TWO-TUBE 1000-CYCLE SIGNALING SYSTEM

TOLL OFFICES

CONTENTS

TWO-TUBE 1000-CYCLE SIGNALING SYSTEM TOLL OFFICES

1. GENERAL:

1.1 This section describes the two-tube type of 1000-cycle signaling system which has been developed to operate on lower values of signaling current and to give greater freedom from false operation from voice and other interfering currents than can be obtained with the one-tube 1000-cycle signaling system. Reliability of signaling to the intermediate point of a built-up connection or to the point where a change in the type of signaling occurs is secured by an improved method of associating the signal receiving circuit with the toll line. This arrangement greatly reduces the effect on the signal receiving circuit of signaling current echoes. The same arrangement also attenuates the transmission to the signal receiving circuit of voice and all other interference currents which travel in a direction opposite to the signal. Besides giving a higher grade of service, it is expected that the improved signaling system will require less maintenance than the older type 1000-cycle ringers.

1.2 The two-tube signaling system operates on the same type of signaling current as has been used heretofore, namely, 1000-cycle current interrupted approximately 20 times a second. The sensitivity of the ringer is such that with a signaling current of one milliampere applied to a 600-ohm circuit, reliable operation can be obtained over a telephone circuit whose loss at 1000 cycles does not exceed a maximum value of 20 db. This level of signaling current is sufficiently low so that the noise which it will introduce into adjacent circuits due to crosstalk will be negligible unless circuit troubles exist.

1.3 Signaling circuits have been provided in four forms, namely, a 1000-20-cycle terminal ringer, a 1000-cycle signaling circuit for use with the No. 3 toll switchboard and with toll positions in the No. 11 switchboard, a 1000-135-cycle intermediate ringer, and a 1000-20-cycle intermediate ringer. The intermediate ringers permit 1000-cycle signaling to be employed over part of the circuit, and either 20-cycle or 135-cycle signaling over the remainder. The arrangement for connecting the ringers to the circuit is the same for two-wire, four-wire and carrier circuits.

1.4 The two-tube ringers are more selective with respect to the frequency of interruption of the 1000-cycle current than the older type. This increased selectivity is gained by the use of an improved circuit operating from the contacts of the polar relay in the output circuit of the detector tube, and results in greater freedom from false operation from voice and other sources of interference.

1.5 The increased sensitivity has been obtained by using two vacuum tubes, one of which functions as an amplifier and the other as a detector. No. 102-F tubes, which operate on approximately one-half ampere of filament current, are employed, four ringers being operated on one filament circuit.

1.6 The equipment has been provided in panel assemblies. In addition to the ringer panels, there has been developed a new test panel for testing the terminal and intermediate ringers. The equipment on this panel provides means for making overall tests of the complete ringer, as well as tests and adjustments of the individual parts. The testing circuit for the signaling equipment for the No. 3 and No. 11 switchboards has been modified to provide for testing the new type of ringer.

2. DESCRIPTION OF SYSTEM:

(a) **General:**

2.1 The 1000-cycle signaling system provides for signaling over all or part of a toll circuit by means of 1000-cycle current interrupted at the rate of about 20 times per second. The use of a frequency in the middle of the voice range avoids the necessity of intermediate equipment at telephone repeater points since the signal is amplified by the repeaters in the same way as voice currents. False operation of the ringers on voice or other interfering currents has been guarded against by designing the signal receiving circuits to be very selective to the signaling frequency of 1000 cycles and to the frequency of interruption of about 20 cycles. An additional safeguard has been provided by slowing up the response of the signaling circuits so that the signaling current must be sustained for a specified minimum time.

2.2 The general arrangement of the signaling circuits for use at the terminals of a toll line is shown in schematic form on Drawings 172-A-34, 167-A-4 and 908-138. The first two drawings apply respectively to the terminal ringers and to the signaling circuits for No. 3 and No. 11 toll switchboards. The third drawing shows in somewhat more detail the terminal ringer circuits.

2.3 When it is desired to use 1000-cycle signaling on only part of the toll line with some other type of signaling on the remainder of it, an intermediate ringer is required at the point where it is desired to change from one type of signaling to the other. The general arrangement of intermediate 1000-cycle ringers for this purpose is shown on Drawing 167-A-60.

2.4 In the improved 1000-cycle signaling system described in this section, an arrangement which is directionally selective has been provided to connect the signal receiving circuits to the toll lines. This arrangement makes the signaling circuit freely responsive to currents transmitted to it from the line side but attenuates greatly all currents approaching the ringer from the drop side. This insures that signaling current echoes from a circuit connected to the drop side of the ringer will not interfere with the proper reception of the signal from the circuit connected to the line side. It also reduces the effect on the ringer of voice and other interfering currents originating on the drop side of the ringer. This arrangement is shown on the above mentioned drawings and consists of the small series resistances in the toll circuit together with the coil which is bridged across them.

2.5 In order to reduce the magnitude of the echoes which may tend to interfere with the operation of the 1000-cycle receiving circuits, care has been taken to see that the lines are properly terminated during the signaling period.

(b) 1000-Cycle Receiving Circuit:

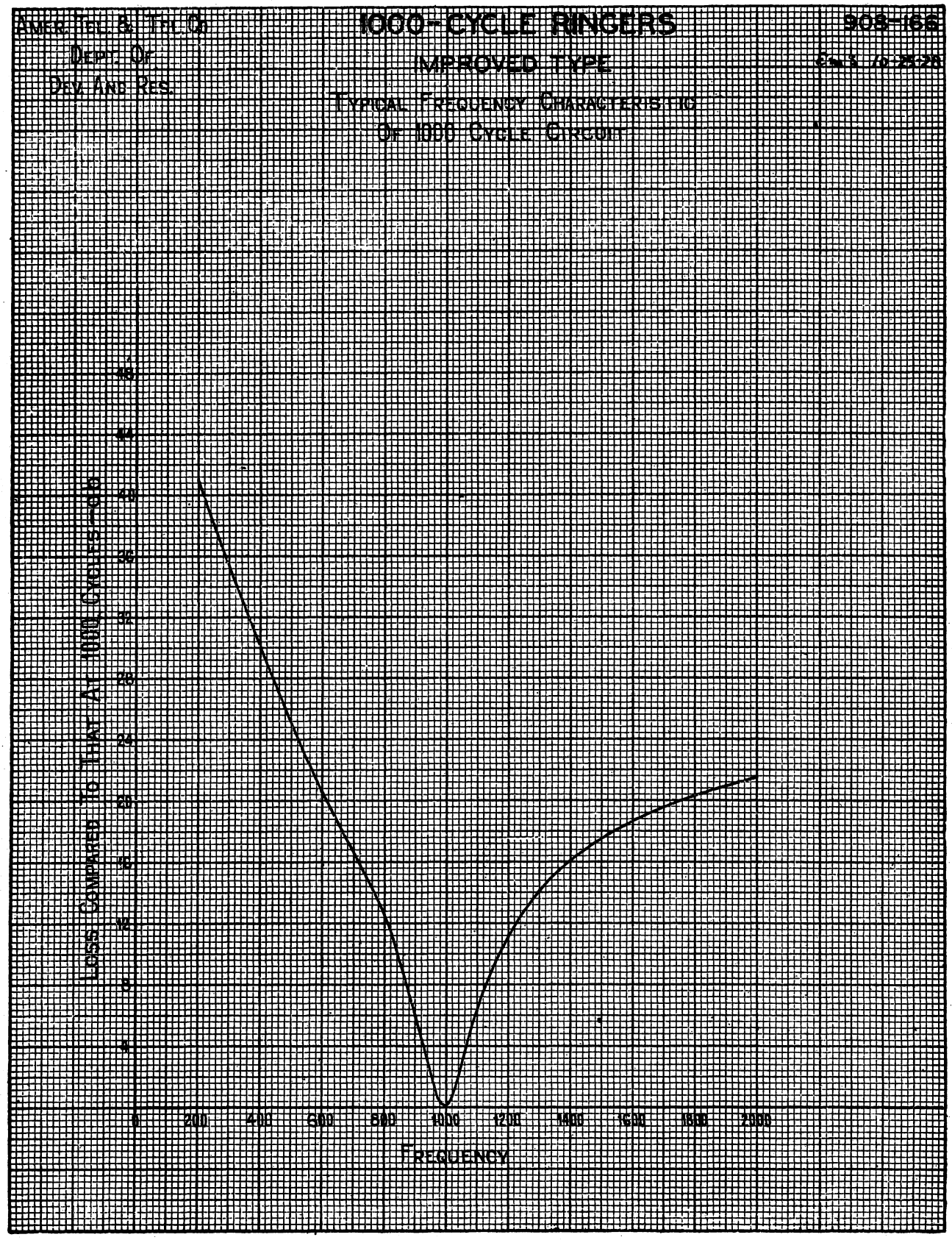
2.6 A common part of the terminal and intermediate signaling arrangements is the 1000-cycle receiving circuit. This circuit receives the incoming interrupted 1000-cycle current and performs the functions which cause either a ringing signal to be operated or a ringing current of a different frequency to be sent out. It consists of a tuned input circuit, an amplifier, a detector, a sensitive polar relay operating from the output of the detector tube, a tuned circuit so arranged that the relay operating from the contacts of the polar relay responds only when the polar relay operates at the proper frequency and a slow release relay which introduces a time delay in the operation of the ringer.

2.7 The input circuit is tuned to the signaling frequency of 1000 cycles. Drawing 908-166 on page 5 shows a typical frequency characteristic. The circuit associated with the polar relay and the relay which operates from its contacts is tuned to 19⅙ cycles. This value of 19⅙ cycles is approximately the same as the frequency of interruption of the signaling current furnished by the 1000-cycle signaling generator, and at the same time is approximately the same as the average frequency of a 20-cycle signaling generator. This permits a 1000-cycle oscillator with relays for interrupting the output to be used as a source of signaling current where a suitable 20-cycle supply for operating the interrupting relays is available. The sharpness of this tuning is such that, if the B-type relay (DC) in this circuit is properly adjusted, the circuit will operate under all conditions if the polar relay operates at a frequency between 18⅓ and 20 cycles, and will in most cases fail to operate if it operates at a frequency less than 16 or greater than 23 cycles per second. This tuning is an important factor in preventing false operation of the ringer on voice and other sources of interference. The time delay is such that the ringer will operate if signaling current is applied for .7 second or more and will fail to operate if it is applied for .4 second or less.

(c) 1000–20–Cycle Terminal Ringer:

2.8 This type of ringer is used with lines terminating in a switchboard in which the switchboard circuits are arranged to send out and receive 20-cycle current. It consists of a 1000-cycle receiving circuit and a 20-cycle circuit as shown on Drawing 908-138. It is associated with the line by the cutoff relay circuit as shown on Drawing 172-A-34. The 20-cycle branch of the ringer consists of a J-type relay in series with a retardation coil and a condenser, and is similar to that used in other types of terminal ringers.

2.9 This ringer is designed for use at the terminals of a circuit. The same cutoff relay circuit is used for associating the ringer with the line for two-wire, four-wire and carrier circuits. In the case of four-wire and carrier circuits the ringer is


AMER. TEL & TEL CO.
DEPT. OF
DEV. AND RES.
1000-CYCLE RINGERS
IMPROVED TYPE
TYPICAL FREQUENCY CHARACTERISTIC
OF 1000 CYCLE CIRCUIT
908-166
Feb. 10, 1928
LOSS COMPARED TO THAT AT 1000 CYCLES (DB)
48
44
40
36
32
28
24
20
16
12
8
4
0
200
400
600
800
1000
1200
1400
1600
1800
2000
FREQUENCY

placed on the two-wire side of the terminal hybrid arrangement.

2.10 The equipment for the terminal ringer with the exception of the cutoff relay circuit equipment and the battery supply equipment is mounted on a panel.

(d) **Signaling Circuit for Use with No. 3 and No. 11 Toll Switchboards:**

2.11 The signaling circuit for use with the No. 3 and No. 11 toll switchboards and its method of connection to the toll line and to the line circuit of the No. 3 or No. 11 switchboard is shown on Drawing 167-A-4. The signaling panel for use with these switchboards contains only the 1000-cycle receiving circuit and a relay for placing a suitable termination on the line during an outgoing ring and disconnecting the 1000-cycle receiving circuit. This 1000-cycle signaling circuit may also be used with No. 5 toll testboard cords.

2.12 The equipment for this signaling circuit with the exception of the battery supply and directional selection equipment is mounted on a panel.

(e) **Intermediate Ringers:**

2.13 In order to take care of cases where it is desired to change the type of signaling at an intermediate point on the circuit, a 1000-135-cycle and a 1000-20-cycle intermediate ringer have been developed. A schematic diagram showing the general arrangement of an intermediate ringer in the toll line circuit is shown on Drawing 167-A-60.

2.14 The change in type of signaling will ordinarily be made at the junction of a four-wire circuit and a two-wire circuit, at the junction of a carrier circuit and a two-wire circuit, or at a repeater point in the case of a circuit which is all two-wire. Referring to Drawing 167-A-60, it will be seen that a cutoff relay is provided for the network circuit as well as for the line circuit. When a signal is passed in either direction, both the line and network cutoff relays operate and terminate the two sides of the hybrid coil by resistances. This is for the purpose of maintaining proper balance on the circuit so as to avoid echoes which would interfere with signaling. Condensers are provided in both leads of the line circuit in order to raise the impedance for 20-cycle and 135-cycle signaling, corresponding condensers being provided in the network circuit for balancing purposes. When used with a four-wire terminating set, these condensers are not required and may be strapped out.

2.15 Where an intermediate ringer is used on a two-wire circuit at a telephone repeater point, the ringer should be connected on the side of the repeater to which the line employing 135-cycle or 20-cycle signaling is connected. Cutoff relays are required in both the line and network circuits.

2.16 Where an intermediate ringer is used at the junction of a four-wire or carrier circuit and a two-wire line not equipped with a two-wire repeater at this point, with 1000-cycle signaling on the four-wire or carrier circuit, and 135-cycle or 20-cycle signaling on the two-wire circuit, the line and network cutoff relays are connected on the line and network sides, respectively, of the hybrid coil in the terminating circuit. When the two-wire line is equipped with a two-wire repeater at this point, the intermediate ringer should be connected to the line and network circuits of the repeater and located on the side of the repeater to which the line employing 135-cycle or 20-cycle signaling is connected.

2.17 Where it is desired to employ 1000-cycle signaling over the two-wire portion and 135-cycle signaling over the four-wire portion of a circuit, a 1000-cycle intermediate or terminal ringer may be used on the two-wire circuit at the junction point. If a 1000-20-cycle intermediate or terminal ringer is used, a 20-135-cycle ringer should be associated with the four-wire terminating set. If a 1000-135-cycle intermediate ringer is used, a 135-135-cycle ringer should be used with the four-wire terminating set. It should be noted that in order to insure satisfactory operation, certain limitations are placed on the circuit layout as covered in paragraph 3.25. For this reason it is desirable to avoid this arrangement when practicable by using 1000-cycle signaling over the entire circuit.

2.18 The 1000-cycle supply leads to the intermediate ringers are equipped with resistances which may be adjusted as required in order to reduce the signaling current in accordance with the transmission level of the circuit at the point where the signaling current is applied. The values are such that the current may be reduced by approximately 4, 8, 12 or 15.5 db. Adjustment should be made to the nearest value provided, by strapping these resistances.

2.19 Balancing equipment for the 135-cycle circuits of the 1000-135-cycle intermediate ringer may be provided if required.

1000-135-Cycle Intermediate Ringers

2.20 The circuit for the 1000-135-cycle intermediate ringer panel consists of a 1000-cycle receiving circuit as described above and a 135-cycle receiving circuit similar to that employed in the regular 135-cycle terminal ringer.

2.21 The equipment for the 1000-135-cycle intermediate ringer with the exception of the cutoff relay circuit equipment and the battery supply equipment is mounted on a panel.

1000-20-Cycle Intermediate Ringers:

2.22 The circuit for the 1000-20-cycle intermediate ringer comprises a 1000-cycle receiving circuit and a 20-cycle circuit employing a 196-type relay.

2.23 This ringer has been designed primarily for use at an intermediate point on the circuit where it is desired to change from 1000-cycle to 20-cycle signaling and has a more sensitive 20-cycle relay than the terminal ringer. In certain cases, particularly in small offices, it may be convenient to use the same ringer either on a circuit passing through the office and requiring a 1000-20-cycle intermediate ringer at that point, or on a circuit employing 1000-cycle signaling and terminating at that point. For this purpose a resistance has been provided in series with the 196-type relay to reduce the 20-cycle current received from the switchboard on an outgoing ring. In addition, resistances have been provided in the 20-cycle supply leads to the ringer to permit the 20-cycle current sent to the switchboard on an incoming ring to be adjusted as required. When used at intermediate points, these resistances are strapped out. Also, to use this ringer as a terminal ringer, the resistances in the 1000-cycle supply leads should be adjusted as covered in paragraph 3.5, and the connection of the interstage transformer changed so as to include both secondary windings in the circuit. This change in the wiring of the interstage transformer increases the sensitivity 6 db and makes it the same as for a terminal ringer. The use of a 1000-20-cycle intermediate ringer as a terminal ringer is not applicable to No. 3 and No. 11 offices since a low voltage 20-cycle supply is not provided.

2.24 The equipment for this ringer exclusive of the cutoff relay circuit equipment and the battery supply equipment is mounted on a panel.

(f) **Battery Supply Circuit:**

2.25 Four ringers or signaling circuits are associated together on one battery supply circuit, the filaments of the eight tubes in the four ringers being connected in series. When less than four ringers are provided on one filament circuit a resistance is provided in place of each ringer omitted.

2.26 In offices having regulated battery, the negative grid potential for the tubes of the ringer at the negative end of the filament circuit is obtained by means of the voltage drop across a fixed series resistance in the filament circuit. In offices having unregulated battery a grid battery is provided. The negative grid potentials for the other ringers in the filament circuit are obtained in each case by utilizing a part of the filament voltage drop of the preceding ringer. When grid batteries are used a jack is provided to facilitate measuring the grid battery voltage.

2.27 An alarm relay is provided in each filament circuit, and is arranged to operate an annunciator or other alarm circuit whenever the filament circuit is opened, and to light a lamp in the ringer bay to indicate which filament circuit is affected. An individual alarm for each ringer is not provided.

2.28 A jack designated FIL is provided in each filament circuit, and is arranged to perform three different functions. Placing a dummy plug in this jack opens up the filament circuit and disconnects the filament alarm. The filament current may be measured by means of a portable milliammeter connected to the tip and ring of a plug by inserting the plug in this jack. The insertion in this jack of a plug which has its tip and sleeve connected together transfers the filament circuit to a filament activity testing circuit if one is provided.

2.29 A jack is provided in the plate circuit of the detector tube in each ringer. This jack is arranged so that placing a dummy plug in this jack transfers the plate of this tube from the lead which normally supplies the 130-volt plate battery to another lead which supplies plate battery through a milliammeter provided as part of the testing equipment, thereby permitting the plate current of this tube to be measured.

2.30 Means have been provided for adjusting and maintaining the filament current within the proper limits. In offices equipped with duplicate batteries, resistances are provided which may be strapped as required to obtain the proper filament current. In offices not equipped with regulated battery, either automatic filament current regulators or manually operated rheostats may be used to regulate the current, the fixed resistances being strapped as required to obtain the proper initial adjustment.

(g) **Patching and Testing Arrangements:**

2.31 In order to facilitate operation and maintenance of the signaling system, means have been provided for patching and testing of the signaling equipment. The patching arrangements include means for connecting this equipment to circuits which are normally not equipped with 1000-cycle signaling. The testing arrangements include means for making overall tests of the operation of the ringers, current flow adjustments of the a-c. relays and filament activity tests of the vacuum tubes. The circuits for making overall tests are designed to test the ringer over a transmission loss about 2 db in excess of the signaling range of the ringer given in paragraph 3.6.

(h) **Assembly:**

2.32 The signaling equipment consisting of the ringer panels and associated apparatus is mounted on relay rack bays. Arrangements for each type of ringer mounted on 11-foot, 6-inch bays are provided. In addition, for each type of ringer, bay layouts which include the testing equipment required for the installation have been designed. For small installations where it is desired to employ the 6-C oscillator as a source of signaling current, bay layouts which include this equipment in addition to the testing equipment and a number of ringers or signaling circuits, have been provided.

3. TRANSMISSION FEATURES:

(a) **General:**

3.1 The following paragraphs cover what are considered the more important transmission features of the improved 1000-cycle signaling system.

(b) **Signaling Current Values:**

3.2 The value of the signaling current at a point of zero transmission level is the same for all circuits and should be one milliampere into a 600-ohm line measured during the "on" period of the interrupted current. The interruption of the signaling current reduces the value as measured with a thermocouple meter to .707 milliampere.

3.3 In the case of lines used as terminal circuits only or equipped for cord circuit repeater operation, the ringers are connected at a point of zero transmission level (with respect to outgoing signals), being connected on the two-wire side of the four-wire terminating sets or carrier terminating sets and on the switchboard side of all pads. The 1500-ohm resistances in the 1000-cycle supply leads, and the 750-ohm resistance bridged across the line during the signaling period are of the right value to send one milliampere into a line of 600 ohms impedance.

3.4 In the case of lines equipped with switching pads of 2, 3 or 4 db, the ringers are connected on the line side of these pads. At this point the transmission level is below zero by the amount of the loss of the pad. In such cases an additional loss of 3 db is provided for outgoing signals by adding two 700-ohm resistances. Drawing 908-138 illustrates this for terminal ringers.

3.5 In the case of a ringer at an intermediate point, additional resistances in the 1000-cycle supply leads are provided so that the signaling current may be reduced to correspond to the transmission level at the point where the signaling current is applied. For example, when an intermediate ringer is located at a telephone repeater point, the signaling current is supplied at the input to the repeater where the transmission level is less than zero. The arrangements are such that the signaling current level may be reduced by about 4, 8, 12 or 15.5 db from the normal value of one milliampere into 600 ohms. Where a 1000-20-cycle intermediate ringer is used at the terminal of a circuit equipped with switching pads the signaling current level may be reduced 4 db by this arrangement.

(c) **Signaling Range:**

3.6 The sensitivity of the two-tube type terminal ringer and the signaling circuit for the No. 3 and No. 11 switchboards is such that, with signaling current values as specified above, a signaling range of 20 db is obtained, that is, the signal will be received satisfactorily if the transmission level at the point where the receiving ringer is located is — 20 db or above.

3.7 It is desirable to limit the sensitivity to which the ringer may be adjusted in order to reduce the possibility of false operation. In order to insure that the ringers have sufficient sensitivity to meet the range requirements, but not too great a sensitivity from the standpoint of false operation, the testing arrangements provide for an operate test (1 milliampere in 600 ohms attenuated 22 db) and a non-operate test (1 milliampere attenuated 30 db). The output voltage of the test set for the operate test corresponds to a level of about —27 db as measured by a 6-A transmission measuring set used as a level indicator.

3.8 In the case of intermediate ringers, the signal is received at a point where the transmission level may be greater than zero. The sensitivity of the intermediate ringers has, therefore, been reduced about 6 db by including in the circuit only one of the secondary windings of the interstage transformer, in order to reduce the possibility of false operation. When a 1000-20-cycle intermediate ringer is used at the terminal of a circuit in place of a terminal ringer it is desirable to increase its sensitivity to correspond to that of a terminal ringer by changing the wiring of the interstage transformer to include both secondary windings in the circuit. Where terminal ringers are employed as intermediate ringers, as covered in paragraphs 4.9 to 4.13 inclusive, it will generally be desirable to change the wiring to include only one secondary winding of the interstage transformer.

(d) **Signaling Echoes:**

General:

3.9 When a signal is passed over a line, not only the direct signal, but, in general, one or more echoes due to reflections which take place in the line reach the place where the receiving circuit is connected. The echoes add to the direct signal at the ringer, and if too great in magnitude, may produce a distorted wave to which the 1000-cycle receiving circuit will not respond. In order to insure satisfactory response of the signaling circuit in every case, the total echo reaching it should be at least 10 db weaker than the direct signal. The next paragraphs discuss features which assist in meeting this requirement.

Termination of Circuits During Signaling:

3.10 In order to reduce echoes which may interfere with the operation of the 1000-cycle receiving circuits, the toll circuits are terminated during the signaling period, as described in the following paragraphs.

3.11 In the case of 1000-20-cycle terminal ringers a 750-ohm resistance is shunted across the line during incoming and outgoing rings by means of the cutoff relay as shown on Drawing 908-138. This 750-ohm resistance in parallel with the resistance in the 1000-cycle supply leads (3000 ohms) makes the termination at the sending end of the line about 600 ohms for lines not equipped with switching pads. For circuits equipped with switching pads this termination is about 640 ohms due to the additional resistance in the 1000-cycle supply leads.

3.12 The termination at the receiving end is about 2000 ohms before the cutoff relay operates, assuming a No. 172-B line relay is used at the switchboard. If a No. 172-A line relay is used, the circuit is practically open which may result in an undesirable condition from the standpoint of signaling echoes. In the case of a rering signal, the termination is provided by the circuit connected to the drop. This case is discussed further in paragraphs 3.15 to 3.22 inclusive. After the cutoff relay operates the termination is provided by a 750-ohm resistance. The 5000-ohm resistance which is connected across the drop by the operation of the cutoff relay is provided in order to suppress the objectionable click in the operator's receiver which would otherwise occur when the operator releases her ringing key.

3.13 In No. 3 and No. 11 switchboard offices the termination at the sending end of the line is the same as for the terminal ringers described above. The general circuit arrangement is shown on Drawing 167-A-4. The termination at the receiving end of the circuit is part of the switchboard circuit and is about 600 ohms at 1000 cycles both before and after the ringer operates. The termination for a rering signal is provided by the circuit connected to the drop both before and after the operation of the ringer.

3.14 In order to obtain an adequate balance between the network and line circuits of two-wire repeaters, four-wire terminating sets and carrier terminating sets at an intermediate ringer point, the line side is terminated during the signaling period by a 750-ohm resistance and the network is replaced by another 750-ohm resistance, as shown on Drawing 167-A-60. If the

intermediate ringer is located on a circuit at a point other than at a repeater point the same circuit is used except that the relay for the network circuit is not required.

Directional Selection Circuit:

3.15 In the case of a rering signal to an intermediate point on a built-up connection, echoes may be received at the intermediate point due to reflection of the signal at irregularities in the line beyond that point. Such echoes reach the place where the 1000-cycle receiving circuit is connected after being increased by the cord circuit repeater gain or by the omission of switching pads, and may be stronger than 10 db below the direct signal.

3.16 To overcome this difficulty, the 1000-cycle receiving circuits are connected to the line through an arrangement known as a "directional selection circuit." This arrangement takes advantage of the fact that the objectionable echoes are traveling in a direction opposite to that of the signal. The receiving circuit is associated with the line in such a way that currents from the direction of the line are received unattenuated, and currents from the direction of the drop or connected line are received highly attenuated. With this arrangement the echoes do not reach the receiving circuit until, after a second reflection, they are traveling in the same direction as the signal. Operation of the receiving circuit should be obtained in all cases if the sum of the active return losses at 1000 cycles looking from the ringer towards the line over which the signal is passed and looking towards the line connected to the drop side of the ringer (through the cord circuit repeater or with the switching pads omitted), is not less than 10 db. This condition will be met unless the active return loss at 1000 cycles of one or both of the circuits connected together is abnormally low. A schematic of this arrangement as applied to terminal ringers is shown on Drawing 908-138.

3.17 The functioning of the circuit for reducing the echo currents received from the line connected to the drop side of the ringer can best be described by reference to Figs. 1, 2 and 3. Fig. 1 of this drawing illustrates the echoes which may reach the ringer in the case of a built-up connection involving a cord circuit repeater. A toll circuit between A and B is shown connected at B by means of a cord circuit repeater to another toll circuit extending from B to C. S_1 and S_2 show the voice-frequency ringers connected to toll circuit A-B. When signaling from A to B with this combination the ringer at B receives not only the direct signal but also an echo from circuit B-C. The strength of this echo is equal to the signal (at B) reduced by the active return loss of circuit B-C and increased by twice the cord circuit repeater gain. The echo may be of the same order of magnitude as the original signal.

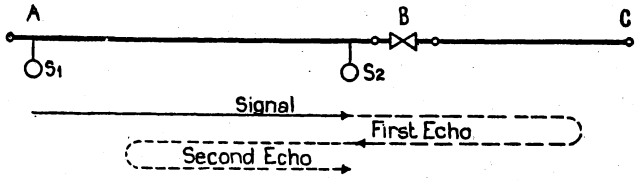


Fig. 1

3.18 With the arrangement for reducing echoes all current waves coming from the direction of C are attenuated greatly before reaching the ringer so that the ringer effectively receives only the original signal plus the second echo resulting from reflection of the first echo in circuit A-B.

3.19 Fig. 2 shows a schematic diagram of the directional selection circuit. A small resistance is connected in each side of the line, and across each resistance is bridged a winding of a transformer whose secondary is in series with the input to the 1000-cycle side of the ringer. The result of this is to add to the voltage across the line an additional voltage derived by stepping-up the potential across the small series resistances. The step-up ratio is such that the additional voltage is equal to the voltage across the line. The coil is so poled for current waves approaching from the drop that the two voltages oppose each other, while for current waves approaching from the line they aid.

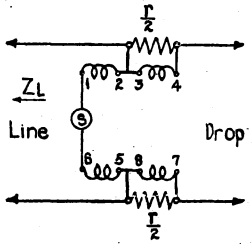


Fig. 2

3.20 Fig. 3 shows the same circuit arranged to show more clearly its principle of operation. Comparison of Figs. 2 and 3 part

by part will show that they are identical electrically. Suppose for a moment that the ringer circuit is open at "a." It will be seen that if the ratio of Z_L (line impedance) to "r" is just equal to the voltage step-up ratio of the windings 4-7 to 2-5 of the coil, the potential across Z_L due to a voltage applied from the drop side will just be equal to that induced in windings 2-5. This being the case there is no potential across "a" and it may be closed without creating any current in "S." It follows further that since closing switch "a" creates no current in "S," the latter can have no effect on transmission from drop-to-line (or, of course, from line-to-drop) and the transmission loss of the arrangement is practically that of the small series resistances whether the ringer is connected or not.

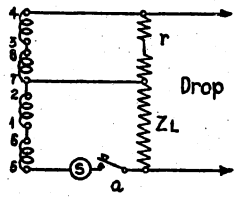


Fig. 3

3.21 It will be noted that for zero current in "S" there is required a ratio between Z_L and "r" just equal to the turn ratio of the coil. This would require a different value of series impedance (reactance as well as resistance) for each different line impedance. However, it has been found that a compromise value of resistance is satisfactory. The value of resistance used for terminal ringers and signaling circuits for No. 3 and No. 11 toll switchboards is 13.5 ohms in series with each side of the line for circuits terminating in cord circuit repeater offices, and 10 ohms for circuits terminating in switching pad offices. For intermediate ringers the resistance in each side of the line is 10 ohms when the ringer is located at a repeater point or at the junction of a four-wire circuit or carrier circuit and a two-wire line. For other cases the 13.5-ohm resistances are used. When a 1000-20-cycle intermediate ringer is used at the terminal of a circuit, the rule for terminal ringers applies. As the No. 109-A repeating coil has a turn ratio of 30, this circuit is exactly balanced when the impedance of the line over which the signal is being passed is 810 ohms resistance where the 13.5-ohm resistances are used, and 600 ohms resistance where the 10-ohm resistances are used. With these values of resistance the highest compromise balance for the line impedances encountered in practice is obtained.

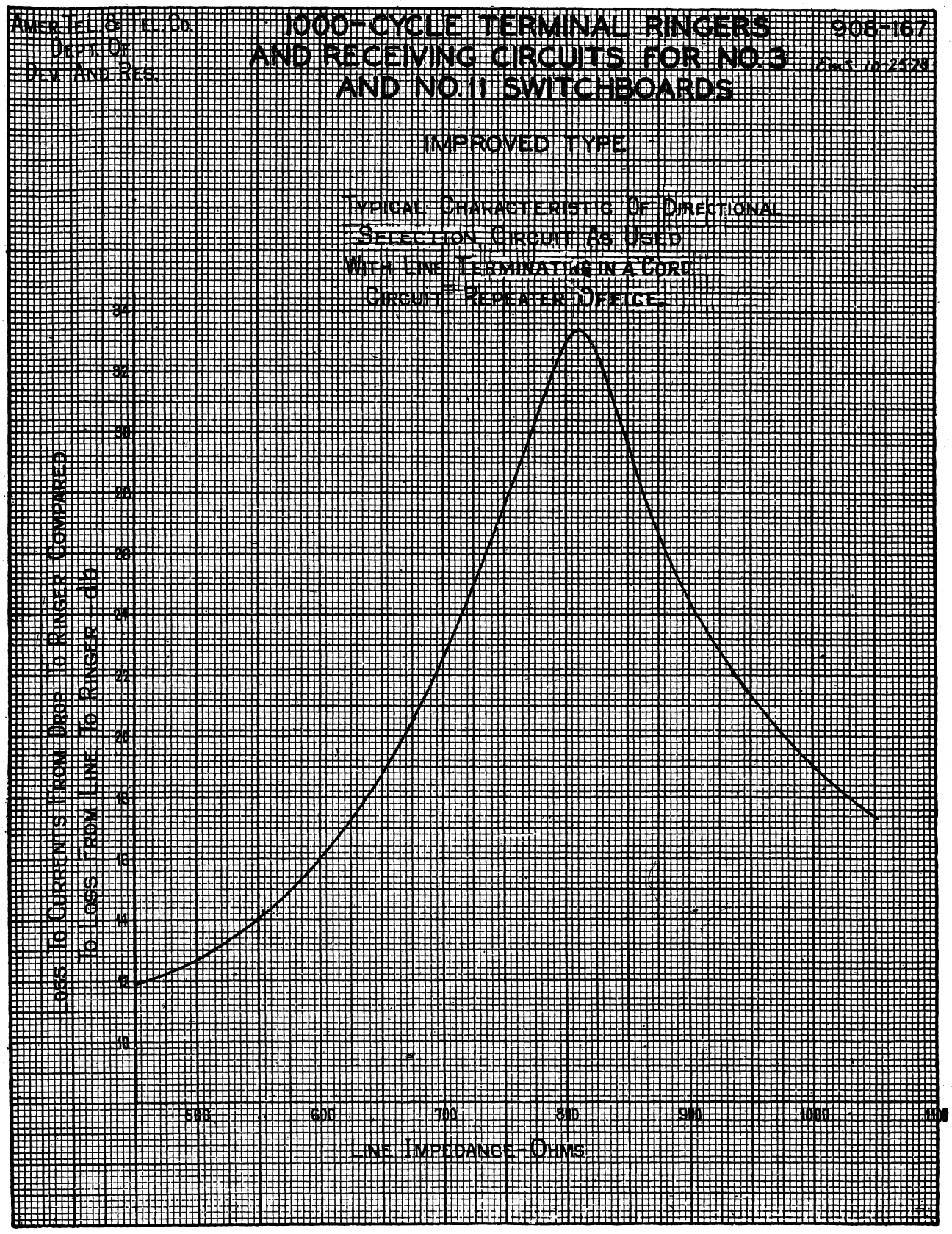
3.22 Drawing 908-167 on page 12 shows a typical curve for the amount by which the transmission loss between the drop and the ringer exceeds the transmission loss between the line and the ringer for various line resistances. The curve represents what might be termed the "discrimination against the echoes." The curve shown is for the case where 13.5-ohm resistances are used. When 10-ohm resistances are used the curve has the same general shape, except the greatest loss is at 600 ohms line resistance. When the line impedance consists of a capacity in addition to a resistance, the loss caused by this arrangement is less than that shown on this curve. The minimum discrimination against the echo currents from the drop circuit is about 15 db for any type of line.

Location of Ringers at Intermediate Points:

3.23 The intermediate ringer should be located on the side of the intermediate two-wire repeater to which the line employing 135- or 20-cycle signaling is connected. In the case where a four-wire or carrier circuit is connected to a two-wire line equipped with a repeater at this point, the intermediate ringer should be connected on the side of the two-wire repeater to which the line employing 135- or 20-cycle signaling is connected.

3.24 With this location of the intermediate ringers, the 10 db requirement given in paragraph 3.9 will be met if the sum of the active return losses at 1000 cycles of the lines looking in the two directions from the ringer is not less than 10 db. This requirement is the same as for a ringer at the terminal of a circuit.

3.25 Where a four-wire circuit is connected to a two-wire circuit not equipped with a repeater at this point, with 1000-cycle signaling on the two-wire portion and 135-cycle signaling on the four-wire portion, a 1000-cycle intermediate or terminal ringer on the two-wire circuit and a 135-cycle intermediate or terminal ringer on the four-wire terminating set will be required as covered in paragraph 2.17. In this case, the active return loss at 1000 cycles of the four-wire circuit under the signaling condition as measured from the intermediate point should not be poorer than — 5 db, that is, 5 db gain. This condition will be met in the case where the


AMER. TEL. & TEL. CO.
DEPT. OF
DEV. AND RES.
1000-CYCLE TERMINAL RINGERS
AND RECEIVING CIRCUITS FOR NO. 3
AND NO. 11 SWITCHBOARDS
908-167
Case 10 2528
IMPROVED TYPE
TYPICAL CHARACTERISTIC OF DIRECTIONAL
SELECTION CIRCUIT AS USED
WITH LINE TERMINATING IN A CORD
CIRCUIT REPEATER OFFICE.
LOSS IN CURRENTS FROM DROP TO RINGER COMPARED
TO LOSS FROM LINE TO RINGER-DB
34
32
30
28
26
24
22
20
18
16
14
12
10
500
600
700
800
900
1000
1100
LINE IMPEDANCE-OHMS

circuit is not arranged for switching at the four-wire terminal, if the sum of the 1000-cycle equivalents of the four-wire portion of the circuit in the two directions (measured through the four-wire terminating sets) does not exceed 10 db gain. In the case where the circuit is arranged for switching at the four-wire terminal, either through a cord circuit repeater or with switching pads removed, the sum of the 1000-cycle equivalents of the four-wire portion of the circuit in the two directions should equal zero or a loss.

(e) **Reactions to Voice Transmission:**

Transmission Loss:

3.26 It has already been shown that the transmission loss of the 1000-cycle signaling circuit is practically that of the small series resistances inserted in the voice transmission circuit as a part of the arrangement for reducing the effect of echoes, and that this loss is independent of whether the 1000-cycle receiving circuit is connected or not. This loss is not more than 0.2 db for all frequencies in the voice range.

3.27 The 20-cycle branches of the terminal ringer and the 1000-20-cycle intermediate ringer have practically no effect on the transmission loss. The 135-cycle branch of the 1000-135-cycle intermediate ringer adds less than .1 db. These losses assume 600-ohm circuit impedances.

Return Loss:

3.28 The equipment added to the line by a terminal ringer or a signaling circuit for a No. 3 or No. 11 switchboard so modifies a 600-ohm line impedance that an otherwise perfect cord circuit repeater balance is reduced to about 33 db. This unbalance is practically entirely due to the series resistance added to the line, and is unaffected by the 1000-cycle receiving circuit itself. If a higher balance than 33 db is required, a resistance of 27 ohms should be added to the cord circuit repeater network.

3.29 Looked at from the other side, the impedance of a drop or line which otherwise perfectly terminates the circuit is so little modified by the signaling circuits that it is not necessary that it be balanced in the drop network circuits of two-wire repeaters, four-wire terminating sets or carrier terminating sets. The return loss due to this arrangement alone will not be less than 40 db except in the case of terminal ringers or signaling circuits for No. 3 or No. 11 switchboards at switching pad offices. In this case, when two circuits employing 1000-cycle signaling are connected together, the return loss is about 35 db at frequencies around 1000 cycles.

3.30 The return loss of the 135-cycle branch of the 1000-135-cycle intermediate ringer looked at from either side of the ringer is approximately 40 db at 800 cycles and 29 db at 300 cycles. The 20-cycle branch of the 1000-20-cycle intermediate ringer has practically no effect upon the balance. The return losses given above are for circuits of 600-ohm impedance.

4. PATCHING ARRANGEMENTS:

(a) **Patching Arrangements for Use with Terminal and Intermediate Ringers:**

4.1 Arrangements are provided for patching ringers to the testing set and to lines brought out in other bays, thus permitting a spare ringer to be connected in a circuit in place of a ringer which may be in trouble. Spare cutoff relay circuits to permit patching ringers to lines which are normally not equipped with 1000-cycle signaling are also provided.

4.2 Each ringer is brought out to jacks at the bay on which it is mounted. Patching cords with the tip, ring and sleeve connected through are required. P3E cords equipped with No. 110 plugs may be used for this purpose.

Patching Trunks:

4.3 Interbay patching trunks are provided to permit patching ringers to the testing set and to lines brought out in other bays. These trunks are wired to jacks in every third bay. Each bay is wired for six patching trunks and one TEST trunk. The trunks are equipped with a busy test feature. In offices of more than six bays, the equipment required in order to determine whether a particular trunk is in use is provided in the second bay and in each sixth bay thereafter.

4.4 In certain cases, trunks to the 135-cycle ringer bays are also required for patching and testing purposes.

Spare Cutoff Relay Circuit for Use with Terminal Ringers

4.5 In order to permit terminal ringers to be patched to lines which are not normally equipped with 1000-cycle signaling, spare cutoff relay circuits are provided. These circuits terminate in jacks at the toll test-

board and at a ringer jack panel so that a ringer may be readily patched to any line.

4.6 Wiring for one of these circuits is provided in the bay cable in each bay of terminal ringers, and the equipment will be furnished when specified.

Spare Cutoff Relay Circuit for Use with Intermediate Ringers:

4.7 In order to permit intermediate ringers to be patched to circuits which are not normally so equipped, spare intermediate cutoff relay circuits, are provided. The jacks to which a ringer may be patched are located in the ringer jack panel. The jacks to be patched to the line and network circuits may be located at the toll testboard, and trunks to the network jack panel used to pick up the network circuits. The jacks designated 135-CYCLE LINE or 20-CYCLE LINE should be patched to the line on which 135-cycle or 20-cycle signaling is to be employed, the jack designated 1000-CYCLE LINE to the input to the hybrid coil of the repeater or terminating set, the HYB NET jacks to the network side of the hybrid coil, and the NET jacks to the network.

4.8 Wiring for one of these circuits is provided in the bay cable in each bay of intermediate ringers but the equipment is only furnished when specified.

Spare Cutoff Relay Circuit Arranged to Permit Use of Terminal Ringers as Intermediate Ringers:

4.9 In order to take care of cases where it is desired to employ a temporary circuit layout requiring a 1000-135-cycle intermediate ringer in an office not equipped with intermediate ringers, a spare cutoff relay circuit arranged to permit a 1000-cycle terminal ringer and a 135-cycle terminal ringer to be patched together so as to function as a 1000-135-cycle intermediate ringer may be provided.

4.10 This cutoff relay circuit is patched into the circuit in the same manner as the intermediate cutoff relay circuit. To connect the ringers to the cutoff relay circuit, the LCXX jack of the 1000-cycle terminal ringer is patched to the jack designated 1000 in the cutoff relay circuit, the DCXX jack of the 1000-cycle terminal ringer is patched to the DCXX jack of the 135-cycle terminal ringer, and the LCXX jack of the 135-cycle terminal ringer is patched to the jack designated 135 in the cutoff relay circuit. The jacks designated 1000 and 135 are located in the jack panel in the 1000-cycle terminal ringer bay. One patching trunk to the 135-cycle ringer bays is provided for each of these circuits in order to permit the necessary patches to be made.

4.11 It should be noted that when a 1000-cycle terminal ringer is used in this manner, the 1000-cycle branch of the ringer may be bridged across the circuit at a point where the transmission level is higher than zero. In this case, it is desirable to change the strapping of the interstage transformer (RC) on the 1000-cycle terminal ringer to include only one secondary winding in the circuit.

4.12 Resistances which may be adjusted to reduce the 1000-cycle signaling current as required in accordance with the transmission level of the circuit at the point where the signaling current is applied are provided in this circuit.

4.13 Inasmuch as this arrangement is required only in special cases, no wiring for these circuits is included in the bay cable. When specified, additional wiring required is provided in a supplementary cable form to be made up by the installer. The provision of one or more of these circuits in a bay will usually require that one ringer be omitted. For operating reasons, it is desirable that they be located in a bay other than that in which the testing equipment is located. The trunks to the 135-cycle ringer bays should appear in the bay in which these cutoff relay circuits are located.

(b) **Patching Arrangements for Use with Signaling Circuits for No. 3 and No. 11 Toll Switchboards:**

4.14 In the No. 3 and No. 11 toll switchboards, the signaling circuits are cross-connected to the toll line circuits, and the necessary patching of signaling equipment is done by patching drop circuits. In the case of spare drops, however, arrangements to permit changing the type of signaling by patching may be provided. In this case spare directional selection circuits are provided.

5. TESTING ARRANGEMENTS:

Testing Arrangements for Use with Terminal and Intermediate Ringers:

Testing Circuits:

5.1 The testing arrangements for use with terminal and intermediate ringers are described in Division 700.

Telephone Set:

5.2 In order to facilitate maintenance, a telephone set may be provided in the bay with the testing equipment and a two-way ringdown trunk wired between this point and the testboard. The telephone set may be connected to any circuit appearing at the terminal ringer bays by patching the jacks marked A and B to the DCXX and DROP jacks, respectively, of the ringer and circuit desired, or to any circuit at an intermediate ringer bay by patching to the corresponding jacks of the intermediate ringer and circuit desired. This patch may be made without opening or interfering with the talking circuit. The arrangements are such that the attendant can either talk or monitor on the circuit, and can ring in either direction. A 135-cycle ringing key is provided for ringing from the telephone set when it is used with 1000-135-cycle intermediate ringers.

5.3 For convenience in patching, the telephone set jacks may be multipled at each third ringer bay.

Mounting for Spare Relays:

5.4 Mounting plates arranged for mounting spare 215-type or 218-type relays may be provided in the test bay.

6. EQUIPMENT FEATURES:

(a) **Assembly of Equipment:**

6.1 The signaling equipment consists of the ringer panels and certain associated apparatus such as cutoff relay circuit equipment, directional selection equipment, battery supply equipment, jacks, etc., which is mounted in the bay with the ringer panels. For the terminal and intermediate ringers, the ringer test set, filament activity test set, telephone set, and the mounting for spare 215-type relays are mounted together with a number of ringers in the initial bay of the installation. The testing equipment for the signaling circuits for the No. 3 and No. 11 toll switchboards is mounted in a separate bay. When a filament activity test panel is provided, it is mounted in the bay with the testing equipment.

6.2 For small offices where it is desired to employ the 6-C oscillator as a source of signaling current, the oscillators and associated equipment are mounted with the signaling equipment.

6.3 In each bay layout, the wiring is arranged so that equipment may be provided for operation of the filament circuit on regulated battery, or with either automatic or manual regulation where unregulated battery is used, depending on the requirements of the particular installation.

6.4 The 1500-ohm resistances in the 1000-cycle supply leads to each ringer are mounted together in order to reduce the danger of an accidental ground or short on the 1000-cycle supply leads, as might occur if these leads were multipled to each ringer bay. These resistances are mounted in the initial bay of a group of ringers.

(b) **Power Supply:**

24-Volt Supply:

6.5 One lead equipped with a 1⅓-ampere fuse is required for filament supply for each four ringers. This is normally obtained from the filtered 24-volt supply in order to avoid introducing noise in the tube circuit of the ringer. This lead is paired with the corresponding ground lead in the cabling to the bay.

6.6 One lead from the 24-volt signaling battery supply for operation of the relays on the ringer panels, and one for operation of the cutoff relays, each equipped with a 1⅓-ampere fuse, is required for each group of four ringers on one filament circuit.

6.7 The voltage of the 24-volt supply should be within the limits of 20 to 28 volts.

130-Volt Supply:

6.8 One lead from the 130-volt plate battery equipped with a ½-ampere fuse is required for each group of four ringers on one filament circuit. An 8-B lamp is required for each ringer. The voltage of the 130-volt supply should normally be between the limits of 125 and 135 volts.

1000-Cycle Supply:

6.9 The 1000-cycle supply for operating the ringers is usually furnished by a 1000-cycle motor-generator set. The capacity of this generator is sufficient to take care of as many as 2000 of the new type of ringer. (In case ringers requiring 2.0 or 3.5 milliamperes of signaling current are being operated from the same generator, this number is, of course, greatly reduced.) It is important that the speed of the generator be maintained within the specified limits.

6.10 In certain cases in the small offices, a 6-C oscillator may be used to supply signaling

current. The interruption of the 1000-cycle current is effected by relays operated by current from the 20-cycle ringing current supply in the office so the frequency of interruption is the same as the frequency of this source. It should be between 18⅓ and 20 cycles to insure satisfactory operation of the ringers in all cases. In offices equipped with a 16⅔-cycle supply, it is necessary to change this frequency to meet the limits given above if the arrangement employing the 6-C oscillator is used for supplying signaling current. If this is not convenient, a 1000-cycle motor-generator set is used. Signaling current can be supplied to about 50 ringers of the two-tube type, from one 6-C oscillator.

6.11 Means for checking the frequency and output of the arrangement employing the 6-C oscillator have been provided. The frequency is checked by beating against a source of 1000-cycle current such as a 6010-B oscillator which may be located in the same office or in a distant office. The frequency should not differ from 1000 cycles by more than 20 cycles. In offices equipped with a transmission measuring set, a trunk to that set may be provided to permit checking the output of the oscillator. Where a transmission measuring set is not available, the output may be checked by means of the thermocouple panel used with the type C carrier system if this is available, using the trunk provided for this purpose. In other cases a thermocouple voltmeter may be used, and space for it has been provided in the bay in which the oscillators are mounted. The signaling current output may be adjusted as required by means of the resistances provided for that purpose. In very small installations this checking equipment may be omitted.

6.12 A 1500-ohm resistance is provided in each 1000-cycle supply lead to each ringer. An additional resistance of 700 ohms in each lead is provided with terminal ringers and signaling circuits for No. 3 and No. 11 toll switchboards in offices equipped with switching pads. In the case of intermediate ringers additional resistance is provided which may be adjusted as required.

20-Cycle Supply:

6.13 Resistances are provided in the 20-cycle supply leads to each terminal ringer in order to reduce the amount of current sent into the drop circuit during an incoming ring. If sufficient 20-cycle ringing current is not obtained, these resistances may be strapped out either wholly or in part. These resistances are also provided with the 1000-20-cycle intermediate ringer for use when this ringer is used in place of a terminal ringer.

6.14 Two leads from the 20-cycle generator, each equipped with an 8-C lamp, are required for each bay of terminal ringers or 1000-20-cycle intermediate ringers, one lamp being provided for each six ringers or less. A 1½-ampere fuse is required for each five lamps.

135-Cycle Supply:

6.15 One pair of leads from the 135-cycle supply equipped with a 74-type heat coil in each lead is required for each bay of 1000-135-cycle intermediate ringers. A 200-ohm resistance is provided in each lead to each ringer at the top of the bay, and in addition, resistances are provided on each ringer panel which may be strapped as required to obtain the desired output of 135-cycle current.

7. CIRCUITS AND CIRCUIT DESCRIPTIONS:

7.1 Table 1 is a list of the standard drawings pertaining to 1000-cycle two-tube ringing equipment. Detailed circuit descriptions will be found in the associated CD sheets.

TABLE 1

1000-Cycle Terminal Ringer	SD-61385-03
1000-Cycle Signaling Circuit for Use with No. 3 and No. 11 Toll Switchboards	SD-61385-02
1000-20-Cycle Intermediate Ringer	SD-61385-04
1000-135-Cycle Intermediate Ringer	SD-61385-05
Battery Supply Circuit for 1000-Cycle Signaling Circuits	SD-62779-01
Cutoff Relay Circuit for Use with 1000-Cycle Terminal Ringer	SD-61390-03
Directional Selection Circuit for Use with No. 3 and No. 11 Toll Switchboards	SD-62529-01
Cutoff Relay Circuit for Use with 1000-Cycle Intermediate Ringers	SD-61391-02
Spare Cutoff Relay Circuit for Use with 1000-Cycle Terminal Ringers	SD-62192-03
Spare Directional Selection Circuit for Use with No. 3 and No. 11 Toll Switchboards	SD-62529-02
Spare Cutoff Relay Circuit for Use with 1000-Cycle Intermediate Ringers	SD-62194-02
Spare Cutoff Relay Circuit for Use with 1000-Cycle and 135-Cycle Terminal Ringers Operating as a 1000-135-Cycle Intermediate Ringer	SD-62205-02
Patching Trunk for Terminal and Intermediate Ringers	SD-62193-02
Testing Circuit for 1000-Cycle Ringers	SD-61389-01
Testing and Adjusting Circuits for 135-Cycle Ringers—546-A Panel	SD-62314-01
Filament Activity Test Circuit	SD-61308-03
Testing Circuit for Signaling Circuits for No. 3 and No. 11 Toll Switchboards	SD-61085-01
Portable Meter Circuits	SD-62098-01
Telephone Set and Ringdown Trunk Circuit	SD-62599-01
1000-Cycle Supply Circuit Employing 6-C Oscillators	SD-62263-01
Testing Circuit for Use with 1000-Cycle Supply Circuit Employing 6-C Oscillators	SD-62530-01

(This section consists of excerpts from D. & R. Bulletin No. 430.)

AMERICAN TELEPHONE & TELEGRAPH CO.
Department of
Development and Research

TOLL SIGNALING EQUIPMENT

1000 CYCLE TERMINAL RINGER

Schematic Showing General Arrangement in Toll Line Circuit of Ringer and Circuit to Reduce Effect of Echoes

172-A-34
Standard
Replacing 166-A-98

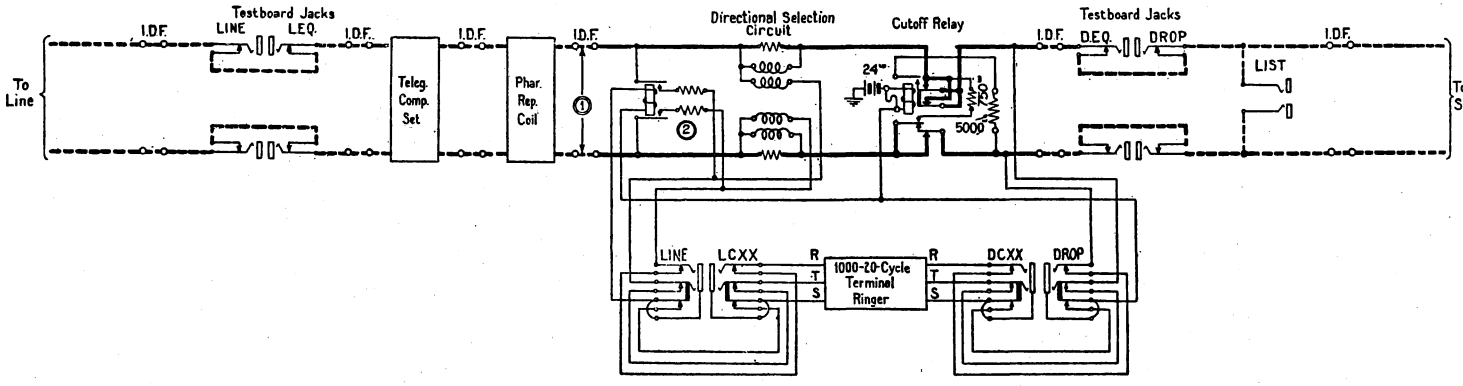
Engineer MKO.
Draftsman L.F.U.
Checked by

Log:No.P21298-6-25
ISSUE 1

Added "Replacing 166-A-98" to rating, Revised Note 2. Made minor corrections and changes. a.c.t.
Log No. P-22016 6.29.29.
ISSUE 2

Changed Cutoff Relay.
Log No. P-22016 6.29.29.
a.c.t. ISSUE 3

Was "Provisional" rated "Standard"
Log No. S-13340
7.18.29.
ISSUE 4



-NOTES-

① The 1000-cycle terminal ringer may be crossconnected at this point to the drop side of the phantom repeating coil, to the drop side of a terminal repeater, to the two-wire side of a four-wire terminating set, or to the two wire-side of a type "C" carrier channel, as required.

② These resistences are required only when the circuit is equipped with a switching pad between the ringer and the switchboard.

AMERICAN TELEPHONE & TELEGRAPH CO.
Department of

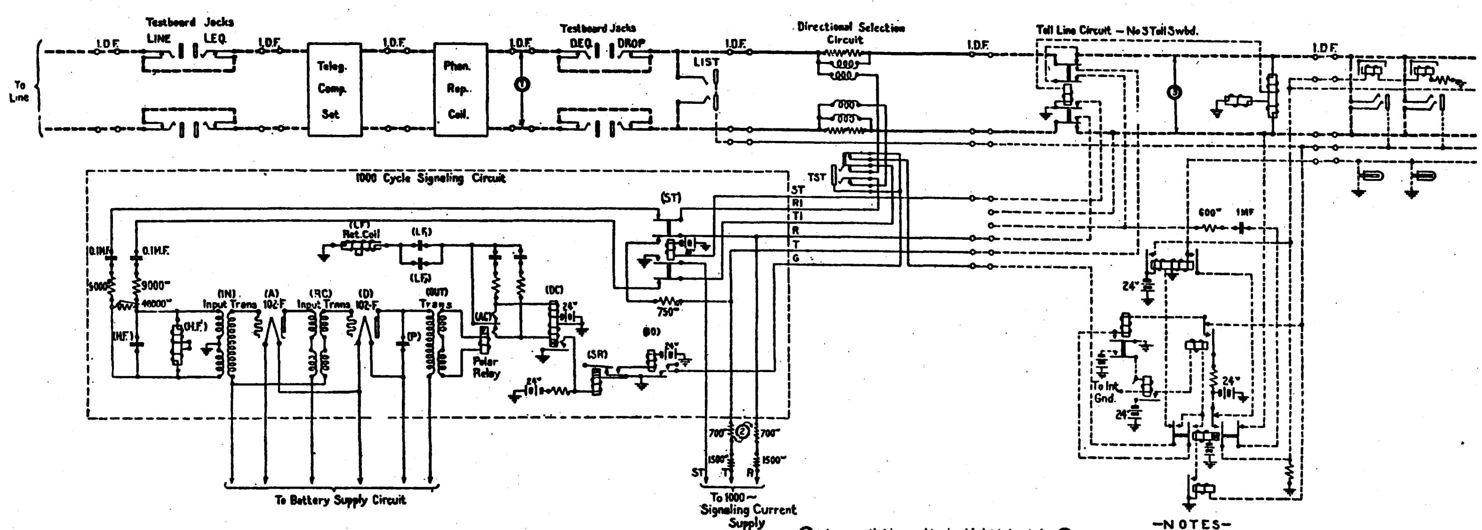
TOLL SIGNALING EQUIPMENT

1000 CYCLE SIGNALING CIRCUIT FOR NO.3 AND NO.11 TOLL SWITCHBOARDS

Schematic Showing General Arrangement in Toll Line Circuit of Signaling Circuit and Circuit to Reduce Effect of Echoes

167-A-4
Standard
Replacing 166-A-99

Engineer ... Draftsman Checked by ...
Log No. P21297 ... ISSUE 1
Added 48000~ resistance in 1000~ signaling circuit. Made minor additions and changes. Log No. P-21656 ... ISSUE 2
Added "Replacing 166-A-99" to rating. Revised note 2 and added note 3. Removed resistance across filament of tube (D). Made minor corrections and changes. Log No. P-21915 ... ISSUE 3
Was "Provisional" rated "Standard". Log No. S-13341 ... ISSUE 4



③ When a switching pad is provided, it is located at this point in the circuit.

—NOTES—

① Crossconnection at this point may be to the drop side of the phantom repeating coil, to the drop side of a terminal repeater to the two-wire side of a four-wire terminating set, or to the two-wire side of a type C carrier channel, as required

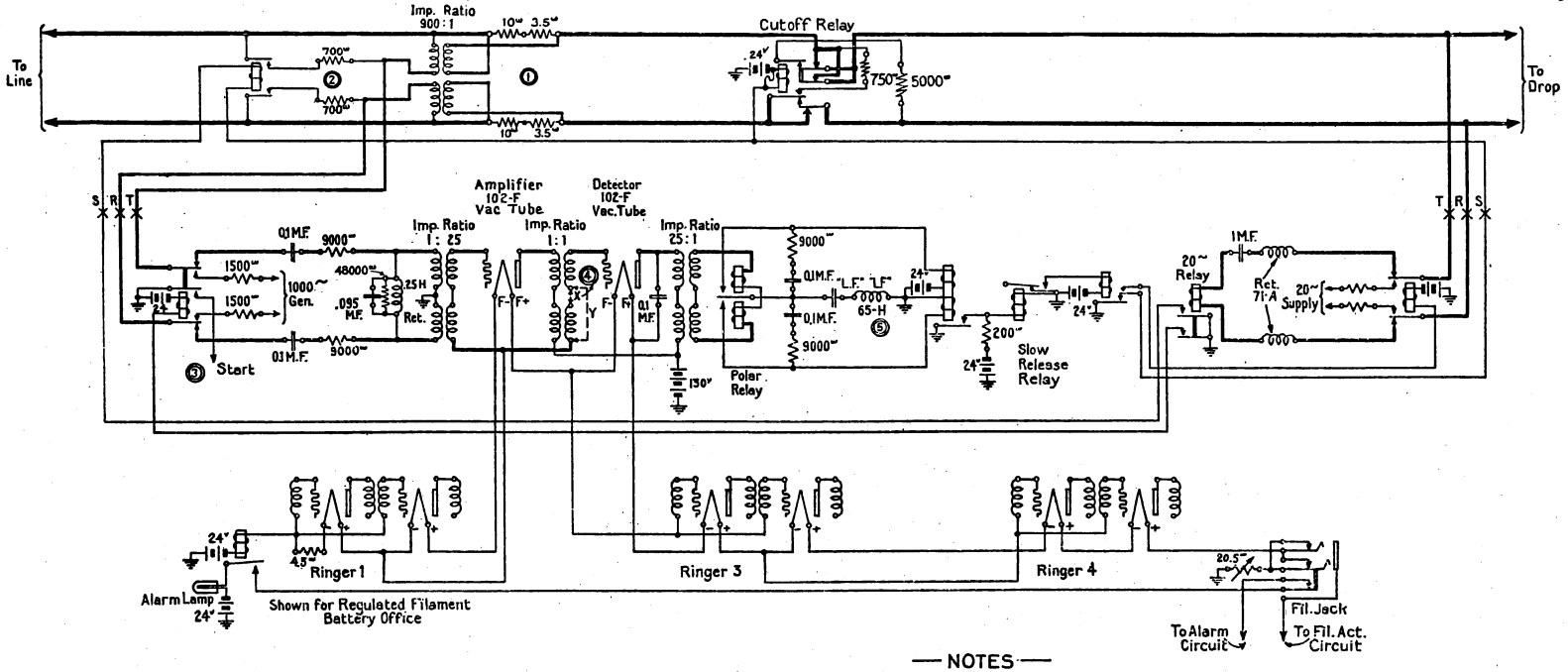
② When the circuit is not equipped with a switching pad these resistances shall be strapped out.

AMERICAN TELEPHONE & TELEGRAPH CO.
Department of
Development and Research

1000 CYCLE TERMINAL RINGER

IMPROVED TYPE
Schematic Diagram of Circuits.

908-138
Revised 10-13-28 Cmb
" 5-6-29 Cmb
" 7-2-29 Cmb



NOTES

① The 3.5" resistances are strapped out when line terminates in a switching pad office.

② The 700 "resistances are strapped out when line is not equipped with switching pads.

③ This lead is required when oscillator is used to supply 1000-cycle ringing current.

④ Use "X" strapping for all cases except when ringer is connected to a point in the circuit where the transmission level is higher than zero. In these cases use "Y" strapping.

⑤ The "L.F." condenser is strapped at the factory to adjust the resonant circuit including retardation coil "L.F." to equal impedances at frequencies of 18⅓ and 20 cycles. This capacity will be between 0.92 and 1.20 M.F. Cmb 12/21/27

AMERICAN TELEPHONE AND TELEGRAPH CO.
Department of
Development and Research.

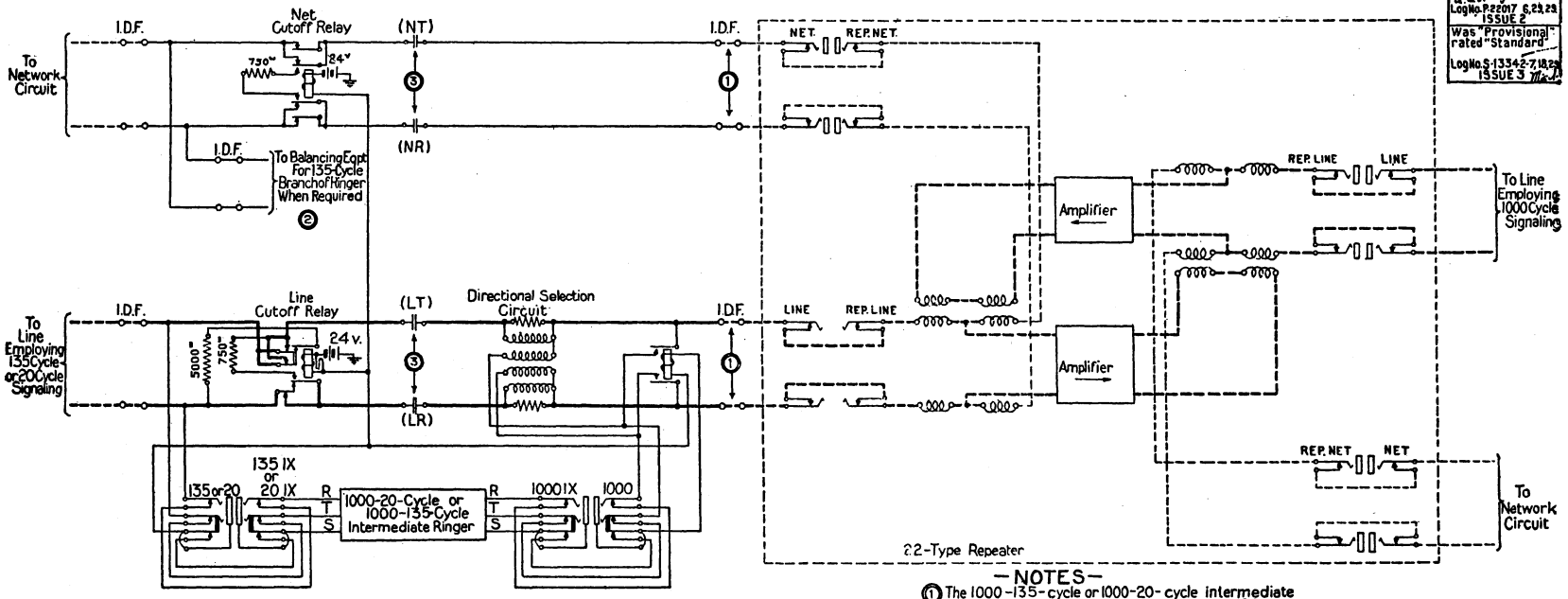
TOLL SIGNALING EQUIPMENT

1000-135-CYCLE AND 1000-20-CYCLE INTERMEDIATE RINGERS

Schematic Showing General Arrangement in Toll Line Circuit of Ringers and Circuit to Reduce Effect of Echoes.

167-A-60
Standard
Replacing Dwg 165-A-85

Engineer a.c.j.
Draftsman
Checked by,
Log No. P.21914 5.14.28
ISSUE 1
Changed Cutoff Relays, a.c.j.
Log No. P.22017 6.29.28
ISSUE 2
Was "Provisional" rated "Standard"
Log No. S-13342-7.18.28
ISSUE 3



—NOTES—

① The 1000-135-cycle or 1000-20-cycle intermediate ringer may be crossconnected at this point to a 22-type repeater, a four-wire terminating set, or a type "C" carrier circuit, as required.

② Balancing equipment for the 135-cycle branch of the ringer is required only when a balance better than 40 db at 800 cycles and 29 db at 300 cycles is desired.

③ These condensers should be strapped out when this circuit is used with a four-wire terminating set.