Dec. 7, 1937. H. S. OSBORNE ET AL 2,101,224

PRIVACY SYSTEM

Filed March 7, 1936 5 Sheets-Sheet 1

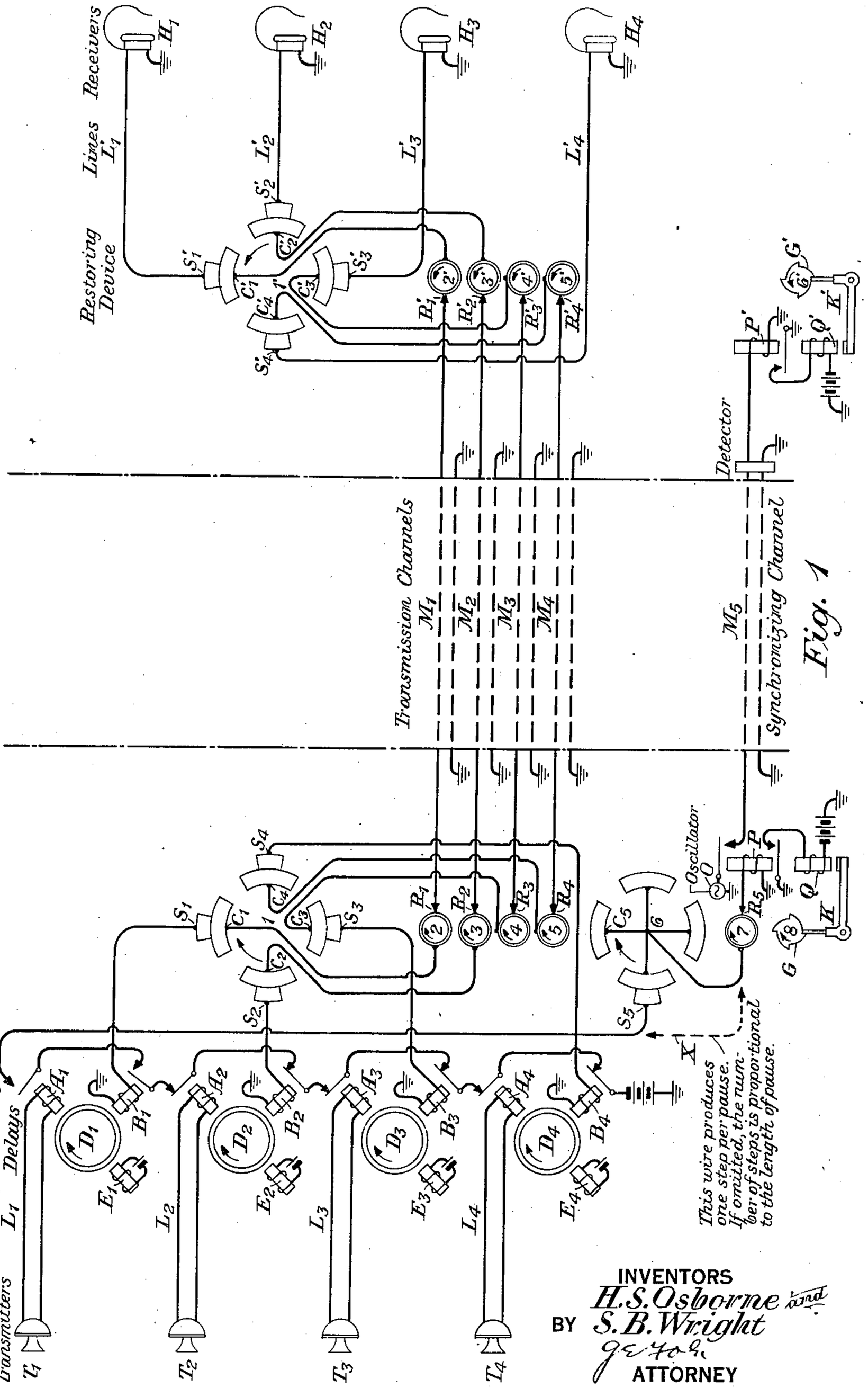

Fig. 1

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PRIVACY SYSTEM

Filed March 7, 1936 5 Sheets-Sheet 2

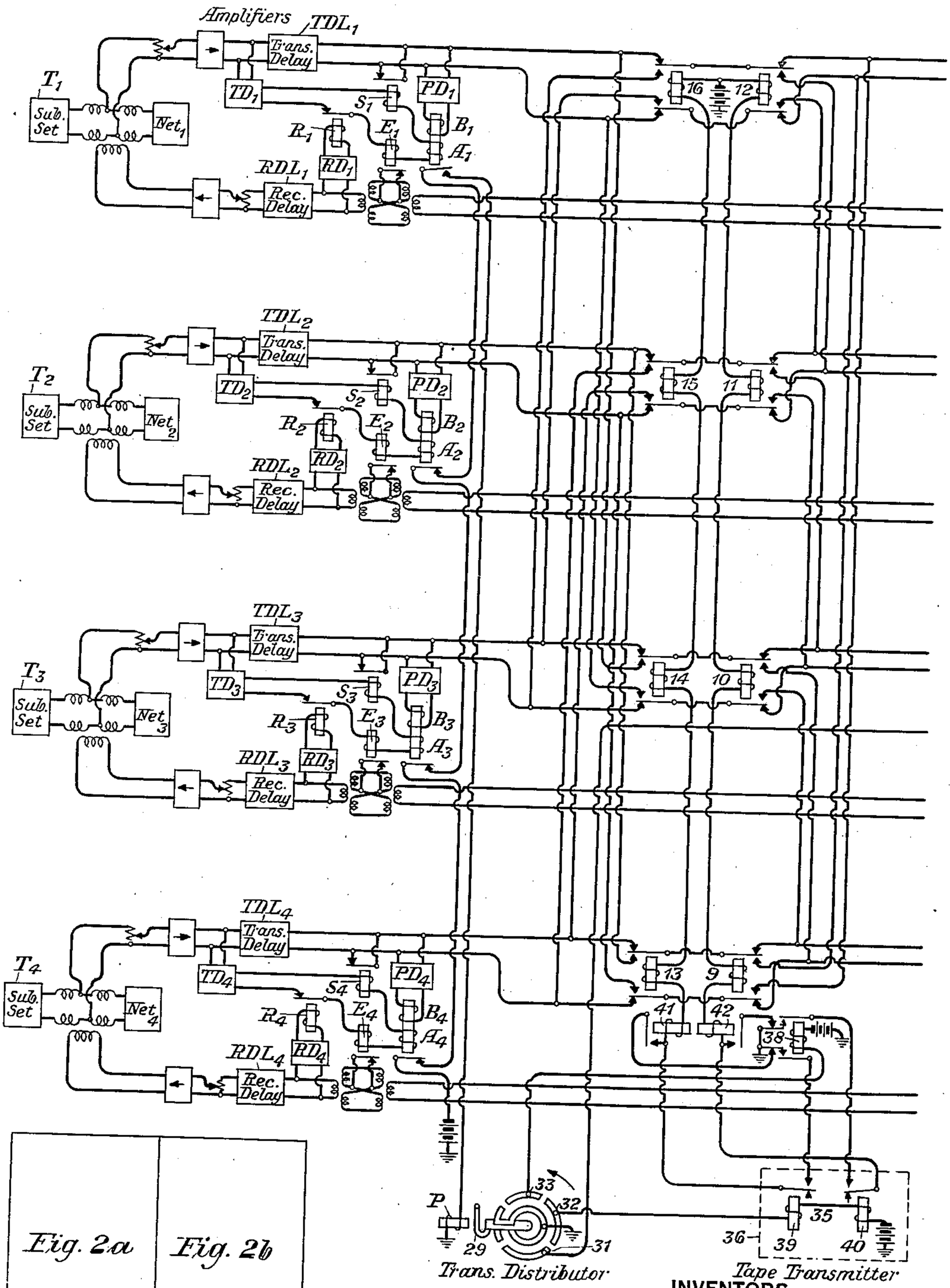

Fig. 2a

Fig. 2a	Fig. 2b

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PRIVACY SYSTEM

Filed March 7, 1936 5 Sheets-Sheet 3

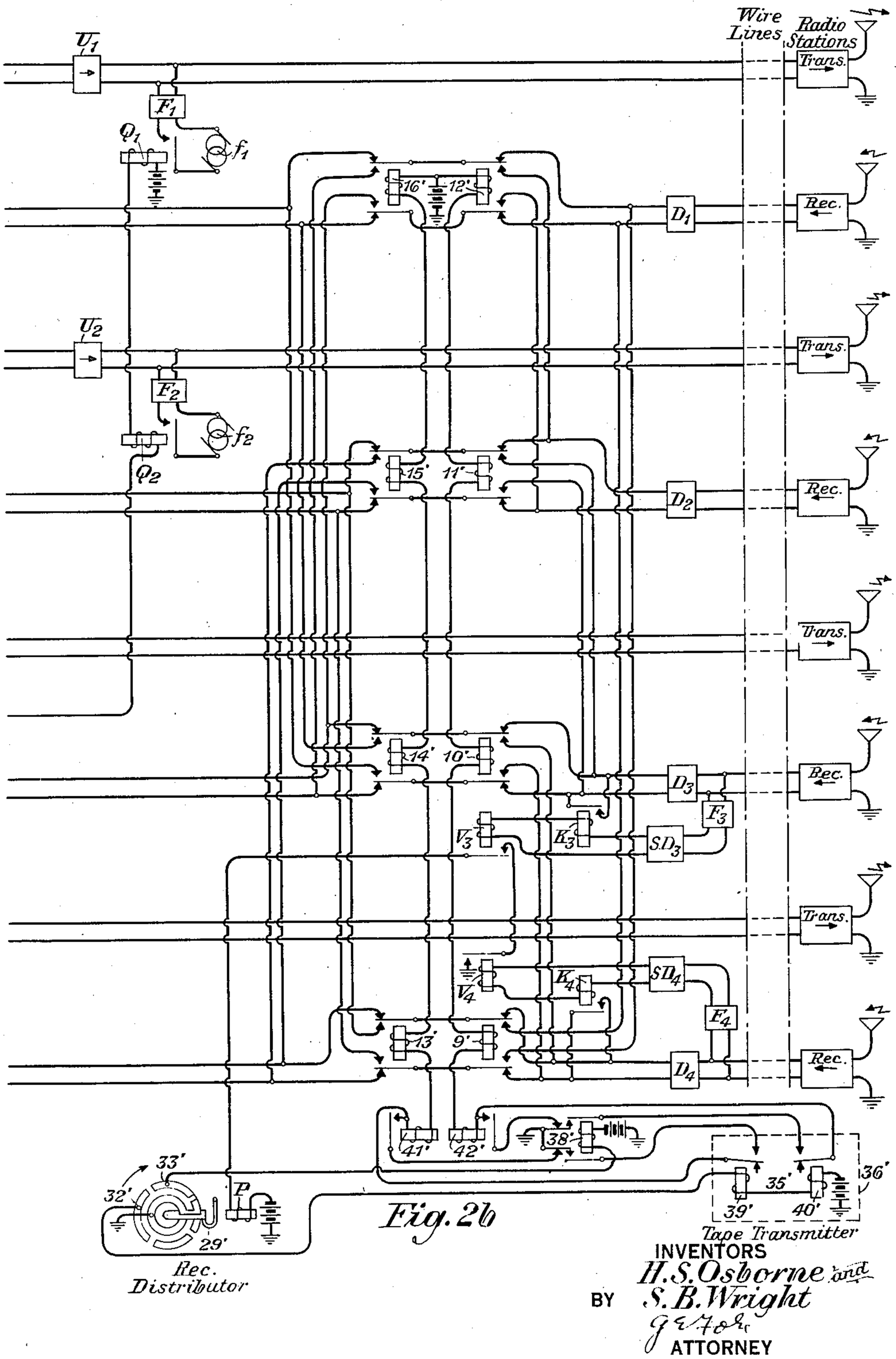

Fig. 2b

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PRIVACY SYSTEM

Filed March 7, 1936 5 Sheets-Sheet 4

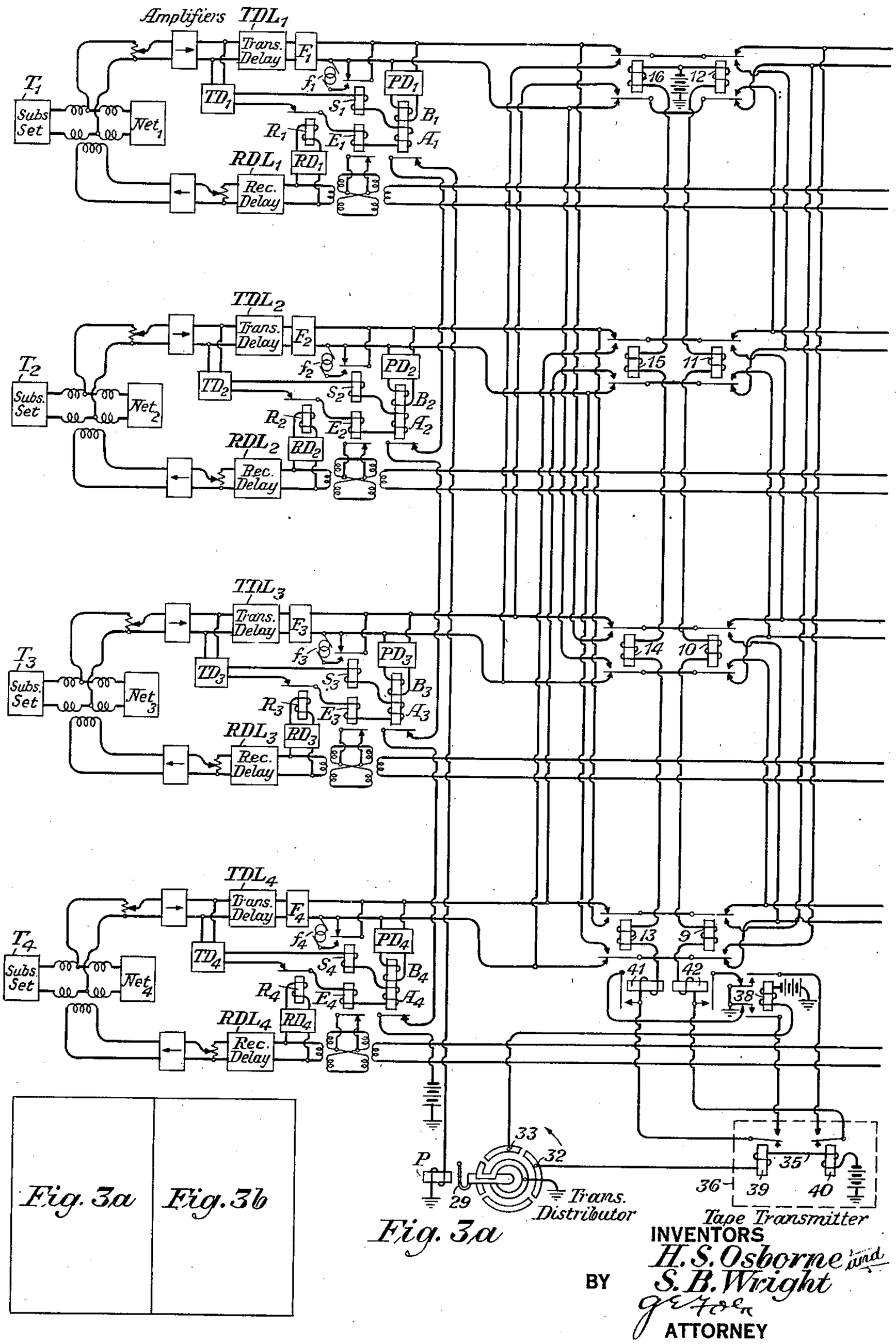

Fig. 3a

Fig. 3a	Fig. 3b

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PRIVACY SYSTEM

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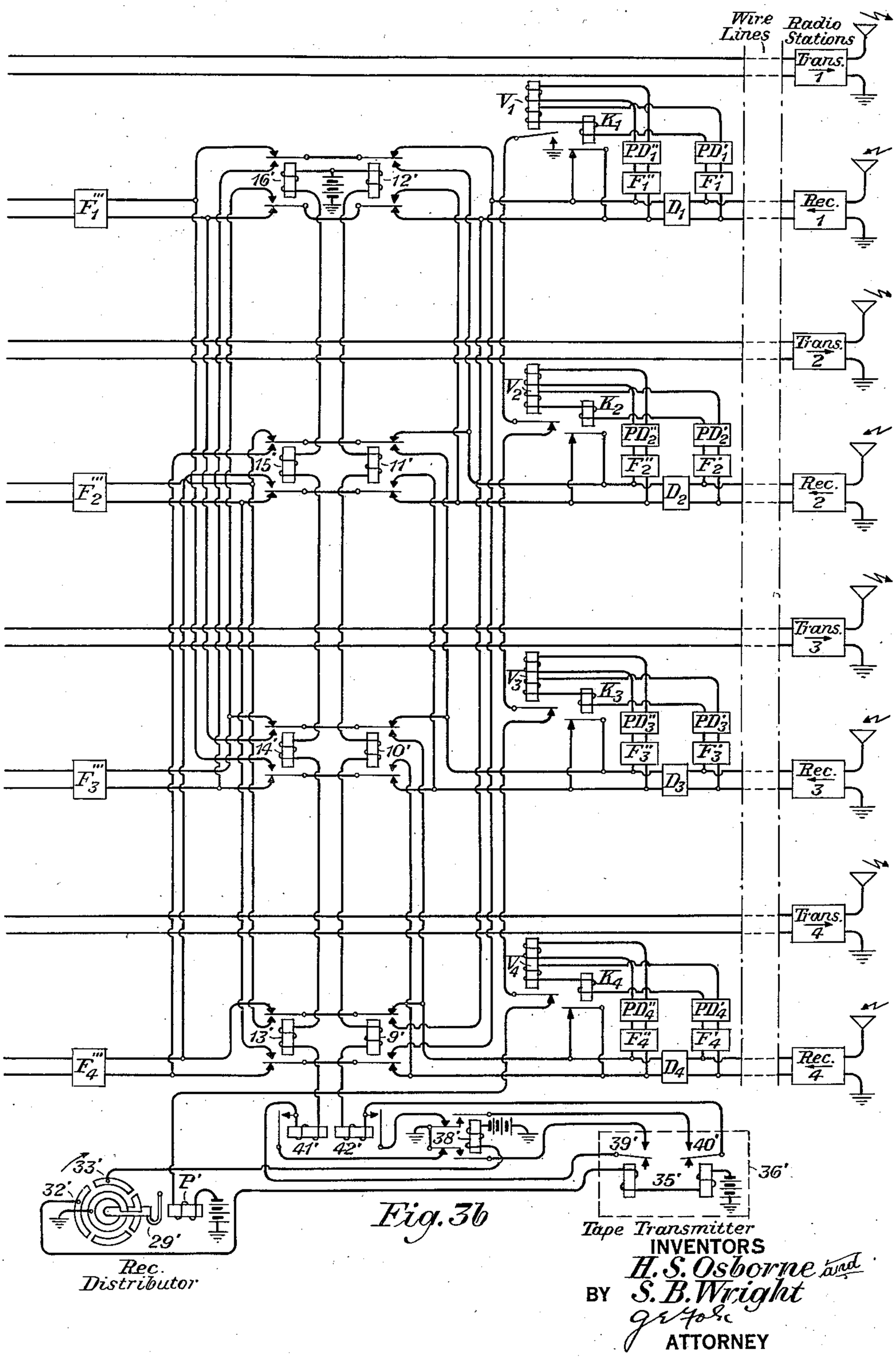

Fig. 3b

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Patented Dec. 7, 1937 2,101,224

UNITED STATES PATENT OFFICE

2,101,224

PRIVACY SYSTEM

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Application March 7, 1936, Serial No. 67,722

18 Claims. (Cl. 179—1.5)

This invention relates to a system for controlling circuit switching and other operations by wave controlled devices. One application of this principle is a privacy system, applicable to a group of telephone circuits operating between two points. Another application is to control the operation of an automatic transmission regulator or gain changer. Many other applications will suggest themselves, such as a band splitting privacy system, in which the various speech bands are interchanged at intervals.

It is well known in the art that telephone waves in one direction of transmission that are produced by conversations are not continuous but occupy only about one-third of the holding time. The other two-thirds is occupied by pauses between syllables and by answering from the distant end. In the privacy schemes herein described, conversations are switched from one circuit to another in the group as frequently as the condition is established of no voice current present on any circuit in the group. By having the proper number of circuits in the group, a person listening in on one circuit (or on one wave length if connections are made by radio) will receive only scattering syllables from the various conversations under way, the amount of each conversation overheard being only a small fraction of the total. In other applications, the usual functioning is held up until an interval occurs in which no current is passing, after which the mechanism is released by the wave operated control system, to function in the usual way.

An advantage of this scheme over previous schemes suggested for switching circuit in use is that the switching is done when no current is in any of the circuits, thus avoiding extraneous clicking and quality effects. Another advantage over privacy schemes employing switching at a fixed rate is that when one or more of the channels is not being used the rate of switching is automatically increased. In the privacy application, by making the number of switches depend on the length of the common pause, random selection of channels can be easily made without the necessity of employing a code so that an eavesdropper will be hampered in determining the order of switching.

Further features and principles of the invention will be understood from the following description when read in connection with the accompanying drawings in which Figure 1 shows a form of the invention; Figs. 2(*a*) and 2(*b*) when arranged side by side illustrate a modification; while Figs. 3(*a*) and 3(*b*) similarly illustrate still a further modification.

Fig. 1 shows in schematic form circuits and apparatus connected to a number of transmission channels in such a manner as to accomplish these results over a group of one-way transmission channels. This drawing shows four telephone connections being switched among four transmission channels but this number is chosen for illustration only and the number might be reduced or increased as desired without affecting the principle of operation.

The four telephone transmitters are designated T_1 to T_4, inclusive, and are shown connected to telephone lines L_1 to L_4, all leading to a common switching point. At this point are located four delay arrangements D_1, etc., of the rotating magnetophone type employing a magnetic tape. Delay arrangement D_1, for example, is provided with a magnetic pattern from the line magnet A_1, and a delayed copy of the waves so produced is transmitted to a magnet B_1, and thence through the scrambler device to a transmission channel. Magnets E_1, etc., contain direct current for erasing the wave pattern from the rotating tape. The A and B magnets are also provided with armatures which operate in the manner shown at A_1 and B_1 to interrupt current from a battery which is connected to a magnet P through the scrambler device.

The scrambler device at the transmitting end of the circuit group consists of rotors 1 to 8 all operating in fixed relation to each other on a common shaft. Rotor 1 is a commutator for interchanging the various circuits of the group. Rotors 2 to 5 are slip rings necessarily associated with the commutator. Rotor 6 is a second commutator for making the number of steps depend on the length of the common pause as will be described later, and rotor 7 is its associated slip ring. Rotor 8 includes a ratchet wheel G which is operated from the pawl K in response to magnet Q which is operated to cause $1/n$ revolution of the shaft by each operation of magnet P, where n is the number of circuits in the group.

The four telephone connections from the delay arrangements are made to rotor 1 through the four stators S_1, etc., and are led from the privacy device through the slip ring stators R_1, etc., to four transmission channels M_1, etc. In addition, magnet P can connect a synchronizing impulse from an oscillator to a synchronizing channel M_5. This synchronizing channel might be obtained by any well known technique such as by

using a portion of the frequency band of one of the main transmission channels.

At the receiving end the four channels and the synchronizing circuit are brought to a common point at which is located a restoring device which consists of rotors 1′ to 6′, inclusive, all operating on the same shaft and in synchronism with the scrambler device at the transmitting end due to the impulses transmitted over the synchronizing channel M_5 under the control of the magnet P. In this device, rotors 1′ to 5′, with their associated stators, switch the various circuits to the proper telephone receivers H_1, etc. Operation of the shaft is caused through the ratchet G′ and pawl K′ in response to magnets P′ and Q′.

In the drawings it is assumed that voice current is present in magnets A_1 and B_1 so that the armatures of these magnets are drawn away from the contacts. This interrupts the current to magnet P which is therefore released. The path of voice currents can then be traced from line L_1 through the delay arrangement D_1 to stator S_1, commutator C_1, ring R_1, channel M_1, ring R_1', commutator C_1', stator S_1' to receiver H_1. In a similar manner the path of currents that may be set up in any of the other transmitters may be traced to its corresponding receiver through the transmission channel having a corresponding subscript.

The operation of the scrambler system is as follows: Assume that voice currents in line L_1 cease so that relay A_1 is released. The energizing circuit for relay P is still broken by magnet B_1 but as soon as the waves have died out in this magnet its armature falls back and if no voice currents are on the other lines P is operated. For the present it will be assumed that wire X is connected in which case the operation of P is continuous for the duration of the common pause. The operation of P causes Q to make the scrambler shaft rotate $1/n$ revolution, at the same time sending a synchronizing impulse from the oscillator over the synchronizing channel M_5 and causing operation of P′ at the receiving end with consequent rotation of the receiving shaft in a direction opposite to the transmitting shaft by $1/n$ revolution. This results in commutator C_1 being connected to stator S_4, C_4 being connected to S_3, S_3 to S_2 and C_2 to S_1. At the receiving end C_1' is connected to S_4', C_4' to S_3', C_3' to S_2' and C_2' to S_1'. The next following conversation from telephone T_1 will, consequently, appear on transmission channel M_4 while if T_2 has voice current it will get to receiver H_2 over channel M_3. Currents from T_3 will reach H_3 over channel M_4 and waves from T_4 will travel over M_1 to receiver H_4. These voice currents will of course operate A and B magnets so as to cause the release of magnets P and P′. As soon as voice currents cease again in all the channels, magnets P and P′ will again be operated causing the shafts to move another $1/n$ revolution with a correspondingly different configuration of the connections.

In the above description it can be seen that the conversations will rotate from one channel to another at unpredictable intervals but in a precise order which is never changed. By omitting the wire X and allowing the magnet P to be operated through the commutator C_5 the magnets P and P′ will be released immediately after a switching operation so that the motion of commutator C_5 when completed will cause P to be operated again, provided the common pause is not interrupted by someone speaking on one of the channels. This results in each of the commutators taking a number of steps which is roughly proportional to the length of the pause. Since the pauses occur at random the interchange of channels will also be at random instead of in regular sequence, thus increasing the difficulty of eavesdropping on a conversation by switching from one channel to another. The magnet P′ which obtains its impulse from P will, of course, take exactly the same number of steps as the sending device so that no matter which channel the conversation is put on at the sending end it will be directed to the proper receiver at the distant end.

The purpose of the delay arrangements at the sending end is to allow time for the mechanism to operate without clipping the beginning of syllables. Assuming no current in any line the commutators will be stepping around and if it were not for the delay arrangement their inertia might cause switching as the initial currents were building up. The delay arrangement prevents this in the following manner: By having the magnet A_1 interrupt the rotation, of the commutator at the same time that the voice waves are impressed on the delay arrangement, the latter stores up these waves for a sufficient interval for the commutator to come to rest before the waves are impressed on the device through magnet B_1. However, it is also necessary to provide B_1 with an armature since if this were not done the release of A_1 would start the mechanism operating again before the final part of the voice wave had been transmitted. It is also assumed that these voice-operated magnets will have slow release characteristics by the provision of circuits or other devices well known in the art so as to delay the operation of the scrambler for a sufficient period to permit all of the trailing weak endings of words to get through.

While the commutation at the two ends is shown synchronous by a separate channel this channel could be avoided by providing at the receiving end voice-operated magnets and delay circuits similar to those at the transmitting end so that synchronization could be brought about by the use of the voice frequency currents themselves; in other words, in periods of no voice currents on any channel commutation would take place at both ends in the same manner.

In practical circuits using privacy systems employing the above principle, the two branches of the circuit which transmit in opposite directions might be combined in a control terminal. Such a terminal generally includes devices for controlling the gain and the direction of transmission and for suppressing echoes and singing, and is frequently referred to as a vodas. It is fundamentally similar to the arrangement described in U. S. Patent No. 1,639,773, "Two-way telephone transmission," issued August 23, 1927, to H. S. Hamilton. The vodas contains delay circuits for insuring that the switching relays function satisfactorily and the same delay circuits and other devices in the terminal might be used in conjunction with the privacy switching system. Also, the privacy system might be arranged to have the switching sequences controlled in a predetermined manner as disclosed in U. S. Patent No. 1,598,673, "Secrecy communication system," issued September 7, 1926 to O. B. Blackwell, D. K. Martin and G. S. Vernam. Either a

commutator as shown in Fig. 1 or a relay switching system might be used.

Figs. 2(*a*) and 2(*b*) when suitably arranged show four vodas control terminals equipped with such a privacy system, switching at the sending end being done during intervals of no speech in any of the four circuits by means of a plurality of relays controlled by the vodas and a key tape. Whenever a switch takes place at the sending end, a corresponding switch is made at the receiving end. This is controlled from the sending end by means of synchronizing or control frequencies that are transmitted over two of the circuits while the speech is stopped, and from the receiving end by means of a key tape identical with that at the sending end. In each of the four circuits, the upper path is shown connected over a wire line to a radio station and the lower path is shown connected from a radio receiver to the control terminal over another wire line. It is assumed that similar arrangements, not shown, are used at the opposite end of the circuit.

Starting with circuit No. 1, a connection is made from a subscriber's set T_1 to a four-wire terminating set including a balancing network Net_1. Here the circuit divides into transmitting and receiving branches. The upper or transmitting branch contains a potentiometer associated with an amplifier and a delay circuit TDL_1. The delay circuit stores up speech waves while the amplifier detector TD_1 is functioning to operate relays E_1 and S_1, which suppress echoes and clear the transmitting path for speech. The receiving branch of the circuit at the terminal contains amplifier detector RD_1 which operates relay R_1 on incoming speech thereby preventing false operation of TD_1 on echoes. The incoming speech also passes through RDL_1, and another potentiometer and amplifier to the terminating set. The above description of the vodas terminal is common to all four circuits simply by changing the subscripts of the various units. Fundamentally, it is the same as the arrangement described in U. S. Patent No. 1,639,773 to Hamilton, above referred to.

The application of the privacy system to these four terminals requires the addition of amplifier detectors PD_1, etc., which operate to energize windings B_1, etc., of relays whose cores are also wound with windings A_1, etc., that are energized from amplifier detectors TD_1, etc. The contacts of these four relays are wired in series with each other, and in circuit with a battery and with a magnet P which controls the operation of the transmitter privacy switching circuit. The effect of windings A_1 and B_1 in combination with the delay network TDL_1 is similar to that ascribed to magnets A_1, B_1 and delay arrangement D_1 of Fig. 1.

The privacy device itself consists of a group of relays in the transmitting branch of the circuit, Nos. 9 to 16, inclusive, and other group of relays in the receiving branch of the circuit Nos. 9′ to 16′, inclusive. These relays are operated by other auxiliary relays energized from transmitting distributor 29, receiving distributor 29′ and tape transmitters 36 and 36′ which are provided with identical perforated tapes as described in the above mentioned Patent No. 1,598,673. The transmitting distributor 29 is supplied with a synchronizing segment 31 which controls two tone generators having frequencies f_1 and f_2 for sending impulses on the transmitting branches of circuits 1 and 2 in order that the corresponding switching may be done at the distant communicating station. This is accomplished by having amplifier detectors in the receiving paths of circuits 1 and 2 at the distant end, arranged like SD_3 and SD_4 which control the starting of a receiving distributor like 29′ on incoming control signals. The effects of adding these auxiliary control signals are isolated from the main transmission circuit by amplifiers, U_1 and U_2 in the transmitting branches of circuits 1 and 2 and by relays corresponding to K_3 and K_4 in the receiving branches of circuits 1 and 2 at the distant station. Delay circuits D_1, etc., are inserted in the receiving branches to hold up the received speech waves long enough for the privacy switching to be completed. Filters F_3 and F_4 are used to select the control frequencies in the receiving branches, excluding extraneous frequencies such as speech and noise. Two control frequencies are used instead of one to reduce the possibility of speech or noise causing false operation of the receiving distributor.

The operation of the transmitting arrangements of the invention is as follows:

Assume that voice currents in all four circuits cease so that both the A and B windings of all the relays, operated by the TD and PD amplifier detectors, are deenergized. The battery is then closed to magnet P which releases the latch and allows the brush of distributor 29 to start rotating. It will also be assumed that the no signal time during which P is operated is sufficient to allow two rotations of the brush but it will be obvious that a larger or smaller number of rotations may occur, depending on the length of time there are no speech waves in any of the four channels. The number two is chosen merely for illustration.

As the brush passes segment 31, ground is supplied to and then removed from relays Q_1 and Q_2, which close the circuits to connect generators f_1 and f_2 to the transmitting branches of circuits 1 and 2. These generators may put out any frequency in the voice range since there can be no interference with speech because it has ceased. They are prevented from interfering with the TD and PD amplifier detectors due to the unilateral devices U_1 and U_2. Filters F_1 and F_2 smooth out any transients that may arise from the closing and opening of the Q relays.

The impulses applied through the operation of the Q relays are thus sent out over circuits 1 and 2 and the brush moves on to segment 32, applying ground to the magnet 35 which pulls down armatures 39 and 40 of the tape transmitter and steps the perforated key tape ahead. When the brush passes off of segment 32, the magnet 35 will be released and the contacts of the tape transmitter will be pressed against the key tape. If there are no holes in the perforated key tape, the contacts 39 and 40 will remain open as shown. Under such conditions, none of the relays 9 to 16, inclusive, will be operated and the first line will be connected to radio transmitter 1 over the back contacts of relays 12 and 16. Similarly, all the other subscribers will be connected through to their respective radio channels. When the brush of distributor 29 passes segment 33, ground will be applied to relay 38 which will operate but this will have no other effect since contacts 39 and 40 will be held open by the tape.

Now, assume that for the second revolution of the brush, the perforations in the tape are so arranged that contact 39 will be closed and contact 40 will remain open. Before this closure

takes place, however, a second pair of impulses of frequencies f_1 and f_2 will be sent out due to the brush having again passed over segment 31. When the brush again crosses segment 33, the relay 38 will be operated and ground will be connected through its lower contact and contact 39 so as to operate relays 41, 13, 14, 15, and 16. When the brush passes off segment 33, relay 38 will be released. However, relays 13, 14, 15, 16, and 41 will remain locked up as a locking circuit will be closed over the contact and armature of relay 41 and the break contact of relay 38 to ground. When this condition is established, subscriber 1 will be connected to radio transmitter 3 over the contacts of relay 14. Subscriber 2 will be connected to radio transmitter 4 over the contacts of relay 13. Subscriber 3 will be connected to radio transmitter 1 over the contacts of relay 16 and subscriber 4 will be connected to transmitter 2 over the contacts of relay 15. In a similar manner, other positions of the relays will permit the subscribers to be switched to other different radio transmitters depending upon whether or not the holes in the tape are arranged so that contacts 39 and 40 are closed or open when the distributor revolves. In short, there are for the particular arrangement illustrated, four possible switching combinations, depending upon whether neither contacts 39 and 40 are operated, whether 39 is operated alone, whether 40 is operated alone, or whether both contacts are operated.

Operations of the receiving arrangements are as follows:

It will be assumed that the operations of the transmitting branch at the distant station were as just described, with the exception that the two synchronizing impulse frequencies have been sent out on channels 3 and 4 which are reserved for controlling the switching at the receiving end of the circuit shown in Figs. 2(*a*) to 2(*d*). Filters F_3 and F_4 will be designed to suppress frequencies other than the control frequencies, two impulses of which are received. The first impulse arriving in circuit 3, for example, will pass into delay circuit D_3 while a portion of the energy will pass through filter F_3 and operate amplifier detector SD_3 so as to close the contacts of relays K_3 and V_3. K_3 will place a short circuit at the output of delay circuit D_3 to prevent the impulse from passing to the circuit terminal and thus being heard by the subscriber. In a similar manner, a corresponding impulse will be at the same time received in circuit 4 and will operate relays K_4 and V_4.

Momentary operation of both relays V_3 and V_4 will cause operation of magnet P' which will release the brush of the receiving distributor 29' so that it will make one revolution. As the brush passes segment 32', it will operate the magnet 35' of the receiving tape transmitter and as it leaves this brush, contacts 39' and 40' will move upward and will complete circuits depending upon the position of the holes in the key tape exactly as in the case of the transmitting tape transmitter. It is assumed that the perforations in the tapes associated with the distant transmitting station and the local receiving station are in exact agreement so that synchronism will be maintained.

Under this assumption the first impulse will cause no change in relays 9' to 16', inclusive, and the four circuits will be connected straight through as at the transmitting end. However, the second synchronizing impulse will cause a revolution of the receiving brush and contact 39' will be closed and will cause the operation of relays 38', 41', 13', 14', 15', and 16' to connect the four receiving circuit branches to the radio channels to which the corresponding transmitting relays have switched them. Each of the receiving circuits has a delay circuit, D_1, etc., to so retard the control impulses and the succeeding voice waves that before the voice waves arrive the receiving paths will have been cleared by the release of relays K_3 and K_4 after the completion of the operation of any of the switching relays 9' and 16' that may have been operated by the particular configuration of the holes in the key tape.

It will of course be clear in connection with the arrangement just described, that while each switching combination is determined by the setting of the key tape, the final switching combination that is used after a no signal interval depends on the length of the interval, i. e., upon whether the distributor has had time to operate only once or more than once. Thus the switching combination is the result of two unpredictable factors, the random perforations of the key tape and the length of the no signal interval.

It will be understood that while the arrangements shown have been specifically described as associated with a radio telephone transmission circuit, the channels connecting the two terminals might equally well be wire lines throughout, or concentric conductors, or repeatered toll circuits of any description, without changing the terminal arrangements. It should be noted also that the vodas terminal itself may be of some other form without essentially changing the purpose of this invention. For example, the vodas might be so arranged that the circuit will be normally disabled in the receiving direction instead of the transmitting direction, or even in both directions together, in which case it would be possible to utilize receiving amplifier detectors and receiving delay circuits to control the switching at the receiving end, thus dispensing with the synchronizing frequencies. This would, of course, require the addition of amplifier detectors at the outputs of the receiving delay circuits, these detectors being connected to relays similar to those with A and B windings to start the receiving distributor.

Still another variation within the scope of this invention would be to transmit synchronizing impulses outside the speech range on all the channels along with the speech. This arrangement is shown in Figs. 3(*a*) and 3(*b*). The vodas operates relays S_1, etc., which send out frequencies f_1, etc., (which are outside the voice range) while the speech is on. These frequencies hold relays V_1, etc., at the receiving end in operated condition so as to prevent the receiving distributor from rotating. When speech ceases in all channels the relays with the A and B windings will be released at the sending end, and relays V will be released at the receiving end, so that switching will take place in the proper sequence and synchronization. The relays K_1, K_2, etc., are released during no signal intervals and hence short circuit the receiving channels while the switching operation takes place. Filters F_1 and F_1''', etc., suppress the control frequencies so as not to interact with the vodas, while filters F_1' and F_1'', etc., pass the control frequencies so they may operate amplifier-detectors PD_1' and PD_1'', etc., while they prevent false operation of these amplifier-detectors by speech and noise by being designed to exclude all but the control frequencies.

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 plurality of terminal circuits, a plurality of transmission channels, one connected to each terminal circuit, switching means for simultaneously interchanging the connections between the terminal circuits and the transmission channels, said means operating to produce such interchange only when no signals are being transmitted in any terminal circuit or transmission channel of the system and before the transmission of signals begins.

2. In a signaling system, the method of obtaining secrecy which consists in switching the signal terminal from one transmission channel to another at times when no signal is present in said signal terminal or in any transmission channel of the system and before the transmission of signals begins.

3. In a signaling system in which a plurality of signal terminals are adapted to be switched to a plurality of transmission channels, the method of obtaining secrecy which consists in simultaneously interchanging the connections between a plurality of said signal terminals and said transmission channels only when no signals are present in any terminal circuit or transmission channel of the system and before the transmission of signals begins.

4. In a signaling system in which any one of a group of signal terminals may be switched to any one of a number of transmission channels, the method of obtaining secrecy which consists in simultaneously switching a plurality of the signal terminals of the group to different transmission channels only when no signals are present in any terminal of the group or in any transmission channel and before the transmission of signals begins.

5. In a signaling system in which any one of a group of signal terminals may be switched to any one of a number of transmission channels, the method of obtaining secrecy which consists in simultaneously switching a plurality of the signal terminals of the group to different transmission channels each time a no signal condition occurs simultaneously upon all of the signal terminals of the group and before the transmission of signals begins.

6. In a signaling system in which a group of signal terminals may be connected with a group of transmission channels in a plurality of combinations, the method of obtaining secrecy which consists in shifting the connections from one combination to another only when no signals are present in either the signal terminals or the transmission channels and before the transmission of signals begins.

7. In a signaling system in which a group of signal terminals may be connected with a group of transmission channels in a plurality of combinations, the method of obtaining secrecy which consists in shifting the connections from one combination to another each time a no signal condition occurs simultaneously upon all of the signal terminals of the group.

8. In a signaling system in which a group of signal terminals may be connected with a group of transmission channels in a plurality of combinations, the method of obtaining secrecy which consists in shifting the connections from one combination to another each time a no signal condition occurs simultaneously upon all of the signal terminals of the group, and determining the combination to which the shift is made in accordance with the duration of the no signal condition.

9. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to variably connect said group of signal terminals to said transmission channels, said switching means operating to simultaneously vary the connections of a plurality of signal terminals only when no signals are present in any signal terminal of the group or in any transmission channel and before the transmission of signals begins.

10. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to variably connect said group of signal terminals to said transmission channels, said switching means operating to simultaneously vary the connections of a plurality of signal terminals whenever no signals are present in any signal terminal of the group or in any transmission channel and before the transmission of signals begins.

11. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to interconnect said terminals and said channels in a plurality of combinations, said switching means operating to shift the connections to a new combination whenever no signals are present in any signal terminal of the group or in any transmission channel and before the transmission of signals begins.

12. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to interconnect said terminals and said channels in a plurality of combinations, said switching means operating to shift the connections to a new combination whenever no signals are present in any signal terminal, and means to determine the new combination in accordance with the duration of the no signal condition.

13. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to interconnect said terminals and said channels in a plurality of combinations, said switching means operating to shift the connections to a new combination whenever no signals are present in any signal terminal, means whereby the new combination is determined in part by the duration of the no signal condition, and an arbitrary combination determining device for in part determining the new combination.

14. In a signaling system, a group of signal terminals, a plurality of transmission channels, switching means to interconnect said terminals and said channels in a plurality of combinations, said switching means operating to shift the connections to a new combination whenever no signals are present in any signal terminal, means whereby the new combination is determined in part by the duration of the no signal condition, and a combination recording tape for in part determining the new combination.

15. In a signaling system, a group of transmitting signal terminals at one station, a corresponding group of receiving signal terminals at another station, a plurality of transmission channels between the stations, switching means at each station to interconnect corresponding signal terminals with said transmission channels in a plurality of combinations, and means controlling the switching means at both stations to shift the connections to new combinations which correspond

to each other whenever no signals are present in any signal terminal.

16. In a signaling system, a group of transmitting signal terminals at one station, a corresponding group of receiving signal terminals at another station, a plurality of transmission channels between the stations, switching means at each station to interconnect corresponding signal terminals with said transmission channels in a plurality of combinations, means controlling the switching means at both stations to shift the connections to new combinations which correspond to each other whenever no signals are present in any signal terminal, and means to determine the new combinations in accordance with the duration of the no signal condition.

17. In a signaling system, a group of transmitting signal terminals at one station, a corresponding group of receiving signal terminals at another station, a plurality of transmission channels between the stations, switching means at each station to interconnect corresponding signal terminals with said transmission channels in a plurality of combinations, means controlling the switching means at both stations to shift the connections to new combinations which correspond to each other whenever no signals are present in any signal terminal, means whereby the new combinations are determined in part by the duration of the no signal condition, and an arbitrary combination determining device at each station for in part determining the new combinations.

18. In a signaling system, a group of transmitting signal terminals at one station, a corresponding group of receiving signal terminals at another station, a plurality of transmission channels between the stations, switching means at each station to interconnect corresponding signal terminals with said transmission channels in a plurality of combinations, means controlling the switching means at both stations to shift the connections to new combinations which correspond to each other whenever no signals are present in any signal terminal, means whereby the new combinations are determined in part by the duration of the no signal condition, an arbitrary combination determining device at each station for in part determining the new combinations, and means to operate said devices synchronously at both stations whenever no signals are present.

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