Nov. 20, 1934. D. MITCHELL 1,981,113

PRIVACY SYSTEM

Filed March 3, 1933 2 Sheets-Sheet 1

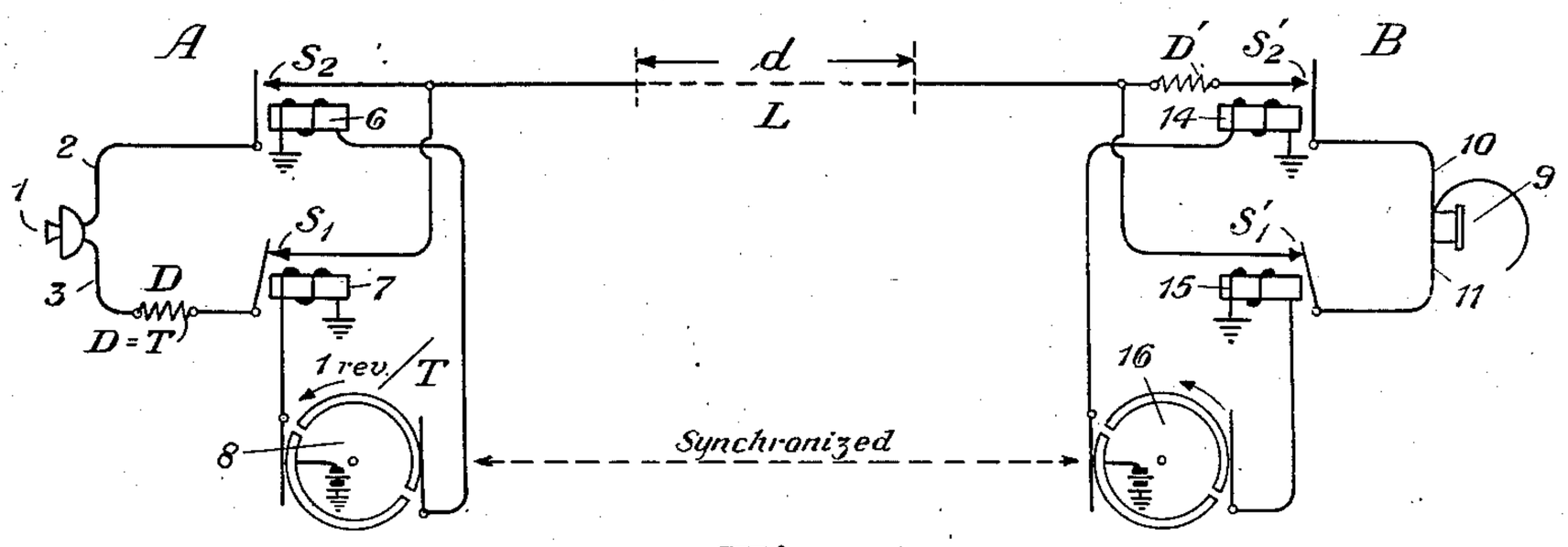

Fig. 1

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

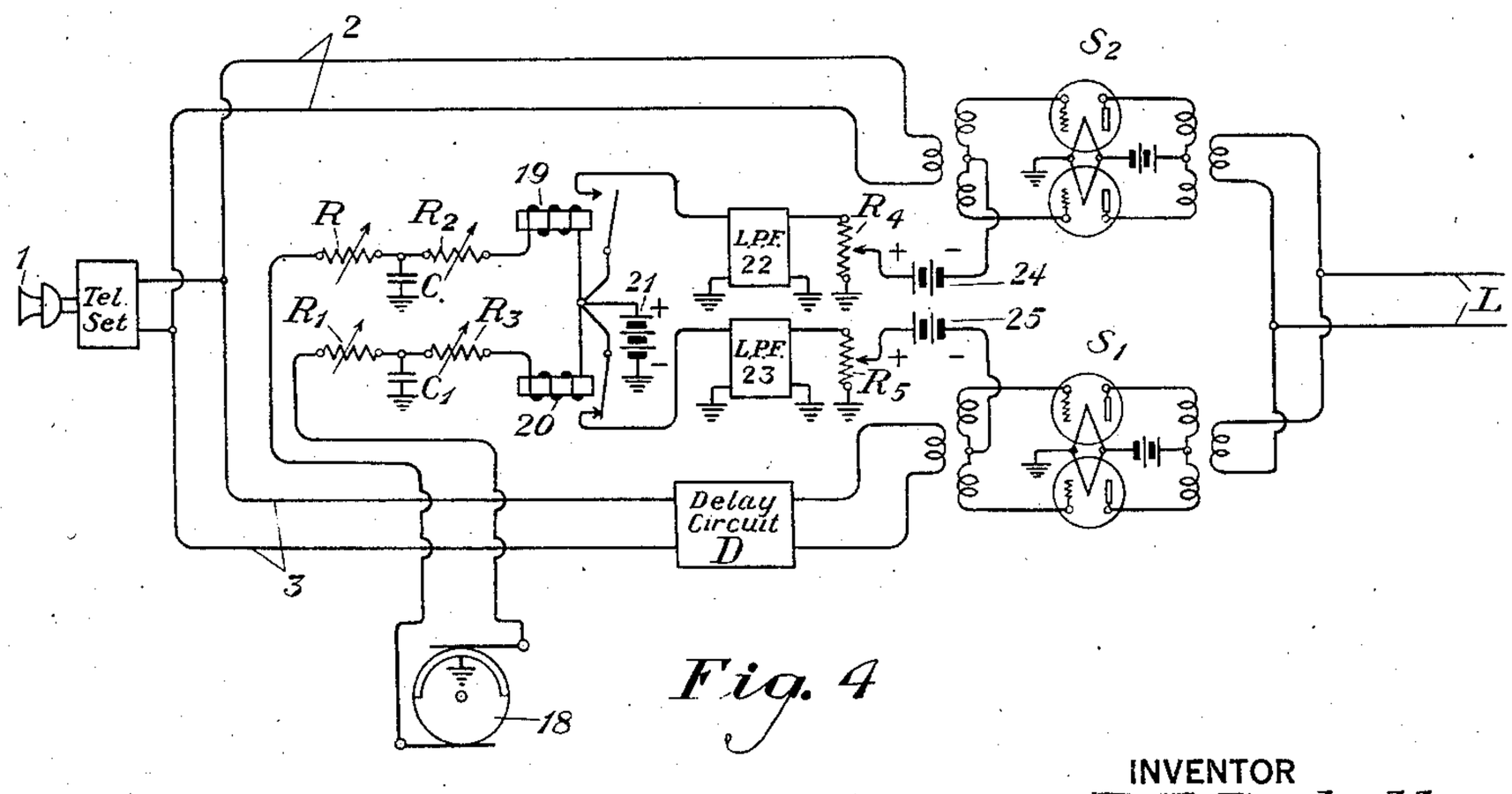

Fig. 4

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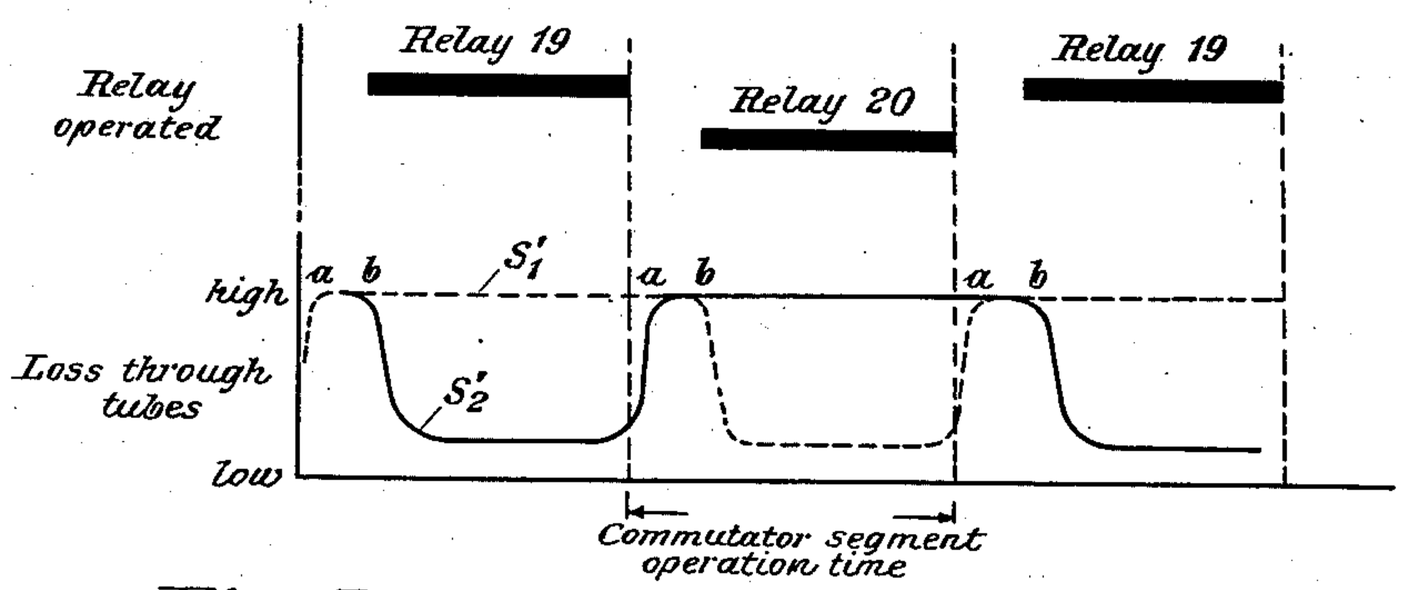

Fig. 5 — Slow operate - quick release relay adjustment.

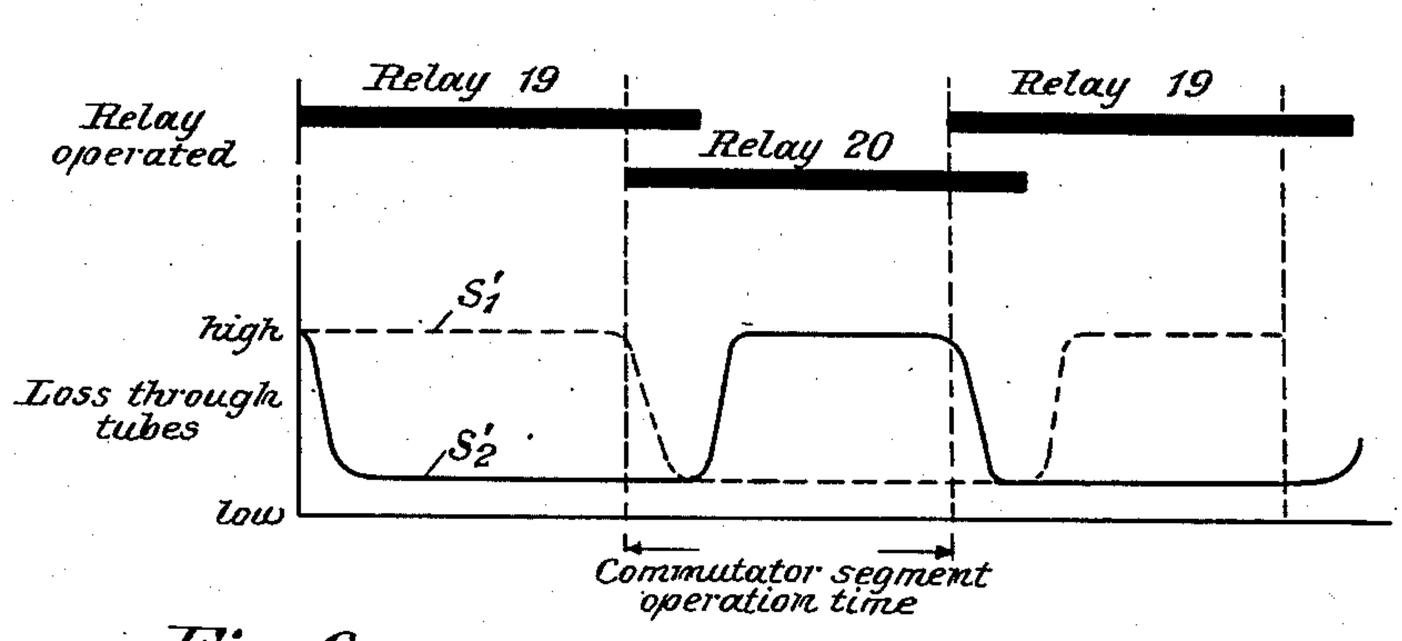

Fig. 6 — Quick operate - slow release relay adjustment.

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Patented Nov. 20, 1934 1,981,113

UNITED STATES PATENT OFFICE

1,981,113

PRIVACY SYSTEM

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Application March 3, 1933, Serial No. 659,559

8 Claims. (Cl. 179—1.5)

This invention relates to switching arrangements, and more particularly to switching arrangements for opening and closing a number of circuits.

One of the objects of the switching arrangements of the invention is to provide means for connecting a device, such, for example, as a transmitter, to a transmission line over a number of different circuits at different times. A further object of the switching arrangements of the invention, when used in connecting a transmitter to a line over different circuits, would be to provide great flexibility in adjusting the quality and character of the message transmitted from the device to the line. For example, with the switching arrangements of the invention it would be possible for the transmitted message to be applied to the line with gaps existing between portions of the message or it would be possible to have portions of the message overlap each other on the line. Adjustments in between these two are provided for with the switching arrangements of the invention. In general, the switching arrangements of the invention are applicable for all purposes wherein it is desired to open one circuit and to close another circuit in timed relationship with respect to each other. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

An illustration of a specific system with which the switching arrangements of this invention might be used, would be a particular type of system for transmitting messages with secrecy or privacy. Such a system is the subject matter of a copending application filed in the names of S. B. Wright and D. Mitchell on March 3, 1933, Serial No. 659,560. In such a system 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 by the switching mechanism of this invention. 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 by the switching mechanism of this invention, and the scrambled units of the message are rearranged in their original order or position. A more detailed reference to this privacy system will be given hereafter solely for the purpose of illustrating one of the uses to which the switching arrangements of the invention may be put. However, it is to be understood that the switching arrangements of the invention are not limited to use in this specific circuit but may be utilized in general for all purposes where it is desired to open and close a plurality of circuits in timed relationship with each other.

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 and 6 of which the invention is illustrated. In Figure 1 is a circuit diagram showing schematically a privacy system utilizing the switching arrangements of the invention. Figs. 2 and 3 are diagrams indicating the manner of scrambling and unscrambling the units of the message transmitted over a system such as shown in Fig. 1. Fig. 4 is a more detailed circuit diagram showing the switching arrangements of the invention as applied to a portion of the system shown schematically in Fig. 1. Figs. 5 and 6 are diagrams illustrating different methods of adjustment of the switching device of the invention as shown in Fig. 4. Similar reference characters have been utilized to denote like parts in certain of the figures.

In Fig. 1 is shown a one-way telephone L interconnecting a sending station A and a receiving station B, and utilizing switching arrangements for privacy purposes. 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 such as the switching arrangements of the invention shown in Fig. 4, 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 re-

volve at a speed of one revolution per T. The two commutators will be operated in synchronism by any well known means. It may be desired to have commutator 16 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 a time 2T. It is then divided into four units of equal duration equal to 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 timed relationship in which they arrive at switch S_2. The time of each individual unit is as pointed out heretofore 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 unit of the scrambled message arrives at S'_1 at a time

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

The time of arrival and order of these 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 the switching arrangements of the invention are shown as applied to the transmitting station A of the system of Fig. 1. In Fig. 4 is shown a telephone transmitter 1 connected to two branched paths 2 and 3, and these paths are connected to line L through the switching arrangements comprising the push-pull amplifiers S_2 and S_1. Circuit 3 would also include the delay circuit D as in Fig. 1. The push-pull amplifier circuits are normally disabled by the large negative bias applied to the grids thereon from batteries 24 and 25. When the commutator 18 operates, its grounded segment will alternately operate either the relay 19 or the relay 20. The operation of relay 19 will close a circuit over its contact from battery 21 through the low pass filter 22 and through resistance R_4 to ground. Due to the drop in R_4 the negative bias applied to the push-pull amplifier S_2 from battery 24 will be reduced when relay 19 is operated. This will allow transmission to pass through the push-pull amplifier circuit S_2 and will effectively close line 2. In like manner, when relay 20 is operated a circuit will be closed from battery 21 through the resistance R_5. The drop in resistance R_5 will reduce the negative bias applied from battery 25 to the push-pull amplifier S_1 and allow it to become operated. Thus, it will be seen that the operation of relay 20 will effectively close the circuit 3. Obviously, the release of relay 19 will restore the negative bias of battery 24 to the push-pull amplifier S_2 and disable it. This will effectively open the circuit 2. In like manner, the release of relay 20 will disable the push-pull amplifier S_1 and effectively open the circuit 3.

With the switching arrangements of the invention as shown in Fig. 4, it is apparent that circuit 2 may be closed and circuit 3 opened, and vice versa, as desired. Furthermore, the arrangements of the invention provide great flexibility in controlling the quality or characteristics of the message transmitted over the lines 2 and 3. For example, gaps may be caused between portions of the message which are sent out from the transmitter 1. This may be accomplished by increasing resistances R and R_1 (R_2 and R_3 are assumed to be very small in this case). Increasing resistances R and R_1 will cause the relays 19 and 20 to become effectively slow operate, quick release relays. This is because condenser C and C_1 will have to be discharged through resistances R and R_1 before relays 19 and 20 can operate respectively. Relays 19 and 20 will release comparatively quickly however since condensers C and C_2 will charge up comparatively quickly through resistances R_2 and R_3 and the relay windings since R_2 and R_3 and the resistances of the relay windings are low compared to resistances R and R_1. This means that at the beginning of each ground impulse from the commutator 18 relay 19 or relay 20 does not operate for a short interval. Thus, transmission through the vacuum tube circuit under consideration does not take place immediately. Eventually, however, the relay operates and enables its vacuum tube circuit, thus allowing transmission to pass therethrough. At the end of the impulse from the commutator 18 the relay will release very quickly, thus quickly disabling the vacuum tube circuit under consideration. An impulse will be transmitted almost im-

mediately to the other relay circuit, but since both resistances R and R_1 are made equal the other relay circuit will also be slow to operate and this will effectively cause a gap between the last portion of the message and the subsequent one. This gap can be increased by increasing resistances R and R_1 up to the point where there will be no speech transmitted whatever, since the relays will not have time to operate during the pulse sent from the commutator.

The manner in which the arrangements of the invention introduce gaps between portions of the message will be more clear from an inspection of the diagram in Fig. 5. The vertical dotted lines indicate the time when the commutator segment changes from one relay circuit to another. With the resistances R and R_1 increased the relays 19 and 20 will be slow operate, quick release relays, and hence, will not operate until a period after the commutator closes a circuit therefor. The operation of the relays in this connection is indicated by the shaded portions in the upper part of the diagram. In the lower portion of the diagram are shown two curves S'_1 and S'_2 which indicate the loss through the tube circuits S_1 and S_2. It will be seen that with the relays operating slowly and releasing quickly, that there will be certain peaks of high loss such as between the points *ab, ab,* etc. This will cause the existence of gaps between portions of the message.

These gaps can be decreased and the portions of the message can be caused to overlap by reducing R and R_1 practically to zero and increasing the resistances R_2 and R_3. This causes the relays 19 and 20 to operate immediately when their circuits are grounded by the commutator, but causes them to be slow in releasing after the ground has been removed from their circuits. In this case the condensers are discharged rapidly through resistances R or R_1 but charge up gradually through resistances R_2 and R_3 and the relay windings since R_2 and R_3 are now large compared to R and R_1. This means that the vacuum tube circuit controlled by a relay is enabled very shortly after the relay circuit is grounded and remains enabled after the ground is removed, for a short time, depending on the size of R_2 or R_3. Thus, by increasing R_2 and R_3 the point will first be reached where one vacuum tube circuit is enabled just up to the time when the other vacuum tube circuit becomes enabled. It will also be seen that by increasing resistances R_2 and R_3 still further, various increasing amounts of overlap may be obtained up to the point where both relay 19 and relay 20 would be operated continuously, since they would remain operated between the times that their circuits are grounded.

The method of causing portions of the speech to overlap will appear more fully from an inspection of the diagram of Fig. 6. As pointed out, the adjustment of resistances R_2 and R_3, has now made the relays quick operating, slow release relays. Their operation, with respect to the operation of the commutator segment, is indicated by the shaded portions in the upper part of the figure. The loss through the tubes is likewise indicated by the curves S'_1 and S'_2. It will be seen that there exist no peaks of high loss with this arrangement.

The low pass filters 22 and 23 have been provided in the circuit through which the current from battery 21 must flow in order to cause a current in resistances R_4 and R_5, and thus cause a positive voltage to be applied to the grids of the vacuum tubes. These filters smooth off the square impulse caused by the operation or release of relay 19 or relay 20. This means that the attenuation of the transmission circuits is changed gradually depending on the number of sections and the cutoff of the low pass filters. This may help to improve the quality of transmission by preventing clicking or disturbing noises from being transmitted. In place of low pass filters any desired shaping network could be used to change the square shape of the impulse in any desired manner.

What is claimed is:

1. A switching system for effectively opening and closing a plurality of circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube device included therein, a second circuit, a vacuum tube device included therein, said tube devices being normally disabled, relays individual to each of said tube devices for controlling the operativeness thereof, means for regulating the speed of operation and release of said relays, and switching means for closing operating circuits for said relays.

2. A switching system for effectively opening and closing a plurality of circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube device included therein, a second circuit, a vacuum tube device included therein, means for applying a negative bias to the grids of each of said tube devices to cause them to be inoperative, relays individual to each of said tube devices, means controlled by each of said relays when operated for reducing the negative bias applied to its associated tube device to cause it to operate, operating circuits for each of said relays, means for adjusting the constants of said operating circuits so that the speed of operation and release of said relays may be regulated, and switching means for opening and closing said operating circuits.

3. A switching arrangement for effectively opening and closing a plurality of circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube amplifier included therein, a second circuit, a vacuum tube amplifier included therein, and switching means comprising slow-operate quick-release relays for gradually rendering one of said amplifiers operative and rapidly rendering the other of said amplifiers inoperative after the operation of said switching means.

4. A switching arrangement for effectively opening and closing a plurality of circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube amplifier included therein, a second circuit, a vacuum tube amplifier included therein, and switching means comprising quick-operate slow-release relays for rapidly rendering one of said amplifiers operative and gradually rendering the other of said amplifiers inoperative after the operation of said switching means.

5. A transmission line, two circuits connected thereto and in parallel with each other, means for simultaneously applying to said circuits units of a message similar to each other in the frequency range, and quick-operate slow-release relay means for causing the units applied from said circuits to said line to overlap each other by any desired amount.

6. A transmission line, two circuits connected thereto and in parallel with each other, means for simultaneously applying to said circuits units

of a message similar to each other in the frequency range, and slow-operate quick-release relay means for causing gaps of any desired amount to exist between the units applied from said circuits to said line.

7. A switching system for effectively opening and closing a plurality of circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube device included therein, a second circuit, a vacuum tube device included therein, means for applying a negative bias to the grids of each of said tube devices to cause them to be inoperative, relays individual to each of said tube devices, means controlled by each of said relays when operated for reducing the negative bias applied to its associated tube device to cause it to operate, operating circuits for each of said relays, means for adjusting the constants of said operating circuits so that the speed of operation and release of said relays may be regulated, switching means for opening and closing said operating circuits, and networks included in each of said operating circuits, said networks having characteristics whereby the gain of said tube devices will be changed gradually.

8. A switching system for effectively opening and closing a plurality of transmission circuits in timed relationship with respect to each other comprising a first circuit, a vacuum tube device included therein, a second circuit, a vacuum tube device included therein, means for applying a negative bias to the grids of each of said tube devices to cause them to be inoperative, relays individual to each of said tube devices, means controlled by each of said relays when operated for reducing the negative bias applied to its associated tube device to cause it to operate, operating circuits for each of said relays, means for adjusting the constants of said operating circuits so that the speed of operation and release of said relays may be regulated, switching means for opening and closing said operating circuits, and filters included in each of said operating circuits, said filters having cut-off characteristics whereby the gain of said tube devices will be changed gradually and transient noises reduced in said transmission circuits.

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