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COMMON SYSTEMS
SIGNALING
RECEIVING CIRCUIT
MULTIFREQUENCY PULSING

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit is for use in multifrequency (MF) pulsing systems to receive signals in the form of MF pulses from a trunk, keyset, or sender and to convert the signals into direct current pulses to operate various code combinations of relays in an associated sender, key monitoring circuit, automatic monitoring circuit, register circuit, or MF test circuit.

2. GENERAL DESCRIPTION OF OPERATION

2.01 The multifrequency pulsing receiving circuit is essentially a circuit for translating signals consisting of various combinations of frequencies sent two at a time, as indicated in 1.01 of Section II, into dc ndications suitable for operation of the egister or translating relay circuit of an ssociated sender which then completes the all in the usual manner. The multifrequency ignals may be sent out manually by an perator using a keyset which connects the proper frequencies for each digit to the runk or automatically by an MF sender.

2.02 The receiving circuit may also be used in conjunction with a key monitoring circuit at the sending end to check the outgoing pulses, and it may be used as part of a test circuit to check the pulses sent out by senders or operators.

2.03 The multifrequency signals which are alternating voltages across the tip and ring are received from the trunk, MF sender, or keyset over the T and R leads. They are transmitted through the input elements of the receiving circuit consisting of the transformer, an impedance correcting network, and input transformer IN. No pad adjustment for input level is required for this receiver and no socket for plug-in pads is supplied. From the secondary of the IN transformer, the signals are placed on the grids of electron tubes or gates of hybrid integrated network (HIN) devices, L1 and L2, of the volume limiter which serves to provide adequate amplification for the operation of the desired channels, but which also limits strong signals to such a value that they will not cause interfering signals in channels other than those for the two frequencies received.

2.04 Optional wiring is provided at the IN transformer to permit it to be used as a battery supply coil and to reduce the bridging loss caused by the receiving circuit when it is associated with key monitoring circuits. Wiring and apparatus options are also provided to allow the receiver to have either a 600- or 900-ohm input impedance. The limiter tubes or HINs L1 and L2, together with associated potentiometers, resistors, and capacitors, are mounted in a plug-in unit which may easily be replaced in case of trouble.

2.05 The output of the limiter supplies energy to three separate circuits. Resistors A, B, and C form a 6-dB, 600-ohm pad between the limiter output and the common input circuits to the channel filters. In addition the input terminals of the bandpass filter SP for the signal present circuit are connected across resistor C of the 6-dB pad. The third circuit receiving energy from the limiter is the variable bias circuit with input connected directly to the plate of electron tube L1 or the drain of HIN L1.

2.06 There are six channel circuits, one for each frequency. Each circuit consists essentially of a filter, one half of a 396A electron tube or KS-21079 HIN, which rectifies the ac signal to a positive dc potential, a 2D21 hot cathode thyratron tube or KS-21081 HIN, and a fast operating relay with its winding in the plate circuit of the thyratron tube or drain circuit of the channel HIN. The equipment is so arranged that the two channel filters for the two lowest-frequency channels are housed in a single case and the two middle-frequency channels and the two high-frequency channels in a second and third case, respectively. The channels are paired similarly in using the two halves of a 396A electron tube or KS-21079 HIN as rectifying diodes. This tube or HIN, together with the two associated thyratron tubes or HINs and associated resistors and capacitors, is mounted in a single plug-in unit. Thus, in case of trouble any one of the three units may easily be replaced. An ac signal of sufficient amplitude from the filter, when rectified to overcome the negative potential from the bias producing circuit on the grid of the associated thyratron, causes that tube to fire, operating the associated relay connected to the plate or drain circuit.

2.07 The KP signal, consisting of a relatively long pulse of 1100- and 1700-Hz, is a priming signal that prepares the receiving circuit for the reception of digit pulses. It is provided because the receiving circuit, when connected to a trunk or keyset, may be exposed to speech or other interfering currents, causing false registration in the sender or other associated circuit if the channel relays were in the pulse receiving condition at that time. To obtain the necessary protection, the circuit is arranged to require the presence of the KP signal alone for a definite length of time (without the presence of any of the four other frequencies) before it will unlock. The incoming KP signal frequencies traverse their respective filters, and these frequencies are rectified. The resulting positive dc potentials are added to the negative bias potential on the grids or gates of their respective channel thyratron tubes or HINs and on the grid and suppressor or gates of the SP electron tube or HIN through back contacts of the KP2 relay. The thyratron tubes or HINs for channels 2 and 10 will remain unfired due to absence of plate or drain potential. If the potentials on the grid and suppressor or gates of the SP tube or HIN, caused by the addition of the rectified signal and the negative bias, are sufficiently positive, a plate or drain current will flow in the SP tube or HIN and the SP relay will operate. The SP tube or HIN requires a definite change toward positive potential on both grid and suppressor or gate elements to produce the required plate or drain current.

2.08 Relay KP is initially held on its back contact by reverse current through its secondary winding. The operation of the SP relay removes ground from terminal 6 of the KP relay. This causes the current through the secondary winding to decay exponentially because of the presence of capacitors E, F, and G and resistor K. When the secondary current has been reduced to a predetermined value, the current in the primary winding causes the KP relay to operate to its front contact. In operating, relay SP connects ground to the J lead. This ground is returned through chain circuit or timing circuit relay contacts in the associated register or sender over lead L to operate relay LK which in operating connects 130-volt battery to the winding circuits of the channel relays except relays 2 and 10. These two circuits are open at contacts of the KP2 relay in the pre-KP condition to avoid firing these two thyratron tubes or HINs and operating their associated relays. Conduction in these tubes or HINs at this time would produce an undesirable effect on the voltage applied to the grid and suppressor elements or gates of the SP tube or HIN. Nonoperation of the 2 and 10 relays permits the other channel relays to function as third-frequency guards.

2.09 With relay KP operated, the release of relay SP at the end of the KP signal operates relays KP1 and KP2 which lock up through a make-contact on the KP1 relay, provided -48 Vdc has been applied on the BAT 1 and BAT 2 leads by the connecting circuit.

2.10 Under certain applications, as described in Section II, 2.02, the receiving circuit can be primed artificially by applying ground to the UL lead after -48 Vdc is applied to the BAT 1 and BAT 2 leads. This action will operate the KP1 and KP2 relays and arrange the receiving circuit for signal reception.

2.11 The operation of relays KP1 and KP2 changes the circuit to the condition for reception of digit pulses, a change which may be described as follows:

(a) Ground is connected to the lower armature springs of all channel relays via the upper make-contact of the LK relay (ZK option) so that when the LK relay and a channel relay are operated, this ground is connected to its associated lead (0, 1, 2, 4, 7, 10) in the connecting circuit.

(b) The grid and suppressor or gate elements of the SP tube or HIN are transferred from channel 2 and 10 rectifiers to cathode or source terminal 2 of the signal present biased detector BR via a resistor-capacitor network consisting of resistor P, capacitors C and H, and diodes C, D, and E.

(c) Resistors 2 and 10 are connected to terminal 7 of relay CK2, thus making their associated channel circuits the same as the other channel circuits.

(d) The bypass capacitors, BC, in the grid circuits of thyratrons 2 and 10 are connected to the bias producing circuit, the same as in other channel circuits. With ZM wiring the 2 channel is permanently connected.

(e) A short circuit across the winding of the CK2 and CK3 relays is removed.

(f) The path is opened by which channel relays 0, 1, 4, and 7 cancel an incoming KP signal when a third channel frequency is present.

(g) A high negative potential is removed from the grid or gate 3 terminal of the BR tube or HIN.

SECTION II - DETAILED DESCRIPTION

1. CODES AND FREQUENCIES USED

1.01 The signaling frequencies used for multifrequency pulsing are 700, 900, 1100, 1300, 1500, and 1700 Hz and have been designated 0, 1, 2, 4, 7, and 10, respectively, as an aid in remembering the digit codes. Frequencies 0 through 7 are used for the digit codes, and frequency 10 is used in combination with other frequencies for the KP and ST signals. Table A gives the frequency assignment for the various codes.

TABLE A

Freq in Hz	Desig	Digit											
		0	1	2	3	4	5	6	7	8	9	KP	ST
700	0		X	X		X			X				
900	1		X		X		X			X			
1100	2			X	X			X			X	X	
1300	4	X				X	X	X					
1500	7	X							X	X	X		X
1700	10											X	X

X = Frequency used.

1.02 Table A may be reproduced at will from the memory designations: thus, the digit 1 is 1 + 0 or 700 Hz and 900 Hz; digit 3 is 1 + 2 or 900 and 1100 Hz, etc. It is necessary, of course, to memorize the combinations for 0, KP, and ST.

2. PREPARATION FOR RECEIVING MF SIGNALS

RECEIVING CIRCUIT ASSOCIATED WITH A SENDER

2.01 When a sender having an associated multifrequency pulsing receiving circuit is seized and the call requires the use of the receiving circuit, the sender cuts the T and R leads through to the trunk and connects battery to the BAT 1 and BAT 2 leads. Battery over the BAT 2 lead energizes the operate (primary) winding of relay KP, but the relay remains released because its secondary winding is energized from local battery over a path to ground via its contacts 4 and 7 and contacts 4 and 7 on relay SP. Potential on the BAT 1 prepares relays KP1 and KP2 for future operation.

RECEIVING CIRCUIT ASSOCIATED WITH A KEY MONITORING CIRCUIT

2.02 When a key monitoring circuit is seized in order to monitor on multifrequency pulsing signals, the monitoring circuit connects the T and R leads to the keyset of the switchboard position being checked and connects battery to the BAT 1 and BAT 2 leads to the multifrequency pulsing receiving circuit, preparing it for the reception of signals as described in the preceding section. In addition, because the KP signal is not sent to the monitoring equipment by certain switchboards, the monitoring circuit primes the receiver artificially when these switchboards are used. This is done by having the monitoring circuit apply ground to the UL lead. With ground on this lead and battery on the BAT 1 lead, relays KP1 and KP2 operate immediately and transfer the circuit to the digit condition in the same way as the operation at the end of a regular KP signal.

RECEIVING CIRCUIT ASSOCIATED WITH A TEST CIRCUIT

2.03 When a test circuit is set up to make tests on outgoing multifrequency pulsing signals from senders or keysets, the test circuit connects the T and R leads to the sender or keyset under test and supplies battery over leads BAT 1 and BAT 2 to the receiving circuit associated with the test circuit, preparing the receiving circuit in the same way as described in 2.01.

RECEIVING CIRCUIT ASSOCIATED WITH THE TANDEM OFFICE CALLS-WAITING SIGNAL CIRCUIT FOR AMA IN CONJUNCTION WITH CAMA 2-WAY SIGNALING CIRCUIT

2.04 When the CAMA 2-way signaling circuit is energized, the receiving circuit is in the digit receive condition with KP1 and KP2 relays operated. Multifrequency signals are then received from the CAMA 2-way signaling circuit to operate the receiver channel relays. The channel relays in operating connect ground to the CAMA 2-way signaling circuit and either indicate team size or lamp signals corresponding to the number of calls waiting.

3. INPUT CIRCUIT, FIG. 1

3.01 The IN transformer is a well balanced, shielded coil provided to reduce the effect of longitudinal currents which might cause false operations of the receiving circuit. It is provided with optional wiring and apparatus arrangements which depend upon the type of circuit associated with the receiving circuit.

3.02 When the associated circuit requires the transformer to be used as a battery supply coil, leads T1 and R1 are used.

3.03 When battery supply feature is not required, V wiring is furnished except when a 900-ohm input impedance is needed.

3.04 When the receiver is used with senders or registers in 900-ohm 2-wire offices including 2-wire senders or registers in No. 5 crossbar offices, ZF option is provided. This option adds a 316-ohm (R1) resistor in series with a 2-MF (B) capacitor between the input windings of the IN transformer which has a nominal input impedance of 600 ohms, thus giving the receiver a nominal 900-ohm input impedance. When ZF or ZE option is not provided, option ZD is provided and the ac path is completed either by V wiring or a 2-MF capacitor in the associated sender or register.

3.05 When the receiver is associated with 2-wire incoming registers in a No. 5 crossbar office, the T2 and R2 leads are used so that relay contacts in the register which are across the R1 resistor permit switching the input impedance from 900 to 600 ohms. This is necessary in No. 5 crossbar offices because the receivers serve both 600- and 900-ohm trunks.

3.06 When the associated circuit requires this circuit to have an input impedance of 600 or 900 ohms, W wiring is furnished to obtain a 1:1 impedance in the transformer.

3.07 When this circuit is used for monitoring and is required to have a high input impedance, X wiring is furnished to obtain a 4:1 impedance ratio.

3.08 Resistors P1, P2, and P3 provide an impedance matching network and cause a loss of approximately 7 dB for 600-ohm input impedance or 5.5-dB loss for 900-ohm input impedance to the value of incoming signal. The grounded midpoint of resistor P3, a balanced circuit point, is provided for the removal of longitudinal currents.

3.09 In order to compensate for variations in the cable capacitance where the office cable is built out, Fig. 5 provides a building-out capacitor.

4. VOLUME LIMITER

WITH ELECTRON TUBES, OPTION ZP, FIG. 2

4.01 Electron tubes L1 and L2 and their associated input and output circuits constitute a volume limiter which provides adequate amplification of the multifrequency pulses to cause operation of the desired channels but which also limits the amplitude of high-level incoming signals to such a value that undesired channels will not operate due to spillover from adjacent channels.

4.02 The limiting action is obtained by means of the control grid resistors and capacitors L1 and L2 which cause the grid bias to become more negative when the alternating current on the grids becomes large enough to cause them to draw current during the positive half cycles. When this condition is reached, the power output increases very slowly with further increases in the grid voltage. The actual point at which limiting occurs is controlled by the voltage on the screen grids and on the cathode as well as by that on the control grids. The desired value for the screens is obtained from variable potentiometer P. The potential on the cathodes is obtained from voltage drop in resistor L3.

4.03 In order to compensate for variations of volume limiter tubes, potentiometer P has been provided. The field adjustment of the volume limiter can only be made when there is no shunt path on the input caused by other circuits. With a 2-frequency digit signal from the pad circuit as input to the receiver at a nominal level of -9.6 ±0.8 dBm, the voltage (as read by a KS-14510, L1 meter on its 12-volt ac scale plugged into the LEV test points, tip and ring) should be adjusted by varying potentiometer P until it reads 11.0 volts. All thyratrons should be in place, and relays KP1, KP2, and LK should be nonoperated.

4.04 To increase the severity of certain tests, thereby making them more effective in determining the point of failure under actual working conditions, provision has been made to degrade operation toward failure from modulation products by reducing the negative bias on the grids of the channel thyratrons by 30 percent. This is accomplished by grounding lead N which short-circuits resistor F.

WITH HINs, OPTION ZQ, FIG. 2

4.05 Two KS-21078 HIN devices are used in sockets L1 and L2. Each network consists of two field-effect transistors connected in cascade with internal fusing and a protection diode. The network provides gain in the linear range and limits high level input signals. Since the HIN device does not have a screen grid for adjusting the limiting point, the P potentiometer is no longer used and is turned fully clockwise, before the HINs are installed, and left in this position. (See HIN kit instruction sheet.)

4.06 Limiting action with the HINs is achieved by carefully controlling the range of I_{DSR} (drain to source current with normal source biasing resistor) so that the limiting point of the input signal is held to small variations. The variable bias adjustment is then used to compensate for variations in the limited output signal.

4.07 HINs are made of solid-state materials and do not change parameters with age; therefore, an initial adjustment is made by following the instructions set forth in the current issue of BSP 179-612-701 or 179-612-702. The adjustment consists of recording the volume limiter reading and adjusting the variable bias to a corresponding value shown in the BSPs.

ADJUSTMENT WITH HINs, OPTION ZQ

4.08 There are two adjusting pad circuits that are available for aligning MF receivers. One pad circuit, SD-95664-01, uses MF frequencies from the office MF current supply circuit. This pad circuit requires no change for use in adjusting HIN receivers; however the companion BSP 179-612-701 must be Issue 8 or later.

4.09 The other adjusting pad circuit, SD-95779-01, uses a 1000-Hz milliwatt supply to deliver certain levels for adjusting the receiver. This adjusting pad circuit must be modified per Issue 6B and Issue 7 or later of the companion BSP 179-612-702 must be used.

4.10 A field adjustment using a 21A TMS, or equivalent, is outlined in 4.11 for use in adjusting receivers with HINs in offices that normally use the 1000-Hz adjusting pad circuit per SD-95779-01 but have not modified it per Issue 6B as yet.

4.11 When initially installing HINs, perform 1 through 10 of the kit instruction sheet, then:

(1) Remove any shunt path on the input caused by the connecting circuit.

(2) Set the TMS output for 1000 Hz at -12 dBm and insert cord at the IN jack of the receiver.

(3) Block relays KP1, KP2, and LK nonoperated.

(4) Using a KS-14510, L1 meter, or equivalent, on the ac scale, observe and record the reading at test points T and R. Reading should be between 9.0 and 16.5 Vac.

(5) If reading in (4) is less than 9.0 or greater than 16.5 Vac, replace L1 and/or L2 HINs until (4) is satisfied.

Caution: Remove and restore power per instruction sheet.

(6) Disconnect the meter leads.

(7) Set the meter to the 60-Vdc scale.

(8) Connect the - and + meter leads to test points R and GRD, respectively.

(9) Adjust the BIAS potentiometer according to Table B.

(10) Repeat (4).

(11) If the limiter reading has changed, repeat (9).

(12) Disconnect the meter leads and TMS and remove blocks from relays KP1, KP2, and LK.

(13) See 5.07 for SP adjustment.

TABLE B*

If Volume Limiter Reading is (Vac):	Adjust Variable Bias to (Vdc):
9.0 - 9.7	20.3
9.7 - 10.1	21.2
10.1 - 10.5	22.1
10.5 - 10.9	23.0
10.9 - 11.25	23.8
11.25 - 11.6	24.5
11.6 - 12.6	25.6
12.0 - 12.5	26.5
12.5 - 13.1	27.3
13.1 - 13.7	28.2
13.7 - 14.3	29.1
14.3 - 14.9	29.9
14.9 - 15.5	30.8
15.5 - 16.5	31.8

*Use only when adjusting with 1000-Hz source.

5. SIGNAL PRESENT CIRCUIT

WITH ELECTRON TUBES, OPTION ZP, FIG. 1

5.01 The output of the volume limiter is connected to three circuits as follows. The input to the bias producing circuit is connected to the plate of electron tube L1; the secondary terminals of the output transformer OUT are connected through a 6-dB T pad to the common input terminals of the six channel filters. The shunt member of the T pad consists of two resistors, a 200-ohm unit and a 600-ohm unit, connected to the common side; the input terminals of the bandpass filter of the signal present circuit are connected across the 600-ohm resistor element of the T pad. This bandpass filter, a 7000-ohm to 7000-ohm unit, has a fairly flat low-loss characteristic from 600 to 1780 Hz and is of considerable value in making operation possible over noisy circuits. The output of this filter is terminated in a 7000-ohm resistor to match its characteristic impedance. The 7000-ohm unit is made up of two resistors, R and S, which serve as a potentiometer to provide the desired voltage at the input terminals of transformer SP. The voltage output of this transformer is applied to the grid, terminal 3, of electron tube BR which functions as a rectifier by virtue of the negative grid bias supplied by potentiometer SP. The output of this tube, a dc potential taken from its cathode, is connected through resistor P to the grid and suppressor terminals of electron tube SP after the KP signal has been received and the KP condition established. Prior to and during the reception of the KP signal, this tube is held nonconducting by a negative bias on grid terminal 3.

5.02 Capacitors C and H comprise a filter of which the H capacitor is selected to provide a signal recognition time of approximately 20 ms. Diodes C, D, and E are so connected that they reduce the time-constant of the P resistor, H capacitor combination at the end of a signal, and thus reduce the release time of the SP relay. The cathode terminal 2 of tube BR is connected to resistors AA and AB, forming a negative bias on the grid and suppressor elements of tube SP. This bias is approximately -8.3 volts. The SP tube operates as a dc amplifier having the secondary or operating winding of relay SP in its plate circuit. As both tubes operate on a threshold bias, the points at which relay SP will operate and release are less than 1 dB apart.

5.03 Adjustment of the operating point by means of potentiometer SP may be made after the adjustment of the limiting amplifier has been completed. Battery voltages should be -48 and +130, relay LK should be block nonoperated, and relays KP1 and KP2 should be blocked operated. Then using the 2-frequency adjusting pad circuit per CD-95664-01, with a digit 6 signal, 1100 and 1300 Hz, having a level of -27 ±0.8 dBm connected to the receiver input terminals, control SP is adjusted until the SP relay just operates. The relay should release when the input signal is reduced by 1 dB.

WITH HINs, OPTION ZQ, FIG. 1

5.04 Operation of the signal present circuit with an HIN device is the same as with an electron tube. The network KS-21080 HIN, replacing the 415A electron tube, consists of two series-connected field-effect transistors in series with a current limiting resistor in the drain and a diode connected to the drain. In addition, a limiting resistor is in series with each gate.

5.05 This network is used to drive the SP relay. It is operated in two modes. In the pre-KP mode, gates 1 and 7 are connected to the rectified outputs of the 1100- and 1700-Hz channel filters and serve as an AND gate to detect the KP signal. In the post KP mode, gates 1 and 7 are tied together, via operation of the KP2 relay, and are driven by the output of the signal present amplifier (one-half of the KS-21077 HIN).

5.06 Adjustment of the signal present circuit by means of the SP potentiometer is the same as outlined in 5.03 for electron tube operation.

SP ADJUSTMENT WITH HINs USING A TMS

5.07 This adjustment should be made after the adjustment of the BIAS potentiometer as outlined in 4.11.

(1) Set the TMS for 1000 Hz at -26.6 dBm and insert cord at the IN jack of the receiver.

(2) Block relays KP1 and KP2 operated and LK nonoperated.

(3) Adjust the SP control until relay SP just operates.

(4) Reduce the TMS level by 1 dB.

(5) Relay SP should release.

(6) Disconnect the TMS and remove blocks from relays KP1, KP2, and LK.

6. SP PULSE CORRECTOR CIRCUIT, FIG. 6, ZM WIRING

6.01 The SP pulse corrector is designed to prevent a pumping condition which can occur on short input pulses mainly generated by operator keying.

6.02 A short input pulse (8 to 18 ms) can cause the following action, without the pulse corrector installed.

6.03 The SP relay in operating causes the LK relay to operate via ground on the J-L loop. The LK relay in operating activates the channel relays and the CK2 relay, if two channel relays are operated. The CK2 relay operates and normally locks the LK relay operated through an additional ground on the L lead via Q option. However, by the time the CK2 relay has operated, the LK relay releases because the SP relay has released by virtue of the short input pulse. Although the CK2 relay releases because the LK relay has deactivated the channel relays, the brief operation of the CK2 relay can reoperate the LK relay and hence the channel relays and CK2 relay. In this manner there can be several cycles of pumping of the CK2, channel, and LK relays before the action subsides. Although the input signal has disappeared at the time pumping occurs, the channels are still reactivated by virtue of charge stored on the 0.022-uF BC and BD capacitors in the thyratron grid circuits. With a minimum required input signal of 27 ms, the SP relay is operated for sufficient time to lock LK and CK2 relays.

6.04 The SP pulse corrector is basically a monopulser which puts a positive pulse of about 22 ms onto the operate grids or gates of the SP tube or HIN via the D lead in Fig. 6. This action increases the time the SP relay stays operated on short input pulses but has little effect on normal pulses. The pulse corrector is activated when the SP relay operates removing ground from the B lead via 4 (SP) relay. An additional ground on the E lead through 5U(KP1) inhibits the pulse corrector until after receipt of the KP tone.

6.05 In the quiescent state, capacitor C1 has a 24-volt charge with the end connected to the base of Q1 at ground potential. Since no current flows through C1, Q1 is held off. When the SP relay operates, C1 will start charging toward 48 volts through resistor R2, causing current to flow in the base of Q1, turning Q1 on. When the charging current through C1 reaches about 0.6 mA (current through R3), the base current of Q1 goes back to zero and Q1 is turned off. The action of Q1 turning on and off causes a positive pulse at the collector which is connected via diode CR4 to the grid of the SP tube. Diode CR3 protects Q1 from a high reverse breakdown voltage across the base-emitter junction when the SP relay releases.

6.06 Diodes CR5 and CR6 are attached via the C lead to the BR tube or HIN. These diodes are designed to clip the operate voltage to the SP tube at 4.3 volts to give a more uniform operate time of the SP relay regardless of signal strength and to prevent its operation on any high level, short burst noises.

6.07 Included as part of the SP pulse corrector circuit is ZM wiring. This wiring removes a KP1 make-contact in the operate path to the grid of the channel 2 thyratron tube. This is done to protect against missing the A digit if the following condition exists: a short A digit (about 20 ms or less) containing channel 2 and any other channel preceded by a short gap (about 10 ms) between the end of the KP tone and the A digit. This condition, although highly improbable in machine pulsing, can occur with improper operator pulsing.

7. VARIABLE BIAS CIRCUIT

WITH ELECTRON TUBES, OPTION ZP, FIG. 3

7.01 Energy for operation of the variable bias circuit is taken directly from the plate element of electron tube L1. The lead from that point is connected through capacitor AA, resistor AC, and variable potentiometer BIAS to the fixed potentiometer formed by resistors AD and AE of Fig. 3 between -48 volt battery and ground. The variable arm of the potentiometer is connected to grid 7 of 396A electron tube BR which operates as an amplifier. The plate circuit of this tube is coupled to the diode voltage doubler circuit consisting of diodes A and B, resistor N, and capacitors D and AB of Fig. 1.

7.02 The grid circuits of the channel thyratrons are each connected to the common filter input terminals through a megohm resistor, either BA or BB, and this common lead in turn is connected through resistor N to the fixed potentiometer formed by resistors D, E, and F between -48 volt battery and ground. The values of D, E, and F are such that a potential of -18 volts is normally supplied to this common lead when no incoming signal is present. If a signal is applied to the input terminals of the receiver, a small alternating voltage from the limiter output is connected to grid 7 of the BR tube, amplified therein, and passed to the rectifier voltage doubler circuit. The polarity of the diodes is such that a negative potential is produced at the common filter terminal, adding to the -18 volt potential mentioned previously. As the input signal is increased, the value of negative bias on all thyratrons also increases, thus maintaining the margin of safety from operation of unwanted channels.

7.03 An adjustment check may be made as follows. With no signal applied to the receiver input terminals, the direct voltage measured between the tip and ground at the LEV test points should be between -16.7 and -19.0 and the voltage from terminal 7 of the BR tube to ground should be between -9.25 and -10.6. With a 2-frequency signal of -9.6 ±0.8 dBm applied to the receiver input, the BIAS potentiometer adjustment should be such that the voltage measured between the tip and ground of the LEV test points is -31.0 volts dc. These voltages should be measured with a KS-14510, L1 meter on its 60-volt dc scale.

WITH HINs, OPTION ZQ, FIG. 3

7.04 The 396A electron tube in the BR socket is replaced by a KS-21077 HIN. The network consists of two field-effect transistors, each with internal fusing and an internal diode. This network performs the same functions as a dual-triode electron tube. One section takes signals from the output of the signals present (SP) filter, rectifies them, and derives a dc signal that is used to drive the SP HIN. The second section is used to develop a variable negative bias voltage for the channel relay drivers.

7.05 Adjustment of the variable bias circuit is made by setting the BIAS poteniometer to a corresponding level of the recorded limiter level as outlined in the current issue of BSP 179-612-701 or 179-612-702.

8. RECEIVING CHANNELS

WITH ELECTRON TUBES, OPTION ZP, FIG. 4

8.01 As previously described, the output of the limiting amplifier is connected through a 6-dB transmission pad to the common input terminals of the six channel filters which separate the signaling frequencies into channels 0 to 10 corresponding to bands 700 ±45 Hz, 900 ±45 Hz up to 1700 ±45 Hz. A compensating filter, terminals 4 and 5, of the 201D filter is provided to improve the characteristics of the 700- and 1700-Hz filters by simulating the effect which would be produced by adjacent filters below and above them.

8.02 The transmission pad between limiter output and filter input serves a threefold purpose:

(a) It provides the attenuation required to match channel sensitivity to limiter output level;

(b) It provides a relatively constant impedance termination between the filters and the varying output of the limiter;

(c) It attenuates transients reflected from the filters to such an extent that they do not adversely affect the SP channel.

8.03 The output of each channel filter is connected through one-half of 396A electron tube A, operating as a diode rectifier, to a 1-megohm resistor termination shunted by a 0.01-uF capacitor. Thus a signal passing through the filter is rectified in the diode which is poled to produce a positive dc potential with accompanying voltage peaks bypassed by the 0.01 capacitor. At the junction of the diode cathode and the terminating resistor, the potential resulting from the addition of the positive rectified signal and the negative potential from the bias producing circuit is placed, via either resistors BC and BF or BD and BE (Fig. 4), on the control grid of the associated channel thyratron tube B or C. A second bypass is provided by capacitor BC or BD, Fig. 4.

8.04 Prior to the reception of the KP signal and operation of the KP1 and KP2 relays, the junction points of the channel rectifier cathode and the channel terminating resistor BA in channels 2 and 10 are connected to the grid and suppressor elements, respectively, of the SP tube. The voltage resulting from the addition of the positive rectified KP frequencies and the negative voltage from the bias circuit is applied both to the grids of the respective channel thyratrons and to the grid and suppressor of the SP tube. However, no action takes place in the thyratrons due to the condition of the plates, but at the SP tube the action is as outlined in Section I, 2.07. The circuit of the bypass capacitor BC nearest the grid of the thyratron is open in the nonoperated condition of relay KP1 to minimize time required for release of the SP relay. However, with ZM wiring only channel 10 is held open in the post KP condition as explained under SP pulse connector operation.

8.05 The channel thyratron, a hot cathode gas tetrode of miniature type, has a steep control characteristic with very low preconduction right up to the required conduction or firing point. In this circuit, conduction may take place with 2 volts negative potential between grid and cathode. As the tube ages, this critical voltage will approach 0. During the operated condition, the anode plate current will be in the order of 70 mA and the voltage drop across the tube will be approximately 8 volts. Care should be taken to ensure that no plate potential is connected to the tube until the heater has been energized for a minimum period of 10 seconds.

8.06 The channel relays, each with its winding connected in the plate circuit of the associated thyratron, are of a fast operating, fast release type. In the digit reception condition, ie, after reception and recognition of the KP signal, operation of the LK relay (ZK option) and of a channel relay connects ground to the associated (0, 1, 2, 4, 7, 10) lead to the register or sender. Prior to the operation of relays KP1 and KP2, the connection between the channel 2 and 10 relay windings and terminal 7 of relay CK2 is open so that no operation of these two channels can take place, as explained in Section I, 2.07. Under this condition, the other channel relay contacts are used as a third-frequency guard in that this ground will be applied to terminal 4 of the KP relay to discharge capacitors E, F, and G and hold relay KP nonoperated. After reception of the KP signal, the above conditions are removed and the operation of all channel relays depends upon the firing of their associated thyratrons.

8.07 Fig. 7 adds contact protection diodes to protect the output UA42 relay contacts in receivers which close ground to unprotected register relays in the associated circuit. Since contact erosion will vary from one receiver to another, Fig. 7 need only be used when there is evidence that contact erosion has started and should be installed only in receivers associated with circuits listed in Note 110.

WITH HINs, OPTION ZQ, FIG. 4

8.08 The three 396A electron tubes used as dual diodes in the receiving channels have been replaced by KS-21079 HINs. The new HIN device consists of two diodes. Three networks are used to provide rectification of the six channel filter output signals.

8.09 The replacement for the 2D21 electron tube thyratron is a KS-21081 HIN. This network consists of a thyristor, field-effect transistor, diode, resistor, and a capacitor. This network is used to operate its corresponding channel relay when a signal from its associated rectifier (KS-21079) appears on gate 1 and the drain voltage, +130 Vdc, has been applied by operation of the LK relay. The network will continue to operate its channel relay in SCR fashion after the gate signal is removed as long as load current is present. When the LK relay releases and removes +130 Vdc from the SCR anode, the network is turned off, causing the channel relay to release.

9. TYPICAL OPERATION

9.01 Typical operation of the receiver is described below in terms of electron tube operation. The operation of a receiver converted to HINs is the same except where differences are described in 4.05 through 4.07, 5.04 through 5.06, 7.04 and 7.05, and 8.08 and 8.09.

9.02 When a register or sender is seized by a trunk for the reception of an incoming MF call, relay operation in this circuit connects battery to the BAT 1 and BAT 2 leads to the MF receiving circuit to energize the primary winding of relay KP and to supply battery for the future operation of relays KP1 and KP2 and connects the T and R leads of the receiver to the incoming line pair. The incoming KP frequencies, 2 and 10, pass through the limiting amplifier for amplification or amplitude limiting, as required, by their received level. At the output of the limiter, the signal divides three ways with the major portion of the energy traversing the 6-dB pad with corresponding attenuation to the common input to the channel filters. The greater part of the signal divides and passes through the 1100- and 1700-Hz filters, although some energy is released in the form of a 4- to 8-ms transient at the output of the other filters as a result of shock excitation. At the output of the channel filters, the signal is changed to a positive dc potential in the channel rectifier tube.

9.03 At the output of the limiting amplifier, the voltage across the 600-ohm resistor in the shunt element of the 6-dB pad is applied through the 201D bandpass filter SP and SP input transformer to grid 3 of tube BR in the signal present circuit. This performs no useful function at this time as the output circuit of this tube is open at the KP2 relay contacts, and the tube grid is given a high-negative bias through contacts on the same relay to avoid placing a positive charge on capacitors C and H.

9.04 At the output of the amplifier, a small part of the signal voltage at the plate of the L1 tube is applied to grid 7 terminal of the BR tube. This signal is amplified and passed on to the voltage doubler diode circuit where it is rectified, and the resulting negative voltage is added to the fixed negative bias voltage (approximately -18 volts) produced by fixed potentiometer resistors D, E, and F. This potential is connected through 1-megohm resistors to a point in each channel at the output of the channel rectifier tube. Here, the bias voltage and the positive rectified signal voltage are added, and the resulting potential is applied to the grid of the channel thyratron. During the reception of the KP signal, this resulting channel direct voltage is applied both to the channel thyratron grids and also to the grid and suppressor elements, respectively, of the SP tube.

9.05 The resulting flow of plate current in this tube operates relay SP which in turn removes ground from terminal 7 of relay KP to start the operate timing circuit for this relay and connects ground to lead J which is connected via the associated register or sender to lead L to operate relay LK. Relay LK operated connects 130-volt battery via the shunted windings of relays CK2 and CK3 and back contacts of KP2 relay to each thyratron plate circuit, except 2 and 10, via a 1260-ohm resistor and the winding of the channel relay. The time required for the operation of relays SP and LK permits the transient condition in the filters of the unwanted channels to die out before the plate voltage is available to fire the thyratron. The thyratrons for channels 2 and 10 do not become conducting at this time. Relays CK2 and CK3 remain unoperated in the pre-KP condition due to the fact that their windings are short-circuited at upper contacts 4-5 of relay KP2. In case any channel thyratron has operated, in turn operating its associated relay, ground from the upper relay contact will be connected to terminal 4 of the KP relay and will stop the timing operation by again grounding capacitors E, F, and G.

9.06 When no third frequency is present, the E, F, and G capacitors associated with relay KP have been receiving a charge from battery through the 6-1 winding of the relay since the SP relay armature left its back contact, thus continuing to hold the KP armature on contact 4 for a period of time. After about 55 ms, the current in winding 6-1 is reduced to the point where the 5-2 winding takes control and the armature moves to contact 3. No further action takes place until the end of the received KP signal. Then relay SP releases connecting ground from its back contact via the 7-3 contacts of relay KP to operate relays KP1 and KP2. This changes the circuit to the condition for the reception of digit pulses as outlined in Section I, 2.20. Relay KP remains operated for the duration of the digits transmission.

9.07 When the 2-frequency signal representing the first digit is received, it traverses the various circuit elements, limiting amplifier, etc, as described for the preceding KP signal, and becomes a voltage on the grids of two channel thyratrons. This voltage as previously described is the addition of a positive rectified signal from the channel filter and a negative fixed bias augmented by a negative potential controlled by the incoming signal amplitude. A small amount of power may traverse other channel filters caused by generation of third-order products in the limiting amplifier, products which have the correct channel frequencies. However, the amplitude of third-order products is small in comparison with the digit signals, and adequate protection is afforded against false operation from this source. In the digit condition, the SP signal channel is made continuous by operation of the KP2 relay, and the voltage applied to grid 3 of the BR tube through band filter SP and input transformer SP is rectified in the tube. The resulting direct voltage taken from the BR tube cathode, terminal 2, is applied through resistor P to the grid and suppressor terminals of tube SP, a dc amplifier stage. The resulting current flow in the plate circuit of tube SP operates relay SP which in turn operates relay LK over the J-L loop in the associated register or sender. Operation of the LK relay connects battery to the channel thyratron plate circuits, and the two tubes with firing voltage on their grids break down, in turn operating their associated relays which in turn connect ground potential to the associated channel leads and to lead J to the sender or register.

9.08 Relay CK2 operates with two channel tubes conducting and performs the following:

(a) Removes ground from the F resistor increasing the fixed potential on the thyratron grids from -18 to -48 volts to ensure that no other channel thyratron will fire from the end transient condition when the signal ceases.

(b) Removes ground from the M lead to associated sender or register circuit.

(c) Connects ground to the H lead to associated sender or register circuit.

(d) When Q wiring is specified, places a second ground on leads J and Q to the associated sender or register, a ground which is independent of the SP relay.

(e) When B wiring is specified, connects ground to the F resistor via lead W from the associated CAMA sender.

(f) When A wiring is specified, places a ground on the V lead to the associated CAMA sender independent of the SP relay.

9.09 The grounds placed on two of the channel leads 0 to 10 result in operation of the register relays in associated senders or register which, together with the changing condition on leads H and M, causes the connected circuit to open the J-L loop. This releases the LK relay, in turn releasing the channel relays and relay CK2. If the signal is still incoming, the SP relay remains operated and ground on the J lead does not permit the sender to reclose the J-L loop. This precludes the possibility of a double registration on a single digit signal. In case of a short signal and slow registration, the SP relay may release, but the ground on lead J from the make-contact of the CK2 relay holds relay LK operated until the J-L loop is opened to show that registration is complete. With the end of the double signal and with registration complete, the SP and LK relays release. This de-energizes the thyratrons and releases the channel relays and relay CK2, and the circuit is ready to receive the next digit.

9.10 In the digit condition, the CK3 relay will operate in case three channel thyratrons become conducting due to the presence of a third channel frequency. Operation of this relay removes the chain advance ground from lead K to the associated sender or register and grounds lead RO to the same circuit to start a reorder signal to the originating operator.

9.11 When H wiring is provided, operation of any channel relay places ground on lead S. This permits use of a single-frequency advance feature.

10. START SIGNAL

10.01 The start signal ST, consisting of frequencies 7 and 10, is sent out after all the digit codes have been transmitted, but whether it serves any useful purpose depends upon the register arrangement provided in the sender or other circuit with which the receiving circuit is associated. In some cases the traffic is such that all calls involve the same number of digits, and, the sender or other circuit proceeds as soon as the full complement of digits has been received. In other cases the number of digits varies from call to call, and it is necessary to indicate when all that are necessary have been registered. The start signal serves this purpose. Although it is superfluous in the former case, it is always transmitted in order to avoid operating complications.

10.02 When the sender or other circuit is arranged to accept the ST signal, the receiving circuit functions in the same way as on digit pulses except that it grounds the 7 and 10 leads. When the sender or other circuit does not require the ST signal, arrangements are provided to prevent its reception in order that it may not interfere with the progress of the call. In either case, battery is subsequently removed from the BAT 1 and BAT 2 leads and ground is removed from the UL lead when it is used to restore the receiving circuit to normal.

11. MISCELLANEOUS

11.01 The W lead is required by the associated CAMA sender to prevent bias shift in the receiver.

11.02 The V lead is required by the associated CAMA sender to allow digit registration on a short signal.

11.03 Y wiring and leads TC1 and TC2 are provided so that the maximum KP relay operating time can be increased from 55 ms to 88 ms when the receiver is part of the incoming register or sender test circuits. Leads TC1 and TC2 connect to a capacity of 6.48 uF located in the test circuit. With Z wiring the KP relay operate time is 55 ms maximum.

11.04 Jacks CK3, KP, and SP are provided to facilitate testing the 280-type relays in the circuit.

11.05 The IN jack is provided to facilitate adjustment of the limiter, signal present, and variable bias circuits.

11.06 Fig. B is provided for use where the receiver is employed as a monitoring or testing unit and will not be used in conjunction with the filament supply circuit. In this case no transfer to dc is involved, and the transfer relay, Fig. A, is not required.

11.07 Resistor LK provides a leakage path to discharge any potential stored in the capacitor element of contact protection unit LK by a possible rebound of contacts on relay LK when releasing.

11.08 The P lead provides a ground removal each time the SP relay operates.

12. LOCATING TROUBLES IN RECEIVERS WITH ELECTRON TUBES, OPTION ZP

12.01 The initial procedure in locating a trouble in a suspected receiver is to apply all the MF receiver tests from the sender or register test frame. By varying the digits pulsed, the trouble can usually be isolated to a particular receiving channel or if several digits are failing, the trouble could be a component common to all receiving frequencies.

12.02 The next step is to apply all the adjustments listed in BSP 179-612-701 or 179-612-702. These tests will verify proper functioning of the volume limiter, variable bias, and signal present circuits. The pulse corrector should also be checked if Fig. 6 is installed.

12.03 If any electron tubes are suspect, they should be checked in a tube tester. However, it should be noted that the test performed by certain tube testers is not an accurate measure of the performance of the tube in a receiver. The final criterion for usage should be satisfactory operation in the receiver circuit as checked by the sender or register test frame.

13. LOCATING TROUBLES IN RECEIVERS WITH HINS, OPTION ZQ

13.01 The procedures described in 12.01 and 12.02 shall be applied first.

13.02 HINs do not have heater filaments and, therefore, should feel cool or only slightly warm in normal operation. An HIN that feels hot, relative to the other HINs, is suspect and should be replaced.

13.03 With the limiter HINs, KS-21078, there are certain conditions where the cooler of the two limiter HINs is suspect. They should be replaced one at a time, following the procedure described in BSP 179-612-701 or 179-612-702.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

DIGIT CODES

1.01 With pulses of 27 ms or longer free from contact chatter, the receiving circuit will operate satisfactorily over the following range of powers measured at the receiving circuit input:

(a) Maximum power of 1 milliwatt at each signal frequency.

(b) Minimum power at 22 dB below 1 milliwatt at any signal frequency, provided that the difference in power between any two frequencies making up a signal does not exceed 6.5 dB

KP SIGNAL

1.02 When Z wiring is used, the receiving circuit will function satisfactorily on the KP signal over the ranges given in 1.01 except that pulses of 55 ms or longer are required. When Y wiring is used, a KP signal of 88 ms or longer is required.

1.03 The circuit applying the signal must not cause a click within 20 ms before the start of the signal.

1.04 Voltage Limits

Voltage (dc)	Min	Max
-48	-45	-50
+130	+125	+135

1.05 Current Drain

Receiver Condition	Voltage	Current Drain (mA) Option ZP	Current Drain (mA) Option ZQ
Idle	-48 Vdc	30	30
	BAT 1*	0	0
	BAT 2*	0	0
	+130 Vdc	36	32
	110 Vac	450	Not Used
Post KP (With No Signal)	-48 Vdc	12	12
	BAT 1*	140	140
	BAT 2*	50	50
	+130 Vdc	33	32
	110 Vac	450	Not Used
Post KP (With Signal)	-48 Vdc	120	130
	BAT 1*	140	140
	BAT 2*	50	50
	+130 Vdc	215	200
	110 Vac	450	Not Used

*-48 Vdc supplied by connecting circuit.

2. FUNCTIONAL DESIGNATIONS

2.01

Designation	Meaning
CK2	Two-Frequency Check
CK3	Three-Frequency Check
FT	Filament Transfer
KP	Key Pulse Signal
LK	Lock Function
SP	Signal Present Function
ST	Start Signal
0	700-Hz Channel
1	900-Hz Channel
2	1100-Hz Channel
4	1300-Hz Channel
7	1500-Hz Channel
10	1700-Hz Channel

3. FUNCTIONS

3.01 This circuit is designed to perform the following functions:

(a) To receive and amplify multifrequency pulsing signals in the form of various combinations of alternating currents covering a range from 700 to 1700 Hz in 200-Hz steps.

(b) As a part of incoming or terminating senders or register circuits, to receive and check incoming multifrequency pulses from trunks.

(c) As part of key monitoring circuits, to receive and check outgoing multifrequency pulses from operator keysets.

(d) As part of sender and position test circuits, to receive and check outgoing multifrequency pulses from sender and operator keysets.

(e) To respond to a gate opening pulse (KP) consisting of a relatively long combination of 1100 and 1700 Hz for protection against false operation on speech and noise.

(f) To prepare the circuit for regular pulsing after a successful gate opening KP signal.

(g) To inform the sender at the end of MF signaling by way of the ST (start) signal.

(h) After the reception of the KP signal, to connect ground to leads extending to an associated sender, register, key monitoring, or test circuit to cause the operation of relays in the associated circuit corresponding to the various signal combinations being received.

(i) To compensate for differences in the input signaling power and to reduce the interfering effect of the transient current generated when the multifrequency signals start and stop and when they build up and die down in the filters.

(j) To make the channel thyratron circuits less susceptible to operation on modulation products by varying the grid bias voltage applied to these tubes under control of the incoming signal amplitude.

(k) To prevent prolonged signal pulses from causing duplicate registration of a single digit by means of a signal present circuit and relay.

(l) To indicate to the sender, register, key monitoring, or test circuit the following conditions:

(1) To check that an incomplete digit signal consisting of one frequency has been received.

(2) To check that a digit signal consisting of two frequencies has been received.

(3) To check that an incorrect digit signal consisting of three or more frequencies has been received.

(4) To check the margin of safety from operation on modulation products by decreasing the margin approximately 30 percent.

(m) To interpret MF signals which originate from the tandem office calls-waiting signal circuit for AMA in conjunction with CAMA 2-way signaling circuit. The MF signals can either indicate team size or corresponding lamp signals for the number of calls waiting.

4. CONNECTING CIRCUITS

4.01 Typical connecting circuits are:

(a) Toll Systems - MF Revertive Senders Used With Toll Switchboards - SD-56072-01.

(b) Toll Systems - Toll Switching System No. 4 - Keypulsing Incoming Sender - SD-68016-01.

(c) Toll Systems - Toll Switching System No. 4 - Outgoing and Incoming Sender Test Circuit - SD-68075-01.

(d) Toll Systems - Toll Switchboard No. 4 - Position Test Circuit - SD-68080-01.

(e) Toll Systems - Toll Switchboard No. 5 - Position Test Circuit - SD-68156-01.

(f) Toll Systems - Toll Switching System No. 4A - Multifrequency Pulsing Incoming Sender - SD-68222-01.

(g) Toll Systems - Toll Switching System No. 4A - MF Pulsing Incoming Sender Test Circuit - SD-68226-01.

(h) Toll Systems - Toll Switching System No. 4M - Multifrequency Pulsing Incoming Sender - SD-68429-01.

(i) Toll Systems - Toll Switching System No. 4A or 4M Overseas Sender Circuit - SD-68551-01.

(j) Common Systems - Sender Circuit - Toll Switchboards No. 1, 1B, 3, 3B, or 3C, Switchboard No. 15C - SD-95481-01.

(k) Common Systems - Service Observing Desk No. 12 - Position Circuit - SD-95521-01.

(l) Common Systems - Pad Circuit for Adjusting Tone to MF Receivers - SD-95664-01.

(m) Common Systems - Filament Supply Circuit - SD-95676-01.

(n) Common Systems - CAMA Two-Way Signaling Circuit - SD-95776-01.

(o) Common Systems - MF Pulsing Receiver Adjusting Circuit - SD-95779-01.

(p) Common Systems - ANI Outpulser-Identifier Test Circuit - SD-95815-01.

(q) Common Systems - Line Concentrator No. 1A MF Signaling Circuits - SD-95971-01, SD-95972-01.

(r) Common Systems - Key Monitoring Circuit - SD-96314-01.

(s) Crossbar System No. 1 - Subscriber Sender Test Circuit - SD-25221-01.

(t) Crossbar Tandem - Sender Test Circuit - SD-25364-01.

(u) Crossbar System No. 1 - Multifrequency Pulsing Terminating Sender Circuit - SD-25455-01.

(v) Crossbar System No. 5 - Sender Test Circuit - SD-25675-01.

(w) Crossbar System No. 5 - Master Test Frame - Automatic Monitor Register and Sender Test Circuit - SD-25680-01.

(x) Crossbar System No. 5 - Incoming Multifrequency Register Circuit - SD-25730-01.

(y) Crossbar Tandem - Multifrequency Sender Circuit - SD-25769-01.

(z) Crossbar Tandem - Sender Circuits Arranged for AMA - SD-25961-01, SD-25999-01, SD-27024-01.

(aa) Crossbar Tandem - Sender Test Circuit for PCI, DP, MF, or RP Senders With or Without AMA - SD-25963-01.

(ab) Crossbar Tandem - Multifrequency Sender Circuit - SD-25978-01.

(ac) Crossbar System No. 5 - Incoming Register - SD-26042-01.

(ad) Crossbar System No. 5 - Trunk Test Register Circuit - SD-27643-01.

(ae) SXS Systems - No. 1 With AMA Sender Identification and Transverter TST Circuit - SD-32208-01.

(af) SXS Systems - Intertoll Dialing Office With CAMA - Sender Circuit - SD-32261-01.

(ag) Step-By-Step Common Control, Manual and Automatic Test Circuits - SD-32362-01, SD-32365-01.

(ah) Panel Systems - Subscriber Sender Test Circuit - SD-21186-01.

(ai) Telegraph and Data Systems - Operators Training Desk - SD-71033-01.

(aj) PBX Systems No. 758C - Register Sender Circuit - SD-67045-01.

(ak) Step-by-Step (SAMA) Trunk Outpulser Test Circuit - SD-32511-01.

(al) Toll Switching No. 4A MF Incoming Sender Circuit - SD-68575-01.

(am) Selecting and Monitoring Circuit - SD-95917-01.

(an) Control Pulsing Circuit - SD-95981-01.

(ao) Position Display Circuit - SD-95982-01.

(ap) Position Test Circuit - SD-95984-01.

(aq) Control Pulsing Test Circuit - SD-95985-01.

(ar) Crossbar No. 5 Trunk Test Register Circuit for Use in Wideband Service - SD-27881-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The manufacturing testing requirements for this circuit are covered in X-67459, Manufacturing Testing Requirements for Multifrequency Pulsing Receiving Circuit.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 When this receiver is associated with a connecting circuit which supplies off-normal battery (BAT 1 and/or BAT 2) to the receiver, follow the TEOS information for the connecting circuit.

6.02 When the receiver is not operated in the manner stated previously, the following procedure should be used:

(a) Check that the receiver is in the idle condition, no relays operated.

(b) Remove power in the following order: +130 Vdc, -48 Vdc, 110 Vac.

(c) When power is applied, the above order should be reversed.

Note: 110 Vac required only with option ZP.

7. ALARM INFORMATION

7.01 The electron tube filament heater circuits are supplied with 6.3 volts ac from a filament transformer mounted on the receiver panel. When the receiver is associated with the Filament Supply Circuit, SD-95676-01, provision is made by means of the FT relay for automatic transfer to dc office battery in case of ac power failure. The alarm is indicated at the filament supply circuit.

7.02 If the +130 Vdc or the -48 Vdc fuses operate, the alarm will be indicated at the top or bottom of the relay rack on which the receiver is mounted.

SECTION IV - REASONS FOR REISSUE

B. Changes in Apparatus

B.1 Added

Hybrid Integrated Networks (HINs), Option ZQ

Fig.	Sockets	HIN Code
1	SP	KS-21080
2	L1, L2	KS-21078
3	BR	KS-21077
4	A, A, A	KS-21079
4	B, B, B, C, C, C	KS-21081

Contact Protection Diodes, Fig. 7

D. Description of Changes

D.1 Option ZQ is used to identify an MF receiver that has been converted from electron tube (option ZP) to HIN operation. An instruction sheet is included in each HIN kit and is repeated in Note 305.

D.2 Fig. 7 adds contact protection diodes to protect output UA42 relay contacts. The diodes are mounted on a printed wiring circuit pack that is installed on the back of the receiver. Instructions governing the use of Fig. 7 are detailed in Note 110.

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