

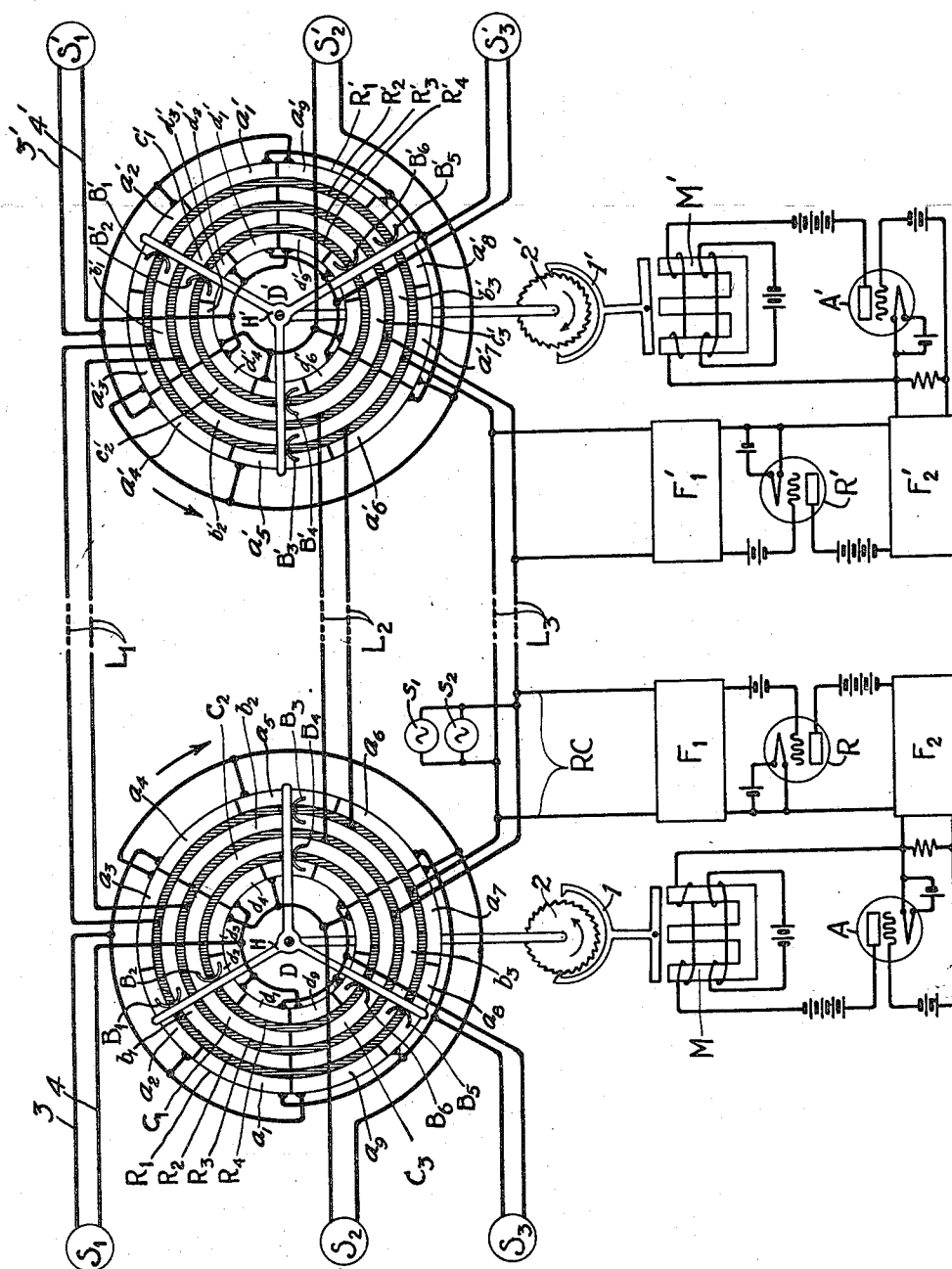
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SECRECY SYSTEM

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SECURITY SYSTEM

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This invention relates to signaling systems and particularly to arrangements for providing secrecy in the transmission of messages over such systems.

5 An object of the invention is to transmit signals in such a manner that they shall be intelligible only at a properly equipped receiving station.

10 A feature of the invention is the provision of means in a signaling system employing a plurality of lines for simultaneously transmitting different messages thereover with secrecy, and in such a manner that each of the lines is, or may be, continuously utilized to
15 full capacity for carrying messages.

In accordance with the invention, switching apparatus is provided at one station for dividing different telephone message waves into fragments on a time basis and for inter-
20 changing the fragment between different outgoing lines in such a manner as to make the transmitted messages unintelligible. At a receiving station corresponding switching apparatus operating in synchronism with
25 that at the transmitting station is provided to split up the received waves into their component message fragments and to recombine the message fragments in their proper intelligible order.

30 The invention will be clear from the following detailed description read in connection with the accompanying drawing which illustrates a signaling system embodying the invention.

35 The signaling system shown in the drawing comprises a plurality of lines $L_1, L_2, L_3, \dots$, each of which is arranged to be connected at one end in rotation to each one of a plurality of telephone stations $S_1, S_2, S_3, \dots$ by
40 means of a commutator or distributor D, and at the other end in rotation to each one of a plurality of telephone stations $S'_1, S'_2, S'_3, \dots$, by means of a commutator or distributor D'. The stations S_1, S_2, S_3 and S'_1, S'_2, S'_3 are provided with the usual telephone
45 transmitting and receiving equipment, which for simplicity is not shown in the drawing.

50 The distributors D and D' may be of any suitable type, the details of design depending upon the number of lines over which mes-

sages are to be transmitted. The type illustrated is designed for associating any one of three lines to any one of three stations. As the two distributors, D and D', are identical, it will only be necessary to describe one of
55 them in detail.

The distributor D illustrated comprises four concentric conductor rings R_1, R_2, R_3 , and R_4 , which are insulated from each other, and each of these rings contains a plurality
60 of segments also insulated from each other. The outer and inner rings R_1 and R_4 have 9 segments each, which are respectively designated a_1-a_9 and d_1-d_9 , while the intermediate rings R_2 and R_3 have three segments each,
65 respectively designated b_1, b_2, b_3 , and c_1, c_2, c_3 .

The west and east terminals of the lines L_1, L_2 and L_3 are respectively permanently connected to certain segments in the intermediate
70 rings of distributors D and D', and the terminals of the circuits leading from the stations S_1, S_2 and S_3 and stations S'_1, S'_2 and S'_3 are respectively permanently connected to
75 certain segments in the inner and outer rings of distributors D and D', as shown in the drawing.

A distributor brush holder H comprising three rigidly connected radial arms of non-conducting material spaced 120° apart is mounted in the center of the distributor D
80 and arranged to be rotated by a motor (not shown) whose shaft is connected to the axis of the holder. Each of the radial arms carries two brushes, which, as the holder rotates, sweep over the distributor face and respec-
85 tively connect in sequence the segments of ring R_1 with the segments of ring R_2 and the segments of ring R_3 with the segments of ring R_4 . The brushes on these radial arms are
90 respectively designated B_1-B_6 .

The distributor D' at the other end of the lines L_1, L_2 , and L_3 , as stated before, is identical with the distributor D just described and its corresponding elements are indicated by
95 the same characters with the addition of a prime (') mark.

Any suitable arrangement may be used for synchronizing the operation of the distributors D and D'. The arrangement shown in
100 the drawing is not a part of the invention, but

is identical with the one illustrated and described in the patent to Henry C. Egerton No. 1,400,039, dated December 13, 1921. Briefly, this synchronizing arrangement operates as follows: The synchronizing oscillations are derived from the alternating current sources s_1 and s_2 which are connected in parallel and arranged to feed into the line circuit L_3 and into the repeater circuit RC connected across the line L_3 . The sources s_1 and s_2 are assigned slightly different frequencies, which frequencies are above the signaling frequencies carried by the line L_3 . The filter F_1 in the repeater circuit RC connected across the line L_3 is adapted to exclude the signaling frequencies and to pass the higher frequencies from the sources s_1 and s_2 to a vacuum tube repeater or combiner R, which produces in its output circuit, in addition to the frequencies from the sources s_1 and s_2 , components representing the sum and difference of these frequencies. The filter F_2 in the output circuit of the repeater R is arranged to pass oscillations of the beat frequency comprising the difference in the frequencies of the sources s_1 and s_2 . These beat oscillations are sent into the amplifier A and amplified sufficiently to effect operation of the distributor magnet M, which governs the rate of travel of the brush holder H through the instrumentality of the escapement mechanism 1 and ratchet 2, which may be frictionally connected to the shaft of the motor continuously driving the brush holder H.

At the east end of the line L_3 , the synchronizing apparatus comprising filters, repeater and amplifier, is a duplicate of the similarly designated apparatus already described at the west end of the line. This apparatus is arranged to permit the beat oscillations produced by the combination of currents from the sources s_1 and s_2 received over the line L_3 to effect the operation of the distributor magnet M' and cause it to step the distributor D' in synchronism with the distributor D at the west end of the line.

The operation of the system of the drawing as a secrecy system will now be explained in detail.

It will be assumed that three different telephone messages are supplied to the distributor D from the circuits connected to stations S_1 , S_2 and S_3 , respectively. In the position of the brush holder H as shown in the drawing, station S_1 is directly connected over line L_1 with station S_1' in a circuit which may be traced as follows: from one side of station S_1 through conductor 3, segment a_2 of conductor ring R_1 , brush B_1 , segment b_1 of ring R_2 , one side of line L_1 , segment b_1' of ring R_2' in distributor D', brush B_1' , segment a_2' of ring R_1' , conductor 3', station S_1' , conductor 4', segment d_2' , brush B_2' , segment c_1' , the other side of line L_1 , segment c_1 of ring R_1 of distributor D, brush B_2 , segment d_2 of ring R_1

and conductor 4 back to station S_1 . Tracing the circuits for the other stations in a similar manner it will be seen that for the position of the brush holder H shown, station S_2 is connected through line L_2 with station S_2' , and station S_3 is connected through line L_3 with station S_3' . Now, if the distributor brush holder H is rotated to the right by the motor (not shown) to a position 40° from its present position as shown in the drawing, the synchronizing arrangement described above will cause a corresponding movement of the distributor brush holder H' at the other end of the lines to a position 40° to the left of its present position. For these changed positions of the brush holders H and H', station S_1 will be connected with station S_1' through the following circuit: from one side of station S_1 , conductor 3, segment a_3 , brush B_1 , segment b_3 , upper wire of line L_3 , segment b_3' , brush B_3' , segment a_3' , conductor 3', station S_1' , conductor 4', segment d_3' , brush B_3' , segment c_3' , lower wire of line L_3 , segment c_3 , brush B_3 , segment d_3 , conductor 4, to the other side of station S_1 . In a similar manner the circuits may be traced to show that for these changed positions of the brush arms, station S_2 will be connected to station S_2' through line L_1 , and station S_3 connected to station S_3' through line L_2 .

If the brush holder H is rotated to the right another 40° , or 80° from its position as shown in the drawing, causing the corresponding advancement to the left of brush holder H' at the other end of the lines, the circuits may be traced to show that station S_1 will be connected to station S_1' through line L_2 , station S_2 connected to station S_2' through line L_3 and station S_3 connected to station S_3' through line L_1 . An advancement of the brush arm H 40° further to the right, or 120° from the position shown in the drawing, will bring the radial arms carrying the brushes in a position such that stations S_1 , S_2 , and S_3 will be again connected to S_1' , S_2' and S_3' , respectively, over lines L_1 , L_2 and L_3 , as was the case in the first arrangement described above. It is evident from the above that in every 120° advancement of the brush holders, the corresponding stations at each end of the lines are connected together for a short interval in rotation over each of the lines L_1 , L_2 and L_3 .

From the above detailed description of the operation of one embodiment of the invention, it is apparent that the switching apparatus at one end of the system insures that different messages from the sources S_1 , S_2 and S_3 , or from the sources S_1' , S_2' and S_3' , for the arrangement described, of course, can be operated as a two-way system, when transmitted, will be unintelligible, as the wave transmitted over each of the three lines will consist only of small fragments of each of the three messages arranged in an arbitrary

trary manner. The degree of unintelligibility will, of course, depend upon the size of the message fragments, which may be controlled by varying the length of the commutator segments or the speed at which the distributor brushes are rotated. A particular advantage of the invention lies in the fact that each message wave transmitted over the lines L_1 , L_2 or L_3 may be continuous, that is, each line may be employed to full capacity at all times in carrying messages. The switching apparatus at the receiving end of the line, operating in synchronism with the switching apparatus at the transmitting end of the line, breaks up the unintelligible waves received over each of the lines, L_1 , L_2 and L_3 into their component message fragments and distributes these fragments to the proper receiving stations combined in their original intelligible order.

In such a system, as described, it is apparent that an unauthorized observer by tapping one or more of the lines will hear only unintelligible fragments of several conversations. Even though the observer taps all three of the lines, he will not be able to make out the messages transmitted unless he is acquainted with the particular arbitrary manner in which the messages are combined and has the proper apparatus for separating them, and has this apparatus suitably synchronized. It is, of course, apparent that in practice the different lines over which the jumbled up messages are transmitted may be widely separated thus making it a practical impossibility for any unauthorized observer to tap all of the lines simultaneously.

It is to be understood that the particular arrangement illustrated and described may be variously modified without departing in any way from the spirit of the invention as defined in the accompanying claims. For example, the invention has been described in connection with its application to three lines, but it is apparent that it is also applicable to any number of lines. Although an arbitrary manner of arranging the message fragments has been illustrated and described, it is apparent that the apparatus may be arranged to give any desired arrangement of the fragments. For example, distributors or commutators at each end of the systems in accordance with the invention may be used in tandem or combined in any other manner to give any desired irregular order for the message fragments. Moreover, although the invention has been illustrated and described in connection with its use in telephone systems, it is to be understood that it is applicable to telegraph systems as well.

Although the invention has been illustrated and described as applied to ordinary telephone lines, it is not limited to such use but the signaling stations S_1 , S_2 , S_3 , . . . and S_1' , S_2' , S_3' , . . . may be connected to high fre-

quency radio or carrier channels, for example, in a manner similar to that disclosed in U. S. patent to Griggs 1,526,335 dated Feb. 17, 1925. If desired, each of the signaling channels S_1 , S_2 , S_3 may be arranged in a manner similar to that disclosed in the Griggs patent referred to above, so that when a station is not being utilized for transmitting messages, noise currents having characteristics of the message wave are automatically supplied to the leads to which said stations are connected.

What is claimed is:

1. The method of securing secrecy in the transmission of telephone messages over a signaling system employing a plurality of transmission paths, which method comprises dividing different telephone message waves into fragments on an arbitrary predetermined time basis, interchanging the fragments of the different messages between the different paths in such a manner that a substantially continuous unintelligible wave comprising fragments of each of the original waves is transmitted over each of said paths, and at a receiving point separating and recombining the transmitted fragments to reproduce the original message waves.

2. The method of securing secrecy in the transmission of telephone messages over a signaling system comprising a plurality of lines which method comprises diverting successively occurring portions of different telephone message waves in rotation and at a predetermined rate into each of said lines in such a manner that a continuous unintelligible wave comprising portions of each of said telephone message waves transmitted over each of said lines, and at a receiving point separating the different message portions in the received wave and recombining them to reproduce the original message waves.

3. In a secret signaling system, a plurality of telephone message current sources, a plurality of outgoing lines, commutating means for dividing the telephone currents from each of said sources into fragments on a predetermined time basis, and for cyclically interchanging the fragments from the different telephone currents between the outgoing lines so that the resultant message wave transmitted over each of said lines is substantially continuous and unintelligible and commutating means operating in synchronism with the first-mentioned commutating means for separating the message fragments received over said lines, and for recombining them in their proper intelligible order.

4. In a secrecy system, a plurality of telephone transmitting stations, a plurality of lines, switching means for cyclically connecting each of said stations in rotation to one end of each of said lines in such a manner that during the interval when a given one of said stations is connected to a given line, each

of the other stations is connected for the same interval to a different one of the other lines, a plurality of telephone receiving stations, and a second switching means operating in synchronism with the first-mentioned switching means to connect said receiving stations in rotation to the other end of each of said lines in such a manner that during the interval when a given one of said receiving stations is connected to a given line, each of the other receiving stations for the same interval is connected to a different line, the period of connection of each transmitting and receiving station to a given line being predetermined and of small duration.

5. In a two-way secret signaling system, a plurality of lines, a plurality of signaling stations each comprising telephone transmitting and receiving apparatus at each end of said lines, switching means for connecting each of the signaling stations at one end of said lines in rotation for a predetermined interval of time to each of said lines in such a manner that during the interval of time when a given one of said stations is connected to a given line, each of the other stations at said end of said lines is connected for the same interval to a different one of the other lines, a second switching means operating in synchronism with the first mentioned switching means for connecting the signaling stations at the other end of said lines in rotation to said lines in such a manner that during the interval when a given one of said signaling stations at said other end of said lines is connected to a given line, each of the other signaling stations at said other end of said lines is connected for the same interval to a different one of the other lines.

6. In a secret signaling system a plurality of telephone transmitting stations, a plurality of receiving stations, a plurality of transmission lines therebetween, switching means for simultaneously connecting one of said transmitting stations to one end of one of said lines and another of said transmitting stations to one end of another of said lines and maintaining said transmission stations so connected for a predetermined small interval of time, and at the end of that interval for disconnecting the first-mentioned transmitting station from the first-mentioned line and connecting it to the second-mentioned line while simultaneously disconnecting the second-mentioned station from said second-mentioned line and connecting it to said first-mentioned line, and a second switching means operating in synchronism with the first-mentioned switching means for simultaneously connecting one of said receiving stations to the other end of said first-mentioned line and another of said receiving stations to the other end of said second-mentioned line and maintaining said receiving stations so connected for another

predetermined small interval of time, and at the end of said interval for disconnecting the first-mentioned receiving station from said first-mentioned line and connecting it to said second-mentioned line while simultaneously disconnecting the second-mentioned receiving station from said second-mentioned line and connecting it to said first-mentioned line.

7. In combination in a secret signaling system, three or more signal transmission paths, a corresponding number of signal stations each comprising telephone transmitting and receiving apparatus, and means for interchangeably connecting said stations with said paths for a predetermined period of time so that at any instant each station is connected to a different transmission path and to only one path, the period of connection of any station to a given transmission path being short in comparison with the length of time required to transmit an intelligible portion of a message.

8. In combination in a secret signaling system, a multiplicity of signal transmission paths, a corresponding number of pairs of signal stations, each pair comprising a telephone transmitting station at one end of said paths and a telephone receiving station at the other end of said paths, and means for interchangeably connecting each pair of said signal stations in succession to each of said paths in accordance with a prearranged scheme so that at a given instant each pair of signal stations is connected to a different one of said paths and to only one path, the period of connection of any pair of stations to a given transmission path being short in comparison with the period of time required to transmit thereover an intelligible portion of a telephone message.

9. In combination in a secret signaling system, a multiplicity of signal transmission paths, a corresponding number of pairs of signal stations, each pair comprising a telephone transmitting station at one end of said paths and a telephone receiving station at the other end of said paths, and means for interchangeably connecting each pair of said signal stations in succession to each of said paths in accordance with a prearranged scheme so that signaling currents from each telephone transmitting station are transmitted continuously over said paths and at a given instant each pair of signal stations is connected to a different one of said paths and to only one path, the period of connection of any pair of stations to a given transmission path being short in comparison with the period of time required to transmit thereover an intelligible portion of a telephone message.

10. In a secret telephone system, a plurality of telephone lines, transmitters and receivers at opposite terminals of said lines,

and synchronously operating switches at said terminals for simultaneously connecting to each respective line a transmitter at one terminal and a cooperating receiver at the other terminal and for simultaneously interchanging the connections in rapid succession to cause the speech currents utilized by each transmitter and its cooperating receiver at the opposite terminal to traverse first one line during the interval in which said transmitter and its cooperating receiver are connected thereto and then another line during the interval in which said transmitter and receiver are connected thereto while the speech currents utilized by another transmitter and receiver traverse said other line during the interval in which said other transmitter and its cooperating receiver are connected thereto and then said first line during the interval in which said other transmitter and its cooperating receiver are connected thereto, and so on, in rapid recurring time intervals.

In witness whereof, I hereunto subscribe my name this 27th day of October A. D., 1925.

RALPH V. L. HARTLEY.