Nov. 20, 1934. D. MITCHELL ET AL 1,981,114

PRIVACY SYSTEM

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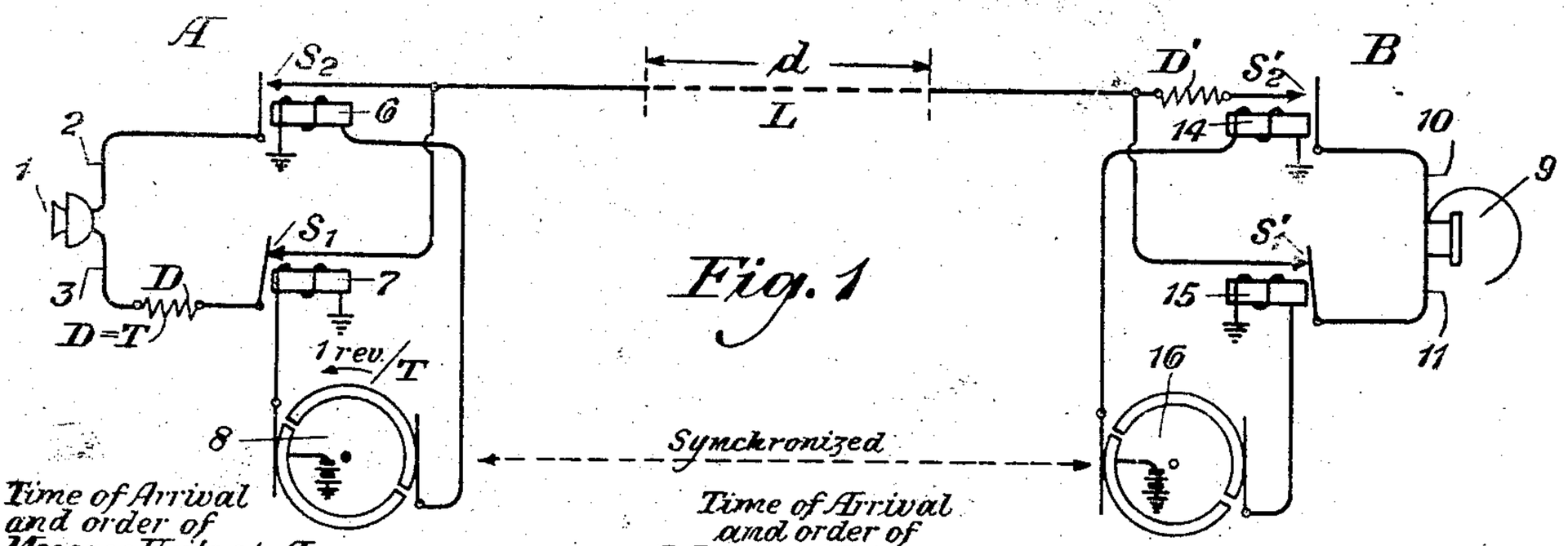

Fig. 1

Time of Arrival and order of Message Units at A

Original at switch S_2	1	2	3	4		
Delayed by T at Switch S_1			1	2	3	4
Scrambled at L		2	1	4	3	

0 T 2T 3T — Time

Fig. 2

Time of Arrival and order of Message Units at B

Scrambled at S_1'		2	1	4	3	
Scrambled delayed by T at S_2'				2	1	4	3
Original at 9			1	2	3	4	

0 T 2T 3T — Time-d

Fig. 3

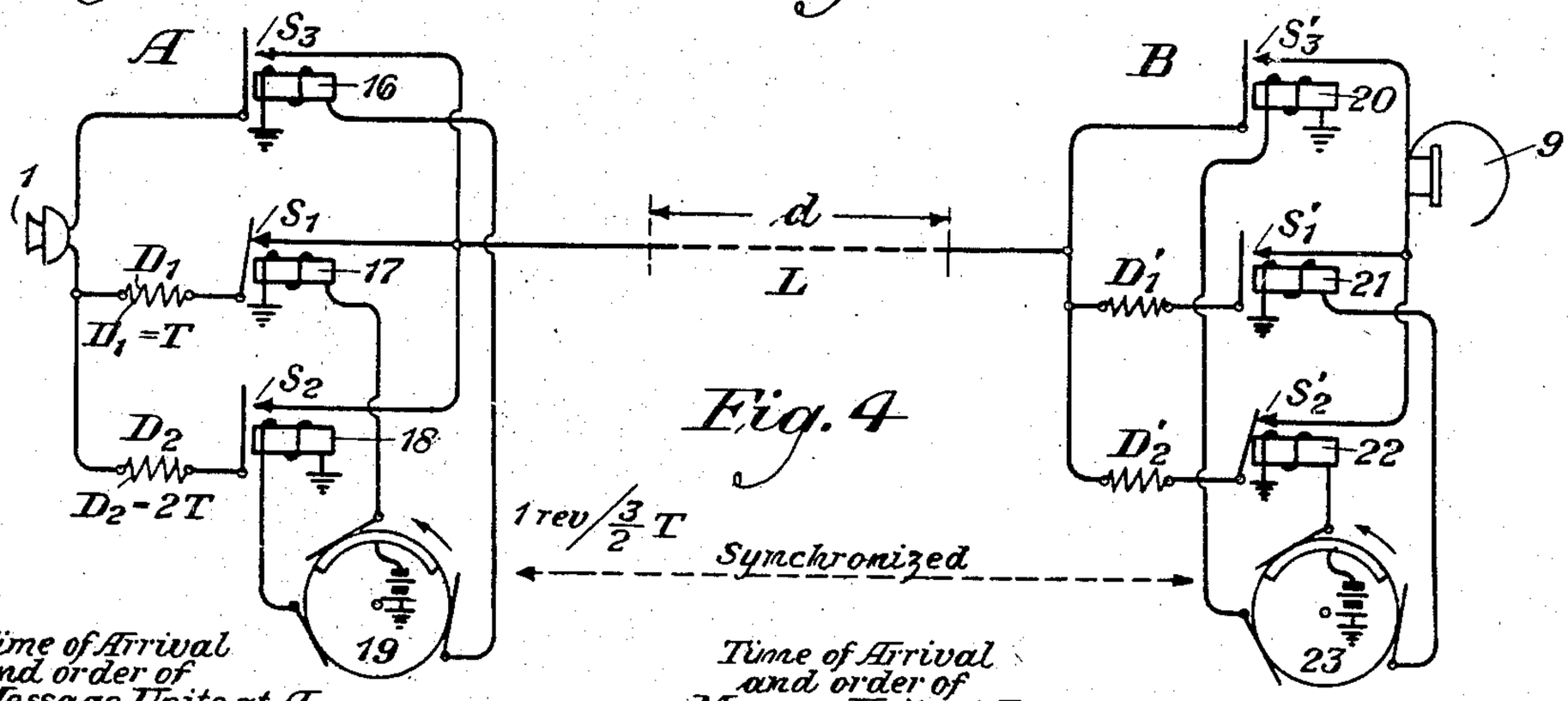

Fig. 4

Time of Arrival and order of Message Units at A

Original at switch S_3	1	2	3	4	5	6		
Delayed by T at switch S_1			1	2	3	4	5	6
Delayed by 2T at switch S_2					1	2	3	4
Scrambled at L			3	2	1	6	5	4

0 T 2T 3T 4T — Time

Switch operated	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2
Necessary delay	T	2T	0	T	2T	0	T	2T

Fig. 5

Time of Arrival and order of Message Units at B

Scrambled at S_3'			3	2	1	6	5	4		
Delayed by T at S_1'				3	2	1	6	5	4	
Delayed by 2T at S_2'					3	2	1	6	5	4
Original at 9				1	2	3	4	5	6	

0 T 2T 3T 4T 5T 6T — Time-d

Switch operated	S_2'	S_3'	S_1'	S_2'	S_3'	S_1'	S_2'	S_3'	S_1'	S_2'	S_3'	S_1'
Necessary delay	2T	0	T	2T	0	T	2T	0	T	2T		

Fig. 6

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PRIVACY SYSTEM

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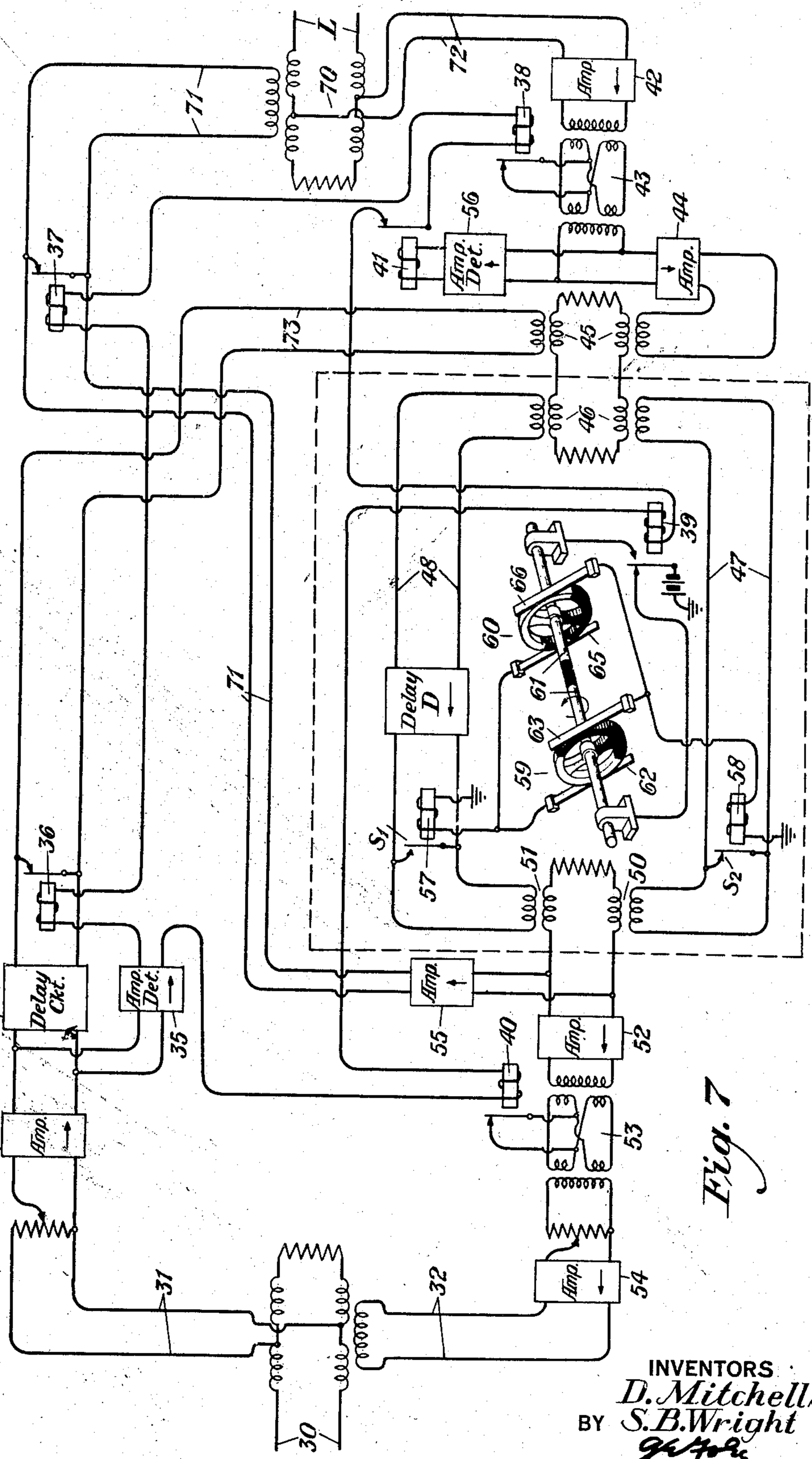

Fig. 7

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PRIVACY SYSTEM

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Application March 3, 1933, Serial No. 659,560

4 Claims. (Cl. 179—1.5)

This invention relates to transmission systems and more particularly to systems over which it is desired to transmit messages with secrecy or privacy.

In the arrangements of the invention privacy in the transmission of the message is secured by changing the order or position of the units of the message from their original order or position at the transmitting end of the system. This is accomplished by introducing various values of delay at the transmitting station. The units of the message are then transmitted to a receiving station in the rearranged or scrambled order and are not intelligible. At the receiving end of the system complementary values of delay are introduced in a synchronous manner and the scrambled units of the message are rearranged in their original order or position. By thus transmitting the message with the original timed relationship between the units thereof changed, the message can not be understood by persons who might have access to the message in this condition and privacy may be secured. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description thereof together with the accompanying drawings in the Figures 1, 2, 3, 4, 5, 6 and 7 of which the invention is illustrated. In Fig. 1 is a circuit diagram showing schematically one embodiment of the invention. Figs. 2 and 3 are diagrams indicating the manner of scrambling and unscrambling the units of the message transmitted over arrangements shown in Fig. 1. Fig. 4 is a circuit diagram showing schematically a modification of the arrangements of the invention. Figs. 5 and 6 are diagrams showing the manner of scrambling and unscrambling the units of the message when transmitted over the arrangements shown in Fig. 4. In Fig. 7 is a circuit diagram showing the arrangements of the invention as applied to a two-way transmission system. Similar reference characters have been utilized to denote like parts in certain of the figures.

In Fig. 1 is shown a one-way telephone line L interconnecting a sending station A and a receiving station B and utilizing the privacy features of the invention. At station A is shown a transmitter 1 connected to two branched paths 2 and 3. In these branched paths would be included the switches S_1 and S_2 for opening and closing these paths. These switches are shown controlled by the relays 6 and 7 and by the commutator 8. The two branched paths are then connected to the line L. Other means for opening and closing the two branched paths could be utilized in place of the relays and switches, if desired. In the path 3 would be provided a delay circuit D. At the receiving station B the line L would be connected to the two branched paths 10 and 11. To open and close these paths there would be provided the switches S_2' and S_1' controlled by the relays 14 and 15 and the commutator 16. The two paths would be connected to a telephone set 9. In the path 10 would be provided a delay circuit D' equal to the delay circuit D. The delay circuits D and D' will be designed to delay the message by an amount T. The commutators 8 and 16 will revolve at a speed of one revolution per T. The two commutators will be operated in synchronism by any well known means. In addition commutator 16 should lag slightly behind 8 to compensate for the delay *d* introduced by transmitting the message over line L.

The diagrams of Figs. 2 and 3 indicate how the arrangements of Fig. 1 operate to scramble the order of transmitted message sounds and restore them at the receiving end. For simplicity, it has been assumed that the original message lasts for 2T. This message is then divided into four units of equal duration of length T/2. These are indicated in the top line of the time diagram of Fig. 2. The units are in their original order and are shown in the time relationship in which they arrive at switch S_2. The time of each individual unit is, as pointed out, one-half the length of time T introduced by the delay circuit D. The original units arriving at switch S_1 will be delayed by T and the time relationship in which they arrive thereat is shown in the second line of the diagram. For transmission onto the line there is then a choice between the undelayed or original message and the delayed message. The two-segment commutator 8 is revolving once per time T. Thus at one-half T the segment with battery connected thereto causes path 2 to be closed and causes path 3 to be opened. Since path 3 was closed during the first one-half T of time nothing has been transmitted onto the line up to that instant due to the inclusion in path 3 of the delay circuit D. Thus it will be seen that when S_2 closes, part or unit 2 of the message will be the first to be transmitted over line L. At time T, however, the commutator has made a complete turn and path 3 with the delay therein is again closed and path 2 is opened. This causes the first part of the message, or unit 1, to be next transmitted on the line L

since it has been delayed by time T. This process is carried on indefinitely although shown in the diagram for only four units. The result is that the message units are transmitted over the line in rearranged order, such as 2, 1, 4, 3, etc., instead of 1, 2, 3, 4. This is shown in the lower line of the diagram.

As heretofore pointed out, at the receiving station B there will be provided a delay circuit D' similar to D and introducing a delay T. The commutator 16 will be rotating at the same speed as 8 but retarded in angle by an amount to compensate for the delay *d* introduced by the line L. The diagram of Fig. 3 shows how the scrambled units of the message are restored to their original form. The first scrambled message unit arrives at S_1' at a time

$$\frac{T}{2}+d.$$

The time of arrival and order of the scrambled message units is shown in the top line of the diagram as 2, 1, 4, 3. The time of arrival at S_2' of the scrambled units delayed T by D' is shown in the second line of the diagram. At the time the scrambled units start arriving, however, the commutator will have made one half-turn and path 10 with delay D' therein will be closed and path 11 opened. At time T+*d*, path 11 will again be closed and the path 10 with delay D' opened. Accordingly, the first message unit to reach the receiver will be unit 1. Next path 10 will be closed and unit 2 will be transmitted to the receiver. This process will be carried on indefinitely with the result that the message units will be delivered to the receiver in their original order. This is shown by the last line of the diagram.

In Fig. 4 is shown a modification of the arrangements of the invention which utilizes two delayed circuits with different values of delay and one undelayed circuit. The transmitter 1 will be connected to three branched paths. One of these will include no delay and may be opened and closed by switch S_3 controlled by relay 16 and commutator 19. Another branch will include a delay circuit D_1 introducing a delay of time T. This circuit may be opened and closed by switch S_1 under control of relay 17 and commutator 19. The third branch will include a delay circuit D_2 introducing a delay of time 2T and it may be opened and closed by relay 18 and commutator 19. The speed of the commutator will be 1 revolution per

$$\frac{3}{2}T.$$

The three branched paths would be connected to line L as shown. At the receiving station, the line L and receiver 9 would be connected together through three branched paths. One path would include no delay and would be opened and closed by switch S_3' controlled by relay 20 and commutator 23. Another path would include a delay circuit D_1', similar to D_1, introducing a delay of time T. This path would be opened and closed by switch S_1' controlled by relay 21 and commutator 23. The third path would include a delay circuit D_2', similar to D_2, introducing a delay of time 2T and would be opened and closed by switch S_2' controlled by relay 22 and commutator 23. The commutator 23 would be operated in synchronism with commutator 19 and would be retarded in angle by an amount to compensate for a delay *d* introduced by the line L.

The diagrams of Figs. 5 and 6 illustrate how the arrangements of Fig. 4 operate. Fig. 5 shows the time of arrival and order of the message units at the switches and line L at station A. Fig. 6 shows the time of arrival and order of the message units at the switches and receiver of station B. The sequence of operation of the switches and the time relationship in their operation at the two stations are also shown in the diagrams. The message is assumed, for purposes of illustration, to last for a time 3T. The message is then divided into six units of length T/2. Their original order is 1, 2, 3, 4, 5, 6, as shown in the upper line of Fig. 5. It will be seen that with the indicated delay introduced by the sequence of operation of the switches, as shown in Fig. 5, that the units of the message will be transmitted over line L in a rearranged order, such as 3, 2, 1, 6, 5, 4 and as such will be unintelligible. From Fig. 6 it will be seen that with the indicated delay introduced by the sequence of operation of the switches, the scrambled message transmitted to station B will be transmitted to the receiver with the units restored to their original order of 1, 2, 3, 4, 5, 6.

It is pointed out that the arrangements of the invention might be modified to assure a greater degree of privacy by increasing the number of delay circuits and commutator segments utilized.

As heretofore pointed out, any well-known system of synchronization could be utilized to operate the commutators. For example, a synchronizing impulse might be sent over the circuit to automatically hold the two ends in step, or clock mechanism might be utilized. It is possible that some adjustment might have to be made between the commutators to compensate for the delay *d* introduced by the line. A simple way to accomplish this would be to send out a short spurt of tone at some predetermined point on the commutator. A similar spurt could be introduced locally at the receiving end and by a simple manual adjustment the two spurts could be brought into synchronism.

In Fig. 7 the arrangements of the invention are shown as applied to a two-way transmission system. Arrangements at one end of the line only are shown. Substantially similar arrangements would be provided at the other end of the line. The arrangements shown would comprise two one-way circuits for transmission in opposite directions for connecting the line L to a transmitting and receiving arrangement such, for example, as a subscriber's telephone set (not shown) which might be connected to the line 30. For transmitting from the set out over the line, the circuit 31 would be provided. This would include the amplifier 33 and the delay circuit 34. Associated therewith would be the amplifier detector 35 and circuit arrangements including relays 36, 37, 38, 39 and 40. The above arrangements would effectively connect privacy apparatus enclosed in the dotted lines and similar in principle to that shown in Fig. 1, into the system for transmission out over the line L. For transmission out over the line L, the operation of the arrangements would be as follows. The message currents coming in over circuit 30 would be transmitted over circuit 31 and through the amplifier 33. The message currents would then operate the amplifier detector 35. The direct current from amplifier detector 35 will then operate relay 36, relay 37, relay 38, relay 39 and relay 40, provided relay 41 is not operated, in a manner pointed out hereinafter. Relays 36 and 37 would open normally closed short circuits across circuits 73 and 71 and thus enable said circuits.

The operation of relay 38 would effectively disable the transformer circuit 43 so that message currents coming in over the line L would not be transmitted therethrough. The operation of relay 40 would effectively disable the transformer circuit 53 so that the outgoing message currents transmitted through the privacy apparatus would not be transmitted over circuit 32. The operation of relay 39 would connect battery over its right-hand contact to the commutator apparatus.

The commutator apparatus comprises a shaft 61 with an insulating portion in the middle thereof having two commutator wheels mounted thereon, such as 59 and 60. Each of these wheels would have two brushes, the wheel 60 having brushes 65 and 66, and the wheel 59 having brushes 62 and 63. The shaded portions of each commutator are non-conducting or insulating portions thereof. The commutator wheel 60 will thus alternately apply battery to the relays 57 and 58 and cause them to operate alternately in a cyclic manner. The operation of these relays will open and close the switches S_1 and S_2, respectively. When switch S_1 is operated, the circuit 48, which includes therein the delay circuit D, will be enabled and the circuit 47, without any delay, will be disabled. When the relay 58 is operated the switch S_2 will be operated and will enable circuit 47. At the same time, the switch S_1 will be closed and the circuit 48, with delay D therein, will be disabled. The message currents transmitted over circuit 31 will be transmitted over circuit 73 through transformers 45 and 46. These message currents will then be transmitted either over circuit 47 or circuit 48 which has the delay included therein depending upon the operation of the switches S_1 and S_2 in a manner similar to that heretofore explained with respect to Fig. 1. The message currents will then be transmitted either through transformer 50 or transformer 51, through the amplifier 55, and over circuit 71 and hybrid coil 70 to the line L.

At the distant station there would be apparatus substantially identical with that shown in Fig. 7. Accordingly, the operation of the arrangements with respect to currents coming in over the line L at the distant station will be described by referring to the apparatus shown for receiving purposes in Fig. 7. These incoming message currents would be transmitted from the line L over conductor 72, through the amplifier 42, through transformer 43, and thence to the amplifier 44 and the amplifier detector 56. The currents applied to the amplifier detector 56 would operate relay 41 which would hold open a circuit for relays 36, 37, 38, 39 and 40, and would thus disable the transmitting side of the apparatus immediately. Accordingly, the message currents coming in over the line L will take control of the device immediately, thus blocking the outgoing transmission. The feature of providing this anti-lockout relay 41 on the input side of the one-way device, such as the privacy arrangements, instead of on the output side, gives immediate control of the apparatus to the incoming message. If the relay were located on the output side of the device the delay introduced thereby would prevent the incoming currents from taking immediate control. The message currents applied to amplifier 44 would be applied to transformers 45 and 46 to the privacy apparatus. As the relay 39 is unoperated, battery will be applied over its left-hand contact to the commutator wheel 59, but not to the commutator wheel 60. The commutator wheel 59 will then alternately and in a cyclic manner control the operation of the switches S_1 and S_2. The message currents will then be transmitted from transformer 46 alternately over circuits 47 and 48 with the delay D therein. These message currents will then be applied over transformers 50 and 51 to the amplifier 52, through transformer circuit 53, through amplifier 54 and over circuits 32 and 30 to the receiving apparatus.

It will be noted from the foregoing description that the apparatus shown at station A will have the scrambling of the message units controlled by the energization of relay 39 and the application thereby of battery to the commutator wheel 60. It will furthermore be noted that when these scrambled message units arrive at the distant station, their unscrambling will be controlled by the deenergization of relay 39 and the application of battery to the commutator wheel 59 at the station B. As has been heretofore pointed out, the transmission of the message over the line L will introduce a certain amount of delay. Accordingly, a commutator wheel 59 at the distant station will be set so as to lag slightly behind the commutator wheel 60 at station A. In a like manner, the commutator wheel at the station A, which controls the unscrambling of the message units, will be set so as to lag somewhat behind the commutator wheel at the distant station which controls the scrambling of the message units. In this manner the delay introduced by transmitting the scrambled message over the line L may be compensated for. Obviously, the commutator apparatus at the two stations should be run in synchronism. As pointed out theretofore, any well-known means for accomplishing this may be utilized.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A transmission system comprising a two-way line interconnecting two stations, two one-way circuits for transmission in opposite directions connected to said line at one of said stations, one of said circuits being normally disabled and adapted for transmission of messages out over said line and the other of said circuits being normally enabled and adapted for the reception of messages coming in over said line, a privacy device comprising separate means for scrambling and unscrambling messages transmitted over said system, said privacy device being effectively connected in said normally enabled circuit, switching means operated by message currents transmitted to said normally disabled circuit for enabling said circuit and for disabling said normally enabled circuit and for effectively connecting said privacy device into said normally disabled circuit and for disconnecting it from said normally enabled circuit, and a privacy device, switching means and one-way circuits at said other station corresponding to those at said first station.

2. A transmission system comprising a two-way line interconnecting two stations, two one-way circuits for transmission in opposite directions connected to said line at one of said stations, one of said circuits being normally disabled and adapted for transmission of messages

out over said line and the other of said circuits being normally enabled and adapted for the reception of messages coming in over said line, a privacy device comprising separate means for scrambling and unscrambling messages transmitted over said system, said privacy device being effectively connected in said normally enabled circuit, switching means operated by message currents transmitted to said normally disabled circuit for enabling said circuit and for disabling said normally enabled circuit and for effectively connecting said privacy device into said normally disabled circuit and for disconnecting it from said normally enabled circuit, an anti-lockout relay operated by messages applied to said normally enabled circuit from said line and associated with said circuit at the input of said privacy device for preventing said switching means from operating, and a privacy device, anti-lockout relay, switching means and one-way circuits at said other station corresponding to those at said first station.

3. A transmission system comprising a two-way line interconnecting two stations, two one-way circuits for transmission in opposite directions connected to said line at one of said stations, one of said circuits being normally disabled and adapted for transmission of messages out over said line and the other of said circuits being normally enabled and adapted for the reception of messages coming in over said line, a privacy device comprising separate means for scrambling and unscrambling messages transmitted over said system, said privacy device being effectively connected in said normally enabled circuit, switching means operated by message currents transmitted to said normally disabled circuit for enabling said circuit and for disabling said normally enabled circuit and for effectively connecting said privacy device into said normally disabled circuit and for disconnecting it from said normally enabled circuit, a privacy device, switching means and one-way circuits at said other station corresponding to those at said first station, and means for adjusting the scrambling means of one privacy device with the unscrambling means of the other privacy device to compensate for the delay in the transmission of the message over said two-way line.

4. A transmission system comprising a two-way line interconnecting two stations, two one-way circuits for transmission in opposite directions connected to said line at one of said stations, one of said circuits being normally disabled and adapted for transmission of messages out over said line and the other of said circuits being normally enabled and adapted for the reception of messages coming in over said line, a privacy device comprising separate means for scrambling and unscrambling messages transmitted over said system, said privacy device being effectively connected in said normally enabled circuit, switching means operated by message currents transmitted to said normally disabled circuit for enabling said circuit and for disabling said normally enabled circuit and for effectively connecting said privacy device into said normally disabled circuit and for disconnecting it from said normally enabled circuit, and a privacy device, switching means and one-way circuits at said other station corresponding to those at said first station, each of said privacy devices comprising two circuits in parallel with each other one of which has a delay included therein, switching means for effectively opening and closing each of said circuits, two commutators for alternately operating said switches whereby a delay may be introduced in the transmission of certain of the units of the message applied to said device, one of said commutators being operative for scrambling the message only when the privacy device is effectively connected in said normally disabled one-way circuit, the other of said commutators being operative for unscrambling the message only when the privacy device is effectively connected to said normally enabled circuit, the unscrambling commutator at each station being adjusted to lag behind the scrambling commutator at the other station to compensate for the delay in transmitting the message over said two-way line.

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