

April 25, 1933.

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1,905,359

CHANNEL SELECTION

Filed Nov. 14, 1931

3 Sheets-Sheet 1

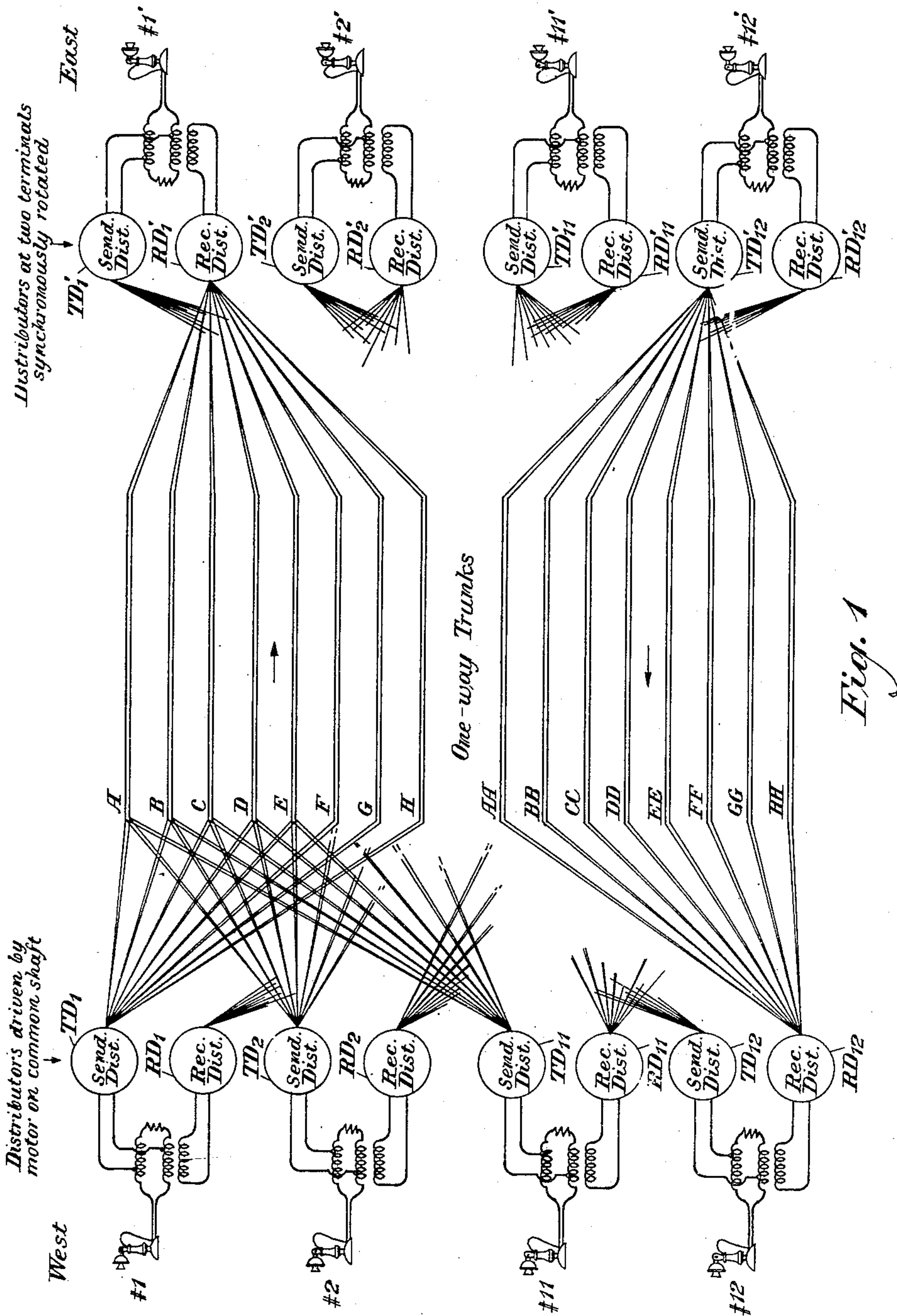


Fig. 1

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3 Sheets-Sheet 2

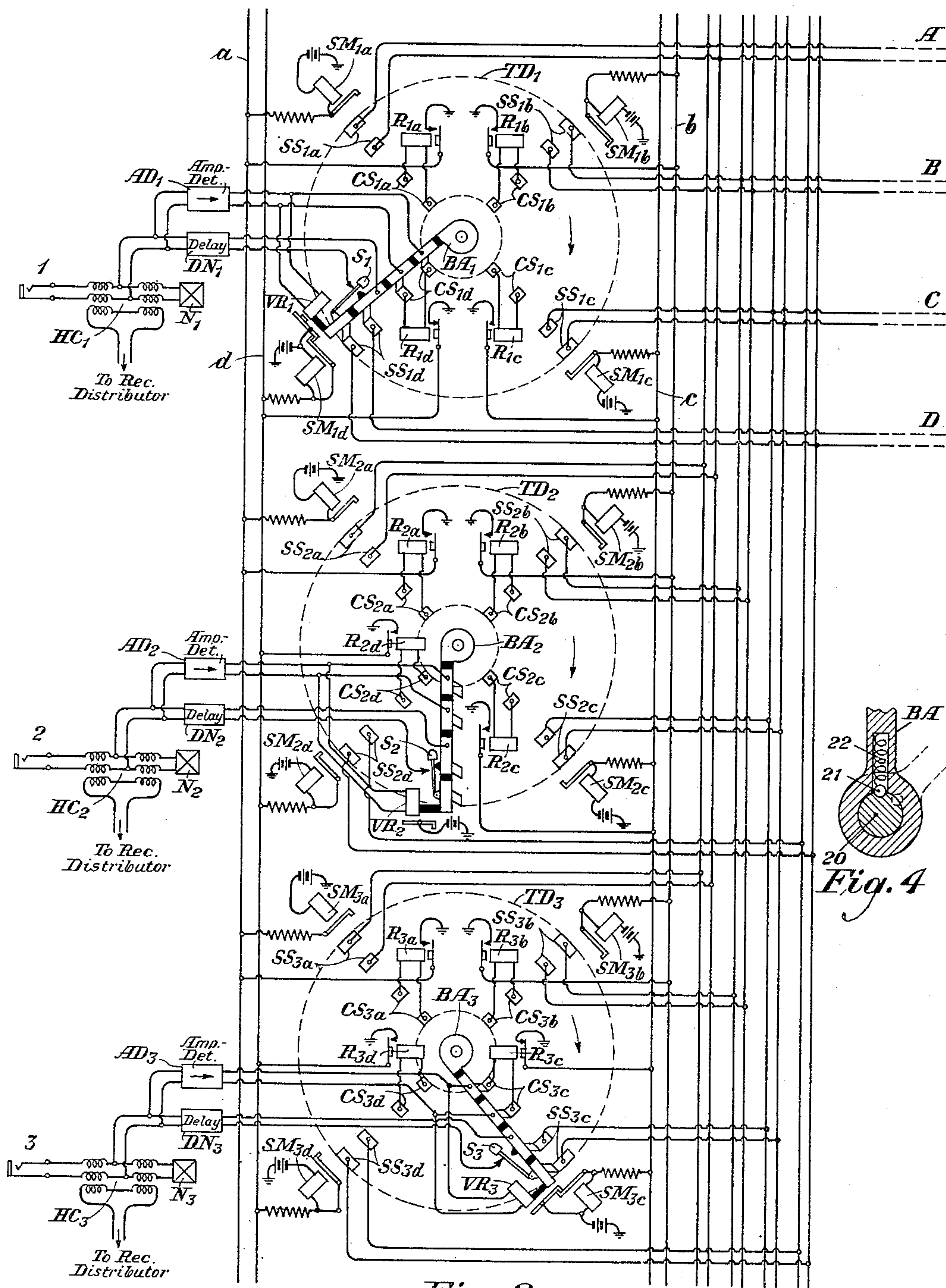
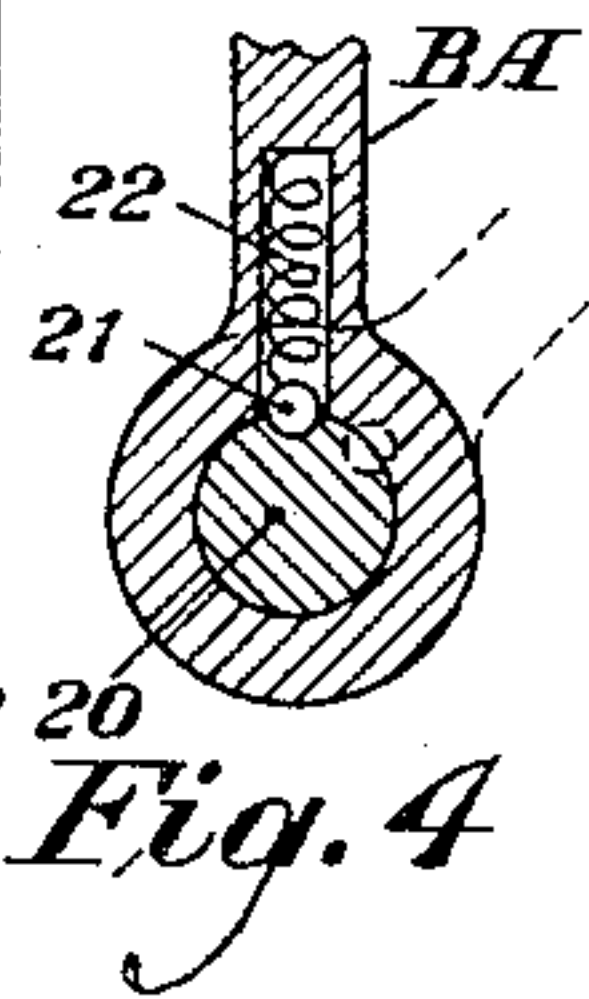


Fig. 2



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3 Sheets-Sheet 3

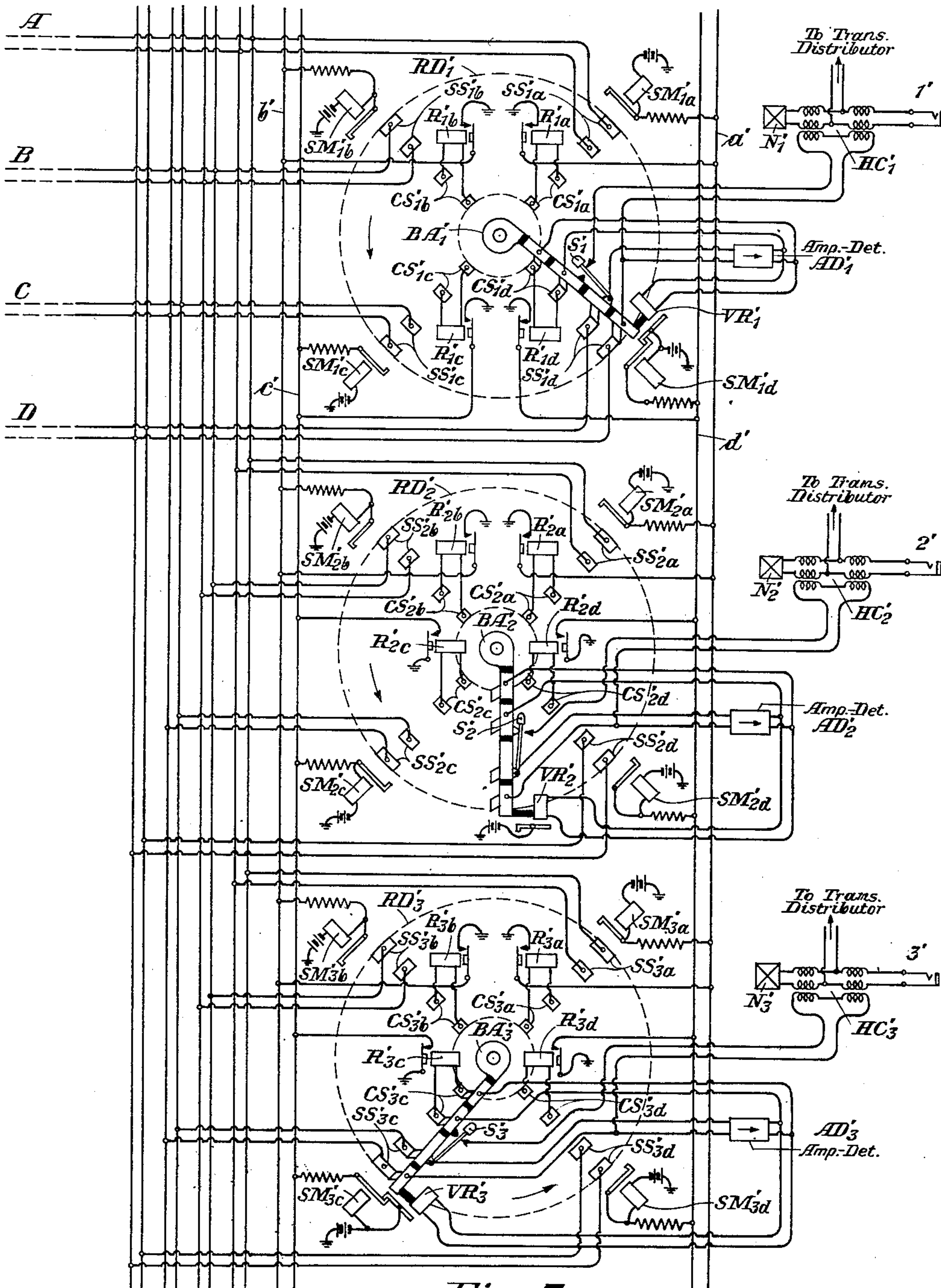


Fig. 3

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CHANNEL SELECTION

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This invention relates to the provision of communication facilities and more particularly to arrangements for decreasing the amount of idle time of the circuits assigned for communication.

In many forms of long distance telephone transmission and, indeed, in other forms of two-way communication, the so-called four-wire type of operation is commonly employed as, for example, in four-wire cable circuits, carrier telephone circuits, two-way radio communication circuits, etc. In four-wire cable operation, for example, a pair of wires together with the necessary terminal apparatus and intermediate repeaters are definitely assigned for transmission in each direction. Similarly, in the case of carrier communication a frequency band with the required terminal apparatus and intermediate amplification is set aside for each direction of transmission.

Considering the idle periods due to time lost in switching and making connections, incidental pauses in conversation, etc., a long distance circuit is at best actually carrying speech only a part of the time. In the case of a two-way communication circuit of the four-wire type where a separate transmission path is set up in each direction, this inefficiency in the use of the communication channel is aggravated by the fact that when one channel is being used for transmission in a given direction, the channel in the opposite direction is usually idle. In other words, even after the communication is set up and the subscribers have control of the circuit, each one-way path of a four-wire circuit is used at an average efficiency of only 50 per cent because on the average, transmission takes place in each direction only about one-half of the time.

This lack of efficient use of the circuit facilities may not be of such serious consequence in connection with the average telephone circuit. However, in connection with super-distance circuits such as transoceanic radio, or the proposed transatlantic telephone cable, the talking paths provided are necessarily very expensive and any improvement in the efficiency of use will be pro-

portionately more profitable. It is therefore proposed, in accordance with the present invention, to increase the efficiency of use of the circuits and to approach double the number of conversations with approximately the same number of one-way paths.

This may be accomplished by so arranging the groups of circuits existing between the points that they may be set up not as individual circuits with definite physical facilities assigned for the period of a conversation but rather that the choice of a particular idle circuit may be made automatically each time the subscriber speaks. This arrangement lends itself particularly to operation in the case of four-wire circuits where the one-way trunks can be grouped together in each direction. In the case of a sufficiently large number of circuits between two points the proposed method of operation offers the possibility of providing for at least twice the number of simultaneous conversations obtained with existing arrangements in which the two separate directional paths are definitely set up to form a particular two-way circuit.

The arrangement for selecting channels automatically each time the subscriber speaks may obviously assume many forms, and for purposes of illustration only, a commutator type of selecting arrangement is herein illustrated. Upon this commutator arrangement all of the one-way trunks terminate, and rotating switch arms are connected to the subscribers' terminals, these switch arms being capable of speedily covering in a single revolution all of the switch points representing the terminations of the group of trunks. When the subscriber speaks his voice operates relay arrangements to cause the rotating arm at his terminal to pause in its rotation at an idle trunk. The rotating switch arms at the two subscribers' terminals are arranged to rotate synchronously so that the corresponding switch arm at the receiving end will also be caused to pause at the desired points by virtue of the voice potentials appearing at the receiving terminal. While the foregoing arrangement serves to illustrate the principles in-

involved, it will be understood that the invention is not confined to any particular type of selecting arrangement.

The invention will now be more fully understood when read in connection with the accompanying drawings, in which Figure 1 is a schematic layout showing in a general way the manner in which the trunks are associated with the terminal stations which they serve to connect; Fig. 2 is a circuit arrangement showing the manner in which the trunks are associated with the transmitting selecting apparatus at one terminal; Fig. 3 similarly shows how the trunks are associated with the receiving selecting apparatus at the other terminal; and Fig. 4 is a detail showing the coupling between the distributor arm and the driving shaft for the various distributors.

As previously stated, no regular circuit assignments of the one-way channels between two points will be made, but in connection with the subscriber's talk, each time a person speaks he will automatically pick out an idle trunk—not a particular circuit, but merely one which at that time is not in use. The general layout of such a scheme is shown in Fig. 1. Here two sets of terminals are shown connected by a number of one-way trunks. In the example illustrated the trunks are eight in number in each direction and are designated A, B, C, etc., from west to east and AA, BB, CC, etc., from east to west. These trunks may be one-way cable circuits for transoceanic telephony, radio channels, or telephone transmission circuits of any type. If the practice of the prior art were followed, one set of trunks would be used for transmission in each direction, that is, two channels, one for each direction, would provide one talking circuit and the total number illustrated would, therefore, provide eight four-wire traffic circuits. The proposed arrangement, however, permits approximately double this number of talking circuits.

Each talking circuit is provided with a speech controlled distributor arrangement comprising two distributors at each end of the circuit, as shown schematically on the drawings. Four sets of distributors are shown out of a possible number approaching sixteen, the sending distributors at the west terminal being designated TD₁, TD₂, etc., the receiving distributors at said terminal being designated RD₁, RD₂, etc., while the corresponding distributors at the east terminal have similar reference characters primed. One transmitting distributor and one receiving distributor are associated with each line terminal. When a person talks, for example, at the No. 1 terminal west, the transmitted speech will reach the associated sending distributor TD₁. The function of this distributor is to pick out approximately

instantaneously one of the idle sending trunks designated A to H, inclusive. For the duration of the particular word or phrase spoken by the talker the connection will be established over this particular trunk. At the receiving terminal the trunk will be correspondingly switched by means of the receiving distributor RD₁' to the No. 1' terminal for the same period of time. As soon as the talker finishes the word or phrase the trunk will be released and will then be available for any other subscriber talking in that direction. The arrangement, of course, functions simultaneously in the reverse direction.

The nature of and the connections to the sending and receiving distributors are shown in Figs. 2 and 3, respectively. In Fig. 2 only the sending distributors associated with the terminals are shown, and in Fig. 3 only the receiving distributors associated with the corresponding terminals at the other end are shown so that the actual circuit arrangements illustrated only take care of transmission in one direction, the similar arrangements for transmission in the opposite direction being schematically indicated.

Each distributor consists of a commutator having several sets of segments passed over by brushes attached to a rapidly rotating switch arm. Each set of segments corresponds to one of the one-way trunks to which the distributor has access. In the case illustrated the number of trunks is four and, consequently, the number of sets of segments is limited to four, but with an increase in the number of trunks the number of sets of segments will obviously be correspondingly increased. Also it will be noted that while only three sending distributors are illustrated at the one terminal and three receiving distributors at the other terminal, the number of distributors sending or receiving as the case may be at each terminal will correspond to the number of terminal stations which may approach twice the number of trunks transmitting in a given direction. For example, if there are four west to east trunks, there might be upwards of eight terminal stations at each terminal, and hence, upwards of eight transmitting distributors and a similar number of receiving distributors at each terminal. If the number of west to east trunks is increased to, say, twenty, the number of terminal stations at each terminal will then approach forty with a corresponding increase in the number of distributors.

Each distributor is provided with a rotating brush arm such as BA₁ to which are attached brushes which pass over the various segments. The rotation of this brush arm is governed by a shaft common to all of the distributors at a particular terminal and the connection between the rotating arm and shaft is of the frictional type permitting the

arm to be held by a stop clutch mechanism arranged to stop the arm at any set of commutator segments while the shaft continues to revolve.

5 For reasons which will appear more fully hereinafter it is desirable that when a particular arm is stopped and then again released, it should start in rotation again in the same phase relation with respect to other
10 rotating distributor arms on the same shaft that existed before the arm was stopped. To permit of this possibility the friction clutch arrangement between the brush arm and the shaft may be of the type illustrated
15 in Fig. 4 where the brush arm BA is freely mounted upon the rotating shaft 20. The rotating shaft 20 is provided with a shallow socket into which may enter a ball 21 carried in a suitable recess in the brush arm and
20 spring pressed against the shaft by a spring 22. Whenever the brush arm BA is held by the stop clutch arrangement, the ball 21 will ride out of the socket in the shaft 20 and the shaft will continue rotating while
25 the brush arm is held stationary. When the brush arm is again released the friction between the ball 21 and the shaft 20 is not sufficient to set the brush arm again into motion until the shaft rotates to the point where
30 the ball 21 can again ride into the socket provided for it, whereupon the brush arm will again rotate in the same phase relation which had previously existed with respect to other rotating brush arms on the
35 same shaft. Presumably the brush arms for the different distributors should each occupy a different normal angular position with respect to the shaft, and consequently, the sockets for the balls such as 21 on the various
40 brush arms will be arranged in different angular positions as shown in dotted lines in Fig. 4. For example, in the case illustrated in Fig. 2, where there are four trunks and may be as many as eight sending distributors and, consequently, eight sending
45 brush arms associated with said trunks, there should be eight different angular positions for the brush arms and hence, the several sockets corresponding to the brush arms should be 45 degrees apart. The angular
50 width of each set of commutator segments on the distributors should be less than the spacing between successive brush arms so that there is no possibility of two rotating brush arms passing over corresponding sets of commutator segments at the same time.

The terminal connections to which subscribers may be connected are represented by jacks such as 1, 2, etc. Each jack is connected
55 to a hybrid coil arrangement such as HC₁ from which a transmitting branch leads to the corresponding transmitting distributor TD₁ and the receiving branch leads to the corresponding receiving distributor, not
60 shown. The connection to the receiving dis-

tributor will be as indicated from the corresponding hybrid coil HC₁' at the opposite terminal (see Fig. 3). The transmitting connection from the hybrid coil is in turn divided
70 into two branches one of which includes an amplifier-detector such as shown at AD₁, the function of this amplifier-detector being to produce an operating current for controlling the switching operations to be later described. The other branch includes a delay
75 circuit for holding up the transmission of the speech currents until the switching operation has taken place.

Each set of commutator segments comprises four segments of which the outer pair
80 is connected to a trunk such as the trunk D and of which the inner pair is connected to a relay such as the relay R_{1a} of Fig. 2. The brush arm carries a corresponding number of wipers. Each distributor, as, for example, the distributor TD₁, is provided with
85 four sets of stop magnets, one for each set of commutator segments, the stop magnets being designated SM_{1a}, SM_{1b}, etc. One of these stop magnets corresponds to each of the trunks A, B, etc., and when the trunk is idle the stop magnet will be deenergized so that a detent upon its armature will be in the path of a corresponding detent upon the armature
90 of a voice-operated relay VR₁ carried by the brush arm. Consequently, if the voice-operated relay VR₁ is energized, its armature will engage with the detent of the first stop magnet which it encounters and brings the
95 brush arm to rest upon the corresponding set of commutator segments. The relays, such as R_{1a}, R_{1b}, etc., associated with the several sets of commutator segments of a given distributor, serve the purpose of energizing
100 corresponding stop magnets of other distributors, thereby withdrawing their armatures and rendering the corresponding segments of such other commutators busy so that the brush arms of such other commutators
105 will not stop at a corresponding position. The voice-operated relay VR₁ is connected to the output of the amplifier-detector AD₁ and therefore only swings the detent of its armature into the path of the detent of a non-
110 energized stop magnet when voice waves arrive from the terminal 1. Each brush arm also carries a weighted switch arm such as S₁. The inertia of the switch arm serves to hold open a contact in the talking circuit from the delay network DN₁ while the brush
115 arm is in rotation. When the brush arm comes to a stop, however, the momentum of the switch arm causes it to close said contact. This prevents talking currents being picked up from talking segments over which the
120 brush arm passes during its rotation and thereby causing the possibility of false operation, as will be explained later.

The above general description applies to
125 all of the sending distributor arrangements
130

shown in Fig. 2. The apparatus associated with the several receiving distributors shown in Fig. 3 is similar to that already described, corresponding elements being designated by corresponding reference characters primed. The essential difference between the sending and receiving distributors is that the amplifier-detector arrangement such as AD'_1 of Fig. 3 is connected to the outer brushes of the brush arm, and therefore serves to rectify currents incoming from one of the trunks such as D to the corresponding talking segments of the distributor. The output of the amplifier detector is then connected through one branch to the voice-operated relays such as VR'_1 which serves to stop the brush arm, and through another branch to the brushes which pass over the control segments such as CS'_{1d} to which the relays such as R'_{1d} are connected. The talking brushes of the brush arm are connected over a branch ahead of the amplifier-detector to the receiving side of the hybrid coil such as HC'_1 . This talking connection is normally held open during rotation by a weighted switch arm such as S'_1 similar to the switch arm described in connection with the sending distributor.

Further details of the apparatus will be clear from a description of the operation, which is as follows:

Let us assume that a subscriber's line is connected to the jack 1 and that the subscriber is carrying on a conversation with another subscriber whose line is connected to the jack 1'. If the subscriber connected to the jack 1 should speak, voice currents would pass into the transmitting connection from the hybrid coil and enter the delay network DN_1 which serves to delay the transmission of the voice currents until the voice-operated relay VR_1 has operated. Some of the voice energy will be diverted into the amplifier-detector AD_1 and appear upon the output side thereof in rectified form. A part of the rectified current then enters the winding of the voice-operated relay VR_1 to energize said relay and thereby cause the detent on the armature of the relay to be moved into such a position that it will engage the corresponding detent of any deenergized stop magnet. All stop magnets correspond to any of the trunks A, B, C, D, which are at the moment engaged will be energized and have the detents of their armatures drawn out of the detent of the armature of the voice relay VR_1 .

If we assume that the trunk D is at the moment not engaged, the stop magnet SM_{1d} will be deenergized at the moment the wipers of the brush arm BA_1 pass over the group of segments opposite the stop magnet SM_{1d} . Consequently, the detent on the armature of the voice relay VR_1 engages the detent on the stop magnet SM_{1d} and therefore brings the brush arm to rest with brushes upon the corresponding group of segments.

When the brush arm thus comes to rest, some of the rectified current on the output side of the amplifier-detector AD_1 passes over the inner pair of brushes of the brush arm and over the segments CS_{1d} to the winding of the relay R_{1d} . Relay R_{1d} is thereby energized and connects ground to the wire d . All of the stop magnets of the various distributors whose subscripts are d are connected to the now grounded wire d and hence, all of the stop magnets such as SM_{2d} and SM_{3d} of other distributors will be energized and their armatures will be pulled out of the paths of the detents of the voice relays carried by other rotating brush arms. Consequently, any other brush arms that are rotated will not be stopped on the segments corresponding to the trunk D. The stop magnet SM_{1d} of the distributor associated with terminal 1, however, is not energized by the connection of ground to the wire d as the engagement of its detent with the detent of the voice relay VR_1 connects a short circuit about its winding.

During the time that the brush arm was rotating, a weighted switch arm S_1 carried by the brush arm was by its inertia caused to rest upon an insulated back contact carried by the brush arm BA_1 . When the brush arm came to rest, however, in the manner above described, the momentum of the weighted switch S_1 caused it to move forward against its front contact, thereby completing a circuit from the output side of the delay network DN_1 to the outer brushes of the brush arm and over the speech segments SS_{1d} to the trunk D. During the time necessary for the brush arm to rotate until it comes to rest upon the segments corresponding to an idle trunk, the voice currents from the terminal 1 are prevented from being transmitted by the open switch S_1 . After the brush arm has come to rest and the weighted switch S_1 has completed the talking circuit, the voice currents pass through the delay circuit and over the speech segments SS_{1d} to the trunk D.

While the brush arm BA_1 was rotating with its voice relay VR_1 energized, it did not come to rest upon the segments corresponding to any trunk which at the moment was engaged because all such trunks had their stop magnets energized so that the detents were drawn out of the path of the detent of the voice relay VR_1 . For example, if we consider the trunk C and refer to the distributor TD_3 which is shown resting upon the segments corresponding to the stop magnet SM_{3c} , it will be seen that the relay R_{3c} is energized to put ground upon the wire c which energizes the stop magnet SM_{1c} of the distributor TD_1 . Therefore, the brush arm BA_1 could not have come to rest upon the segments corresponding to the trunk C. Furthermore, as will be explained later, there is no possibility that two brush arms of dif-

ferent distributors whose voice relays are at the same moment energized by talking currents will come to rest upon sets of segments corresponding to the same trunk because the brush arms when rotated will always be out of phase with each other.

We have now traced the operation to the point where the terminal 1 has been connected to the trunk D and the voice currents are passing over the trunk D. We will now see how the corresponding terminal 1' is connected to the same trunk D and no other during the continuance of the train of voice waves from the terminal 1. The voice currents now transmitted to the trunk D pass over said trunk to the speech segments SS'_{1d} of the receiving distributor RD'_1 and also pass to the corresponding speech segments of the distributors of the other receiving terminals. The brush arm BA'_1 during its continuous rotation has its receiving connection from its outer segments to the hybrid coil HC'_1 held open by the inertia of the weighted switch S'_1 so that any speech currents picked up from talking trunks as its outer brushes pass over the speech segments corresponding to such trunks are not transmitted to the terminal 1' so long as the brush arm continues to rotate. Each time the outer brushes pass over energized speech segments, voice currents pass to the amplifier-detector AD'_1 and some of the rectified output energy causes voice relay VR'_1 to move its detent outwardly. The brush arm is not brought to rest, however, upon a set of segments whose speech segments are energized, if the corresponding trunk has already been switched into connection with another talking terminal such as the terminal 3', because in that case the corresponding stop magnet of the distributor RD'_1 will be energized under the control of some other distributor in a manner which will be described later. Furthermore, the brush arm of the distributor RD'_1 will not be brought to rest upon a group of segments that are not energized by speech currents, because in that case the relay VR'_1 will not be energized as the brush arm passes over such set of segments, and hence its detent cannot engage the detent of the stop magnet.

In other words, the brush arm will not come to rest upon the set of segments corresponding to an idle trunk. It can only come to rest upon segments corresponding to a trunk which at the moment is applying speech currents to the speech segments of the set of segments. And it cannot come to rest upon a set of segments corresponding to a trunk which has already been connected to some other terminal. It will come to rest, however, upon the set of segments corresponding to the trunk D because that trunk will not have been connected by any other distributor to any other terminal than the terminal 1' and hence, its stop magnet SM'_{1d}

will be deenergized at the moment the brush arm passes over the group of segments corresponding to the trunk D. As will be more fully explained hereinafter, all of the receiving brush arms which are in rotation have fixed angular positions with respect to the rotating shaft which are out of phase with each other so that only one brush arm will pass over a set of energized segments at a time. Furthermore, the synchronism between the rotating shafts at the transmitting end and at the receiving end is such that when the brush arm BA_1 at the sending end comes to rest and transmits voice currents over the trunk D, the voice currents will arrive at the receiving end of the trunk D and will be applied to the corresponding speech segments SS'_{1d} just before or at the moment the outer brushes of the receiving brush arm BA'_1 are passing over said speech segments. Consequently, the voice relay VR'_1 is energized and its detent engages the detent of the corresponding stop magnet SM'_{1d} which at the moment is energized. This brings the brush arm BA'_1 to rest on the set of segments corresponding to the trunk D.

Some of the rectified voice energy now appearing on the output side of the amplifier-detector AD'_1 passes to the inner or control segments CS'_{1d} and thence to the relay R'_{1d} . This relay is therefore energized and applies ground to the wire d so that all of the corresponding stop magnets of other receiving distributors are energized. Stop magnet SM'_{1d} of the distributor RD'_1 is not energized, however, as its winding is short-circuited by the contact between the detent of its armature with the detent of the voice relay VR'_1 . The switch arm now remains at rest on the set of segments corresponding to the trunk D and will remain associated with this set of segments so long as voice currents continue to come over the trunk D and energize the voice relay VR'_1 . As soon as the brush arm comes to rest the weighted switch S'_1 is by its momentum moved from its insulated back contact to its front contact, thereby completing a circuit from the energized speech segments SS'_{1d} to the hybrid coil HC'_1 so that the speech from the terminal 1 is transmitted to the terminal 1'.

If during the time that speech is incoming from trunk D and the brush arm BA'_1 is resting upon the segments of the distributor RD'_1 corresponding to said trunk, the brush arm of any other receiving distributor passes over the contacts of such other distributor which corresponds to the trunk D, the brush arm of such other distributor will not come to rest even though its voice relay is energized. For example, suppose the brush arm BA'_2 rotates over the segments corresponding to the trunk D with the result that its voice operated relay VR'_2 is energized at that moment. It

cannot come to rest because the ground applied to the wire d' by the relay R'_{1d} of the distributor RD'_1 will have energized the stop magnet SM'_{2d} to pull its detent out of the path of the detent of the voice relay VR'_2 .

It will, of course, be obvious that any brush arm of any distributor will be released as soon as voice currents cease to energize its voice relay. For example, the transmitting distributor TD_1 will have its brush arm released as soon as voice currents cease to arrive from the terminal 1 because the voice relay VR_1 will be deenergized and its detent withdrawn from contact with the detent of the stop magnet SM_{1d} . Similarly, the receiving brush arm BA'_1 will be released and start into rotation again as soon as voice currents cease to arrive from the trunk D, for the voice relay VR'_1 will be deenergized and as a consequence its detent will be withdrawn from contact with the detent of the stop magnet SM'_{1d} . As soon as the two brush arms commence to rotate the previously energized relays, R_{1d} of the transmitting distributor and R'_{1d} of the receiving distributor, will release and remove ground from the wires d and d' , respectively, to release the corresponding stop magnets of other distributors.

If ordinary friction drive arrangements were employed between drive shafts and the brush arms it would be possible for the brush arms of two sending distributors to rotate in phase with each other and in response to voice currents arriving from two sending terminals at the same instant come to rest with their brushes on the segments corresponding to the same trunk. There would then be a possibility that the two brushes on the corresponding pair of receiving distributors (which would presumably be rotating in phase) would come to rest and connect two receiving terminals to the same trunk. This not only would cause a cross connection but might result in getting the brush arms of corresponding sending and receiving distributors out of proper synchronism with respect to each other if no arrangement were provided to prevent this action. A receiving distributor would get out of proper synchronous relation to its corresponding transmitting distributor if, under the conditions above mentioned, one of the transmitting distributors was released by the cessation of voice currents from its terminals before the other sending distributor is released. The two receiving distributors which were stopped upon the same trunk would inevitably be released at the same time upon the cessation of talking current from the trunk to which they are connected. The sending distributors would, however, only be held upon the trunk so long as talk was incoming from the sending terminals with which the distributors are associated. Consequently, when all four of the distributors

involved are released, the two receiving distributors would rotate in phase and the corresponding transmitting distributors would rotate out of phase and with the brush arm of only one of the sending distributors in proper synchronous relation to the corresponding receiving brush arm at the opposite terminal.

The difficulties referred to in the previous paragraph are overcome in accordance with the arrangement disclosed by providing means to assure that when a set of brush arms of distributors at a given terminal are rotated they will always rotate in a fixed angular relationship with respect to the rotating shaft and will be out of phase with each other. This may be accomplished by means of the arrangement previously described in connection with Fig. 4. In this figure let 20 represent the rotating shaft with which all of the brush arms of the various distributors at a given switching station are associated. Each brush arm is connected to the shaft by means of a ball pressed by a spring 22 which ball rests in a socket in the shaft 20. When the ball is in the socket the frictional engagement between the brush arm BA and the shaft 20 is sufficient to cause the brush arm to rotate. When the brush arm is held by engagement with a detent, as previously described, the ball 21 will ride out of the socket and the shaft will continue to rotate without carrying the brush arm with it. The sockets in the shaft 20 for the various brush arms of the various distributors will be arranged at different angular positions about the shaft 20 as indicated in dotted lines in Fig. 4 to show the angular position of a second brush arm. Consequently, when any brush arm is released it will remain stationary until the shaft has rotated to bring its own socket into proper relationship, whereupon the ball enters the socket and the brush arm then rotates with the shaft in the same angular position with respect to the shaft which it occupied before it was stopped by engagement with the detent.

Each brush arm, therefore, when rotated must necessarily rotate in a different phase relation with respect to every other brush arm. Consequently, if two subscribers at the sending terminal should both commence talking at the same time, there is no possibility of two sending brush arms stopping upon the segments corresponding to the same subscriber. For example, if the subscribers corresponding to terminals 1 and 2 should both commence talking at once and the brush arm of distributor TD_1 is ahead of the brush arm of distributor TD_2 , the terminal 1 will be connected to the first idle trunk and will lock out the distributor associated with terminal 2 from connection to that idle trunk. The distributor associated with terminal 2 will then select the next idle trunk. If by a similar relationship of distributor arms to driv-

ing shaft the receiving distributors of Fig. 3 are rotating out of phase with each other but in proper synchronous relationship to the corresponding sending distributors, voice currents will arrive at the receiving end over the trunk connected to the terminal 1 before they will arrive over the trunk connected at the terminal 2, because the connection to terminal 1 was completed before the connection to terminal 2. Since the brush arms of the corresponding receiving distributors are each in proper synchronous relationship to its corresponding sending distributor, the brush arm of the distributor associated with terminal 1' will come to rest upon the trunk to which the terminal 1 is connected by virtue of the fact that it will be passing over the energized speech segments of such trunk at the moment voice currents arrive over such trunk. Similarly, the brush arms of the distributor associated with the terminal 2' will come to rest upon the segments associated with the trunk which was connected to the terminal 2 because the voice currents will arrive from its trunk after the voice currents have arrived from the terminal 1 and will arrive at the moment the brush arm associated with terminal 2' passes over the corresponding segments. This takes place notwithstanding that speech started from terminals 1 and 2 at the same instant. The delay in the arrival of speech at the terminal 2' is due to the fact that an idle trunk was connected to the terminal 2 after the idle trunk was connected to the terminal 1.

By means of the mechanical connection between driving shaft and brush arms above described and with the sockets in the shaft corresponding to different brush arms all arranged in different angular positions, it will be evident that when any brush arm is stopped and then again released, it will always start rotating in the same angular position with respect to its shaft that it occupied before it was stopped. Hence if the shaft of a set of sending distributors is in synchronism with a shaft of receiving distributors, each sending brush arm will rotate in proper synchronous relation to each receiving brush arm no matter when it is stopped nor how long after it is stopped it is again released. Thus the possibility of false switching connection being made between two terminals is avoided.

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 signaling system, a pair of switching stations, trunks extending between said stations, a signaling terminal at one station, and means responsive to sound currents in-

coming from said terminal to select and connect thereto an idle trunk.

2. In a signaling system, a pair of switching stations, trunks extending between said stations, a signaling terminal at one station, and means responsive to sound currents incoming from said terminal to select an idle trunk and maintain said trunk connected to said terminal only during the continuance of sound currents.

3. In a signaling system, a pair of switching stations, trunks extending between said stations, a signaling terminal at one station, and means responsive to sound currents incoming from said terminal to select and connect thereto an idle trunk, and means to release said trunk upon the cessation of sound currents.

4. In a signaling system, a pair of switching stations, trunks extending between said stations, a signaling terminal at one station, and means responsive to sound currents incoming from said terminal to select and connect thereto an idle trunk, means to release said trunk upon the cessation of sound currents, and means to select and connect to the terminal a new trunk upon the initiation of a new train of sound currents.

5. In a signaling system, a pair of switching stations, trunks extending between said stations, signaling terminals at each station arranged to intercommunicate in pairs between stations, and means responsive to sound currents incoming from one terminal to select and connect thereto an idle trunk, and means to connect said trunk to the corresponding terminal at the other station.

6. In a signaling system, a pair of switching stations, trunks extending between said stations, signaling terminals at each station arranged to intercommunicate in pairs between stations, and means responsive to sound currents incoming from one terminal to select and connect thereto an idle trunk, and means to connect said trunk to the corresponding terminal at the other station, said trunk remaining connected only during the continuance of said sound currents.

7. In a signaling system, a pair of switching stations, trunks extending between said stations, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one terminal to select and connect thereto an idle trunk, and means to connect said trunk to the corresponding terminal at the other station, and means to release said trunk upon the cessation of said sound currents.

8. In a signaling system, a pair of switching stations, trunks extending between said stations, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one terminal to se-

lect and connect thereto an idle trunk, and means to connect said trunk to the corresponding terminal at the other station, means to release said trunk upon the cessation of said sound currents, and means to select and connect to the same terminals a new trunk upon the initiation of a new set of sound waves.

9. In a signaling system, a pair of switching stations, a group of trunks extending between said stations for transmission in one direction, a second group of trunks extending between said stations for transmission in the opposite direction, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one signaling terminal to select an idle trunk from one group and connect it to said terminal, means to connect said trunk to the corresponding terminal at the other station, means responsive to sound currents incoming from said last mentioned terminal to select a trunk from the other group and connect it to one terminal, and means to connect it to the other terminal.

10. In a signaling system, a pair of switching stations, a group of trunks extending between said stations for transmission in one direction, a second group of trunks extending between said stations for transmission in the opposite direction, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one signaling terminal to select an idle trunk from one group and connect it to said terminal, means to connect the selected trunk to the corresponding terminal at the other station, means responsive to sound currents incoming from said last mentioned terminal to select a trunk from the other group and connect it to one terminal, and means to connect it to the other terminal, said trunks remaining connected only during the continuance of said sound currents.

11. In a signaling system, a pair of switching stations, a group of trunks extending between said stations for transmission in one direction, a second group of trunks extending between said stations for transmission in the opposite direction, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one signaling terminal to select an idle trunk from one group and connect it to said terminal, means to connect the selected trunk to the corresponding terminal at the other station, means responsive to sound currents incoming from said last mentioned terminal to select a trunk from the other group and connect it to a terminal, means to connect it to the other terminal, and

means to release said trunks upon the cessation of sound currents.

12. In a signaling system, a pair of switching stations, a group of trunks extending between said stations for transmission in one direction, a second group of trunks extending between said stations for transmission in the opposite direction, signaling terminals at each station arranged to intercommunicate in pairs between stations, means responsive to sound currents incoming from one signaling terminal to select an idle trunk from one group and connect it to said terminal, means to connect the selected trunk to the corresponding terminal at the other station, means to release said trunk upon the cessation of sound currents from said terminal, means to automatically reselect a trunk from said group upon the initiation of a new set of sound waves from the same terminal, means responsive to sound currents incoming from said terminal at the other station to select a trunk from the other group and connect it to a terminal, and means to connect it to the other terminal, means to release said trunk upon the cessation of sound currents from said last mentioned terminal, and means to automatically reselect a trunk from said second group upon initiation of a new set of sound currents incoming from said last mentioned terminal.

13. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, and means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station.

14. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, and means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, said trunk remaining connected only during the continuance of said signals.

15. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to in-

tercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, and means to release said trunk upon the cessation of said signals.

16. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, means to release said trunk upon the cessation of said signals, and means to select and connect a new trunk to said transmitting and receiving branches upon the initiation of a new set of signals to be transmitted in the same direction.

17. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, and means to select and connect another trunk between the transmitting branch of said second terminal and the receiving branch of said first terminal upon the initiation of a set of signals at said second terminal.

18. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, and means to select and connect another trunk between the transmitting branch of said second terminal and the receiving branch of said first terminal upon the initiation of a set of signals at said

second terminal, said trunks remaining connected for transmission in a given direction only during the continuance of signals.

19. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, means to select and connect another trunk between the transmitting branch of said second terminal and the receiving branch of said first terminal upon the initiation of a set of signals at said second terminal, and means to release said trunks upon the cessation of signals in a given direction.

20. In a signaling system, a pair of switching stations, a plurality of trunks extending between said stations, signaling terminals connected to each station and arranged to intercommunicate in pairs between stations, each terminal terminating at its switching station in a transmitting branch and a receiving branch, means responsive to signals from one terminal in its transmitting branch to select and connect thereto an idle trunk, means to thereupon connect said trunk to the receiving branch of the corresponding terminal at the other station, means to select and connect another trunk between the transmitting branch of said second terminal and the receiving branch of said first terminal upon the initiation of a set of signals at said second terminal, means to release said trunks upon the cessation of signals in a given direction, and means to select and connect a new trunk for transmission in a given direction in response to the initiation of a new set of signals in that direction.

21. In a system in which a plurality of trunks extend between two stations and signaling terminals are provided at each station for communication in pairs between stations, the method which consists in connecting an idle trunk between a given pair of terminals only during the continuance of sound waves from one of said terminals.

22. In a system in which a plurality of trunks extend between two stations and signaling terminals are provided at each station for communication in pairs between stations, the method which consists in connecting an idle trunk between a given pair of terminals only during the continuance of sound waves from one of said terminals and disconnecting said trunk upon the cessation of sound waves.

23. In a system in which a plurality of

trunks extend between two stations and signaling terminals are provided at each station for communication in pairs between stations, the method which consists in connecting an idle trunk between a given pair of terminals only during the continuance of sound waves from one of said terminals, disconnecting said trunk upon the cessation of sound waves, and selecting and connecting between the terminals a new idle trunk upon the initiation of a new set of sound waves.

24. In a system in which a plurality of trunks extend between two stations and signaling terminals are provided at each station for communication in pairs between stations, the method which consists in connecting an idle trunk between a given pair of terminals only during the continuance of sound waves from one of said terminals, disconnecting said trunk upon the cessation of sound waves, and selecting and connecting between the terminals a new idle trunk upon the initiation of a new set of sound waves from the other intercommunicating terminal.

In testimony whereof, I have signed my name to this specification this 13th day of November 1931.

HERMAN A. AFFEL.

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