIT
120/250 VOLTS, 50-60 CYCLES, A-C
50 VOLTS, 8 AMP. CONT., 10 AMP. INTR., D-C

1. PURPOSE OF CIRCUIT

1.1 This circuit is designed for providing d-c power for charging storage batteries from an a-c supply.

2. WORKING LIMITS

2.1 A-C input 110-120 or 210-250 volts, 50-60 cycles.

2.2 D-C output at nominal line voltages

21.5 volts)		(10 cells
23.7 volts)		(11 cells
25.8 volts)	8 amperes - continuous - floatnng or	(12 cells
34.4 volts)	10 amperes - intermittent - charging	(16 cells
36.6 volts)		(17 cells

2.3 Room Temperature 0°- 104° Fahrenheit

3. FUNCTIONS

3.1 To provide a means for rectifying a-c power to filtered d-c supply for charging 10,11, 12, 16 or 17 cell storage batteries. The rectifier will float loads up to its continuous rated load of 8 amperes with changes in line voltage not exceeding $\pm$ 5%. For loads above this, and without change in adjustment, the rectifier will deliver the intermittent rating of 10 amperes, but at a reduced voltage. If it is desired to fully float the battery at all times, the load connected to the battery must be limited to 8 amperes. However, the rectifier may be used for batteries having variable loads larger than 8 amperes if there is sufficient time to charge the battery during light load periods when the load is less than the output of the rectifier. The excess load is taken from the battery during the heavy load period and no change in the adjustment of the rectifier is required due to this method of operation.

4. CONNECTING CIRCUITS

4.1 Power charge and discharge circuits

DESCRIPTION OF OPERATION

5. The power rectifier circuit consists of a transformer "T1" which furnishes plate voltage for the rectifier tubes "V1" and "V2". Transformer "T2" furnishes the filament for the rectifier tubes "V1" and "V2" and has an additional winding to supply 5 volts to the time delay relay and 8.5 volts to the varistor "H". The d-c output of the rectifier is filtered by means of a retardation coil connected in the negative charge lead. It is necessary to use this coil in order to obtain regulation from this rectifier. Ballast lamp "V3" is used to absorb the excess voltage from the rectifier when operating with high line voltage and low battery voltage. Ammeter "A" is provided to read the charging current.

The regulating circuit consists of resistances "B", "E" and "F", rheostat "R", varistor "H" and the grid battery. The point between the resistance "B" and the rheostat "R" is connected to the rectifying tubes through the grid battery and the resistances "E" and "F" by way of the lower contacts 1-2 of the "GR" relay. The drop across the resistance "B" is negative with respect to the cathode of the rectifying tubes and the grid battery is poled to oppose this voltage sufficiently to allow a net negative voltage of 1 to 3 volts to be applied to the grids of the rectifying tubes. When the battery voltage is at the floating value this negative grid voltage is sufficient to reduce the output of the tube to a small value just sufficient to float the battery. When a load is applied to the battery, its terminal voltage drops slightly and this small change in voltage is reflected over the regulating lead (Fuse 1) to the varistor "H", rheostat "R", grid battery and resistances "E" and "F" to the grids of the tubes, reducing the value of the net negative voltage. With reduced negative voltage the output current of the tubes increase until it is sufficient to return the battery voltage to the floating value. This operation will continue until the load on the battery has reduced the net grid voltage to approximately one volt. If the grid voltage is less than one volt, the grids lose control and the tubes carry current during practically their entire cycle and operate in the same manner as the conventional two element tubes. Under this condition, when the load on the battery is equal to the full load capacity of the rectifier or greater, the output current of the rectifier is determined by the battery voltage, power supply voltage, drop over the ballast lamp and the impedance drops in the series charging circuit. The ballast lamp at loads less than full load has a small voltage drop. With loads of 10 amperes the voltage drop increases rapidly and tends to limit the rectifier output current. The resistances "E" and "F" limit the grid current to a small value and assist in load regulation.

The relays "GR" and "TD" serve as a time delay to prevent bombardment of the cathodes of the rectifer tubes "V1" and "V2" while their filaments are heating. During the starting period, negative voltage is obtained from the varistor through lower contact 3 of the (GR) relay to the grids. The return path is from the plus terminal of the varistor "H" through the "C" resistance to the cathodes of "V1" and "V2" by way of terminal 2 of "T2". This furnishes a negative voltage sheath around the cathode to protect it until the filament has normal emission. At the same time, the filament starts to heat and voltage from the 4-5 winding of "T2" is applied through the top contacts "2-1" of the "GR" relay to the heater of the "TD" relay. After 45 seconds, the "TD" relay contacts close and operate the "GR" relay, using current from the varistor "H". The "GR" relay locks up over its top contacts "3-4" which disconnects the heater of the "TD" relay with its top "2-1" contacts and transfers the grid from the regulating lead on its lower contact "3" to the normal regulating circuit connected to its lower contact "1". The varistor "H" and condenser "C" provide a small source of filtered d-c to operate the "GR" relay and also to provide a variable voltage to the grids of the rectifying tubes "V1" and "V2". This compensates for line voltage changes. When the line voltage changes, the small d-c source changes in direct proportion and this fraction of volt change, reflected through the regulating circuit to the grids of the rectifying tubes is of sufficient magnitude to compensate for the change in the grid characteristics of the tubes due to a change in the plate voltage supply to the tubes. This feature permits the line voltage to change with very little effect on the regulated voltage when the grids of the rectifying tubes have control.

The retardation coils "L1" and "L2", condensers "H1", "H2" and "D" serve to suppress the radio interference generated in the rectifying tubes.

Grid batteries as described in Note 108 shall be connected to the C+ and C- terminals. It is important to use the correct number of cells in the grid battery. When the battery is new the rheostat "R" shall be near the counter-clockwise end of its travel (facing the front of the rectifier) and when the rheostat "R" is in its maximum clockwise position, it will indicate that the grid battery has aged and should be replaced. Cells should not be added to compensate for decreased battery voltage but the entire battery should be replaced when aged.

If it is desirable to have a high and low voltage alarm, Fig. 2 or 3 may be furnished consisting; of a voltage relay "VR1" or VR2" resistance "D" and relay "V".

The output range is grouped into two parts with a plate voltage for each. The plate voltage is selected by changing primary taps on "T1" as described in Note 108.

6. ADJUSTING THE REGULATING VOLTAGE

Charge the battery by removing the fuse No. 1 in the regulating lead until its voltage is at the upper end of the floating range. Replace the fuse and turn the rheostat "R" until the rectifier output is approximately 3 amperes with the voltage still at the upper end of the floating range. The rectifier current will in several minutes change to the value required to float the load and the voltage will remain in the floating range is the rectifier output is less than 8 amperes. With larger rectifier output current the voltage will decrease to approximately two volts per cell. Never attempt to adjust the regulated voltage by rheostat "R" when the voltage is not at the upper end of the regulating range. The voltage should be checked again at suitable intervals and the regulated voltage adjusted as described above if necessary. When checking the regulated voltage be sure that the rectifier output is less than 3 amperes.

7. POWER FAILURE CONDITION

No adjustments are required after a power failure. If the battery is discharged, the rectifier when the power is restored will charge the battery at a rate between 9 and 11 amperes until the voltage is up to the floating value.

8. EQUALIZING CHARGE FOR BATTERY

An equalizing charge may be given to the battery by removing the Fuse No. 1 in the regulating lead. The rectifier will charge the battery to approximately 2.3 volts per cell. However, at the higher output voltages the current output will decrease, the decrease being greater for lower a-c line voltages. After completion of the equalizing charge replace the fuse No. 1 in the regulating lead and the voltage will return to the floating value all with no change in the rheostat "R".

9. MISCELLANEOUS

It is important that the grid battery used in the rectifier should be less than three months old when installed, as the life of this type of battery is approximately two year from its date of manufacture. After a new batter is installed there might be a slight increase in the regulated voltage which will decrease with time. When regulated voltage decreases, the rheostat "R" should be turned in a clockwise position to bring the voltage up to the floating value.

An open in the regulating circuit will cause the rectifier to deliver its maximum output.

If the regulating circuit is functioning a counter-clockwise rotation of the rheostat "R" will always reduce the rectifier output current to approximately no load or a removal of the fuse No. 1 in the regulating lead will cause the output current to increase to its maximum value.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 331

DKT)
RDdek) IF