TYPE K CARRIER TELEPHONE SYSTEM

LINE SWITCHING AND AMPLIFIER

SWITCHING ARRANGEMENTS

CONTENTS

1. GENERAL

1.01 This section, prepared by the Bell Telephone Laboratories, contains the description and method of operation of the line switching circuit and the amplifier switching circuit for use in maintaining type K carrier telephone equipment and systems.

1.02 The line switching circuit provides arrangements for utilizing an alternate high frequency line section in order to free a regular line section for those maintenance operations which cannot be made on a working system. The line switching equipment consists of two complementary units located in the main stations at the ends of the section of line to be switched.

1.03 The amplifier switching circuit provides arrangements for utilizing alternate circuits in place of the regular circuits listed below, in order to free the regular equipment for those maintenance operations which cannot be made on a working system.

Line Amplifier
Line and twist amplifier in tandem
Group modulator and transmitting amplifier in tandem
Line amplifier, twist amplifier, group demodulator and auxiliary receiving amplifier in tandem.

The amplifier switching circuit consists of a single panel and associated miscellaneous equipment arranged for use in either terminal, intermediate main, or auxiliary repeater stations.

1.04 In both switching units, provision is made for preliminary patching between regular and alternate circuits and the actual transfer is made through a relay circuit under control of manually operated keys. The switch is effected during the interval of operating time of the relays involved; fast operating telegraph type relays are used which results in a switching interval in the order of a few milliseconds. The transfer is made without opening the transmission path. To insure minimum interference with service due to possible operating errors, safeguards are provided in so far as practicable to prevent the transfer circuit from operating unless the patches are properly made.

1.05 The general scheme of operation of the line switching circuit is to set up a transmission path through a high impedance bridging amplifier and over an alternate high frequency line paralleling the regular high frequency line. The output of the alternate high frequency line at the receiving end of the section is short circuited until the switching relay at this end operates. The switching operation at the receiving end consists of transferring this short circuit to the output of the regular line. While the switching relay armature is travelling from the back to the front contact, the outputs of the regular and alternate lines are connected in series, thus avoiding opening the through circuit during the transfer operation. At the transmitting end, a similar transfer, which is made after the receiving end has been transferred, releases the auxiliary switching amplifier and connects transmission at this point directly through a repeating coil. A simplified schematic of the line switching arrangement is shown in Fig. 1.

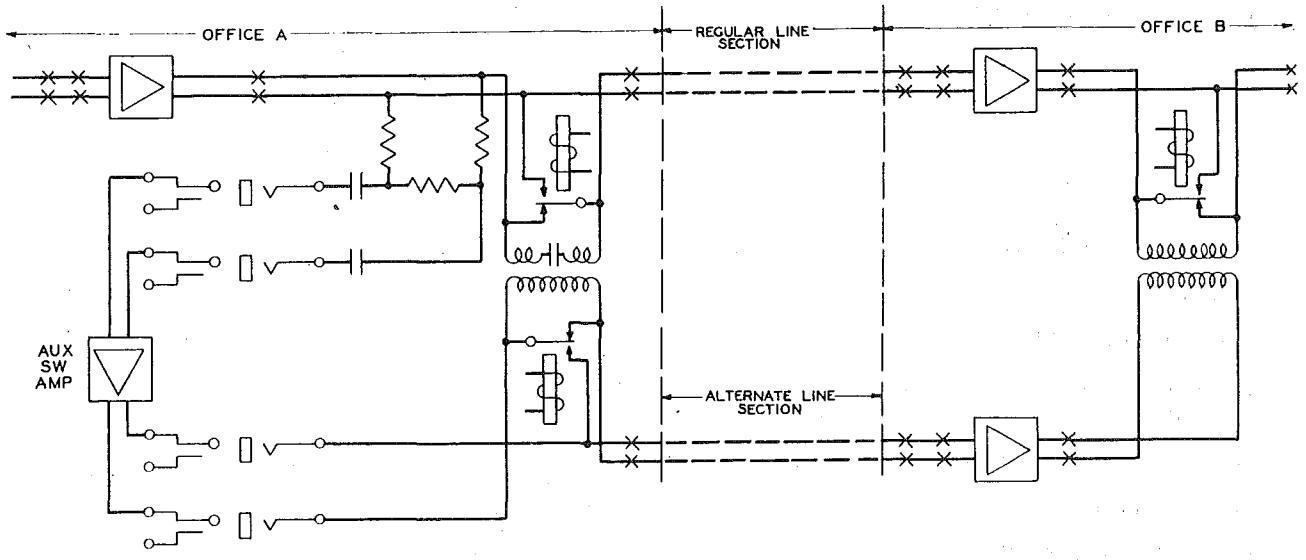

Fig. 1 - Simplified Schematic Line Switching Circuit.

1.06 The general operation of the amplifier switching circuit is similar to that of the line switching circuit except that both input and output are transferred simultaneously and no bridging amplifier is required. A set of patches is made which takes the circuit to be switched off its input and output jack normals after completing a through path via back relay contacts and test jack contacts in series. At the time of the switch, the through transmission circuit is completed through the front relay contacts. The regular circuit is then ready for any maintenance operation. A simplified schematic of this arrangement is shown in Fig. 2. This figure shows the specific case where line amplifiers are being switched; where other circuits are involved, the arrangements are similar.

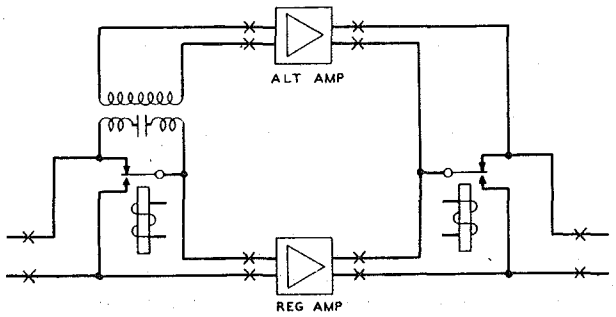

Fig. 2 - Simplified Schematic Amplifier Switching Circuit.

1.07 In order to provide a maximum of reliability in operation, protective features have been included in both the line switching and amplifier switching circuits. The actual transfer is under control of non-locking push-button type keys, two of which must be operated simultaneously so that accidental operation of a single key will not cause the circuit to transfer or restore. The control relays are interconnected with supplementary contacts on the jacks for testing the regular circuit, so that the regular circuit cannot be restored while patch cords are in these jacks. Similar interlocking features are included to insure that the auxiliary switching amplifier is connected at the time a line switch is made. Parallel connections are provided for all relay contacts in the transmission path; the contacts on the 209 type relays used for the fast transfer are paralleled by contacts on the slower acting relays in the control circuit or by a coil winding permanently connected across the contacts. Relays also disconnect the regular equipment after the transfer has been completed, in order to avoid the possibility of test power being applied to a working circuit.

2. LINE SWITCHING CIRCUIT

(A) Description of Circuit and Equipment

2.01 The general schematic of the line switching circuit with the guard features and parallel contacts omitted, is shown in Fig. 3.

2.02 A series of manual operations at both offices is necessary in order to put the circuit in condition for switching. An auxiliary switching amplifier is connected into the circuit at the transmitting end by plugging its input and output plugs into their associated bridging jacks in the switching circuit; the two-prong plugs at both ends are inserted into their respective transmitting and receiving jacks associated with the alternate high frequency line. The four-prong plugs are inserted in the line and equipment jacks at both ends of the section of regular line. When each

of these four-prong plugs is being inserted, it completes a parallel circuit to the regular line jack normals through the paralleled back contacts of certain relays in the transmission circuit which are in series with normal contacts in the jacks provided for testing the regular line; when each of these plugs is fully inserted into its associated jacks, the normals between line and equipment jacks at both ends are disconnected and transmission is through the relay back contacts and test jack normals heretofore mentioned. Fig. 4 shows, in simplified form, the transmission path for the regular line section as modified by the insertion of the four-prong plugs.

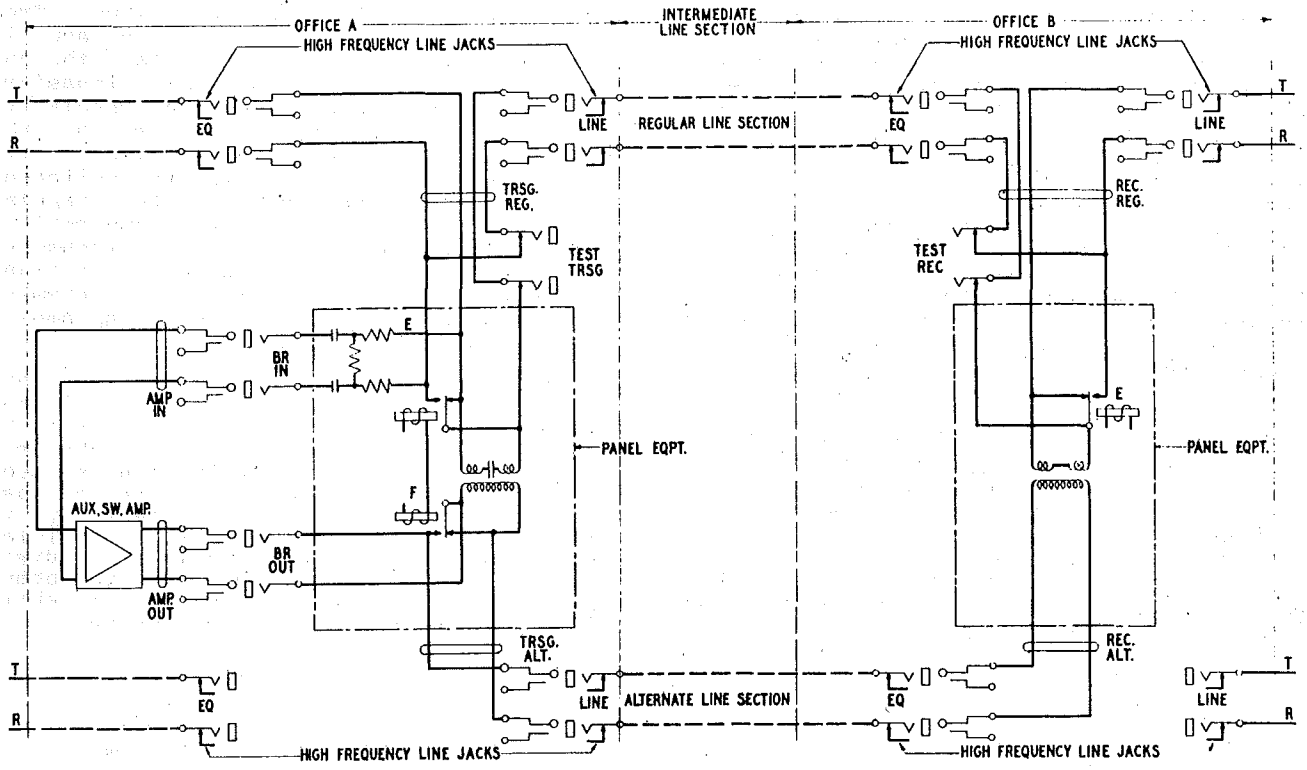

Fig. 3 - General Schematic Line Switching Circuit.

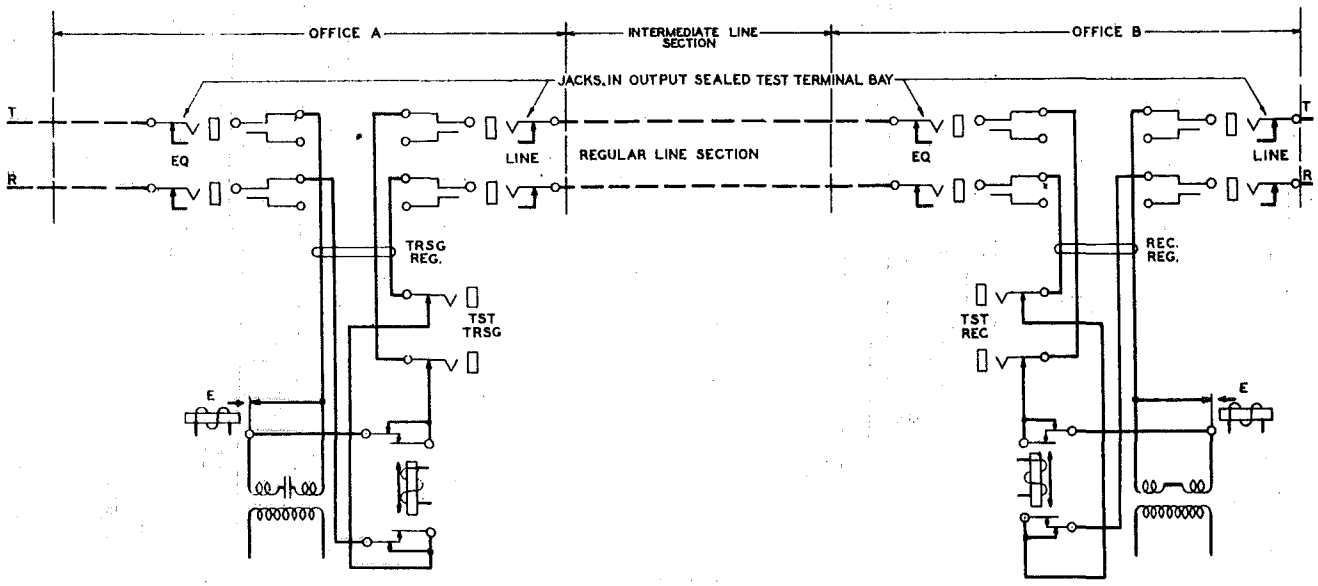

Fig. 4 - Transmission Path over Regular Line Section After Four-Prong Plugs are Inserted and Before Switch.

2.03 After the patching up operations are completed, the alternate line is also transmitting but this path is short-circuited by relay contacts at the input of the repeating coil at the receiving end; the output of this repeating coil is also short circuited by the back contacts of the switching relay.

2.04 The pilot frequency levels over the regular line may be checked prior to any patching or after the transmitting end is patched; the check of pilot levels over the alternate line can only be accomplished after patching the transmitting end and before patching the receiving end, i.e., it is necessary to complete all the patches at the transmitting end in order to effect transmission of the pilot frequencies over the alternate line. The pilot level measurement on the alternate line must be made before the two-prong plug associated with receiving end switching circuit is plugged up; this is necessary in order to avoid a short circuit to the pilot current through relay contacts in the switching circuit.

2.05 After pilot levels have been measured and the switching plugs have been inserted at the receiving end, the circuit is ready for switching at this point. The receiving end must be switched first in order to prevent opening the circuit to through transmission. The switch is accomplished by depressing two non-locking push-button type keys simultaneously; two keys are used in the circuit, one a control key supplying ground and the other a switching key connecting this ground through to a starting relay in order to guard against operation of the switching circuit due to one of the keys being accidentally or inadvertently depressed. The operation of the control and switching keys locks up a starting relay, thus initiating a chain of relay operations which removes the short circuit from the output of the alternate line and, in turn, operates the switching relay; the operation of the switching relay transfers through transmission from the regular to the alternate line and after operation, the slower operating C relay parallels its front contacts. Also, after the switching relay operates, the output of the regular line is short-circuited by the comparatively slow operating B relay. The transmission path at this point in the operations is shown in Fig. 5, and involves transmission through the auxiliary switching amplifier at the transmitting end.

2.06 A guard lamp, located near the control and switching keys, is lighted during the time the switching circuit is in use. Auxiliary contacts on the jacks provided for testing the regular line section provide a ground for preventing the release of the starting relay while a test cord is plugged into these jacks; this provision guards against the possibility of inadvertent attempts to switch back to normal transmission over the regular circuit while it is opened to through transmission.

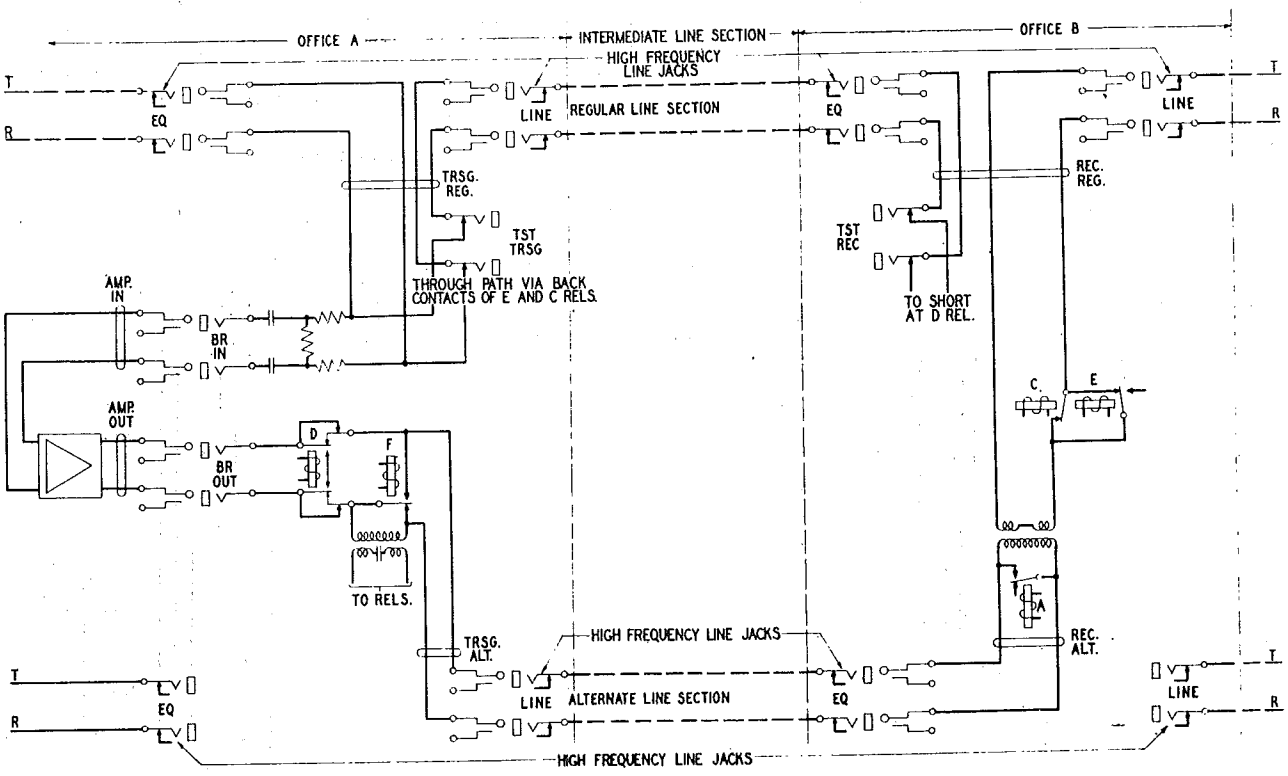

Fig. 5 - Transmission Path Line Switching Circuit Plugged Up and Switched at Receiving End Only.

2.07 The transmitting end of the line section is switched after the transfer has been made at the receiving end. A set of control and switching keys together with an associated guard lamp and starting relay are also provided at the transmitting end. The starting relay initiates a sequence of relay operations accomplishing the following results: the two fast operating switching relays operate in series in order to effect, as nearly as possible, a simultaneous transfer from transmission through the bridging amplifier to direct transmission through a repeating coil; the comparatively slow B relay parallels the front contacts of both switching relays; relays C and D operate from the B relay, the C relay shorting the outgoing end of the regular line and the D relay shorting the output of the auxiliary switching amplifier. The transmission path is now as shown in Fig. 6.

2.08 The auxiliary switching amplifier may now be removed from the switching circuit and used in effecting transfers with other switching circuits if desired.

2.09 The short circuits at both ends of the regular line prevent the possibility of interference with through transmission due to any test voltages on patch cords being applied in two directions while the plugs are being inserted in the test jacks and before the normals on the jacks are opened by pushing the plugs all the way in.

2.10 When test and maintenance operations have been completed on the regular line, the switching circuit is restored by reversing the order of operations used in switching. The transmitting end must restore first. In this case, also, two non-locking push-button keys are used, one being the control key used for the switch, and the other a restore key which must be operated at the same time as the control key in order to be effective. Auxiliary contacts are provided on the auxiliary switching amplifier bridging jacks which supply the ground for the control and restore keys, making it impossible to restore without plugging this amplifier back into the circuit. A holding ground is also applied to the starting relay through an auxiliary contact in the jacks used for testing the regular line, in order to prevent restoration while a test cord remains plugged in; this prevents restoring transmission to a line section which is open at the test jacks. The guard lamp is extinguished after restoration as an indication that the switching circuit is available for use in other transfers.

2.11 The receiving end is also restored by the use of control and restore keys, and the guard lamp indicates a normal circuit condition after restoration. The same guard provision is included at the receiving end for preventing restoration while a test cord is in the test jacks.

2.12 Any length section may be switched to an alternate line where the proper transmitting and receiving equipment is available for effecting such a switch. Ordinarily, the length of section switched will be comprised of one or more twist sections of line.

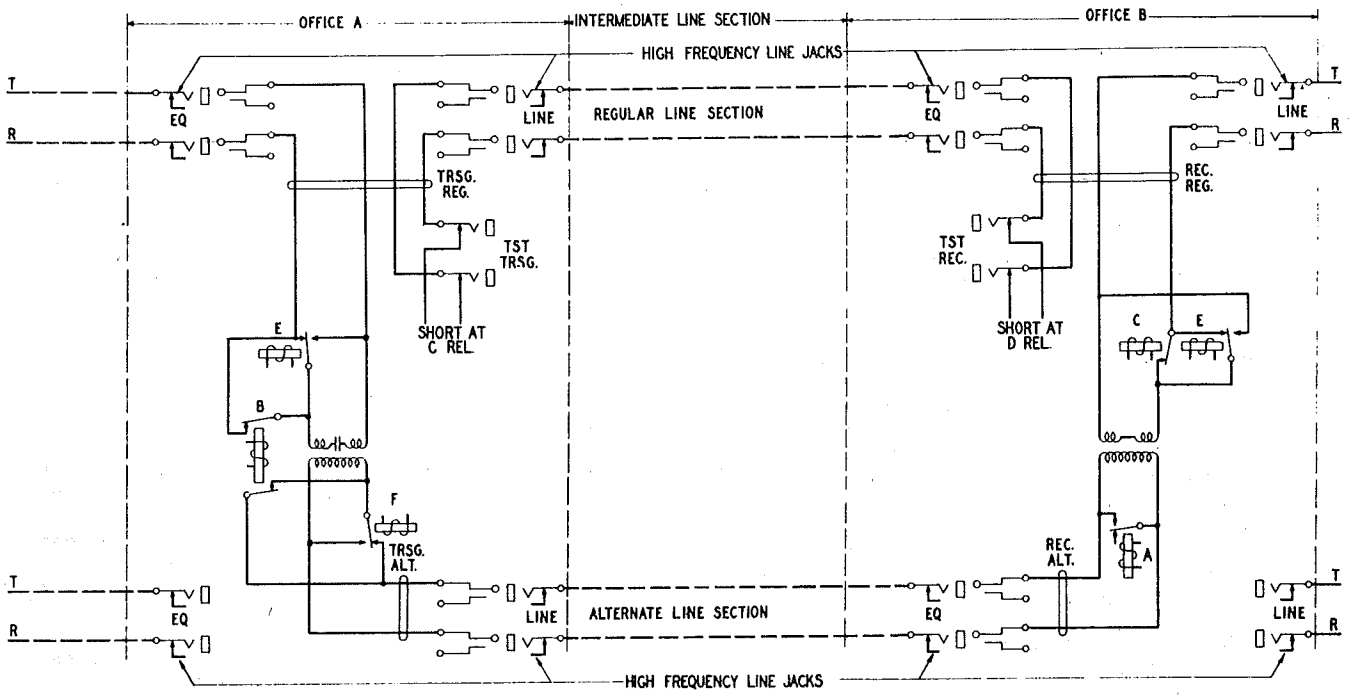

Fig. 6 - Transmission Path Line Switching Circuit Switched at Both Ends.

2.13 The auxiliary switching amplifier used with the line switching circuit is essentially the same as the test amplifier and the terminal transmitting amplifier described in other sections of these practices. It consists of three pentode stages consisting of two 310A and one 311A tubes. The usual provision of a Yaxley jack as well as grid and cathode resistances permits the use of the 1R tube test set for measuring grid and space current as required; connections are provided for control of heater current which also permits the measurement of cathode activity with the 1R test set.

2.14 The relay and miscellaneous equipment for the transmitting and receiving circuits is mounted on standard 19-1/2" relay rack panels. The receiving and transmitting panels occupy 5-1/2" of rack space each.

2.15 A four conductor cord is associated with each transmitting and receiving panel and is suspended from a terminal block on the panel. At the free end, each of these cords is equipped with a four-prong plug which provides access to the high frequency line and equipment jacks without opening the circuit to through transmission. The four-prong plug is equipped with a guide pin which engages a corresponding socket in the jack field and thus prevents a reversal of line and equipment jack connections. A two-conductor cord and plug is also associated with each transmitting and receiving panel, and similarly mounted, in order to make contact with the alternate line. The input and output cords of the auxiliary switching amplifier are also suspended from a terminal block on the transmitting switching panel. The control key, switch key, and restore key together with the associated guard lamp are located in the piling rail of the high frequency line jack bay which this equipment serves.

2.16 The 305A two-prong plug is arranged with pin jacks for bridging the pilot level measuring set onto a working alternate circuit by means of its 308A plug. The 316A four-prong plug is equipped with a ferrule which acts as an operating handle and is not provided with pin jacks.

2.17 The panels are mounted so that the 6' cords supplied with each will reach any high frequency line jacks associated with the line sections it is desired to test. Figs. 7 and 8 show the front view of the transmitting end and receiving end panels respectively.

2.18 The auxiliary switching amplifier is mounted in miscellaneous relay rack space, preferably near the line and twist amplifiers in order to simplify power supply wiring and to facilitate the testing of the tubes in connection with general cathode activity tests.

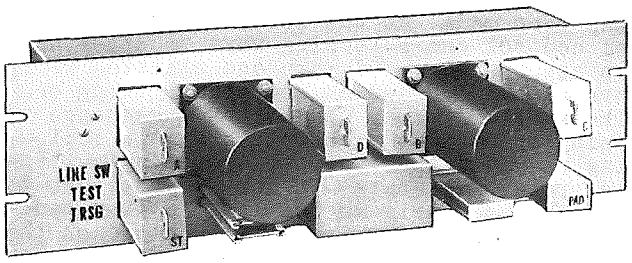

Fig. 7 - Front View Line Switching Panel Equipment, Transmitting End.

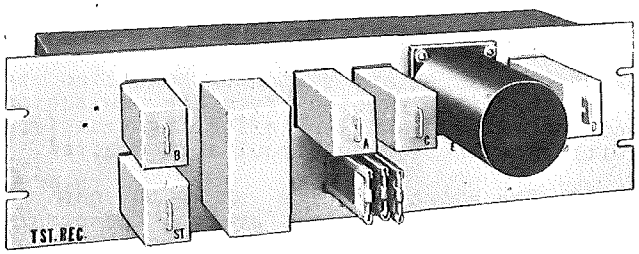

Fig. 8 - Front View Line Switching Panel Equipment, Receiving End.

(B) Transmission Characteristics

2.19 Since voice frequency telegraph may be superimposed on type K carrier channels, the guard, test and fast operating features described in part 2A are intended to result in minimum adverse reaction to telegraph signals.

2.20 The bridging amplifier circuit provides a means of avoiding the need for instantaneous coordination of transmitting end switching with receiving end switching. This bridging circuit produces a loss of about .1 db to transmission over the regular line section; the auxiliary switching amplifier supplies enough gain to compensate for the loss in the high impedance bridging pad and provides a level at the input of the alternate line equal to that at the input of the regular line.

2.21 The auxiliary switching amplifier is identical with that used as a test amplifier with the pilot level measuring system and that used as a transmitting amplifier between the group modulator and the line; the twist amplifier is also the same except for appropriate arrangements for connecting its input to twist regulating networks.

2.22 The amplifier proper has a constant flat gain in the band from 12 to 60 kc of about 66 db. The input circuit to the amplifier as used in this application consists of a 1:1 repeating coil and an impedance matching pad having a combined loss

of about 12.5 db; this results in a net gain for the amplifier and pad of about 53.5 db.

2.23 The amplifier is provided with two feedback paths. The outer feedback path is from the output transformer to the input transformer through a 164A feedback network and provides control of the gain within the transmitted band of frequencies, giving the amplifier a flat characteristic; the amount of negative feedback afforded by this path is in the order of 9 to 15 db depending on the frequency being transmitted. The inner feedback path is from the output bridge to the grid of the first tube and provides control of frequencies above the transmitted band, which results in an improvement of stability and a reduction in harmonic output.

2.24 The nature of overall circuit level fluctuations due to the operation of the line switching circuit is shown approximately in Fig. 9.

2.25 The data in this diagram are based on the assumption that the loss of the alternate section has been adjusted to the same value as that of the regular section, making due allowance for the loss of the repeating coils introduced in the circuit after the pilot levels have been measured. During periods in the switching and restoring operations when only one of these coils is transmitting, the level over the alternate line section will be .2 db higher than normal.

2.26 The level fluctuation values shown in Fig. 9 fairly accurately portray the level changes that may be expected; however, the values shown in the time axis are hypothetical and quite dependent on switching relay adjustments. At the receiving end, the relays are operated so that the short is removed from the output of the alternate line before the transfer to the alternate line can be effected. The operation of the switching relay at the receiving end causes a rise in level of about 2.5 db during the interval of travel time of the relay. At the sending end, the two switching relays are energized by a series circuit which insures against any possible sequence of operation which would open the transmission circuit. At the transmitting end, during the time both switching relay armatures are travelling, a drop in level of about 1.2 db occurs; during the interval after the faster of the two relays has made its contact and before the slower of the two has completed its travel, a drop in level of about 3.5 db or a rise in level of about .9 db occurs, depending on which relay first makes contact. When a trouble condition exists on a line section which lowers its operating level excessively, the alternate section level is adjusted with respect to the nominal level of the regular section rather than to its operating level.

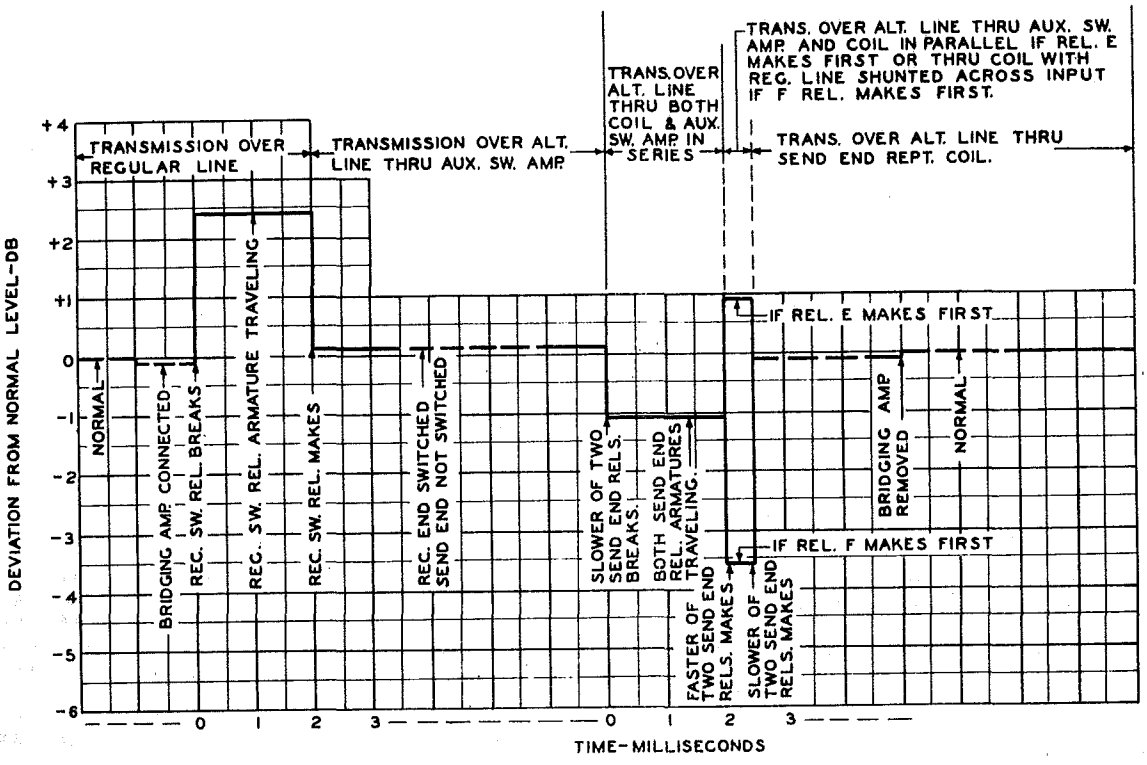

Fig. 9 - Representative Time - Level Diagram of Line Switching Operation.

This, of course, will result in a sudden rise in level at the time of the switch equal to the amount the regular section is below its nominal level.

2.27 In operating the line switching circuit, it is necessary to switch at the receiving end first and restore at the sending end first in order to avoid opening the path to through transmission.

(C) Operation

2.28 The operating procedure for accomplishing a line switch is as follows: At the transmitting office, which in the procedure below and in Fig. 3 is designated as "office A," a high-impedance amplifier is bridged across the working circuit and the output of the amplifier patched to the input of the alternate line section so that the two line sections are transmitting in parallel. At the receiving office "B," the pilot levels of the regular and alternate line sections are checked at 27.9 kc before the receiving terminal is switched to the alternate line section in order to insure that the loss over the alternate high frequency line is less than the loss over the regular line by an amount sufficient to compensate approximately for the loss of the two transformers which are in the circuit when the switch is completed. By patching a receiving transfer circuit into the working system and by bridging a transmitting transfer circuit across the output of the regular line section, the receiving end may be transferred to the alternate high frequency line section. After the transfer has been completed at the receiving end, a transfer is made at the transmitting end which removes the auxiliary switching amplifier from the circuit, and at the same time makes the regular line section available for test. Care must be taken to avoid turnovers in patching the switching circuits into the working circuit. It is assumed that the switching circuit equipment is in proper adjustment prior to its use in the operations covered herein.

2.29 Apparatus:

Line Switching Equipment.
42A Transmission Measuring System.
312A or 323A Plug as required.

2.30 Procedure - High-Frequency Line Switching (Refer to Fig. 3)

Caution: The operations should be completed in the order indicated.

At Transmitting Office A

(1) Patch the plug associated with the cord designated AUX SW AMP IN into the BR IN jacks.

(2) Patch the plug associated with the cord designated AUX SW AMP OUT to the BR OUT jacks.

(3) Insert the two-prong plug attached to the cord designated TRSG ALT into the output line jacks of the alternate section.

(4) Insert the four-prong plug attached to the cord designated TRSG REG into the transmitting line and equipment jacks of the regular line section.

At Receiving Office B

(5) Check the 27.9 kc pilot levels at the output of the regular and alternate line section; if the alternate line section is not terminated in an impedance of 135 ohms, as is normally provided by a connecting line section or group demodulator, a 323A plug, which embraces such a termination, is used in place of the 312A plug normally used with the pilot level measuring set.

(6) If the pilot level at the output of the regular line section is within the limits set in other sections of these practices, the gain of the line amplifier at the output of the alternate line section is adjusted by means of the GC condenser so that the 27.9 kc pilot at the output of this section is 0.5 ± 0.3 db higher than the corresponding pilot level on the regular section. (This allowance provides compensation for the .1 db loss on the regular section due to the bridged auxiliary switching amplifier and for the .2 db loss in each repeating coil which later is switched into the alternate line section.)

(7) If the pilot level on the regular line section is beyond the limits set in other sections of these practices, the level should be checked at the transmitting end of the section. If the level is within limits at the transmitting end of the section, and out of limits at the receiving end, the pilot on the alternate section should be set 0.5 db ± 0.3 db higher than the nominal working value of the regular line.

(8) If the pilot level on the regular line is outside limits at the transmitting end, a preceding line section, whose transmitting pilot is within limits, first is switched and its troubles are cleared.

(9) Insert the two-prong plug attached to the cord designated REC ALT into the jacks designated REC AMP OUT at system terminals, or the alternate output EQ jacks at intermediate stations.

(10) Insert the four-prong plug attached to the cord designated REC REG into the regular line jacks designated GR DEM IN and REC AMP OUT at system terminals or the regular output LINE and EQ jacks at intermediate stations.

(11) The switching circuit at both ends of the line is now connected to the regular and alternate line sections and ready for the first transfer operation to be made. At office B, simultaneously operate the CONT and the SW push-button keys of the SW REC circuit; the accomplishment of the switch is indicated by the lighting of a red lamp designated ALT. This completes the transfer operation at office B.

At Transmitting Office A

(12) Upon notification that the transfer has been completed at office B, the attendant at office A simultaneously operates the CONT and SW push-button keys of the SW TRSG circuit; the accomplishment of the switch is indicated by the lighting of a red lamp designated ALT. This completes the transfer at office A making it possible to remove the auxiliary switching amplifier from the circuit, if desired, and making the regular line section available for test.

Measuring on Regular Line Section

(13) Measurements over the regular line section may be made between the TEST TRSG jacks in the switching circuit at office A, and the TEST REC jacks in the switching circuit at office B.

Restoring Service Over the Regular Line Section

(14) At office A, patch the AUX SW AMP IN and AUX SW AMP OUT cords of the auxiliary switching amplifier to the BR IN and the BR OUT jacks, respectively.

(15) Remove any cords from the TEST TRSG jacks at office A and from the TEST REC jacks at office B.

(16) At office A, simultaneously operate the CONT and RST keys of the SW TRSG circuit; this extinguishes the red lamp and reestablishes the circuit over the alternate line section through the auxiliary switching amplifier and also restores transmission to the regular line section in parallel with the alternate line section.

(17) At office B, upon notification that the switch has been made at office A as indicated in (16), simultaneously operate the CONT and RST keys of the SW REC circuit; this extinguishes the red lamp and reestablishes service over the regular line section.

(18) At both offices A and B, remove the four-prong plugs from the regular line section jacks; remove the associated two-prong plugs from the alternate line section jacks.

(19) At office A, remove the auxiliary switching amplifier input and output plugs from their respective jacks.

3. AMPLIFIER SWITCHING CIRCUIT

(A) Description of Circuit and Equipment

3.01 The fundamental theory of the amplifier switching circuit is similar to that of the line switching circuit, that is, arrangements are provided for substituting an alternate circuit in place of a similar working circuit in order to release a regular equipment unit for tube changes or maintenance tests. The general schematic of this circuit is shown in Fig. 10.

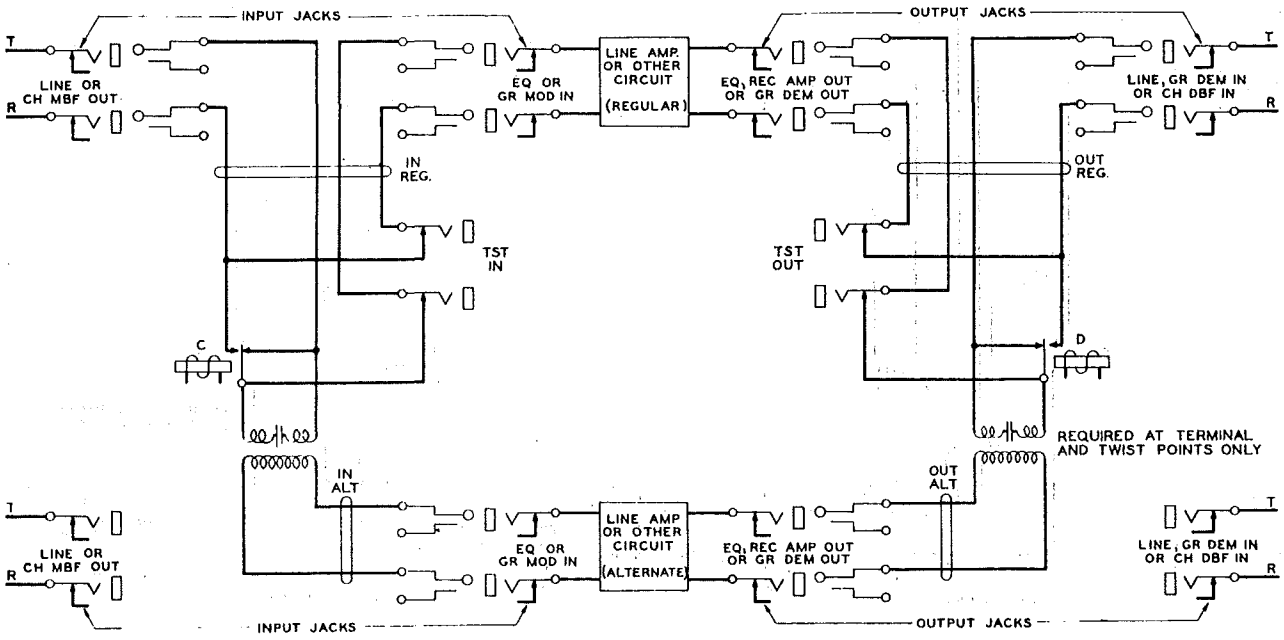

Fig. 10 - General Schematic Amplifier Switching Circuit.

3.02 The general operation of amplifier switching circuit is as follows: The four-prong input and output cords are plugged into their respective jacks associated with the input and output of the circuit it is desired to remove from service; this operation opens the normals of these jacks and provides an alternate path across them through relay contacts in the switching circuit which in turn are in series with normal contacts of other jacks in the switching circuit which are provided for testing the regular circuit element after it is removed from service. The condition of the circuit at this point in the operation is shown in Fig. 11.

3.03 Corresponding two-prong input and output plugs are also inserted into the respective equipment jacks associated with the alternate circuit it is desired to use during the period the regular circuit is out of service. After the plugging up operations are completed, the circuit is in a condition to respond to an operating pulse initiated by the simultaneous operation of the control and switching keys. The operation of these keys starts a sequence of relay operations which accomplish the switching from one circuit to another by the operation of two telegraph type relays operating in series. The time involved by the relays in making the switch is in the order of 2 milliseconds. The transmission path after the switching operation is as shown in Fig. 12.

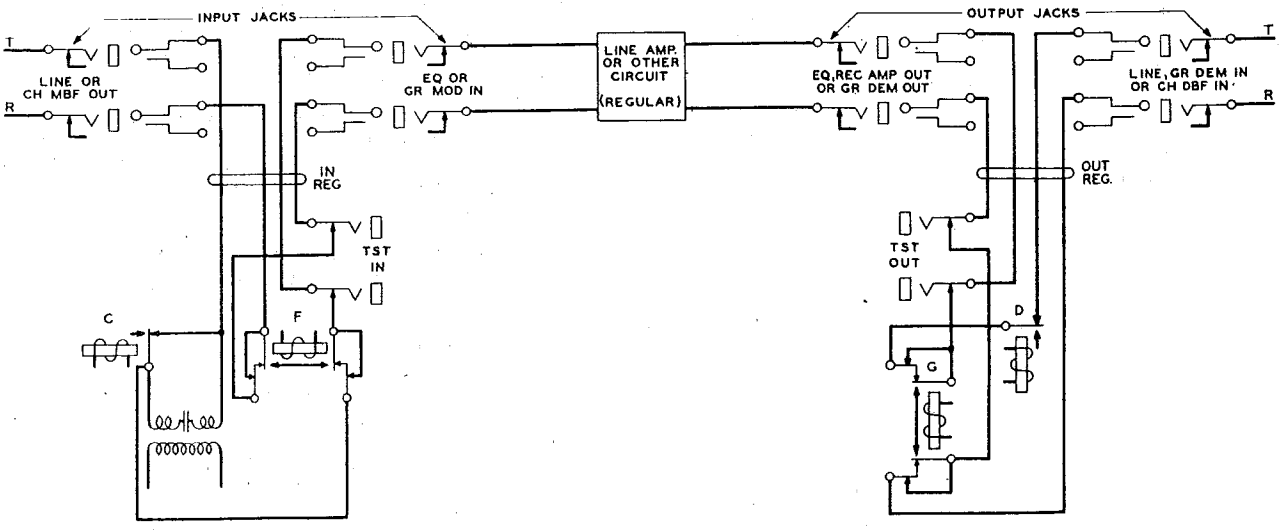

Fig. 11 - Transmission Path Amplifier Switching Circuit Plugged Up But Not Switched.

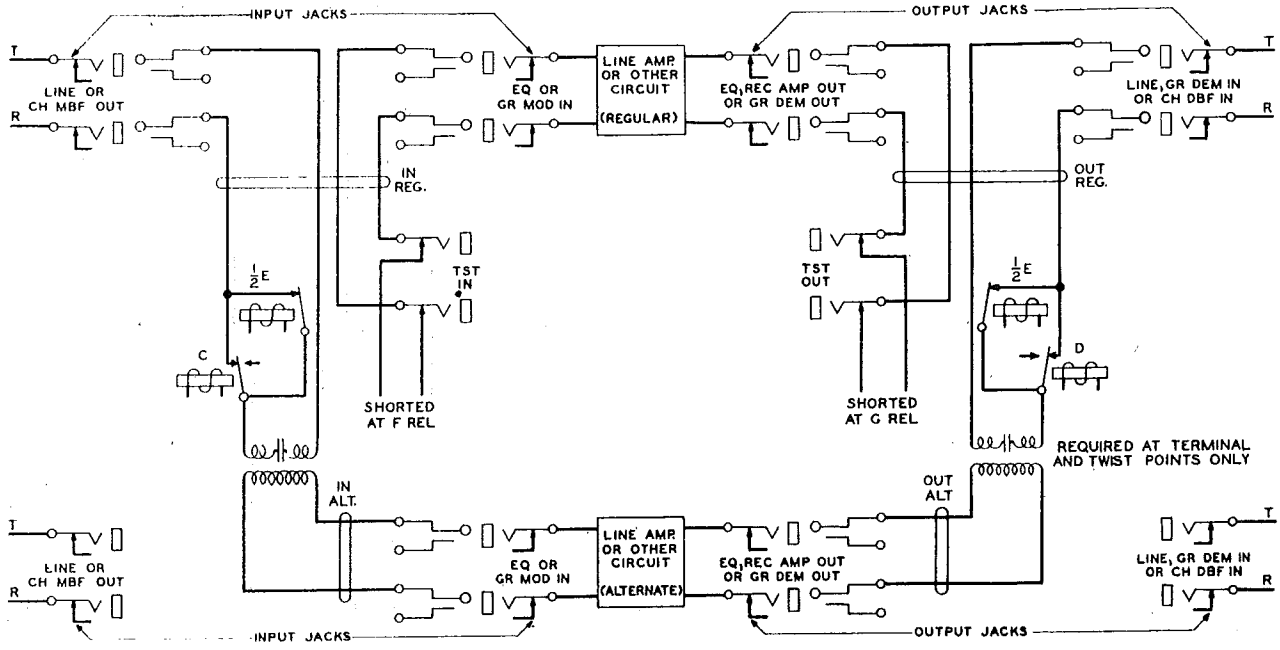

Fig. 12 - Transmission Path Amplifier Switching Circuit Plugged Up and Switched.

3.04 After a regular circuit has been tested and found ready for reinsertion in the regular transmission path, the reverse of the above processes is accomplished by the simultaneous operation of a control and restore key which starts a sequence of relay operations, resulting in the restoration of transmission over the regular circuit. After the four plugs associated with the regular and alternate circuit are removed, transmission is completed through the normals of the jacks associated with the regular equipment unit and the switching circuit is released.

3.05 In addition to the fast operating telegraph switching relays, other relays are included to provide parallel contacts to the switching relays and safeguards against false or inopportune operations of the switching circuit; the most important of these safeguards is an arrangement whereby the switching keys are made ineffective during the period when any test cords remain plugged up. The actuating keys themselves are wired in such a manner that for either the operating or restoring operation two keys must be operated simultaneously in order to accomplish a switch or restore operation of the chain of relays.

3.06 The equipment involved in this circuit is arranged similarly to that for the line switching circuit except that it is totally contained in a single office and may either be installed in terminal, intermediate main or auxiliary repeater stations. The panel for installation in terminal or intermediate main stations is provided with battery supply arrangements for operating from the office battery (24 volts), whereas the panel intended for operation in auxiliary stations operates from the standard 152-volt battery supplied at these stations. At non-twist points a single line amplifier can be switched out of a working circuit for test, but at twist points a line and a twist amplifier in tandem must be substituted for a similar arrangement in any working circuit; at terminals, a group modulator and transmitting amplifier in tandem or a line amplifier, twist amplifier, group demodulator and auxiliary receiving amplifier all in tandem or a line amplifier and twist amplifier in tandem may be switched to similar alternate circuits.

3.07 The relay equipment associated with the switching circuit is mounted on a panel arranged for installation on standard 19-1/2" relay rack bays and the equipment occupies 7" of rack space. A reproduction of the front view of this switching panel is shown in Fig. 13. These panels are mounted in bays convenient to the jacks associated with the circuits they are intended to serve. Emanating from each panel are four 6' cords; two of these cords are equipped with four-prong type plugs and the other two are equipped with two-prong type

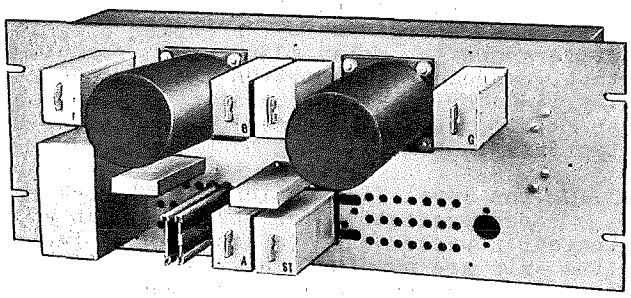

Fig. 13 - Front View Amplifier Switching Panel.

plugs. The two-prong plugs are provided with pin jacks for effecting a bridging connection to a pilot level measuring system when required. The guard lamp and the three non-locking push-button type keys are located in the piling rail of the bay involved.

(B) Transmission Characteristics

3.08 Several provisions have been made for the prevention of coupling between the output and input of the regular and alternate line amplifiers. The wiring on the panel of these amplifiers has been arranged to separate so far as possible the input and output leads; the cables carrying high and low level currents enter the panels from opposite ends. Other measures are taken to minimize the coupling due to stray capacitance when the physical separation of the panel wiring cannot be maintained because of circuit limitations. Thus spring combinations, of the switching panel relays which carry both high and low level currents, have been segregated from top to bottom on the relay. Direct ground to the frames of these relays and direct ground between the top and bottom spring combinations also minimizes the coupling. In a similar manner, test power coupling with the transmission circuit is kept low by direct ground connected between the test and transmission circuit when test plugs are inserted in the test jacks. The windings of the two switching relays provide a path for inductive coupling and hence a high frequency choke coil is inserted between the windings of these two relays operating in series. The windings of the other relays are provided with a high frequency path to ground. A repeating coil is employed in each circuit to provide separation of the inputs of the regular and alternate amplifiers which have grounded midpoints. An additional repeating coil is used in the output of each switching circuit when it is to be used for switching circuits having outputs with grounded midpoints; this arrangement obtains in the twist amplifier and transmitting amplifier. The provision of input and output repeating coils in the switching circuit prevents a short circuit of a portion of the amplifier input or output coil windings during the switching interval.

3.09 Even though the two switching relays are energized by a series circuit, differences in relay adjustment from time to time produce a condition whereby one relay leads or lags the operation of the other. This results in level fluctuations as typified in Fig. 14.

3.10 The level fluctuations indicated are representative for the condition portrayed; however, the values shown in the time axis are hypothetical, and are dependent on relative relay adjustments. It is assumed that no condition is likely to occur where one relay makes before the other breaks. If this condition ever occurred it would, of course, result in an interruption in through transmission.

(C) Operation of the Amplifier Switching Circuit

3.11 The amplifier switching circuit is to be used in maintenance work where it is desired to remove from service a line amplifier, a line amplifier and twist amplifier in tandem, a line amplifier, twist amplifier, group demodulator and auxiliary receiving amplifier all in tandem or a group modulator and transmitting amplifier in tandem; this is done without turning down a working system when it is necessary to replace a tube which is outside the cathode activity test limits or when other maintenance activity is indicated.

3.12 In cases where a line amplifier is involved it will be necessary to check the gain adjustments of the alternate amplifier so that it will have a gain very nearly equal to the nominal gain of the regular amplifier. At twist regulation points it will be necessary to switch a twist amplifier and a line amplifier in tandem, as no jacks are provided between the amplifiers. The twist amplifier is fixed in gain and no adjustment can be made on the alternate unit but a check should be made on the associated regulator equipment to be sure that the overall gain will be as close as possible to that of the regular unit. A switch cannot be made of a group demodulator and auxiliary receiving amplifier only in tandem due to the impracticability of providing satisfactory patching arrangements with guard features against reversals; however, these circuit elements may be switched when taken in tandem with their associated line and twist amplifier. In the case where a group modulator and transmitting amplifier in tandem are to be switched, no gain check or adjustment need be made.

3.13 The designation of equipment referred to under procedure is shown in Fig. 10.

3.14 Apparatus:

Amplifier Switching Circuit.
42A Transmission Measuring System.
312A Plug or 323A Plug as required.

3.15 Procedure - Switching a Line Amplifier

Caution: The operations should be completed in the order indicated.

(1) Check the designation cards on the covers of the regular and alternate amplifiers to insure that both amplifiers are equipped with the same type equalizer and that the gain strappings (x, y and z wiring) are identical.

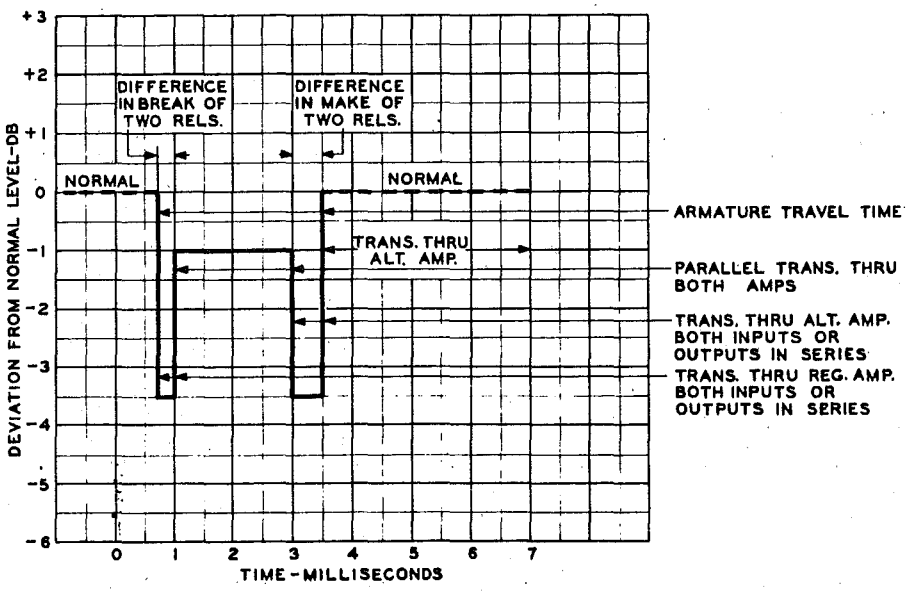

Fig. 14 - Representative Time - Level Diagram of Amplifier Switching Operation.

(2) If a regulating amplifier is to be switched, check the GR condenser dial settings of the regular and alternate amplifier to insure that they are in step as compared to the master controller. It is not necessary to adjust the GC condenser of the alternate amplifier if the regular and alternate amplifiers have been lined up for use over the same cable and the same section; switches should only be made involving amplifiers satisfying this condition.

(3) Since the actual gain of the regular amplifier is not known and cannot be measured without removing it from service, an exact adjustment of the alternate amplifier is not practicable. However, the gain of the alternate amplifier should be measured at 28 kilocycles as a general check on its operation.

(4) With no cords plugged up, simultaneously depress the CONT and SW keys; the ALT lamp should light. Simultaneously depress the CONT and RST keys to restore the switching circuit to normal; the ALT lamp should be extinguished.

(5) Insert the plug associated with the cord designated AMP SW IN ALT into the input EQ jacks of the alternate amplifier.

(6) Insert the plug associated with the cord designated AMP SW OUT ALT into the output EQ jacks of the alternate amplifier.

(7) Insert the four-prong plug associated with the cord designated AMP SW IN REG into the input LINE and EQ jacks of the regular amplifier.

(8) Insert the four-prong plug associated with the cord designated AMP SW OUT REV into the output LINE and EQ jacks of the regular amplifier.

(9) Simultaneously operate the CONT and SW push-button keys. This completes the transfer and lights the red light designated ALT.

(10) Measure the pilot level at the output of the alternate amplifier.

Requirement: The pilot level at 27.9 kc should not differ from the normal value by more than ± 2 db.

Note: In the case of stations where no pilot level measuring system is available, the pilot level is measured at the nearest station beyond where the measuring equipment is available.

(11) Measurements may now be made on the regular amplifier between the TEST IN and TST OUT jacks in the amplifier switching circuit. Tubes may also be changed as required or other maintenance items performed.

(12) Before restoring the regular amplifier to the circuit remove any patch cords from the TST IN and TST OUT jacks.

(13) Simultaneously operate the CONT and RST push-button keys. This restores the regular amplifier and extinguishes the red light ALT.

(14) First, remove the four-prong plugs associated with the cords designated AMP SW IN REG and AMP SW OUT REG; next, remove the two-prong plugs associated with the cords designated AMP SW IN ALT and AMP SW OUT ALT. The circuit is now restored to its normal condition.

3.16 Procedure - Switching a Line Amplifier and Twist Amplifier in Tandem

Caution: The operations should be completed in the order indicated.

(1) Check the designation cards on the covers of the regular and alternate line amplifiers to insure that both amplifiers are equipped with the same type equalizer and that the gain strappings (x, y and z wiring) are identical.

(2) Check the GR condenser dial settings of the regular and alternate line amplifier to insure that they are in step as compared to the master controller. It is not necessary to adjust the GC condenser of the alternate line amplifier if the regular and alternate line amplifiers have been lined up for use over the same cable and the same section; switches should only be made involving amplifiers satisfying this condition.

(3) Check the values of the 110 type resistances in the regulating network of both the regular and alternate twist amplifiers to insure that they are the same.

(4) If the regular and alternate twist amplifiers are connected to regulating networks operating from different receiving Selsyn motors a check should be made to insure that both the receiving motors involved are in step with the twist master controller.

(5) From this point on the procedure is the same as given under 3.15 (3) to (14).

3.17 Procedure - Switching a Line Amplifier, Twist Amplifier, Group Demodulator and Auxiliary Receiving Amplifier in Tandem

Caution: The operations should be completed in the order indicated.

(1) Perform operations given under 3.16 (1) to (4).

(2) With no cords plugged up, simultaneously depress the CONT and SW keys; the ALT lamp should light. Simultaneously depress the CONT and RST keys to restore the switching circuit to normal; the ALT lamp should be extinguished.

(3) Insert the two-prong plug associated with the cord designated AMP SW IN ALT into the input EQ jacks of the line amplifier associated with the alternate circuit element chosen for the switch.

(4) Insert the two-prong plug associated with the cord designated AMP SW OUT ALT into the alternate demodulator output jacks designated GR DEM OUT.

(5) Insert the four-prong plug associated with the cord designated AMP SW IN REG into the input LINE and EQ jacks of the line amplifier associated with the regular circuit to be switched.

(6) Insert the four-prong plug associated with the cord designated AMP SW OUT into the output jacks designated GR DEM OUT and CH DBF IN of the circuit to be switched.

(7) From this point on the procedure is the same as given under 3.15 (9) to (14).

3.18 Procedure - Switching a Group Modulator and Transmitting Amplifier in Tandem

Caution: The operations should be completed in the order indicated.

(1) Observe the pilot levels at 15.9 kc, 27.9 kc and 55.9 kc at the output of the alternate transmitting amplifier; if the alternate transmitting amplifier is not connected to a line, the 323A plug, which provides a 135-ohm termination, is used instead of the 312A plug normally used with the pilot level measuring set.

Requirement: The pilot level at all frequencies should read 0 ± 1 db when the measuring set is equipped with a 0 db plug type pad (11 db below 1 mw at the + 9 level).

(2) With no cords plugged up, simultaneously depress the CONT and SW keys; the ALT lamp should light. Simultaneously depress the CONT and RST keys to restore the switching circuit to normal; the ALT lamp should be extinguished.

(3) Insert the two-prong plug associated with the cord designated AMP SW IN ALT into the input jacks designated GR MOD IN of the alternate group modulator.

(4) Insert the two-prong plug associated with the cord designated AMP SW OUT ALT into the output EQ jacks of the alternate transmitting amplifier involved in the switch.

(5) Insert the four-prong plug associated with the cord designated AMP SW IN REG into the CH MBF OUT and GR MOD IN jacks of the circuit to be switched.

(6) Insert the four-prong plug associated with the cord designated AMP SW OUT REG into the output LINE and EQ jacks of the regular transmitting amplifier involved in the switch.

(7) From this point on the procedure is the same as given under 3.15 (9) to (14).

4. MAINTENANCE

4.01 The maintenance of the line switching and amplifier switching circuits consists of keeping the relays in the circuit within their operating limits and in maintaining the auxiliary switching amplifier both of which are covered in other sections of these practices. In addition to the above certain checks of the guard features provided are made as follows:

1. To check for an indication of a burned out guard lamp (amplifier switching circuit or receiving end line switching circuit)

With no cords plugged up, simultaneously depress the CONT and SW keys; the ALT lamp should light. Simultaneously depress the CONT and RST keys to restore circuit to normal; the ALT lamp should be extinguished.

2. To check for an indication of a burned out guard lamp (line switching circuit, transmitting end)

Insert dummy plugs in the BR. IN and BR. OUT jacks associated with the auxiliary amplifier. Repeat the procedure given in (1) above.

3. To check test cord guard feature

Insert dummy plugs, first in the TST IN jacks and next in the TST OUT jacks and for each condition repeat the operations given under (1) and (2) above. In any case the guard lamp ALT should not light.

5. LIST OF DRAWINGS

(A) Circuit Drawings (Not Attached)

SD-64453-01 - Amplifier Switching 152 V Battery

SD-64453-02 - Amplifier Switching 24 V Battery

SD-64454-01 - Line Switching

SD-64329-02 - Auxiliary Switching Amplifier

(B) Equipment Drawings (Not Attached)

ED-61438-01 - Sealed Test Terminal Bays Aux. Station
ED-61439-01 - Sealed Test Terminal Bays Aux. Station
ED-64453-01 - Amplifier Switching
ED-64454-01 - Transmitting Line Switching Panel
ED-64454-02 - Receiving Line Switching Panel
ED-64306-03 - Piling Rail Sealed Test Terminal Bays
ED-64329-02 - Auxiliary Switching Amplifier