# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 "F" Option replaces "G" on capacitors A, B, C, D, G, and F to permit operation in higher ambient temperatures.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5152-KK-JMD-SF

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Connections on the (T3) transformer shown in Fig. D changed, H4 was connected to X1 and X3; now connected to X2 and X4.

D.2 X2 and X4 were connected to 4 of (T1) transformer; now X1 and X3 are connected to 4 of (T1) transformer.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5152-PWC-JMD-BD

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

B. CHANGES IN APPARATUS

B.1 RV1, 2, 3, 4 KS-15561, L1 or L2 Stacks replaced by RV1 KS-15866, L1.

B.2 365A Trans replaced by 365B.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Fig. A was part of Fig. 1.

D.2 Figs. B, C and D were not shown.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5152-PWC-JMD-PM

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

B. CHANGES IN APPARATUS

| B.1 Replaced | Replaced By |
|---|---|
| TR Autotransformer KS-15685, L1 | KS-15685, L11 |

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Option "H" was added to the drawing.

D.2 TR Autotransformer KS-15685, L1 is replaced by KS-15685, L11 which is an improved autotransformer having a fire protection device.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5153-HMK-DET-CS

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

B. CHANGES IN APPARATUS

| B.1 | Replaced | Replaced By |
|---|---|---|
| | TRM KS-5559,L4,Motor | KS-5559,L5 |

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Capacitor E formerly was designated "Part of KS-5559,L3."

D.2 Leads in the main rectifier section were reduced from 8 gauge to 10 gauge.

D.3 In Circuit Note 101, the following was added: "No. 10 gauge wire shall be KS-13385 stranded."

All other headings, no change.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5233 - HMK-DET-ID

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

## B. CHANGES IN APPARATUS

| B.1 | Replaced | Replaced by |
|---|---|---|
| | TRM Motor KS-5559, L3 | KS-5559, L4 |
| | A&M Only | STD |
| | RECT.STACKS, KS-15561, L2 | KS-15716, L1 |

## D. DESCRIPTION OF CIRCUIT CHANGES

D.1 KS-15561, L2 rectifier stacks have been rated "A&M" and KS-15716, L1 stacks, having a lower current density, have been rated "Std."

D.2 TRM motor KS-5559, L3 has been replaced with KS-5559, L4 which is equipped with oil fill and drain tubes to facilitate lubrication of the gear train and an oil lubricated sleeve bearing.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5233-HMK-DET-JA

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

CHANGES

B. CHANGES IN APPARATUS

| B.1 | Replaced | Replaced By |
|---|---|---|
| | Resistor KS-13492, L1 3000 Ω | KS-13492, L1 1000 Ω |

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Options "P" and "Q" and Note 109 were added to the drawing. Option "Q" was formerly part of the circuit.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5233-HMK-DET-JL

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

B. CHANGES IN APPARATUS

| B.1 Replaced | Replaced By |
|---|---|
| KS-15585, L1 Auto-transformer TR | KS-15685, L1 |

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Options (R) and (S) were added to the dwg. Option (S) was previously a part of the circuit.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5233-HMK-DET-JL

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

### B. CHANGES IN APPARATUS

| B.1 Replaced | Replaced By |
|---|---|
| RV1-RV4<br>KS-15561 L1<br>Rectifier Stacks | KS-15561 L2<br>Rectifier Stacks |

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

C.1 Note 4 which specifies that A-C input fuses be removed has been added to the circuit requirements table. This note applies to (RR) and (RL) relay testing.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5750-FWA-DET-GG

CD-S1130-01
Issue 2-A
Appendix 2-B
Dwg. Issue 4-B

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

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

C.1 In Circuit Preparation Column for (OL) and (RF) relays, (RF) relay was shown erroneously as (TF).

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 In Note 101, KS-5482-01 stranded wire was formerly shown as KS-13385 stranded.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5750-HMK-DET-EM

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

### B. CHANGES IN APPARATUS

B.1

| Replaced | Replaced By |
|---|---|
| Transformer (T2) 366A | Transformer (T2) 371C |

### D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The code of the transformer (T2), as covered in B.1 above, was changed for improved performance of the rectifier circuit.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5740-AH-CHA-K1

# POWER SYSTEMS
# RECTIFIER CIRCUIT
# METALLIC TYPE - AUTOMATIC REGULATION
# 48 VOLTS - 30 AMPERES
# J86263A

## CHANGES

### B. CHANGES IN APPARATUS

B.1 Added

Terminal Punchings (TP1), (TP2) and (TP3)

B.2

| Replaced | Replaced by |
|---|---|
| Resistor (R)-5K, Koolohm, 500 ohm ±5% | Resistor (R)-KS8512, L1A 511 ohms |
| Resistor (S)-5K, Koolohm, 500 ohm ±5% | Resistor (S)-KS8512, L1A 511 ohms |
| Capacitor (E) - KS13380, L6 1MF | Capacitor (E) - part of KS-5559, L3 Motor (TRM) |
| Capacitor (A&B), 141C 0.5-0.5MF | Capacitor (A&B), 441C 0.5-0.5MF |
| Fuse (CHG-FA), 35F Type, 0.5 Amp. | Fuse (CHG-FA), 70G Type, 0.5 Amp. |

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

C.1 The designation of transformer (T3) was changed to (T2) to follow the logical numbering of apparatus.

C.2 The (R), (B) and (G) connections of the motor (TRM) are terminated on the assigned Terminal Strip (TS2).

C.3 The control leads, 1 to 12 as shown as T.S. on Rectifier, are terminated on the assigned Terminal Strip (TS1) with a correction on terminal 5 as (LOWER) KEY instead of (RC) FUSE.

C.4 The terminal numbering 1, 2, 3, 4-GRD were added to the (AR) Shunt, with control leads numbered 2 & 3 and power leads numbered 1 & 4-GRD with terminal 1 shown as TOP on Shunt.

C.5 The strap wire (F) is shown connected directly across terminals 2 and 2 of (A) and (B) rheostats instead of across TOP (2-1) of (RB) relay.

### D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Terminal punchings (TP1), (TP2) and (TP3) were added for use as mounting connectors for resistors (L), (M & N), and (P & Q), respectively.

D.2 The resistors (R) and (S), as covered in B.2 above, were changed for manufacturing and electrical reasons.

D.3 The capacitor (E), as covered in B.2 above, is supplied as a component part of the KS-5559, L3 Motor (TRM).

D.4 The code of the dual capacitor (A & B) as covered in B.2 above, was changed to agree with manufacturing information.

D.5 The code of the fuse (CHG-FA), as covered in B.2 above, was changed for use on another code of fuse block.

D.6 The lead to terminals (R) and (B) of (TS2) were interchanged.

D.7 Information on "F" leads 20 Gauge KS-13385 strap wire was added to Note 101.

All other headings under Changes, no change.

## 1. PURPOSE OF CIRCUIT

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

## 2. WORKING LIMITS

2.1 A-c input voltages 210 ± 5%, 230 ± 5% or 250 ± 5%, 60 cycles a-c.

2.2 Continuous d-c output at nominal line voltages measured at the rectified end of the charge leads.

50 volts - 3 amperes, Minimum Output
57 volts - 30 amperes, Maximum Output

2.3 Room Temperature 0° to 104° Fahrenheit.

## 3. FUNCTIONS

3.1 To provide a means of rectifying a-c power to filtered d-c power.

The rectifier in conjunction with the connecting circuit automatically controls the charging rate to maintain the battery voltage in the floating range, prevents the rectifier from overloading and provides means for automatically starting the rectifier.

3.2 The rectifier may be used without the connecting circuit as a manually controlled rectifier. Keys are provided to start the rectifier and to raise and lower the output current.

3.3 The rectifier must be used with a 233C Inductor or its approved equivalent connected in the "B-" output lead.

4. CONNECTING CIRCUITS

4.1 110A Power Plant - SD-80722-02.

4.2 81D1 Teletypewriter System - SD-81186-01.

4.3 Misc. Charge or Discharge Circuits.

DESCRIPTION OF OPERATION

5. GENERAL

The rectifier is the single phase full-wave type using four selenium rectifier stacks. The transformer (T1) supplies the voltage to the stacks. The d-c output current is measured by the ammeter relay (AR) which indicates the current as well as acting as a relay. The output current is controlled by changing the voltage applied to the stacks.

The booster control equipment to change the voltage consists of a motor driven continuously tapped auto-transformer (TR) and an insulating booster transformer (T2) to raise the primary of the transformer (T1) above the line voltage. The variable auto transformer (TR) operates in a manner similar to a motor driven rheostat except instead of cutting in and out resistance it cuts in and out turns of an auto-transformer. As the number of turns in use are increased or decreased the voltage across the primary of transformer (T2) is raised or lowered respectively. Raising the voltage on the primary of transformer (T2) will cause a corresponding increase in the secondary voltage of this transformer. The secondary of (T2) is connected in series aiding with the primary of (T1), thus the (TR) auto transformer can control the output of the rectifier by raising or lowering the secondary voltage of (T1) which is the voltage applied to the rectifier stacks.

The motor associated with (TR) is controlled by the operation of relays (RR) and (RL). When the (RR) relay operates, the motor is rotated in a direction to move the contact arm to connect more turns into the circuit between terminal 1 of (TR) and the variable arm to raise the output. When the (RL) relay operates, the motor rotates the contact arm to connect less turns in the circuit between terminal 1 and the variable arm to lower the output.

The motor is the a-c capacitor type which is operated on single phase by means of a capacitor in parallel with one winding. By transferring the capacitor from one winding to the other winding the direction of rotation is reversed. The (RR) and (RL) relay contacts switch the (E) capacitor from one winding to the other, and connect the motor to the line.

The operation of the control is as follows: If the voltage of the battery being floated is low, battery from the connecting circuit is connected to the rectifier terminal 3 or if the (RAISE) key is pressed, battery through the center contacts of the (RAISE) key, (R) limit switch contact (1-2) of (TR), winding of the (RR) relay rectifier terminal 12 to ground, operating the (RR) relay. The (RR) relay when operated connects the (B) terminal of the motor through its (5-4) contacts to the "L1" side of the a-c line at contactor (C1). The (R) terminal of the motor is connected over the (6-3) contacts of the (RR) relay to the "L2" side of the line at contactor (C1). The motor lead (G) is connected through the (E) capacitor to the (R) terminal of the motor through the (4TM-5) terminals of the (RL) relay. This operation of the (RR) relay rotates the arm of the auto-transformer (TR) in a direction to increase the a-c boost voltage of (T2). Increasing the boost voltage increases the charging current until the battery voltage is raised sufficiently for the connecting circuit to remove battery from the rectifier terminal 3. If the voltage of the battery being floated is high, battery is placed on the rectifier terminal 2 by the connecting circuit or if the lower key is pressed, battery is fed from the center contacts of the (LOWER) key over the (L) 1-2 contacts of (TR) to the winding of the (RL) relay to ground. Operation of the (RL) relay connects the (R) terminal of the motor over the (3-6) contacts of the (RL) relay to "L2" side of the line. The (B) terminal of the motor is connected over the (4TM-5) contacts of the (RR) relay to the "L1" side of the line, through the (4-5) contacts of (RL) relay. The (G) lead is connected through the (E) capacitor to the motor lead (R) and (L1) side of the line by the (4-5) contacts of the (RL) relay. The operation of the motor in this direction decreases the voltage applied to the primary of (T2) thus

decreasing the boost voltage and decreasing the output charging current of the rectifier until the battery voltage reduces sufficiently for the charge circuit to remove battery from the rectifier terminal 2. The (A) capacitor and the (N) resistor are connected across the (RR) relay and the (B) capacitor and the (M) resistor are connected across the (RL) relay to serve as contact protection. The limit switches (R) and (L) contacts (1-2) open the circuits to the windings of the (RR) and (RL) relays when the arm of the auto-transformer (TR) is in the extreme positions.

The ammeter relay (AR) is equipped with a high and low contact. The low contact is adjusted to close at approximately three amperes and the high contact to close when the output of the rectifier reaches 30 amperes. When the high contact of the ammeter relay closes, ground is connected thru rectifier terminal 9 to the connecting circuit causing the control to function and prevent the output of this rectifier being increased by opening the lead to rectifier terminal 3. When the low contacts close, ground is connected thru rectifier terminal 10 to the connecting circuit to operate a relay which may be used to release the (C1) contactor and remove the rectifier from the charging circuit. Resistors (P) and (Q) and capacitors (C) and (D) are for contact protection. In some cases it will be found that the busy hour load will fluctuate at a value near the high contact setting of the ammeter relay, which may cause frequent starting and stopping of the succeeding rectifier. This condition can be reduced by readjusting the high contact for reduced ampere output of the rectifier. At a later date when additional equipment requiring increase load is provided it will in most cases eliminate the condition outlined above and the ammeter relay may be reset to obtain full ampere output from the rectifier.

If the rectifier is operating in the condition where it is prevented from increasing its current by the operation of the high contact of the (AR) relay, an increase in the a-c input voltage or a decrease in the battery voltage will cause the rectifier current to increase even though the position of (TR) remains the same. In order to reduce th output current to the full load value the (OL) relay is connected across the (AR) shunt in series with the (A) and (B) rheostats. The rheostat (A) is adjusted so that the (OL) relay will operate when 32 amperes flow through the shunt. The operation of the (OL) relay puts ground over its 2-1 contacts to the (5T) winding of the (RB) relay. Since this relay has battery on its 3B winding it will operate. Operation of the (RB) relay connects battery over its bottom (1-2) contacts to the lead between the (LOWER) and (TEST) keys. This battery thru the (LOWER) key operates the (RL) relay thus reducing the output of the rectifier in the manner described above until the current through the shunt reaches 28 amperes to release the (OL) relay, it in turn releases the (RB) relay and removes battery from the (RL) relay. With certain (OL) relays the margin of 32 to 28 amperes may not be obtainable. In this case the strap (F) is removed between the sliders of the (A) and (B) rheostats so that the top (1-2) contacts of the (RB) relay will insert part of the rheostat (A) and rheostat (B) in series with the (OL) relay to increase the value of current through the shunt at which it will release.

For automatic starting battery is connected to rectifier terminal 1 by the charge circuit. This circuit is completed through contacts of (TEST-NORM) key in the normal position, winding of the (C1) contactor, contacts on (ON-OFF) key in the normal position to ground, operating the contactor (C1) which closes through the a-c supply and the negative d-c charge lead of the rectifier.

The (ON-OFF) key is provided to open the (C1) contactor winding circuit to stop the rectifier from charging. The (C1) contactor also opens the negative charge lead but does not disconnect the rectifier control circuit. If the rectifier is to stand idle or work is to be done, remove the a-c and d-c fuses. The (ON-OFF) key also puts ground on rectifie. terminal 11 which may be used to start another rectifier.

The (RAISE) and (LOWER) keys provide a means of controlling the output current of the rectifier at the rectifier panel for manual control or for inspection of the operation of the motor and its control circuit.

The (TEST-NORM) key is provided as means to remove a rectifier from service, when it is used as part of an automatic plant. Operating the key to the (TEST) position, switches the battery supply for the (C1) contactor from the connecting circuit through rectifier terminal 1, to battery on terminal 5. It also opens the lead from rectifier terminal 2 and grounds the rectifier terminal 11 which may be used to start another rectifier. Then the rectifier may be controlled with the (ON-OFF) key and the (RAISE) and (LOWER) keys.

During (NORM) operation, if any of the rectifier stacks (RV1-RV4) shouldfail, the charging current will reduce to a small value, the connecting circuit will connect battery continually to the (RR) relay and the continuously tapped auto-transformer (TR) would be driven to the end of its

travel to operate the (R) limit switch and transfer contact 2 from 1 to 3. This puts battery on the "3B" winding of the (RF) relay and since the 5T winding has ground on it the (RF) relay operates. The (RF) relay locks up with battery on its bottom contacts 1-2, which is obtained through the contacts of the (ON-OFF) key. The top 3-4 contacts of the (RF) relay connects battery to the rectifier terminal 4 through the (S) resistor. Battery on this terminal through the connecting circuit will remove battery from rectifier terminal 1 to release the (C1) contactor, stop the rectifier and give an alarm. After the circuit has been restored to normal the (RF) relay is released by momentarily operating the (ON-OFF) key. If the (CHG) fuse should blow, battery is placed on rectifier terminal 4 to turn off the rectifier and give an alarm in a similar manner.

When the power fails the connecting circuit puts battery on the lower lead rectifier terminal 2 to operate the (RL) relay but since there is no a-c power to run the motor the circuit stands in this condition until the power is restored then the motor runs the auto-transformer (TR) until the (L) limit switch transfers contact 2 from 1 to 3. This puts battery on rectifier terminal 6 to inform the connecting circuit that the rectifier is ready to be started in the usual way.

A 233C Inductor must be connected in the "BC" charge lead as the secondary voltage of (T1) is selected to be correct with the use of this coil. If it were not used the output current of the rectifier could not be reduced to obtain control.

## 6. STARTING AND ADJUSTMENTS

When this rectifier is used in conjunction with the connecting circuit the (ON-OFF) key shall be in the (ON) position and the (TEST) key in the (NORM) position. The starting and stopping of the rectifier is done automatically.

When the rectifier is used separately with a manual control of the charging rate, battery must be connected to rectifier terminal 5 and ground to terminal 12. To start the rectifier throw the (ON-OFF) key to the (OFF) position and the (TEST) key in the (TEST) position. Then connect the d-c and a-c power service fuses. Press the lower key until the motor has driven the auto-transformer (TR) until it operates the (L) limit switch and stops the motor. Turn the key to the (ON) position, which will operate the (C1) contactor. Then the (RAISE) key may be pressed to increase the voltage until ammeter relay (AR) shows the desired charging current. The (TEST) key must be always left in the test position. If the charge current is increased to 32 amperes the (CL) and (RB) relays will reduce it to 28 amperes. After a power failure the voltage will be applied at the value it was before the power failure. The rectifier should be turned off during the power failure and started as described above, after the power failure.

If it is thought that the rectifier or connecting circuits are not functioning properly or when replacing fuses always run the auto-transformer (TR) to its minimum boost position by pressing the (LOWER) key until the limit switch stops the motor, before turning on the rectifier. If a rectifier stack or fuse fails, when the connecting circuit is used, the auto-transformer (TR) will automatically run to a minimum output position. It will be necessary in some cases to momentarily turn the rectifier (OFF) by the (ON-OFF) key to release the (RF) relay before operation can be resumed.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5740-AH-CHA-F3