

Aug. 27, 1946.

F. G. BUHRENDORF

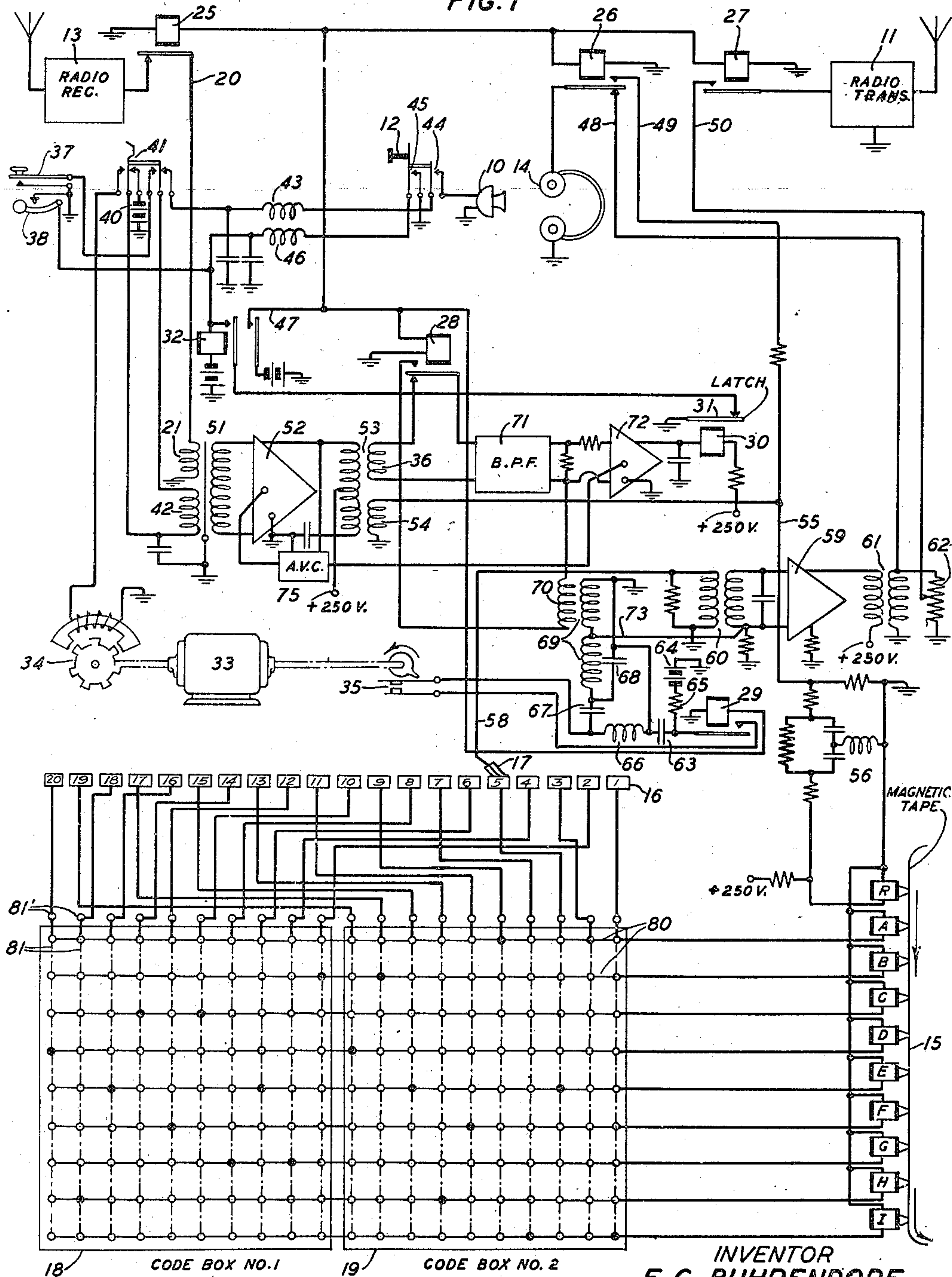
2,406,349

SECRET SIGNALING

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2 Sheets-Sheet 1

FIG. 1



INVENTOR
F. G. BUHRENDORF

BY

J. A. Surges

ATTORNEY

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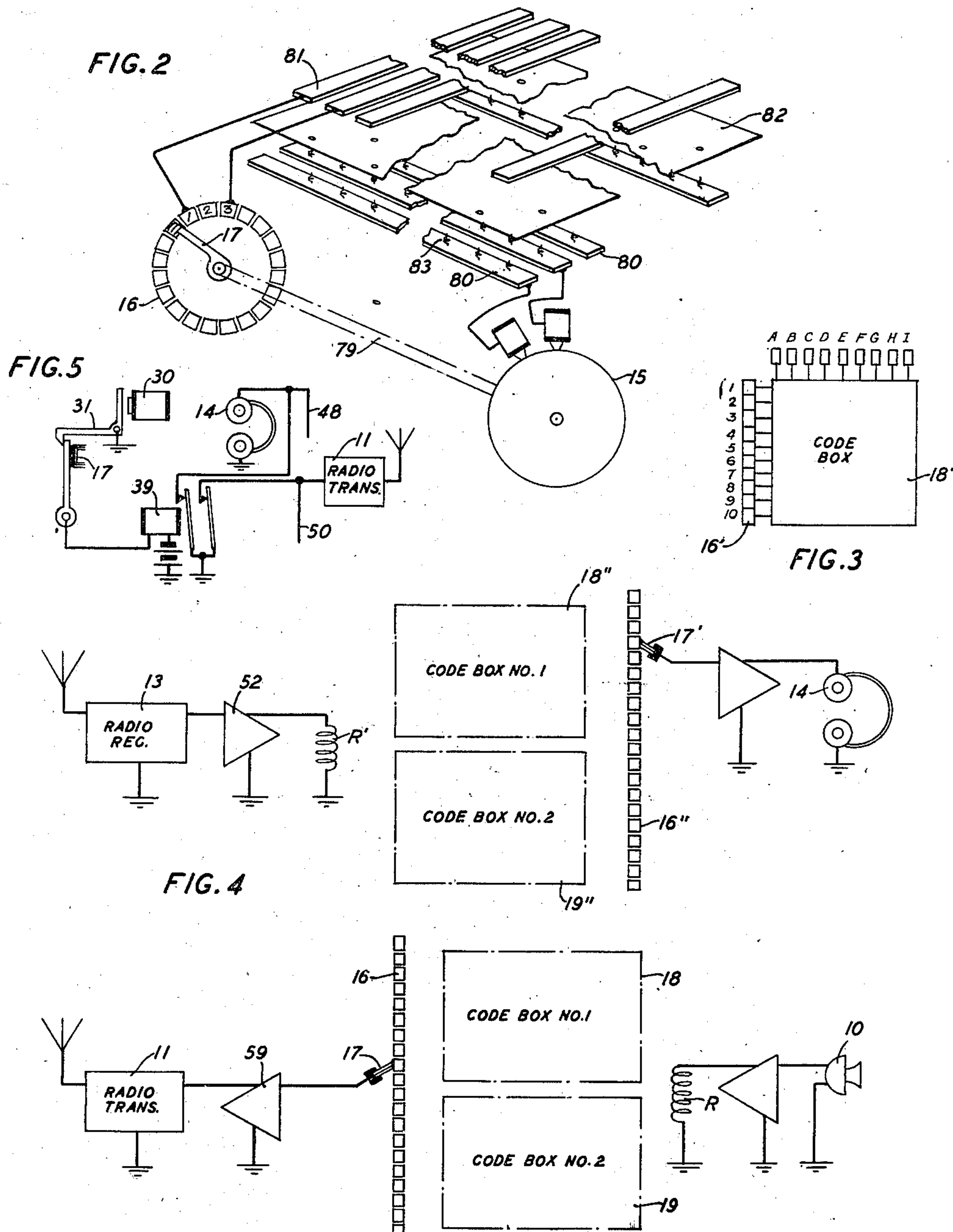
F. G. BUHRENDORF

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SECRET SIGNALING

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2 Sheets-Sheet 2



INVENTOR
F. G. BUHRENDORF
BY *H. A. Burgess*
ATTORNEY

UNITED STATES PATENT OFFICE

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SECRET SIGNALING

Frederick G. Buhrendorf, Hastings on Hudson,
N. Y., assignor to Bell Telephone Laboratories,
Incorporated, New York, N. Y., a corporation of
New York

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14 Claims. (Cl. 179—1.5)

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The present invention relates to the secret transmission of signals such as speech waves. More particularly, the present invention relates to the type of privacy transmission in which message waves are divided into fragments on a time basis and the fragments are sent out with each fragment subjected to a delay, different for different fragments so that they are not in their normal time order.

A general object of the invention is to improve upon prior systems of this type by providing a greater degree of secrecy in transmission while avoiding undue complexity in apparatus employed.

The embodiment of the invention to be disclosed can be built into a compact portable unit suitable for use on moving vehicles, including airplanes, for communicating between such movable vehicles or between such vehicles and fixed stations on ground or shore. The privacy is not destroyed by capture of the apparatus itself so long as the particular schemes in use at a given time for varying the delay of the message fragments are not known. As will be pointed out, the scheme of variations in delay or the code may be changed frequently by prearrangement so that interception of the message information by unauthorized parties is rendered highly difficult.

In the particular embodiment of the invention to be disclosed herein, the message waves such as speech are recorded on a suitable medium such as magnetic tape and are reproduced from the record in such manner that the time order of sending of fragments of the message can be varied. A rotary commutator breaks the recorded waves into fragments of definite length, each of a small fraction of a second duration, and the connections between the reproducers and commutator segments can be varied to alter the scheme of time delays. In receiving, each of the fragments of speech is again delayed between recording and reproducing so that each fragment is reproduced in its correct order.

A system of this general type is disclosed in my prior application Serial No. 404,111, filed July 26, 1941. The present invention is in the nature of an improvement upon the system disclosed in said application. The improvement features will be described hereinafter.

The nature and objects of the present invention and its various features will be apparent from the following detailed description in connection with the drawings, in which:

Fig. 1 is a schematic circuit diagram of a complete two-way terminal in accordance with the present invention;

Fig. 2 is a fragmentary view, partly exploded and in perspective, of the crossbar code switch and punched card;

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Fig. 3 shows in outline how a single code box would be connected in the system;

Fig. 4 is a block diagram showing how the apparatus of Fig. 1 would be disposed for four-wire transmission; and

Fig. 5 shows a detail modification of a portion of the Fig. 1 circuit.

Referring first to Fig. 1, the system shown enables speech spoken into transmitter 10 to be sent out with privacy over radio transmitter 11 and enables speech so transmitted when received on radio receiver 13 to be received as intelligible speech in receiver 14. Transmission and reception could, of course, be by wire line, as well.

The means for scrambling the outgoing message and unscrambling the received message comprises the telegraphone tape 15 (shown in the lower right-hand corner of the figure) and the commutator 16 shown as twenty segments laid out in a straight line and traversed by brush 17. The tape and commutator may be arranged as in my prior application to be driven from a common motor or even from the same shaft. The tape may be mounted on the rim of a disc or wheel and closed on itself to form a ring, as in my prior application, with the recording magnet R and the nine reproducer magnets A, B, C . . . I mounted at equal distances around the ring. An erasing magnet (not shown) would be placed just ahead of the recording magnet R as in my prior application.

In place of the five-point switches shown in my prior application, the present invention makes use of crossbar switches with punched cards to determine the points of interconnection between the leads from the reproducer magnets and the commutator segments. These are shown diagrammatically in Fig. 1 as included in two code boxes 18 and 19 to be described in detail hereinafter. It will be understood that previously prepared punched cards are inserted, one in each code box, to condition the system for transmitting (and/or receiving) the message with the two codes interlaced with each other. Other codes may be substituted by merely removing these cards (or either of them) and substituting others.

The circuits involved in the actual transmission and reception, and in synchronizing, are substantially similar to those disclosed in my prior application. Relays 25, 26, 27, 28, and 29 are all energized in common from relay 32 which is under the direct control of push-to-talk button 12. These relays shift contacts at various points in the system to change over from receive to transmit condition whenever the button 12 is pressed, the system being in receiving condition when button 12 is in released position.

The motor 33 supplies power for the rotating parts, principally the commutator 16 and magnetic tape 15. This motor should be a constant

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speed motor and may be provided with any suitable speed control for maintaining constant speed. A mechanical governor may be used for this purpose as disclosed in my prior application or an electrical system may be used, one type being that shown in Stoller Patent 1,695,035, December 11, 1928.

The motor drives a pilot generator 34 (for a purpose to be described later on) and a cam for operating synchronizing contacts 35 as in my prior application. The motor may be driven from a 24-volt battery and may be wound to provide a 250-volt output for plate supply for the various tubes of the system.

The operation of the system will now be described in such detail as is necessary to a full understanding of the present invention.

Let it be assumed that the communicating parties have agreed on the codes that are to be used at a particular time and that the two code cards are inserted into the two code boxes 18 and 19 at each station, of which there may be two or any other number. The sending of the start impulse from contacts 35 of the transmitting station releases all brushes 17 at all stations when brush 17 is on start segment 20 as explained in my prior application. The brushes are at rest against their stops at all stations except when some one of the stations has pressed its push-to-talk button 12. A release magnet 30 is provided at each station, which when energized releases a latch 31, as in my prior application. This allows the brushes 17 at all stations to start out on a revolution in phase with each other. Contacts 35 are closed for a brief instant once each revolution to operate release magnet 30 at the transmitting station and to send a start pulse for releasing the release magnet at each receiving station, as will be described more in detail later on.

Assuming first that the station shown in Fig. 1 is to transmit secret speech, the party presses button 12 and speaks into microphone 10. Button 12 closes contacts which supply talking current from battery 40, normal contact of key 41, winding 42, normal contact of key 41, radio choke 43, contact 44 of button 12, to microphone 10. Contact 45 of button 12 closes a circuit for relay 32 from battery, winding of relay 32 and radio choke 46. Relay 32 energizes and locks itself up over its inner armature and front contact and over back contact of latch 31 to ground. (However, this locking circuit is ineffective so long as key 12 remains pressed.) Relay 32 at its outer armature closes contact for supplying battery over lead 47 to the windings of relays 25, 26, 27, 28, and 29 causing all of those relays to open their back contacts and close their front contacts to condition the circuits for transmitting. Relay 25 cuts off the receiving lead from radio receiver 13. Relay 26 opens the receiving branch conductor 48 leading to head phones 14 and closes side-tone lead 49 to head phones. Relay 27 closes the lead 50 to the radio transmitter 11. Relay 28 opens the receiving circuit for the start pulse and closes the transmitting circuit for the start pulse. Relay 29 closes the start pulse generating circuit.

The speech currents generated in microphone 10 traverse the circuit previously traced through winding 42 and are impressed through input transformer 51 upon the input of amplifier 52. The amplified output speech waves are sent through output transformer 53 and winding 54 to the recorder magnet R over lead 55. Interposed in this lead 55 is a band elimination filter

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56 for suppressing a narrow range of speech frequencies located at about 2,000 cycles, this narrow range of frequencies being reserved for transmitting the start pulse. Filter 56 prevents speech components that happen to lie in that range from reaching the recorder magnet R. The speech waves are recorded on the moving tape 15 at R and the tape then passes along past the nine reproducer magnets A . . . I. A portion of the speech is taken from lead 55 over lead 49 to the head phones 14 over front contact of relay 26 so that the talker can gauge the loudness of his input speech into the system.

The code boxes permit cross-connections between any commutator segment and any reproducer magnet so that as brush 17 sweeps over any given segment any preselected reproducer magnet can be connected at that time to the brush. By properly placing the perforations in the code cards, as will be more fully described, the reproducers A . . . I can be individually connected to the brush in any order and at any given times in the cycle.

Brush 17 is connected by lead 58 to the input of transmitting amplifier 59 via input coil 60. The amplified scrambled speech is sent through output transformer 61 and potentiometer 62 over lead 59 to the radio transmitter 11 over front contact of relay 27.

Once each revolution of the brush 17, when it is in contact with the short synchronizing segment 20 of commutator 16, contacts 35 are energized. Since relay 29 is closed at this time, a circuit is closed for discharging condenser 63 through inductance 66. Condenser 63 was previously charged up from battery 64 through resistance 65. Contacts 35 are closed for only a brief instant and condenser 63 in discharging into the inductance 66, forming a part of a filter consisting also of capacities 67, 68 and inductances 69, generates a damped wave of 2,000 cycles per second. This is transmitted through coil 69, 70, upper contact of relay 28 and into filter 71 leading to the input of gas-filled tube 72. This tube breaks down upon the first sufficiently large positive swing of its grid and energizes the tripping magnet 30 which releases the brush arm for another rotation. At the same time, a part of the 2,000-cycle wave is applied over lead 73 to the grid of transmitting amplifier 59 so that the start pulse is sent to the distant receiving stations.

An automatic volume control 75 is shown for the amplifier 52. This also controls the sensitivity of the gas tube circuit 72. This automatic volume control may be of known type and uses rectified audio waves in the output of amplifier 52 to develop a bias voltage for the grids of amplifier 52 and gas tube 72, varying as the level of the input level varies so as to maintain substantially constant output level. The bias on the tube 72 controls the sensitivity of the gas tube increasing or decreasing it as a function of signal level to maintain the time of release of the latch 31 independent of receiving level and to maintain the discrimination between signal and speech level approximately constant.

The system can also be used for sending tone telegraph by means of key 37 when switching key 41 is thrown to the left. The tone may be derived from a pilot generator 34 driven from the motor 33. This pilot may be the same as that used for speed control of the motor as disclosed in the Stoller patent referred to. The side switch 38 on the key is closed when sending to energize relay 32 and is opened when receiving. The dot

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and dashes are split up by the commutator and the fragments are scrambled as described for the case of speech. This in effect breaks up the spaces also so that the marking and spacing signals are confused. The telegraph is received at the distant station in headphones 14 after decoding in the manner that will be described for speech.

When the talker stops talking he releases button 12 so that the station can revert to receiving condition. Release of button 12 does not immediately release the various transmit-receive relays, however, but they remain energized until the brush 17 completes its full revolution and is released for the succeeding revolution. This is accomplished by the locking circuit for relay 32 which remains closed through the back contact of the latch 31. In this way the portions of the talker's speech that have been recorded on the tape 15 are given time to be on the average more fully transmitted before the switching relays release. The sending of the additional pulse has the important effect at the receiver of starting another revolution of the brush after the transmitting period has ended so that all received and recorded speech elements are reproduced before the brush stops.

When relay 25 releases, it reconnects the radio receiver lead 20 to the input of amplifier 52 over winding 21 of transformer 51. Thus received scrambled speech can now be applied to amplifier 52, amplified and then applied to recorder magnet R. Relay 26 in releasing connects the output of amplifier 59 to the head phones 14 over lead 48. The input of amplifier 59 is connected to the brush 17 so that now the decoded speech is applied to the head receivers. Relay 29 in releasing disables the pulse generating circuits under the control of cam operated contacts 35. Relay 28 in releasing connects secondary winding 36 of output transformer 53 of amplifier 52 to the 2,000-cycle filter 71 so that the tripping tube 72 and magnet 30 are placed under the control of the 2,000-cycle pulses from the distant transmitting station. Band elimination filter 56 greatly attenuates these pulses so that they do not reach the recorder R. It will be understood that the code cards used at the receiver so interconnect the reproducer magnets A . . . I and the commutator segments that the scrambled speech fragments are reproduced in their normal order to form understandable speech.

With the circuit arranged as in Fig. 1 it is possible to receive normal speech if the brush 17 is held stationary and if normal speech is coming in over the radio receiver 13. For such speech is recorded at R and the tape is continuously in motion so that the normal speech is reproduced in each reproducer A, B etc. Since some one of these reproducers will always be connected to the segment 20 on which the brush is normally at rest, the speech will be received. This type of operation may be desirable in some cases while in other cases it may be objectionable since it offers the possibility of false signaling by an enemy who might send normal speech without any start pulses to operate the start latch.

One way of preventing this kind of reception is shown in Fig. 5. In this figure the tripping magnet 30, latch 31, brush 17 and brush arm are shown together with a relay 39 energized when the brush is stationary and provided with contacts which shunt out both the radio transmitter 11 and head set 14. Relay 39 is sufficiently slow not to close its contacts when brush 17 is stopped

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during normal operation. Speech can only be heard, therefore, if the brush is operating normally. If the operator fails to hear his own speech while he is talking he knows that the set is not transmitting secret speech. This could occur if the set fails for any reason to operate or if the brush should accidentally fail to start but remains stationary for an abnormal time. The operator is thus warned against sending out non-secret transmission and is enabled to distinguish between a received secret transmission and false message.

The actual construction of the code boxes will be clear from the diagrammatic representation in Fig. 2 of one of the two units. The brush arm 17 and disc for tape 15 are represented as connected by shaft 79 for driving them. Two of the reproducer magnets A, B are indicated. There are nine bars 80, 80, etc., each connected to an individual reproducer magnet A, B, etc. Over these are ten bars 81 extending at right angles to bars 80 and individually connected to alternate commutator segments as indicated in this figure and in Fig. 1. A code card 82 is indicated as positioned between the two sets of bars, and as having perforations registering with certain of the pins 83 mounted on bars 80. In one form, bars 81 are on the under side of a hinged lid which is lifted to permit laying a punched card on the tops of the pins 83. When the lid is closed down, all of the pins 83 except those registering with holes in the card are pushed down into seats in bars 80 while those registering with the holes project up against and make contact with the bars 81. Coil springs at the base of pins 83 urge the pins upward and also serve to make good contact between the pins and bars 80. In an actual construction, in order to avoid flexing lead wires, the commutator segments may be connected to a row of pins 81' (Fig. 1) which make contact with the ends of the individual bars 81 when the lid is closed, instead of connecting the wires to bars 81 directly, as shown in Fig. 2.

In my prior application, several types of coding were described, such as double coding using two independent codes, converse coding, interlaced coding (with independent codes) and interlaced converse coding, as well as other types. In accordance with the construction disclosed therein, the codes were set up on multipoint switches which were so interconnected with the reproducer magnets and commutator segments as to insure certain sending orders and receiving orders of the speech fragments, such as to produce the desired coding and decoding of the message. For any one type of coding involving its required scheme of wiring, certain restrictions existed as to the particular reproducer magnets that could be connected to certain distributor segments. For example, if a code consisting of five units, by way of specific illustration, were adopted for use and the wiring carried out for that code as therein disclosed, no provision needed to be made for connecting commutator segment No. 1 in sending condition to magnets *f*, *g*, *h*, or *i*. Other similar restrictions existed.

The present invention is based in part upon a new concept of coding and decoding and it involves important simplifications in construction and operation. In a privacy system, the degree of privacy is increased as the number of secret code combinations is increased. The present invention in one aspect provides increased privacy by making usable a greatly increased number of code combinations. The simplification which is

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achieved at the same time is particularly important in portable sets where reliability of service and lightweight are important. The servicing in case of trouble is also simplified.

In accordance with the present invention, no restrictions are placed by the wiring and crossbar switches upon the interconnections that can be made between the distributor segments and reproducer magnets. Any reproducer can be connected to any commutator segment. The code used is determined entirely by the punching of a code card. In making up the card certain restrictions must be observed in order to preserve the speech intact. For instance, none of the fragments of speech should be omitted but every fragment should be sent in the interest of full intelligibility. No fragment should be repeated, for similar reasons. Obviously, some code combinations are more secret than others. But the coding possibilities afforded by the mechanism itself are made perfectly general within the limits provided by the design as to total number of speech fragments that can be handled.

Consider for example a single code box and a ten-segment commutator as indicated in Fig. 3, where the commutator 16' is shown at the left. The single code box 18' is constructed as in Figs. 1 and 2, and the nine reproducers A . . . I are shown just above the code box. All of the coding schemes disclosed in my prior application for a ten-segment commutator can be used with the Fig. 3 construction, it being only necessary to punch the card to correspond with the particular code. By providing a twenty-segment commutator and twenty bars like 81 of Fig. 2, one bar for each segment, the interlaced codes of my prior application can be used.

The code box, ten-segment commutator and nine reproducer magnets arranged as in Fig. 3 can be used also, by way of further example, for a ten-element code. In the following table the numbers in the columns below the reproducer magnets represent the speech fragments arranged as they have been recorded on the tape at the sending end. They do not, of course, exist as fragments until they have been broken up by the commutator since they are recorded as continuous speech, but they may be thought of as sections of speech later to be separated from one another by the action of the commutator. The numbering is arbitrary and merely indicates that with increasing time the speech is moving toward the right under the reproducer magnets.

Table I

Commutator times	Reproducer magnets								
	A	B	C	D	E	F	G	H	I
1	5	4	3	2	1	0'	9'	8'	7'
2	6	5	4	3	2	1	0'	9'	8'
3	7	6	5	4	3	2	1	0'	9'
4	8	7	6	5	4	3	2	1	0'
5	9	8	7	6	5	4	3	2	1
6	0	9	8	7	6	5	4	3	2
7	1''	0	9	8	7	6	5	4	3
8	2''	1''	0	9	8	7	6	5	4
9	3''	2''	1''	0	9	8	7	6	5
10	4''	3''	2''	1''	0	9	8	7	6
11	5''	4''	3''	2''	1''	0	9	8	7

The primes indicate different fragments belonging to a previous set of speech elements with respect to those represented by the unprimed numbers. The double primed numbers indicate dif-

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ferent fragments belonging to one following set of speech elements. From inspection of the table it can be seen that if one desired to send the fragments in the jumbled order

9' 3 5 2 1 4 0 8 7 6

it is merely necessary to punch the card where these numbers occur underscored in the table so that commutator segment 1 is connected to reproducer G, segment 2 is connected to reproducer D, and so on giving the code in terms of the reproducer magnets as G D C G I G B E G I.

When these fragments are received they are laid down on the recording tape in the order of their transmittal so that a similar table constructed to represent the receiving action would appear as follows, beginning with commutator time 6, since one commutator time interval is used up in recording at the receiver and five speech fragments are assumed to have been recorded at the transmitter at commutator time 1.

Table II

Commutator times	Reproducer magnets								
	A	B	C	D	E	F	G	H	I
6	1	2	5	3	9'	6'	7'	8'	0'
7	9	1	2	5	3	9'	6'	7'	0'
8	0	4	1	2	5	3	9'	6'	7'
9	8	0	4	1	2	5	3	9'	6'
10	7	8	0	4	1	2	5	3	9'
11	6	7	8	0	4	1	2	5	3
12	9	6	7	8	0	4	1	2	5
13	3''	9	6	7	8	0	4	1	2
14	5''	3''	9	6	7	8	0	4	1
15	2''	5''	3''	9	6	7	8	0	4

By inspection, it can be seen that the speech fragments are received in their normal order (1, 2, 3, etc.) if commutator segment 6 is connected to reproducer A, segment 7 to reproducer C, etc., as indicated by the underscoring in the table. Expressing the decoding formula in terms of reproducer magnets beginning with segment 1, we get A C E C H A C F C G.

By referring to Tables I and II, it is seen that speech fragment 1 was sent in the 5th time interval. During this interval it is being recorded at the receiver so that in the next or 6th interval it can be received since it is then passing under reproducer A. Thus, fragment 1 is being received while fragment 4 is being sent and recorded; fragment 2 is being received while fragment 10 (0) is being sent; fragment 3 is being received while fragment 8 is being sent, etc. Fragment 9 is sent in commutator time 11 and received in commutator time 14.

The above discussed ten-element code is expressed as

send G D C G I G B E G I

9' 3 5 2 1 4 0 8 7 6

receive A C E C H A C F C G

The synchronizing pulse is sent between commutator times 10 and 1.

If two code cards with different punchings are placed in the code boxes 18 and 19 of Fig. 1, each of the ten speech fragments considered above is divided into two halves, the first half being sent in the time interval determined by the first code and the second half being sent in the time interval determined by the second code, and so on. In other words, the two codes are interlaced. If one were concerned with only one-way transmis-

sion, any two codes, which might be entirely independent of each other, could be used in the two code boxes. For two-way transmission of the type shown in Fig. 1 involving no change over switch contacts between the reproducer magnets and commutator segments, self-converse codes should be used. One such code, for illustration, is B G E G C F C E H D, which is the same for both coding and decoding. Another is I A E I A F H E B D. These two are indicated as in use in the code boxes 18 and 19 by the solid circles representing holes in the cards.

Fig. 4 illustrates a system in which any number of stations can communicate with one another secretly by four-wire transmission. While two separate machines are required, this arrangement permits the use of a very great number of code combinations since the two codes used for transmitting can be entirely independent of those used for receiving. The converse of the two sending codes are set up on the receiving machine. The circuits may otherwise be the same as in Fig. 1. The parts are identified on the drawings by the same reference characters as in Fig. 1, with prime marks to indicate parts that are needed in duplicate.

For the sake of concrete examples, definite numbers of reproducers, speech fragments and commutator segments have been used in the foregoing description, as an assistance in understanding the operation. Obviously, the invention is not restricted to any given numbers of elements and there are only two basic restrictions which are imposed on the general method. These are:

1. Each element shall be transmitted only once (and the converse, every element shall be transmitted).

2. Each element shall be subjected to the same total time delay; that is, the delay in the sender plus the delay in the receiver shall be the same for each and every element of speech.

Let us now consider the delay provided by the different reproducer magnets arranged with respect to the recording reproducer magnets so that reproducer magnet No. 1 gives a delay of one time element, and reproducer magnet No. 2, two time elements so that if we have P reproducer magnets, we may write

Reproducer magnet 1, 2, 3, 4 . . . (P-2), (P-1), P gives a delay of 1, 2, 3, 4 . . . (P-2), (P-1), P time elements.

In order to obtain the maximum use of these available delays, it becomes evident that a total delay (sending plus receiving) should be (P+1) time elements. So that when a unit of speech is transmitted by reproducer magnet 1, 2, 3 . . . (P-2), (P-1), or P, it must be received, respectively, by reproducer magnet P, (P-1), (P-2), . . . 3, 2, or 1.

Consider any element of speech X, that is, the speech element recorded by the sending machine in time element X. Suppose, we wish to transmit this unit of speech by means of reproducer magnet N, then we must connect reproducer magnet N to the line during the (N+X) time element as this will be the only time during which it will be available to reproducer magnet N. It follows then, that speech element X will be received by and recorded by the receiving machine during time element (N+X) and in order to be placed in its proper location in the reconstructed speech, it must be reproduced during the (X+P+1) time element and, therefore, reproducer magnet (P+1-N) of the receiving machine must be con-

nected during the time element (X+P+1). This produces a total delay of (P+1) time element.

To make the above paragraph more concrete, assume a machine having nine reproducing magnets, assume that the fifth element of speech is under consideration and that we wish to transmit it by means of reproducer magnet No. 3. Then it will be necessary to connect reproducer magnet No. 3 during time element No. 8 and in the receiving machine to connect reproducer magnet No. 7 during time element No. 15, thus producing a total delay of ten time elements.

In order to insure that each element is sent but once and that every element is sent once, it is more convenient to utilize the converse of the first theorem, namely, that every element shall be transmitted. To do this, it is but necessary to tabulate the transmission order as follows: To each speech element number add the reproducer magnet number N and make the selection in such a manner that the resulting number (X+N) will be a scramble with no repetition of numbers. If it is desired to make a repetitive scramble of Q elements, that is, to use a commutator of Q segments, then in this scramble, we must consider that Nos. 1, 2, 3, 4, etc., may be used interchangeably with, but not in addition to, (KQ+1), (KQ+2), (KQ+3), etc., where K is any whole number.

To demonstrate this whole procedure, construct a twelve-element (twelve commutator segments) repetitive scramble using nine reproducer magnets. The result is given in the following Table III.

Table III

X Speech element	N Send rep. magnet	(X+N) Send com. segment	(X+P+1) Rec. com. segment	(P+1-N) Rec. rep. magnet
1	3	4	11	7
2	7	9	12	3
3	5	8	1	5
4	1	5	2 (+12)	9
5	9	2 (+12)	3 (+12)	1
6	6	12	4 (+12)	4
7	3	3 (+12)	5	7
8	2	10	6 (+12)	8
9	4	1 (+12)	7 (+12)	6
10	1	11	8 (+12)	9
11	8	7 (+12)	9 (+12)	2
12	6	6 (+12)	10 (+12)	4

The actual transmitted order as given by this scramble will be 9', 5', 7', 1, 4, 12', 11', 3, 2, 8, 10, 6, where the primed numbers represent speech elements from the preceding cycle.

It will be noted that some care in selection is necessary to obtain a satisfactory condition when the number of reproducer magnets is exceeded by the number of time elements in the cycle to insure getting a complete transmission sequence.

For the sake of clarity, two other examples are listed below. The first one (Table IV) in which we have nine reproducer magnets and four commutator segments and the second (Table V) in which we have four reproducer magnets and eight commutator segments.

Table IV

X Speech element	N Send rep. magnet	(X+N) Send com. segment	(X+P+1) Rec. com. segment	(P+1-N) Rec. rep. magnet
1	9	2 (+8)	3 (+8)	1
2	1	3	4 (+8)	9
3	6	1 (+8)	1 (+12)	4
4	4	4 (+4)	2 (+12)	6

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Table V

X Speech element	N Send rep. magnet	(X+N) Send com. segment	(X+P+1) Rec. com. segment	(P+1-N) Rec. rep. magnet
1	3	4	6	2
2	4	6	7	1
3	2	5	8	3
4	4	8	1 (+8)	1
5	2	7	2 (+8)	3
6	4	2 (+8)	3 (+8)	1
7	2	1 (+8)	4 (+8)	3
8	3	3 (+8)	5 (+8)	2

For the first code, the transmitted order is 3, 1, 2'', 4'' and for the second 7', 6', 8', 1, 3, 2, 5, 4, 7. The foregoing illustrates that this method may be applied to any number of reproducer magnets and segments, and that the number of commutator segments could, in fact, be made infinite.

What is claimed is:

1. In a secrecy system, means for recording speech message waves on a moving strip, reproducers spaced along the strip, a signaling channel, a rotary distributor having a brush movable with respect to distributor segments comprised of interleaved sets, for switching said reproducers one at a time in circuit with said signaling channel, the motion of the strip being so related to the motion of the distributor that a point on the strip moves from one reproducer to the next in the time taken by the brush to traverse one distributor segment of each interleaved set, and switching means for variably connecting any one of said reproducers to any one of said distributor segments of either set.

2. In a secrecy system, means for recording speech message waves on a moving strip, reproducers spaced along the strip, a signaling channel, a rotary distributor having a brush movable with respect to distributor segments comprised of interleaved sets, for switching said reproducers one at a time in circuit with said signaling channel, the motion of the strip being so related to the motion of the distributor that a point on the strip moves from one reproducer to the next in the time taken by the brush to traverse one distributor segment of each interleaved set, and switching means for variably connecting certain of said reproducers individually with said distributor segments of a respective set to effect rearrangement of successive portions of the speech in time in accordance with a recurrent code combination having a greater number of fragments, in the case of each set of segments, than the number of said reproducers.

3. In a speech privacy system, means to record speech message waves on a suitable medium, a plurality of separate reproducers for reproducing the speech with different respective amounts of delay, each succeeding reproducer increasing the delay by one unit, a commutator for dividing the speech message waves into fragments to be interlaced in groups, one fragment from each interlaced group together having a duration equal to one unit of delay, and means variably connecting said reproducers to said commutator to effect different amounts of delay in sending the various fragments up to a total delay equal to the maximum delay obtainable by any one reproducer, with the fragments in recurring interlaced groups each containing a greater number of fragments than the number of said reproducers.

4. In a privacy system, means to record signals on a suitable medium, means to reproduce and transmit said signals from said medium with dif-

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ferent amounts of delay including a rotary distributor, start-stop driving means therefor including a stop release member, a signal transmission channel, and means under control of said release member for controlling the operativeness of said channel to transmit said signals.

5. The combination recited in claim 4 including also a manually operable switch for initiating operative condition of said transmission channel, and means operated by said switch for placing the operativeness of said channel under control of said release member.

6. In a speech privacy system, a transmission channel, means to record speech message waves, means to reproduce said waves with varying amounts of time delay, a rotary distributor for distributing fragments of said speech waves having various amounts of delay to said transmission channel, start-stop mechanism for said distributor including a stop release member, a push-to-talk button, and means under the joint control of said member and said button for controlling the operativeness of said transmission channel to transmit said wave fragments.

7. In a privacy system for message waves, means for recording the message waves on a suitable medium, a plurality of reproducers spaced along said medium whereby the message may be reproduced by successive reproducers with different amounts of delay, a commutator, switching mechanism having provision for connecting any segment of the commutator with any one of said reproducers, and form-operated contactors forming a part of said switching mechanism, for effecting connections selectively between certain only of said segments and reproducers at one time.

8. In a speech privacy system, means to record speech message waves upon a suitable record medium, reproducers spaced along said medium for reproducing said speech with different amounts of delay, a rotary distributor having segments divided into groups, interconnecting code switch mechanisms each having one set of conductors connected individually to all of said reproducers and another set of conductors connected individually to all of said segments in a respective group, and contact-determining means for each switch mechanism selectively controlling cross-connection of any conductor of the first set with any conductor of the second set.

9. The combination recited in claim 8 in which said cross-connecting means comprises form-operated movable contactors for individually establishing contact between a conductor of the first set and a conductor of the second set.

10. In a speech privacy system, a two-way speech scrambler for transmitting and receiving, including a rotary distributor, start-stop mechanism for said distributor including a latch and latch magnet adapted when energized to actuate the latch to start said distributor, means to condition the circuit for transmitting, locking means for said conditioning means, and a circuit for controlling said locking means including a contact controlled by said latch magnet.

11. In a speech privacy system, a record medium for recorded speech, means to record speech thereon and reproduce speech therefrom, a rotary start-stop distributor for breaking the reproduced speech into fragments for sending, a two-way talking circuit and switching means for conditioning said circuit respectively for sending and receiving, a latch mechanism for stopping and releasing said rotary distributor in each revolu-

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tion, and a circuit controlled by said latch mechanism for determining the time of changeover of said circuit from transmitting to receiving.

12. In a speech privacy system, rotary distributor mechanism for breaking up the transmitted speech into fragments, start-stop mechanism for said distributor, a stop member for stopping and, when tripped, for starting said distributor mechanism, a two-way talking circuit, switching means for conditioning said circuit respectively for sending and receiving, a relay for operating said switching means and a locking circuit for said relay including a contact on said stop member in closed position except when said stop member is tripped.

13. In a privacy system for signals, a signal receiver, means to receive and store coded signals,

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cyclically operating timing means for decoding the stored signals and impressing them on said receiver, means to disable said receiver, and means controlled from said timing means for preventing the disabling means from disabling the receiver except during abnormal stoppage of said timing means.

14. In a two way privacy system for signals, a signal receiver, a signal transmitter, means to code signals for transmission by said transmitter, means to decode received coded signals for reception by said receiver, cyclically movable timing means for said coding and decoding means, and means operative only upon failure of said timing means to move through an operating cycle to disable said receiver and said transmitter.

FREDERICK G. BUHRENDORF.