VOLCAS FOR 22-TYPE REPEATERS USED WITH TOLL CONFERENCE GROUPING CIRCUITS

CONTENTS PAGE

1. GENERAL

1.01 This section describes a voice operated device known as a volcas* which is used to increase the echo and singing margin in toll conference connections. The section discusses the application of this volcas to 22-type repeaters of toll conference bridges. The conference bridge itself (with 22-type repeaters) and associated apparatus is described in Section 332-430-100.

1.02 The principal changes in this section from the previous issue are in the description of the detector and relay circuits of the volcas which have been changed.

1.03 Each volcas device is applied to a 22-type repeater which in turn is used in one of the legs of the conference bridge. Where volcas equipments are installed in a conference bridge it is expected that as a rule three of the legs will be so equipped.

* Taken from the first letters of "Voice Operated Loss Control and Suppressor."

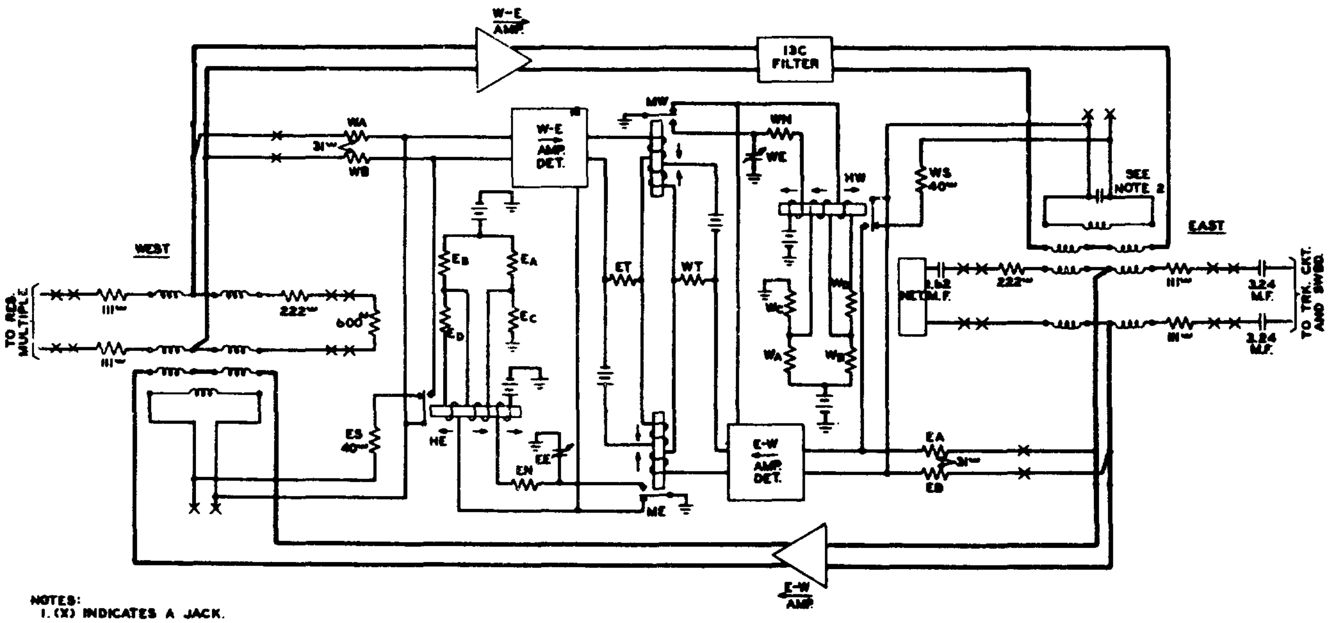
1.04 The volcas device is essentially a voice operated switching circuit which removes loss from the side of the repeater over which the useful transmission is passing (known as the go path) and inserts a larger loss in the other side at the same time to maintain the desired singing margin and to obtain satisfactory echo conditions.

1.05 It is necessary to increase the echo and singing margin for some of the limiting conditions in conference connections so that sufficiently low net losses may be obtained between the subscribers. Otherwise when a number of subscribers are connected and particularly when more than one conference bridge is involved in a connection the net losses which could be obtained without volcases would be unsatisfactory. It is the practice to use a volcas leg of one bridge and a nonvolcas leg of another when connecting two bridges in the same office. When in different offices volcas legs in both bridges are employed. Volcas legs are also used if it is necessary to employ single switched connections to reach distant toll centers. Connections involving more than two links from the bridge to a distant toll center are not generally suitable.

2. GENERAL DESCRIPTION

2.01 Fig. 1 shows a simplified schematic of a volcas applied to a 22-type repeater. The volcas consists essentially of two amplifier-detectors operating a chain of two relays each. Referring to the west-to-east amplifier-detector, its input is connected through resistances WA and WB to the bridge points of the west output transformer of the repeater. Its output is connected to a polarized relay chain composed of quick operating master relay MW and a slow releasing "hangover" relay HW. The east-to-west side of the volcas is connected into the circuit in the same way as the west-to-east side. Several batteries are shown in Fig. 1 in order to avoid complicating the diagram. In the actual device all battery functions shown are performed by a common 130-volt plate battery.

2.02 In the idle condition of the volcas all relays are released. Resistance ES is connected across the west monitoring winding through the back contacts of relay HE and resistance WS across the east monitoring winding through the back contacts of relay HW. In this way a loss is inserted at the output of each side of the repeater. This loss improves the singing margin and is placed so that it



NOTES:
1. (X) INDICATES A JACK.
2. USE 1 M.F. WITH 123C OUTPUT TRANS. AND 0.5 M.F. WITH 104AA OUTPUT TRANS.

Fig. 1 - Toll Conference Arrangements - Simplified Schematic Diagram of Volcas Applied to 22-Type Repeater

does not decrease the sensitivity of the volcas to incoming speech waves. During the idle condition there is no current flowing in the operating windings of the four relays MW, HW, ME and HE. Current flows in the biasing windings of the relays however, in the proper direction to hold the armature of each relay firmly against its associated back contact. Referring to the west-to-east chain, the master relay MW is biased against operation by current flowing from battery through the lower or biasing winding of MW and resistance WT. This current acts to move the armature away from the pole face, as indicated by the direction of the small arrowhead adjacent to the biasing winding of relay MW. (Similarly, currents flowing in any of the relay windings will move, or tend to move, the armature in the direction indicated by the associated arrowhead.) While the armature of relay MW is against its back contact it will be seen that the ground on the armature completes an electrical path for current from battery, through resistances W_B and W_D and the right-hand winding of relay HW to ground. This current, as indicated by the arrowhead, biases relay HW against operation. In the same way, relays ME and HE, of the east-to-west side of the volcas, are biased against operation while in the idle condition. Resistances W_A, W_B, W_C, W_D and the right-hand or biasing winding of relay HW form the arms of a Wheatstone bridge. When relay MW is released current flows through resistances W_B and W_D and the biasing winding of relay HW. Current also flows in the path which includes resistances W_A and W_C. The resistance of W_A is the same as that of W_B while W_C equals W_D. Since the resistance of the relay biasing winding in series with resistances W_B and W_D is quite small relative to that of W_B plus W_D, the bridge circuit is, for all practical purposes, balanced and there is no appreciable potential difference between the junction of resistances W_A and W_C and that of W_B and W_D. Consequently, no current will flow in the middle winding of relay HW, connected to these points. Neither will current flow through the left-hand winding of relay HW, since its path is interrupted at the front contact of relay MW. It should be noted that condenser ME is connected across the last mentioned battery and is, therefore, fully charged.

2.03 A direct connection is shown between the back contact of relay MW and the east-to-west amplifier-detector. The cathode of the east-to-west detector tube is grounded through this connection and the detector can function normally as long as relay MW remains on its back contact.

2.04 In order to understand the actions which occur when one side of the volcas operates, it may first be assumed that speech waves from a conferee are passing through the repeater from west to east. A part of these waves will be amplified and detected by the west-to-east amplifier-detector. The resulting rectified detector output current flows through the upper winding of relay MW, exerting a force on the armature in the direction to operate the relay. This current also flows through the biasing winding of relay ME in such a direction as to add to the normal biasing current, exerting additional force on the armature in the direction to prevent operation of the relay. The east-to-west volcas side is thereby partially disabled and protected from operation by echoes of the speech waves transmitted across the east output transformer.

2.05 When the armature of relay MW leaves its back contact, the biasing circuit of relay HW is broken. At the same time the Wheatstone bridge circuit formed by resistances W_A, W_B, W_C and W_D is unbalanced, causing an operating current to flow in the middle winding of relay HW. Ground on the east-to-west detector cathode is replaced by approximately +70 volts which still further disables this side of the volcas, principally by making the control grid effectively 70 volts more negative relative to the cathode. When the armature of relay MW reaches the front contact of MW, condenser WE is discharged, and an additional operating current flows in the left-hand winding of relay HW. It should be noted here that the operation of relay HW begins as soon as the armature of relay MW leaves the back contact, thus producing the fastest possible full operation of the west-to-east side.

2.06 The operation of relay HW first removes the loss in the west-to-east transmission path, termed the transmitting switched loss, by breaking the circuit through resistance WS. It then inserts loss in the east-to-west transmission or echo path, known as the receiving switched loss, by short circuiting the connection between resistances EA and EB and the east-to-west amplifier-detector input. This effectively bridges resistances EA and EB, in series, across the east-to-west transmission, or echo, path. At the same time, the east-to-west amplifier-detector is completely disabled by the short circuit across its input, so that it cannot be falsely operated by echoes.

2.07 When the conferee, whose speech waves are assumed to be passing through the repeater from west to east, stops talking, relay MW will release as soon as the amplitude of the speech waves falls below the value required to hold it operated. Relay HW does not release immediately, however, because of the slow-releasing or hangover action provided by resistance WN and condenser WE. As soon as the armature of relay MW leaves the front contact it, of course, interrupts the d-c path through the left-hand winding of relay HW. At the same time, however, the short circuit of condenser WE is removed, so that a charging current flows from battery, through the relay winding and resistance WN, until condenser HW is fully charged. This current holds relay HW operated for a considerable number of milliseconds after the voice waves from the west have ceased. This slow-release is necessary to permit the last of the echoes to return from the most distant unbalance before the short circuit is removed from the echo path. Condenser WE is made adjustable so that the release time can be changed, if desired.

2.08 The operation of the east-to-west side of the volcas is substantially identical with that of the west-to-east side, described in the preceding paragraphs.

3. CIRCUITS AND EQUIPMENT

Amplifier-Detector

3.01 The principal circuit features are shown in a simplified schematic diagram, Fig. 2. Since the two sides are practically identical, only the west-to-east side is described.

3.02 Input - The amplifier-detector has a high-impedance input consisting of series resistances WA, WB, WC and WD and the primary of the W IN input transformer, whose midpoint is grounded. The wiring to resistance WA and WB can be varied to provide five different effective values of resistance and, therefore, five different values of receiving switched loss, as explained in Part 4. The resistance WC and WD assist in building out the input impedance, thereby reducing the bridging loss.

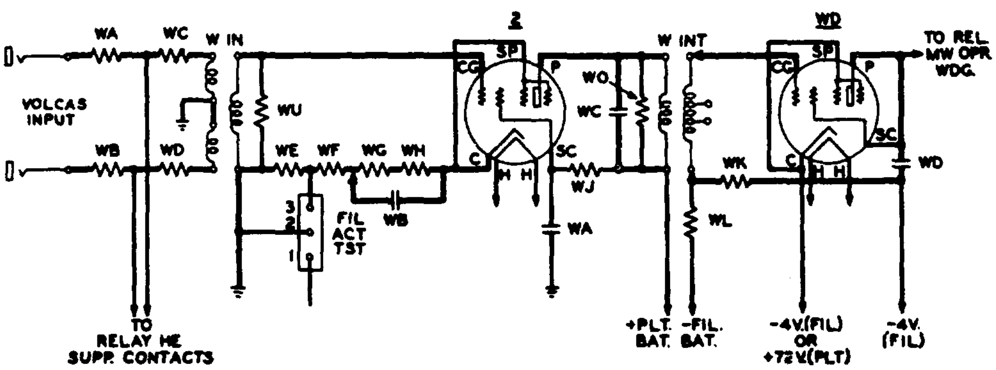


Fig. 2 - Schematic Diagram of Amplifier-Detector - West-to-East Side

3.03 Amplifier - The secondary of the W IN input transformer is connected to the control grid of the amplifier tube and, through resistance, WE, WF, WG and WH, to the cathode of this tube. With the grounded return path for the cathode located as shown, the flow of space current through resistances WE, WF, WG and WH provides the negative bias for the control grid. These resistances also introduce negative feedback into the amplifier circuit. When the by-pass condenser WB is connected across all four resistances the negative feedback is a minimum and the gain of the amplifier is a maximum. Larger amounts of negative feedback, obtained by including fewer resistances between the condenser terminals, provide amplifier gain (sensitivity) control in small steps. The voltage change across the WE resistance, when the heater current is varied within specified limits, is used as a measure of cathode activity. For this test, the testing meter connections are made at the FIL ACT TST jack Terminals 2 and 3. The amplifier tube is a suppressor-grid pentode. Its plate is connected to the W INT interstage transformer primary, which is shunted by a condenser WC and resistance WO. Condenser WC is used to "tune" the interstage transformer so that the amplifier-detector will have maximum sensitivity at about 1200 cycles.

3.04 Detector - The secondary winding of the interstage transformer is connected to the control grid of the detector tube and, through resistances WK and WL, to the heater (filament) circuit. The secondary winding is tapped to provide two large step adjustments of sensitivity. Resistances WK and WL form a simple potentiometer by means of which a portion of the heater circuit (filament battery) voltage is utilized for biasing the detector control grid negatively. The detector tube is of the same type as the amplifier tube. The detector plate and screen grid are both connected to the operate winding of the west-to-east master relay.

Relays

3.05 The west-to-east and east-to-west relay circuits are shown in simplified schematic form in Fig. 1. These circuits are described in Part 2.

3.06 Battery Supply and Heater Circuits - The circuits for supplying battery to the volcas are shown in simplified schematic form in Fig. 3. The 10-volt heaters of the east-to-west amplifier Tube 1 and detector Tube ED are connected in series, as are the heaters of the west-to-east amplifier Tube 2 and detector Tube WD. These two heater groups are arranged in parallel and operated from the 24-volt filament battery. Series resistances X, Y, and Z are strapped to obtain the proper heater current. The heater current may be measured, or turned on and off, at the heater circuit FIL jack.

3.07 Grid Circuits - The manner in which the various grid biases are obtained is shown in Fig. 3. The amplifier control grid CG is biased negatively with respect to the cathode C by means of the space current IR drop across resistances E, F, G and H. The

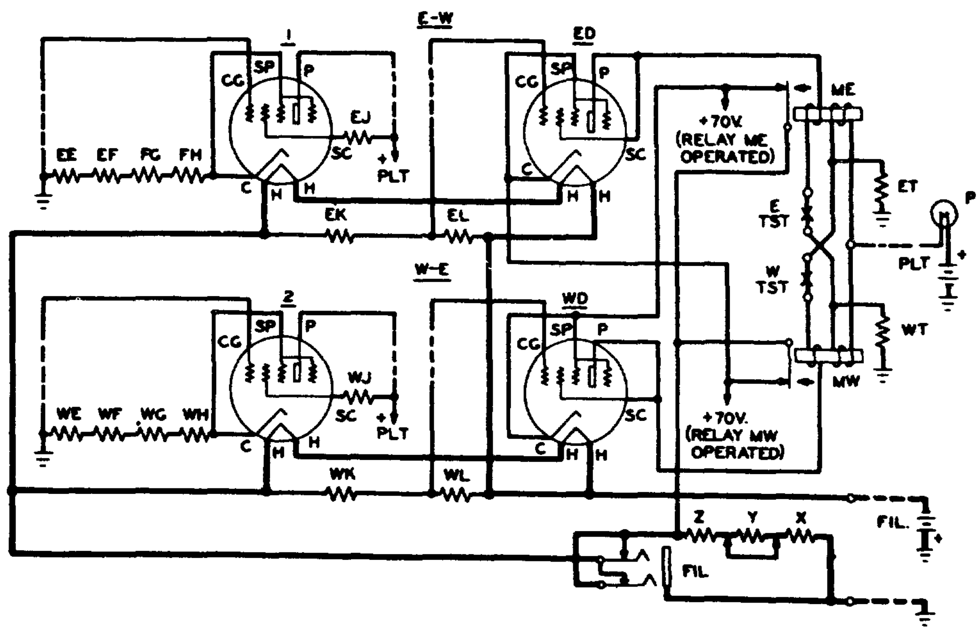


Fig. 3 - Schematic Diagram of Volcas Battery Supply

amplifier screen grid SC is connected through resistance J to positive plate battery. In all tubes the suppressor grid SP is connected directly to the cathode. The detector control grid CG is biased negatively with respect to the cathode C. For this purpose a simple potentiometer composed of resistances K and L is bridged across a portion of the heater circuit and the junction of these resistances connected (through the interstage transformer secondary winding) to the detector control grid CG. The detector screen grid SC is connected directly to the plate P and acts as an additional plate area.

3.08 Plate Circuits - The amplifier plate P is connected (through the interstage transformer primary winding) to positive plate battery. The detector plate P is connected through the operate winding of its associated master relay and the biasing winding of the opposite-side master relay, to positive plate battery. In the idle condition of the volcas, the master relay is biased electrically by current flowing from the plate battery through the biasing winding and the T resistance, to ground. The E TST and W TST jacks in the detector plate circuits are used for testing purposes, as described in Paragraph 3.12.

Monitoring, Patching and Testing Arrangements

3.09 The monitoring, patching and testing arrangements are shown in a simplified application schematic diagram, Fig. 4.

3.10 Monitoring and Talking - Since the repeater monitoring windings must be kept separated in a volcas-equipped repeater, a pair of repeating coils (MON CCT) is required to obtain the usual tip-ring-sleeve MON jack appearance. The monitoring windings are connected to the monitoring circuit coils by patching the HO DROP jacks to the DROP MON jacks and the HO LINE jacks to the LINE MON jacks, after which the telephone set may be patched to the MON jacks and used in the regular manner.

3.11 Patching - A volcas equipped repeater is patched as a unit. No jack facilities are provided which permit the substitution of a spare for the regular volcas on a patching cord basis.

3.12 Testing - For testing purposes, a dummy plug in the E TST or the W TST jack transfers the corresponding detector plate circuit to the PLT C jack, where the plate current may be measured on a portable meter set; or, where available, to the meter panel of the echo suppressor testing circuit. A dummy plug in the TR jack operates the TR relay and transfers the operate contacts of the HE and HW relays to the OPR lamp circuit, either at the volcas bay or on the echo suppressor testing panel, for obtaining a visual indication of volcas operation.

Equipment Features

3.13 The two amplifier-detectors and associated relay chains comprising the volcas are assembled on a 10-1/2 inch (6 mounting plate spaces) steel panel. The apparatus is mounted on the front of the panel with the panel wiring in the rear. No covers are required. The panel assembly of the volcas is shown on Drawing ED-64366-01, not attached.

3.14 Drawing ED-64624-01, not attached, shows a typical bay unit containing six repeaters and as many as four volcases or three volcases and a telephone set panel, as well as the jack facilities described in Part 3 and the necessary interbay and testing trunk jacks.

3.15 Although it is expected that only three volcases will ordinarily be installed in any one bridge, in a few cases four may be used and it may be that there will even be some installations in which each conference leg will be volcas equipped. Where more than four volcases per bridge are involved it will be necessary to arrange the equipment on a special job basis.

3.16 The bay containing the 22-type repeaters and the volcas is a complete unit and contains all the jacks and testing arrangements necessary for the volcas.

4. TRANSMISSION FEATURES

Sensitivities

4.01 At a frequency of about 1200 cycles the volcas has a maximum sensitivity of approximately 62.5 db. This means that when the volcas is bridged across a 600-ohm circuit, with the negative feedback set to the minimum amount and the interstage transformer on its top step, it requires 62.5 db below 1 milliwatt of power at the volcas input to just operate the volcas relays. At 500 cycles, the maximum sensitivity is about 15.0 db less than this value and at 2000 cycles it is about 9.5 db less.

4.02 Sensitivity adjustments can be made over a range of approximately 20 db in 2 db steps. This is accomplished by means of two taps on the interstage transformer secondary which permit sensitivity reductions of 6 db and 12 db below the top value, supplemented by adjustment of the amplifier negative feedback in steps of 2 db over a total range of approximately 8 db.

4.03 When in use the volcas is connected to the output transformer bridge points of a 22-type repeater. The sensitivity referred to the repeater input, termed the operating sensitivity is approximately 8.5 db less than that of the bare volcas when bridged across a 600-ohm measuring circuit.

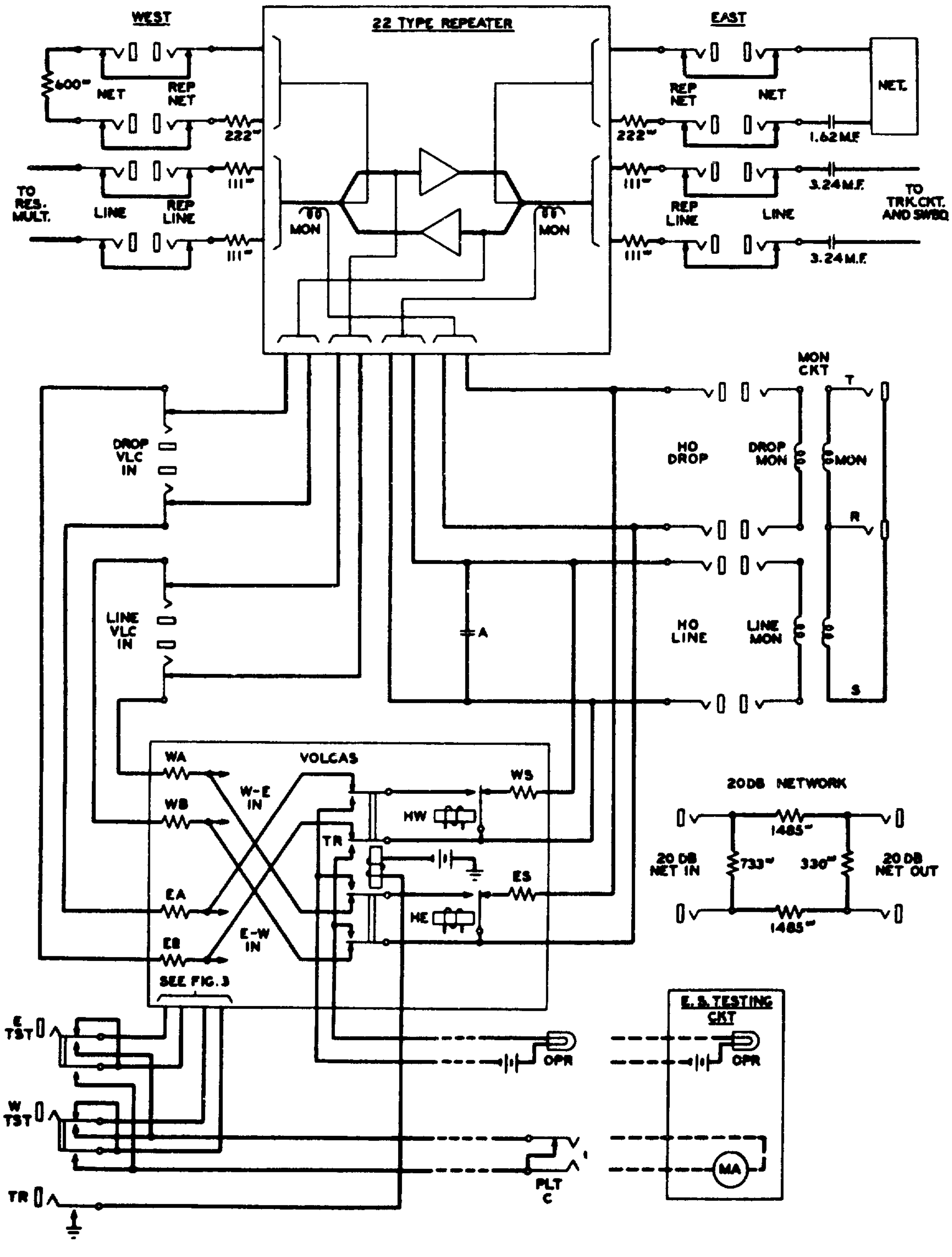


Fig. 4 - Toll Conference Arrangements - Schematic Diagram of Monitoring, Patching and Testing Arrangements

Switching Losses

4.04 It is the function of each side of the volcas, in operating, to remove loss from the talker's voice path and insert loss in the talker's echo path of the circuit. The first loss, termed the transmitting switched loss, depends upon the value of the S resistance shunted across the monitoring winding associated with the talker's voice path. This resistance ordinarily is set at 40 ohms to obtain a transmitting switched loss of 3 db. The following table gives the approximate relationship between the available values of resistance and the resulting transmitting switched loss (TSL):

S Resistance Value in Ohms	TSL in db
0	7.8
10	5.5
20	4.3
40	3.0
Open	0.0

The second loss, which is termed the receiving switched loss, is determined by the value of the A + B resistance shunt across the opposite side repeater bridge points. These resistances ordinarily are set to their maximum value of 62.5 ohms, which produces an RSL of 11 db. The values of resistance and approximate receiving switched loss (RSL) which can be obtained by strapping the A and B resistances, are given in the following table:

A + B Resistance in Ohms	RSL in db
0	35
15.4	20
27.2	17
35.3	14
62.5	11

The effective receiving switched loss is less than that indicated in the preceding table by the amount of the bridging loss (Paragraph 4.05), since operation of the HE or HW relay automatically removes the bridging loss while applying the receiving switched loss.

Bridging Loss

4.05 When the volcas input is connected to the repeater, it introduces a small bridging loss into the transmission path. The bridging loss varies from 0.3 to 1.1 db, over the frequency range from 250 to 2750 cycles. This loss is included in the repeater gain as measured.

Operate and Release Times

4.06 The volcas relays will operate in less than 11 milliseconds for inputs which produce 5 mils of master relay operate current. The release time is a function of the effective capacitance of the condensers E, R and G. The following table gives the approximate relationship between these quantities, for the more important range of release times:

Condensers Used	Avg. Capacitance in Mf.	Release Time in Milliseconds
E or F	4.32	66
E,G	5.45	83
E,F	8.64	132
E,F,G	9.77	150

Operation on Noise

4.07 In general, the volcas will just fail to operate when the noise at its input is equal to 80 db minus the sensitivity of the volcas. Ordinarily, in determining the probable margin against noise operation, the noise would be measured at, or referred to, the input to the volcas-equipped repeater. In this case, the "operating" sensitivity of the volcas would be used.

5. LIST OF DRAWINGS

Title	Drawing No.
Toll Systems - Telephone Repeater Toll Conference Service Voice Operated Loss Control and Suppressor Circuit (Volcas)	SD-64366-01
Toll Systems - Telephone Repeater Toll Conference Service Voice Operated Loss Control and Suppressor Equipment (Volcas)	ED-64366-01
Toll Systems - Telephone Repeater Toll Conference Service Repeater and Volcas Application Schematic	SD-64624-01
Toll Systems - Telephone Repeater Toll Conference Service Repeater and Volcas Bay Equipment	ED-64624-01