

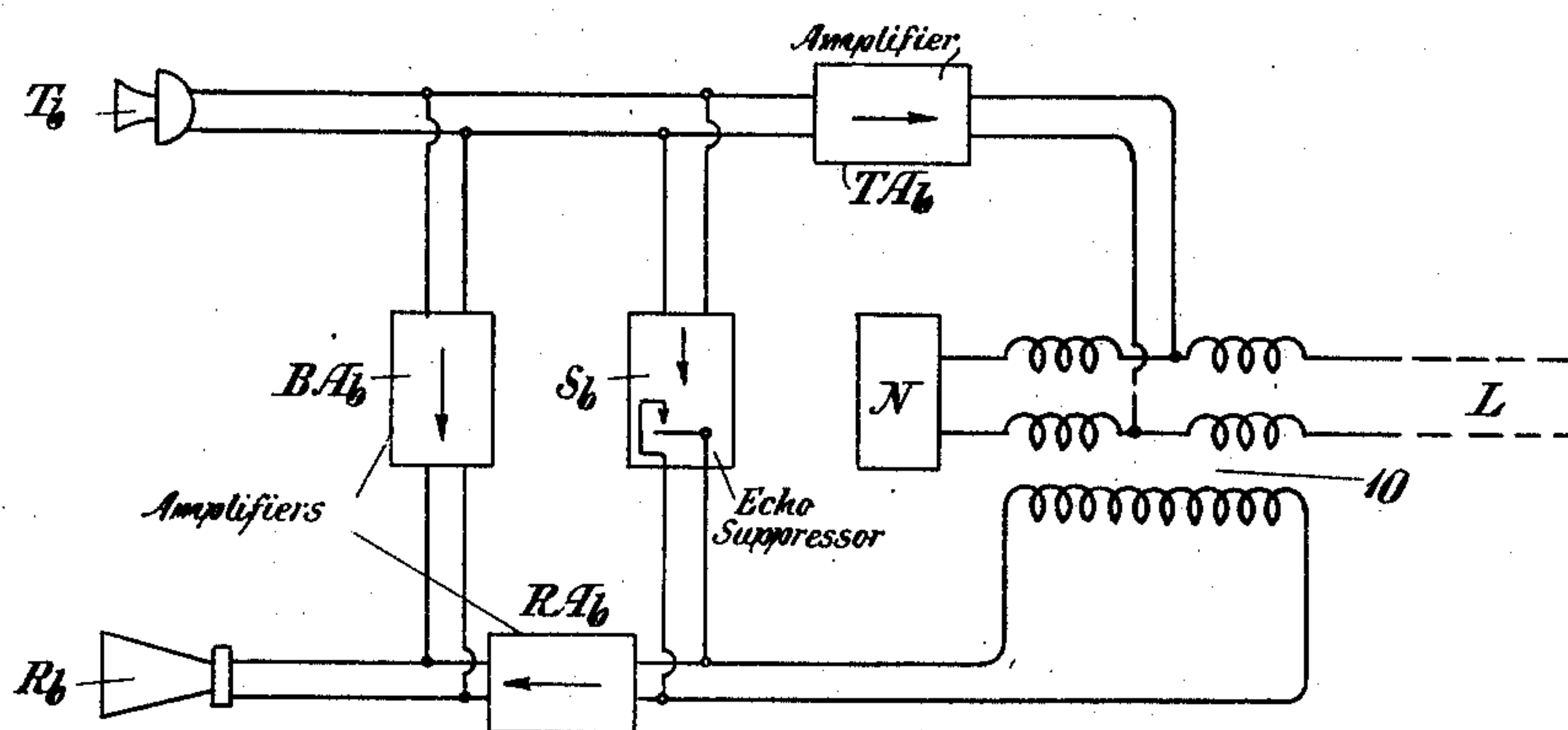
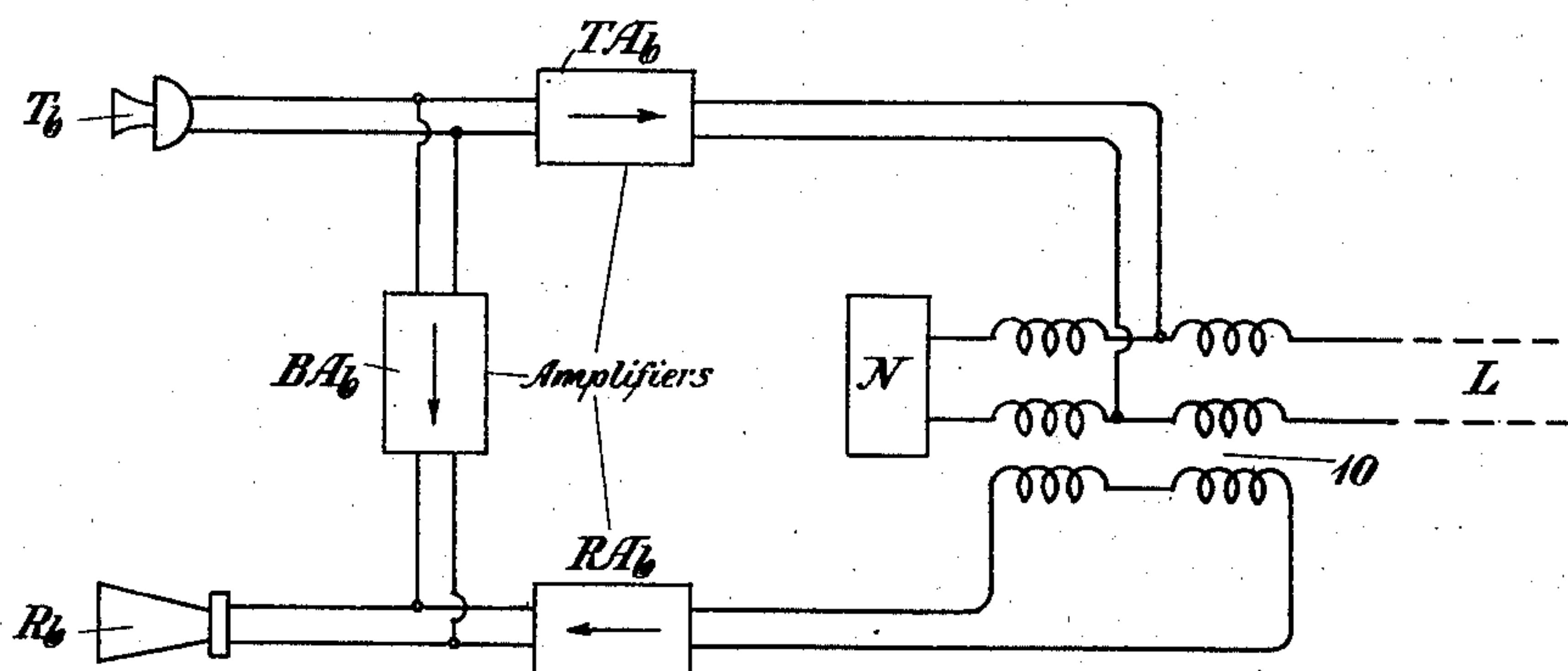
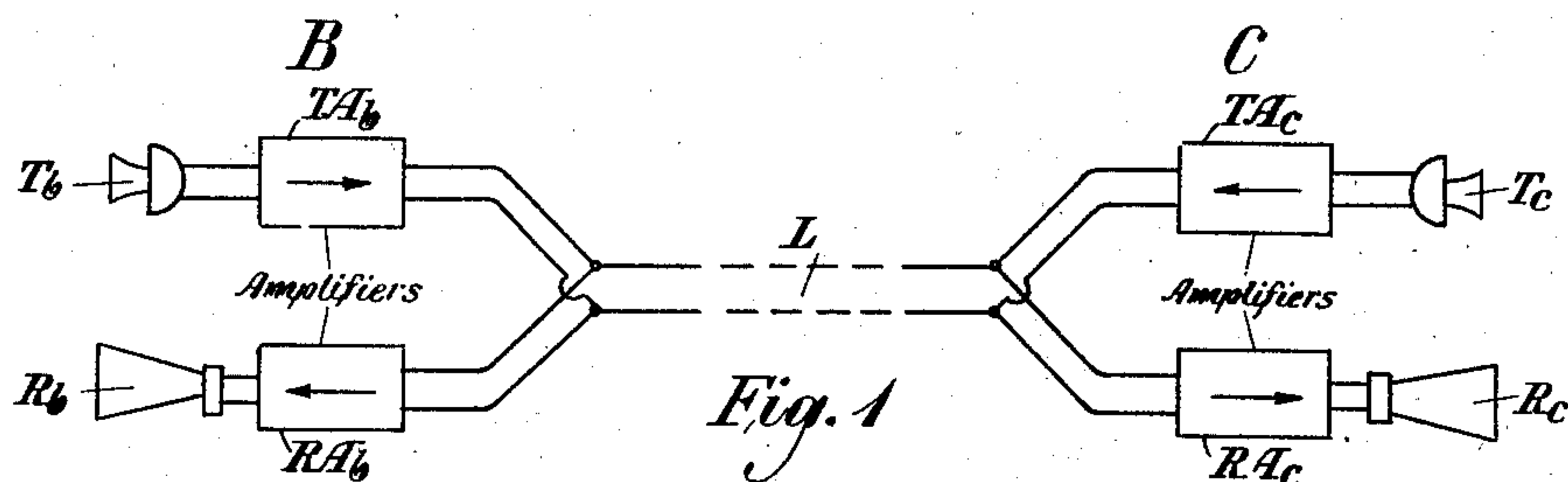
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TRANSMISSION CIRCUITS

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TRANSMISSION CIRCUITS.

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This invention relates to transmission systems, and more particularly to transmission systems adapted for interconnecting public address systems or radio broadcasting stations or the like, to enable a plurality of widely separated audiences to hear speech or music presented before either.

Where a plurality of public address systems or radio broadcasting stations are interconnected so that a program presented at any station may be heard at all of the others, difficulty arises from the fact that the audience at a particular station will hear the program from the local transmitter better than programs transmitted from distant transmitters. This arises from the fact that a transmission loss inevitably occurs in transmitting from the distant to a particular local station. Heretofore it has been proposed to provide a special interconnecting arrangement between each receiver and its local transmitter to regulate the volume transmitted but such arrangements are not satisfactory where the transmission loss from distant points is determined by echo effects. It is therefore one of the objects of the present invention to provide a circuit arrangement for interconnecting a plurality of public address systems or radio broadcasting stations in such a manner that a local audience will hear the program from the local transmitter with substantially the same volume as that from a distant transmitter notwithstanding echo effects.

This and other objects of the invention are attained by means of the arrangements set forth in the following detailed description and illustrated in the accompanying drawing, Figure 1 of which shows a simple arrangement for interconnecting two public address systems; Fig. 2 of which shows an arrangement which will permit equalization of volume as between the local and distant transmitter if no echo effects are present; and Fig. 3 of which shows an arrangement for accomplishing the same result in accordance with the present invention even when echo effects are present.

Referring to the drawing, Fig. 1 shows schematically a simple form of two-way arrangement for interconnecting two public address systems or radio broadcasting stations so as to enable two widely separated audiences to hear speech or music presented before either. As will be seen the transmitter T_b and loud speaker or other form of receiver R_b at the station B are bridged to one terminal of the transmission line leading to the distant station C. At the latter station the transmitter T_c and receiver R_c are similarly bridged across the terminals of the line. One-way amplifiers, such as TA_b , RA_b , etc., are connected in each branch. It is of course understood that the line may include suitable two-way repeaters at various points, as is customary.

Since the system above described is symmetrical, and the speakers may be assumed, for purposes of comparison to have voices of equal volume, the receiving apparatus at either station will receive from the distant station a smaller volume of speech than from the nearby transmitter, this difference being equal to the transmission loss in the line. This difference in volume becomes very annoying when it is very great. If an attempt is made to overcome the difficulty by reducing the gain of the nearby transmitter amplifier, such as TA_b in the case of the transmitter T_b , the same volume may be heard in the local receiver R_b from the local transmitter T_b and from the distant transmitter T_c . Unfortunately, however, such adjustment produces a corresponding decrease in the volume from the transmitter T_b as heard in the receiver R_c at station C. It is evident, therefore, that with such an arrangement as that shown in Fig. 1 it is impossible to equalize the volume for transmitters at different stations.

In order to overcome this difficulty the arrangement shown in Fig. 2 has been proposed, and where no echo effects are present this arrangement will give quite satisfactory results. In this case the branches to the local transmitter T_b and local receiver R_b

are interconnected with the line L through a hybrid coil 10, the line being balanced by the usual network N. By this arrangement the local transmitter and receiver may be made substantially conjugate with respect to each other so that the local transmitter does not transmit to the local receiver through the common connection to the line L. In order that transmission may take place between the local transmitter and the local receiver, a by-pass connection including a suitable amplifier BA_b is provided. If the balance at the hybrid coil 10 is good and there are no echoes returning from the line to the receiver, the receiver will not be affected by currents from the transmitter by way of hybrid coil 10, and the gain in the by-pass circuit may be so adjusted that the receiver will receive the same volume from the local transmitter T_b as it receives from the distant transmitter.

The above described arrangement will not permit the equalization of volumes where talker echo effects are of serious consequence. In order to understand how the echo effects bear on the equalization of volume, it will be necessary to say a word as to the nature of echoes. In general, echoes are of two kinds—talker echoes and listener echoes. When the voice currents originating at a transmitter are transmitted to a distant point and there encounter impedance irregularities, the currents reflected back to the local receiver are known as talker echo currents. If, however, the voice currents, after being reflected back once encounter another impedance irregularity and are again reflected in the direction of original transmission, the currents thus transmitted to the distant receiver are known as listener echoes.

Now suppose we have a transmission line with a number of two-way repeaters located at suitable points, and the gain of one of the two-way repeaters in each direction is raised one unit. Obviously, the direct transmission over the line is only raised one unit. Talker echoes, however, pass through this repeater twice, once in the direction of original transmission and once when they are reflected back to the local receiver. Listener echoes, on the other hand, will pass through the repeater three times, for not only are they reflected back towards the local receiver but they are again reflected through the repeater in the original direction. Obviously, then, the echo currents are amplified to a greater extent than the direct transmission, and as we attempt to reduce the transmission loss of the line by increasing the gain of the amplifiers, a point is reached where the echo currents have been so amplified as compared with the direct transmission that the situation becomes intolerable.

Thus, it will be seen that echo currents become a limiting factor in determining the transmission equivalent of the circuit, and limit the gain to which the repeaters may be set to a point below singing. Depending on the electrical characteristics of the line, its physical make-up, etc., in some instances talker echoes limit the gain of the repeaters in the line and in other instances listener echoes limit the gain.

When the line connecting two stations is of such type that its minimum net loss is limited by talker echoes, the arrangement shown in Fig. 2 does not permit the equalization of volumes because the hybrid coil 10 does not keep the echoes from the line out of the receiver. The talker echoes coming from the line are heard in the receiver R_b with the same volume as in the case of Fig. 1. Consequently, the by-pass amplifier BA_b must be adjusted to give at least the same volume of sound from the transmitter as in Fig. 1 in order to avoid trouble from echoes. That this is so will be clear if we consider that the amplifier BA_b in Fig. 2 is adjusted so that the same volume of sound is heard in the receiver R_b from the local transmitter T_b as would be the case with the circuit set up as shown in Fig. 1. If, under these conditions, the amplifiers in the transmission line L are adjusted until talker echoes limit further increase in the gain of repeaters it will be evident that the gain of the amplifier BA_b cannot be cut down without reducing the signal as compared with the echoes. As this would be intolerable under the conditions just outlined, it is clear that the difference between the volumes of sound from the local transmitter and the distant transmitter is the same in both arrangements under the conditions where the minimum net loss is limited by talker echoes.

If the line L is of such a character that its minimum net loss is determined by listener echoes (or by other causes than talker echoes) it would be possible to reduce the gain of the by-pass amplifier BA_b or increase the gain of the amplifier RA_b until talker echoes prevent further changes. In other words, so far as listener echoes are concerned, since their magnitude is not determined by the volume of the signal from the transmitter T_b , and by-pass amplifier BA_b may have its gain reduced until the signal volume from the transmitter T_b is the same as the signal volume from the distant station. On the other hand, if we consider the signal volume from the transmitter T_b as being fixed, and adjust the amplifier RA_b to bring the volume of the signal from the distant station up to that from the local station, no discrimination results so far as listener echoes are concerned, for the listener echoes are amplified only to the same extent as the desired

signal currents. It must be noted, however, that these adjustments can be made only to the extent that talker echoes do not interfere. If there were no talker echoes present the arrangement of Fig. 2 might be adjusted to produce a full equivalence between signals from the local transmitter and signals from the distant transmitter. If talker echoes are present, however, the equalizing adjustment cannot proceed beyond the point at which the talker echoes effectively limit the gain. The difference in the volumes heard from the local transmitter and the distant transmitter will in this case be less than the net loss of the line by the change in gain of the by-pass or receiver amplifiers permitted by the talker echoes.

Since talker echoes will occur in all cases where echoes are present at all, and since talker echoes definitely limit the equalizing adjustment which may be made in the arrangement of Fig. 2 it becomes desirable to provide the circuit with an echo suppressor as shown in Fig. 3. Here the echo suppressor unit S_b (which may be of the well known type, including an amplifier rectifier arrangement for operating a relay contact by rectified voice currents), has its input side bridged across the transmitter path and its short-circuiting contact arranged to be bridged across the receiver path. When voice currents are transmitted from the transmitter T_b , the echo suppressor operates to short-circuit the receiver at a point between the amplifier RA_b and the line L . Consequently, when the speaker at the local transmitter is talking, no echo currents can enter the receiver R_b . It is therefore permissible to adjust the gain of the amplifier BA_b to produce the same volume from the local transmitter as that heard from the distant transmitter. When the distant transmitter is operating, the echo suppressor is of course without effect, and the listener echoes enter the receiver. The only effect of these echoes, as has been previously pointed out, is to limit the gain of the repeaters in the line L . Consequently, if the line is adjusted so that a proper ratio exists between signal and echo, no harm results.

If the line L includes a number of 22-type repeaters, of which one or more is equipped with echo suppressors of the ordinary type, so that the net transmission loss is greatly reduced, the difference between the volume of the signal from the local transmitter and the distant transmitter may, in some cases, be small enough so that the provision of a special echo suppressor at the terminal stations, as shown in Fig. 3, will not be necessary.

It will be obvious that the general principles herein disclosed may be embodied in

many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:—

1. In a transmission system, a transmission line extending from a signaling station to a distant station, a transmitting path and a receiving path substantially conjugately connected to said line, a by-pass connection between the transmitting path and the receiving path to determine the volume of transmission from the transmitting path which will be heard over the receiving path, and means to prevent currents transmitted from the transmitting path over the line toward the distant station and then reflected back toward the originating station as echo currents, from entering said receiving path.

2. In a transmission system, a transmission line extending from a signaling station to a distant station, a transmitting path and a receiving path associated with said line at said first-mentioned station, means to render said paths substantially conjugate with respect to each other, a by-pass connection between the paths to determine the volume of transmission from the transmitting path to the receiving path, and an echo suppressor responsive to signaling currents to prevent talker echo currents from entering said receiving path.

3. In a signaling system, a transmission line extending from a signaling station to a distant station, a transmitting path and a receiving path associated with said line, means to render said paths substantially conjugate with respect to each other, a by-pass connection between the paths to determine the volume of transmission from the transmitting path to the receiving path and an echo suppressor responsive of currents transmitted from the transmitting path to prevent transmission from the line to said receiving path.

4. In a signaling system, a transmission line extending from a signaling station to a distant station, a transmitting path and a receiving path connected to said line at said first-mentioned station through a hybrid coil, a balancing circuit for said line, a transmitter associated with the transmitting path and a receiver associated with the receiving path, a by-pass connection extending from the transmitter to the receiver independently of said hybrid coil, means in said by-pass to control the volume of said transmission from the transmitter to the receiver, and an echo suppressor associated with said transmitting path and responsive to currents transmitted from said transmitter to prevent echo currents from being transmitted from the line through said hybrid coil to the receiving path.

5. In a transmission system, a transmission line extending from a signaling station to a distant station, a transmitting path and a receiving path associated with the line at said first-mentioned station, means to render said paths substantially conjugate, a by-pass connection from the transmitting path to the receiving path to determine the volume of transmission from the transmitting path to the receiving path, and means responsive to signaling current transmitted toward the distant station and then reflected toward said receiving path to prevent said currents from being transmitted over said receiving path. 15

In testimony whereof, we have signed our names to this specification this 22nd day of October 1925.

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