

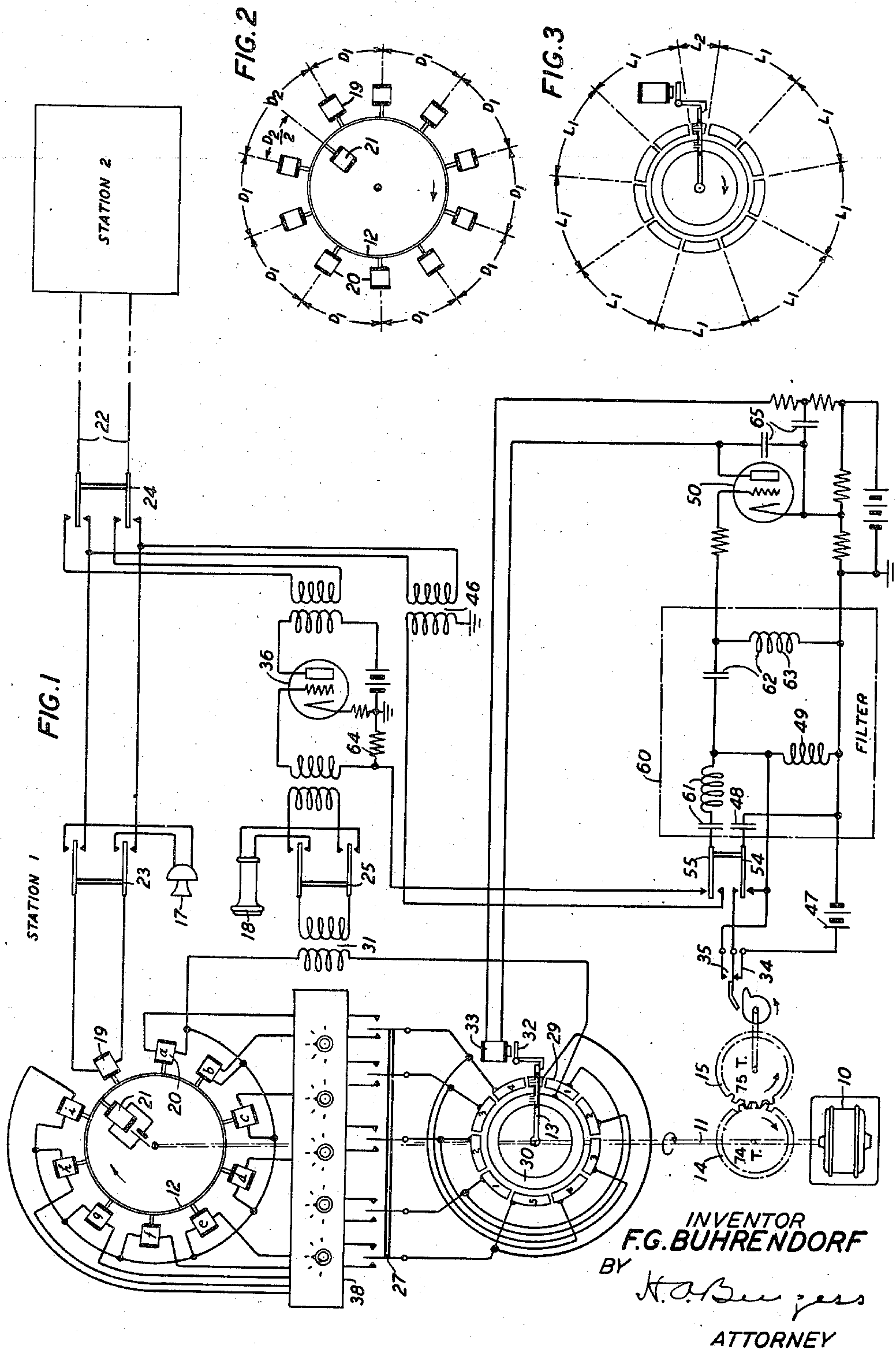
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SPEECH PRIVACY COMMUNICATION

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SPEECH PRIVACY COMMUNICATION

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5 Claims. (Cl. 179—1.5)

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The present invention relates to the use of rotary distributors for subdividing message waves on a time basis for transmission or reception. More particularly the invention relates to the problem of coordinating the movements of a recording medium such as a magnetic tape and a rotary distributor located at one point to the movements of similar apparatus at a distant point.

The invention will be disclosed, for illustration, as embodied in a speech privacy system in which speech is recorded on a moving magnetic tape and is subdivided on a time basis by a rotary distributor so arranged as to send out the fragments of speech in abnormal sequence to make reception by unauthorized persons difficult. A similar magnetic tape recorder and rotary distributor at the receiving point subdivide the received privacy speech and rearrange its parts into understandable speech.

Various ways of synchronizing the transmitting and receiving distributors in such a system have been proposed heretofore. These have involved rather complicated constructions or have, in the case of the simpler constructions, been subject to dropping out certain small portions of the message waves under normal operating conditions with introduction of some noise or distortion.

An object of the present invention is to improve upon such apparatus by providing a simple construction which in normal operating condition loses none of the message in the subdividing process.

It is common practice in printing telegraphy to use start-stop distributors and to run the receiving distributor normally slightly faster than the transmitting distributor so that normally it is stopped for a longer time, in each revolution, than the transmitting distributor. Errors in speed of the receiving distributor result in varying the duration of stoppage of the receiving distributor, and by running the receiving distributor normally too fast a greater margin is allowed in stoppage time to compensate for speed variations. If the receiving distributor varies in speed by becoming still faster the stoppage period is prolonged. If the variation is slowing down, the stoppage time is reduced. It is customary in such systems to make the receiving distributor segments shorter than the transmitter segments so as to pick out the middle part of the transmitted pulse.

In a speech privacy system in which rotary distributors are used to subdivide the message waves as referred to above, start-stop distributors may also be used but the synchronizing presents a much more difficult problem since it is necessary to preserve as far as possible the entire wave, which means that ideally each transition of the two distributors from one segment to

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the next should be made at the same instant and with minimum transition time. Moreover, if the same apparatus is to be used alternatively to transmit and receive for purposes of two-way conversation, the distributors must be capable of serving for either transmitting or receiving and cannot be of different design.

It is possible to secure some of the advantage of running the receiving distributor slightly fast, by actually running it at the same constant speed as the transmitting distributor but delaying slightly the sending out of the start impulse so that both distributors are normally stopped for an interval to allow a time margin in which to correct for errors in speed of the receiving distributor. This enables all distributors to be alike in construction, and when any distributor is converted from receiving to transmitting it is arranged automatically to send out the delayed starting pulses. All receiving distributors are then synchronized to the distributor that is at the time transmitting.

The invention makes use of the delayed starting pulse but avoids the attendant loss of a small percentage of the speech which has been experienced with the delayed impulse method. While the delayed starting impulse allows a time margin for purposes of synchronizing the start-stop distributors, there remains the problem of fitting the distributor movements to the motion of the recording tape. The message is recorded continuously throughout its duration which has no necessary relation to the distributor operate time, and the tape moves continuously. What is desired of the distributor is to enable equal lengths of the record as measured along the tape to be reproduced in any order in accordance with the particular code and to repeat such reproductions indefinitely without loss of any part of the message.

This is accomplished in accordance with one feature of the invention by making one distributor segment shorter than the others by such amount that the travel time across such segment plus the stoppage or waiting time is equal to the travel time across each of the other segments.

The nature of the invention and its objects and features will be more fully understood from the following detailed description and the accompanying drawing.

In the drawing,

Fig. 1 is a schematic circuit diagram of a system of speech privacy incorporating the invention, and

Figs. 2 and 3 are diagram views respectively of the tape and recording and reproducing magnets to show their spacings, and of the commutator to show the use of a short segment in accordance with the invention.

Referring to Fig. 1, a constant speed motor

10 of suitable type drives a shaft 11 which is shown as driving magnetic tape 12 mounted on the rim of a suitable disc, brush arm 13 rotatable over the segments of commutator 29, and a gear train 14, 15 driving a contact making cam 16. The system is arranged to transmit with privacy when speech is spoken into the transmitter 17, under certain circuit conditions to be described, and to receive with privacy in receiver 18. The transmission and reception of the privacy waves takes place over the line 22 shown interconnecting the terminals in Figs. 1 and 2.

A number of two-position switches are illustrated at 23, 24, 25, 27, 54 and 55. These switches may, if preferred, be ganged together or they may be in the form of relays operated by a single push button. These switches are all assumed to be operated to their upper positions in the figure (and switch 27 to the right) when speech is to be transmitted and to be operated to their lower or opposite position when speech is to be received. Such switches are commonly referred to as push-to-talk switches and may conveniently be retracted to their receiving positions by springs (not shown), the receiving position in such case being considered normal. The circuit of Fig. 1 will first be described for the transmitting condition, so that switches 23 to 27, 54 and 55 are considered thrown to their upper or talking positions.

The tape 12 is assumed to be rotating in a clockwise direction at constant speed. Located around the periphery of the tape are an erasing magnet 21 supplied continuously with current from the battery shown, a recording magnet 19 and nine reproducer magnets 20 located at equal intervals around the tape. When speech is spoken into transmitter 17, therefore, the speech is recorded on the tape at 19 and the recorded portions in passing the magnets 20 generate corresponding electromotive forces in their windings. The terminals of these windings are connected through code switches 38, five in number, and thence through contacts of switch 27 to the segments of commutator ring 29, which are numbered in order 1, 2, 3, 4, 5 over one-half of the circumference, with these numbers repeated in the second half of the circumference, diametrically opposite segments being directly connected together. The code switches are so arranged that, one winding terminal of reproducers 20 may be connected in a number of different sequences to the commutator segments of ring 29. Brush arm 13 carries brushes bridging across from segmented ring 29 to solid ring 30, the latter being connected to one terminal of winding of speech coil 31, the opposite terminal being common to one terminal of each of the reproducer magnets 20.

It will be seen, therefore, that as the brush arm 13 rotates and sweeps the brush over the segments of the commutator, different reproducers 20 are connected to the speech coil 31 in sequence, and the particular sequence is at any given time determined by the setting of the code switches 38. For example, designating the reproducers 20 beginning next to the recording magnet 19 and continuing around the periphery of the tape as reproducers *a*, *b*, *c*, . . . *i*, reproducer *a* may, with one code setting be connected to commutator segment 1, reproducer *c* may be connected to segment 2, reproducer *e* may be connected to segment 3, etc. With a different setting of the code switches 38 reproducer *d* might be connected to segment 1, and other reproducers

to the other segments. In this way it is arranged that the currents transmitted through coil 31 represent fragments of the recorded speech picked up in a sequence different from the sequence in which they were recorded. Moreover, this sequence is varied from time to time by changing the settings of the code switches 38. This general method of transmitting fragments of speech out of their normal sequence and of changing the code is more fully disclosed in a copending application of J. C. Steinberg, Serial No. 401,897, filed July 11, 1941, which may be consulted for further details including the construction of the code switch mechanism 38.

The speech waves occurring out of their normal order in coil 31 are transmitted through switches 25 and 24 and amplifier 36 to the outgoing line 22.

Attention will now be given to the start-stop mechanism to which the invention particularly relates. The brush arm 13 frictionally engages the shaft 11 by suitable friction clutch mechanism so that when the brush is released by latch 32 it rotates with the shaft 11 but can be held stationary by latch 32 while shaft 11 continues to rotate. Latch 32 is released by tripping magnet 33 when energized from tube 50 under control of cam 16 and contacts 34 and 35 when the station is transmitting or under the control of similar impulses received over the line from a distant station through coil 46 and filter 60 when the station shown is receiving.

The gear train 14, 15 drives the cam 16 at a slightly slower rotational speed than shaft 11. For example, the gear 14 may have seventy-four teeth and the gear 15 seventy-five teeth. This feature is disclosed and claimed in the copending application of W. A. MacNair, Serial No. 414,054, filed Oct. 8, 1941.

Assuming that the arm 13 is stopped against latch 32 and that the cam 16 is about to move the contact spring upward to close contact 35, this contact will, then, be closed and connect condenser 48 through upper contact of spring 54 across inductance 49. The condenser, which has previously been charged to the full potential of battery 47 through contact 34, now discharges suddenly through the inductance 49, causing a highly damped wave of 2,000 cycles per second frequency to be generated in the filter 60. One series tuned branch 61 of the filter transfers some of this 2,000-cycle voltage to the input of tube 36 across resistor 64, and the other series tuned branch 62 transfers some of the 2,000-cycle voltage to the input of tube 50 the grid circuit being connected across the inductance 63. On the first positive swing of this pulse wave, tube 50 breaks down and sends a fairly heavy current through release magnet 33, releasing the brush 13. At the same time, the brush at the distant station is released by the pulse sent over the line. At the end of the pulse the tube 50 is restored by the aid of plate circuit condensers 65 in combination with the rest of the circuit elements.

Since the apparatus at station 2 is a duplicate of that at station 1, the action taking place in station 2 in receiving the waves sent out from station 1 in accordance with the foregoing description can be understood by considering that similar waves are being received in station 1 in which case all of the two-position switches 23, 24, 25, 27, 54 and 55 are assumed in their lower or receiving position.

Considering first the start impulse sent out from station 2, this is received through trans-

former 46, lower contact of spring 55 to input terminals of filter 60. It will be noted that condenser 48 is now in parallel with inductance 49 and forms part of the filter to separate the start pulse wave from the speech waves. The 2,000-cycle frequency wave is applied to the grid of tube 50 and the first positive swing renders the tube conducting, sending a large pulse of current to the winding of the tripping magnet 33 releasing brush 13. As long as the station in Fig. 2 continues to transmit, the cam 16 at such station sends out a start impulse once each revolution of the cam, which as stated rotates at a slightly lower speed than the distributor shaft. This causes the brush arm 13 at station 2 to be stopped momentarily once each revolution. The brush arm 13 at station 1, serving as the receiving station, if running in exact synchronism is stopped once each revolution for the same length of time as the transmitting commutator brush or, if the receiving brush is running slow or fast by a slight amount, it is stopped for a shorter or longer length of time as the case may be.

The jumbled speech waves received from station 2 through switches 24 and 23 energize the winding of recording magnet 19 to make a record of the received waves on the tape 12. As this tape rotates past the various reproducer magnets 20, these latter pick up the recorded waves and transmit them through code switch 38 and switch 27 to the segments of commutator 29 and the wiring and settings of the code switches are such that as the brush 13 passes over the commutator segments in succession the speech fragments are rearranged in their normal order in the coil 31, from which they are transmitted through switch 25 to receiver 13. When the code switches 38 and the wiring are made in accordance with the disclosure of the Steinberg application above referred to, a given setting of the knobs 28 will result in transmitting in accordance with a particular code and also in receiving in accordance with the same code. The knobs 28 in Figs. 1 and 2 are, therefore, given the same setting.

The ideal timing relations are such that a given point on the tape passes the successive reproducer magnets at the same instants that the brush passes from one commutator segment to the next and that these occur at equal intervals and at the same instants at transmitter and receiver. Where the tape is running continuously and a continuous record is being made, a stoppage of the brush is immaterial so long as it passes off one segment and on to the next segment at the right instant. If there is to be stoppage of the brush, it must be required to travel less distance during its moving time since the brush when moving is running at constant speed (except for acceleration time) for otherwise it could not reach the end of the segment in time. By making the segment on which the brush is stopped slightly shorter than the other segments, the stoppage time plus travel time over that segment can be made equal to the travel time over the other segments. The stoppage allows the brushes to be started in the proper timing despite small errors in rotational speed.

If the segment on which the brush is stopped has the same length as the other segments, the brush is on that segment for a longer total time than it is on any of the other segments, which means that the length of tape passing the corresponding reproducer magnet is longer than in the other time units. When the speech fragments are sent and recorded at the receiver in

altered sequence, this long speech fragment may occur as the last recorded fragment, or more generally, depending on the code combination in use, the material recorded at the receiver in the last (long) interval will be a normal length fragment plus a small portion of another fragment out of its normal sequence, and this material is what is received in the final or long interval. This extra amount or left-over material appears, therefore, as noise, and the corresponding small portion of the long speech fragment is dropped out. This effect is avoided by making the segment on which the brush is stopped shorter by a suitable amount than the other segments.

Reference is made to Figs. 2 and 3 for an understanding of how the length of the short segment may be properly determined in any case. These figures are based on the assumption that a five-unit code is being used, although any other number of time divisions, such as six, seven, etc., could as well be used, in which case instead of the ten segments shown there would be 12, 14, etc. In interpreting the formulas given below the number 10 should be considered as illustrative of the five-unit case and not as limiting.

In Fig. 2 a plan view, or view in diagram, is given of the tape 12 on the rim of the tape disc, and of the nine reproducer magnets 20, recording magnet 19 and eraser magnet 21. The angular distance between pole-pieces of magnets 20 is D_1 , and the angular separation of the last reproducer 20 from the recorder 19 is D_2 . The eraser is shown half way along D_2 , although this spacing is not especially significant.

In Fig. 3 the commutator 29 is composed of nine segments of angular length L_1 and one short segment of angular length L_2 , the latter being the segment on which the brush 13 is stopped. The difference in length of L_1 and L_2 is exaggerated in this figure for illustration.

If the tape disc and commutator arm are both mounted on the same shaft 11 as in Fig. 1, they have the same angular velocity S when rotating. There is no necessity that they should have the same angular velocity since either or both may be driven through gearing. If it is assumed for generality that the velocity in degrees per second of the brush is S , while that of the tape is S_2

$$\frac{10L_1}{S_1} = \frac{10D_1}{S_2} = T$$

where T is the time between start pulses in seconds.

Considering revolutions per second, if

V_1 = R. P. S. of the brush arm shaft

V_2 = R. P. S. of the tape drum shaft

V_3 = R. P. S. of the cam shaft driving cam 16

$$V_1 = \frac{S_1}{9L_1 + L_2}$$

$$V_2 = \frac{S_2}{9D_1 + D_2}$$

$$V_3 = \frac{S_1}{10L_1}$$

In a practical case

$$\frac{L_2}{S_1} < \frac{L_1}{S_1} + .005 \text{ sec.}$$

where an allowance of .005 second is made to insure that the brush comes to absolute rest when the latch is operated and to allow the brush to come up to speed.

The details may be varied to suit various conditions of requirements without departing from

the invention, the scope of which is defined in the claims which follow.

What is claimed is:

1. In a start-stop distributor, a plurality of equal length segments, a brush rotating over said segments, an additional segment shorter than said first-mentioned segments, means to stop the brush on said short segment, means to release the brush to start on its next revolution, means to produce a start impulse to operate said release means, and means to time said impulse to cause the total travel time plus rest time of the brush on said short segment to be the same as the travel time across one of said equal length segments.

2. In a speech privacy system comprising independently driven continuously moving record media at transmitting and receiving stations, means to record speech on the record medium at the transmitting station, means to record received privacy waves on the record medium at the receiving station, rotary distributors at said stations comprising segments and brushes rotatable over said segments, a plurality of reproducers for each record medium connected individually to segments of the corresponding distributor, start-stop mechanism for each distributor, means to start said distributors in step with each other and to stop them on a given segment at the end of a revolution, said segment being of such length that the travel time of the brush over such segment plus the stoppage interval thereon is substantially equal to the travel time of the brush over each of the other segments when the distributors are rotating at correct speed.

3. In a start-stop distributor for transmitting currents in equal time intervals, a ring of conducting segments including a plurality of equal length segments and one short segment, a circuit connected to each segment, a common circuit-closing means for sweeping over said segments and closing each of said circuits in rotation, means to stop said common circuit-closing means on the short segment, and means to start said common circuit-closing means on its next rotation over said segments, said short segment be-

ing of such length that the duration of closure of the circuit connected to said short segment is equal to the duration of closure of each of the circuits connected to said other segments.

4. In a speech privacy system, the combination with a magnetic tape, a recording magnet and a plurality of reproducer magnets spaced along said tape, a reproducer circuit and means including a start-stop rotary distributor for selectively connecting said reproducers to said reproducer circuit in sequence, said rotary distributor comprising a segmented ring and a brush movable over said ring, a start segment, and means to stop the brush periodically on said start segment, of means for transmitting to said circuit the same length of recorded speech on said tape from each reproducer magnet comprising a shorter length of start segment than other segments on said distributor, the difference in length thereof with respect to the other segments on the distributor being equal to the distance of travel of the brush in a time equal to the normal period of stoppage of the brush on said short segment.

5. In a speech privacy system, the combination with a magnetic tape recorder, a plurality of reproducers spaced along said tape, a reproducer circuit, a rotary distributor having a segmented ring and brush movable relative thereto to connect said reproducers in sequence to said reproducer circuit, a common driving means for moving said tape past said reproducers and for rotating said distributor, of means for insuring equal time intervals of connection of said reproducers to said reproducer circuit comprising a short stop segment for said distributor, said segment serving also to connect one of said reproducers to said reproducer circuit, means to stop said brush on said short segment and to restart the brush, the difference in length of said short segment from the other segments being equal to the distance of travel of the brush, at its normal rate of travel, in a time equal to the time of stoppage of the brush on said short segment.

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