United States Patent

[11] **3,555,203**

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[45] Patented **Jan. 12, 1971**
[73] Assignee **The United States of America as represented by the Secretary of the Army**

[54] **METHOD OF AND APPARATUS FOR TIME ADJUSTMENT OF INFORMATION**
9 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **179/100.2,** 179/15.55
[51] **Int. Cl.** **G11b 5/52**
[50] **Field of Search** ..... 179/15AS, ATI, ATG, ST, AM, 1.5R, 15.55TC, 100.2T(Inquired), 100.1TD(Inquired); 178/6BWR

[56] **References Cited**

UNITED STATES PATENTS

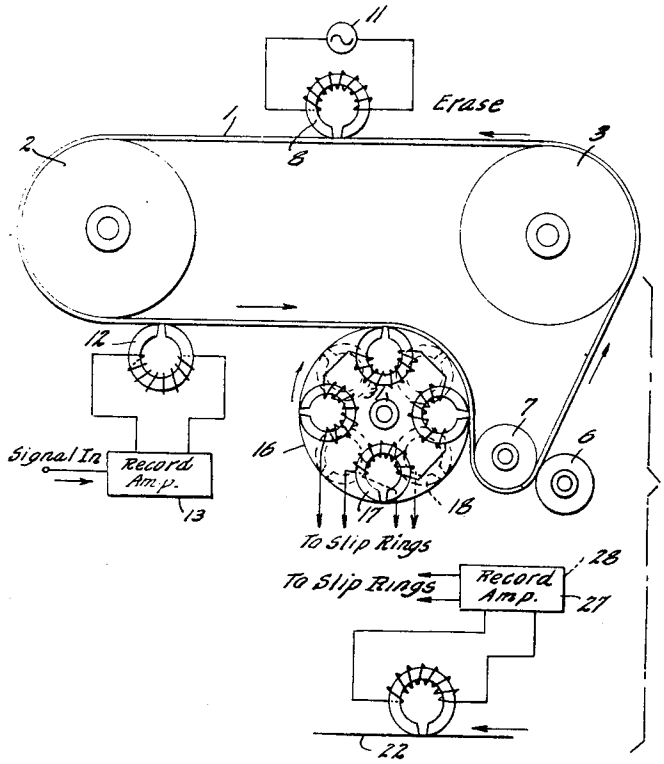
2,539,837	1/1951	Howell	179/100.2
2,792,449	5/1957	Bottini	179/100.1
2,886,650	5/1959	Fairbanks et al.	179/100.2
2,903,521	9/1959	Ellison	179/100.2
2,923,773	2/1960	Reynolds	178/6
3,197,575	7/1965	Eckstein	179/100.2

FOREIGN PATENTS

682,569	11/1952	Great Britain	179/15

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ABSTRACT: A train of information is sectioned into two groupings of information. Each grouping is an alternate sample of the original information and is channeled to one ear of a listener thereby adjusting the listening time with minimal discarding of any of the original information. Two quadripole transducers, secured to a shaft so as to be offset with respect to each other, sample the original information to obtain the two groupings.



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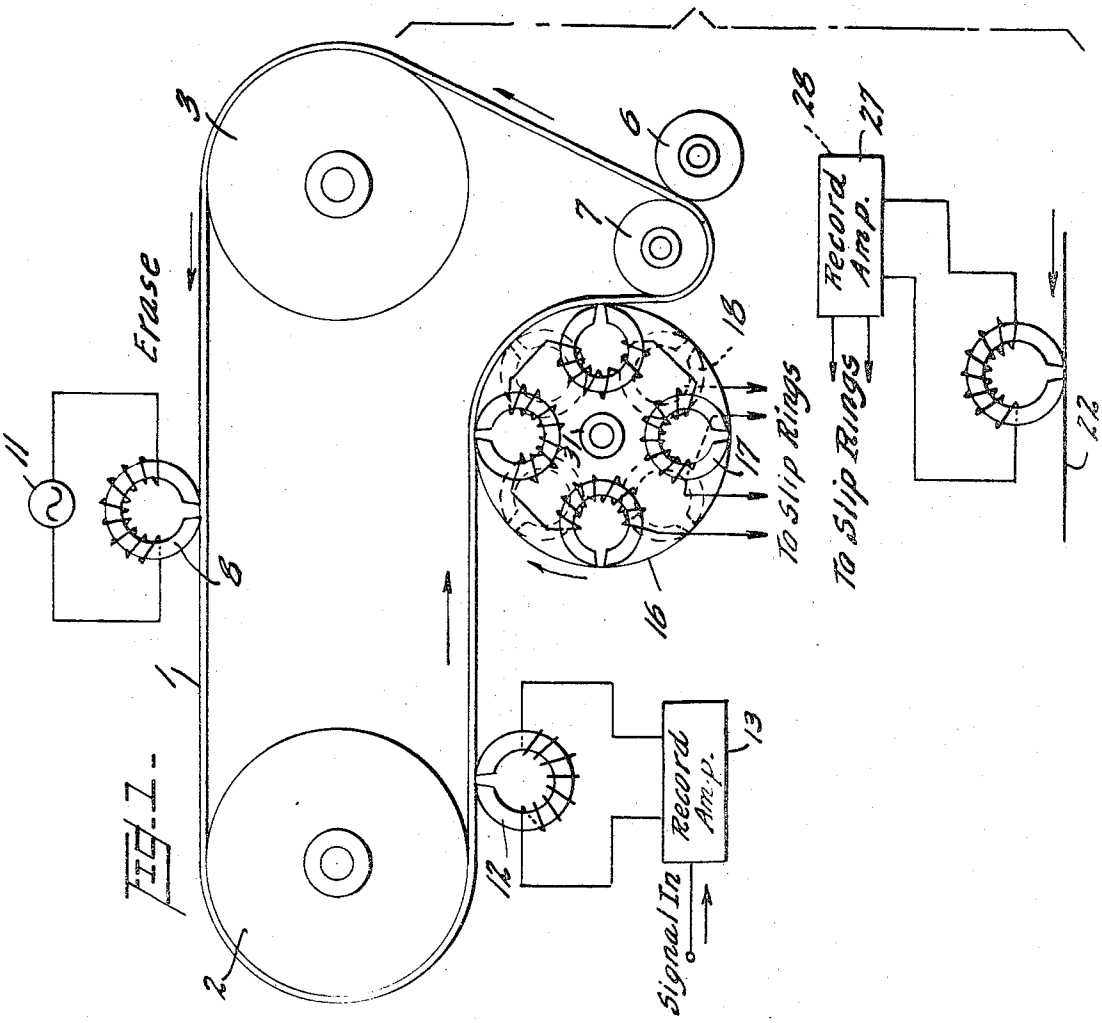


FIG. 1.

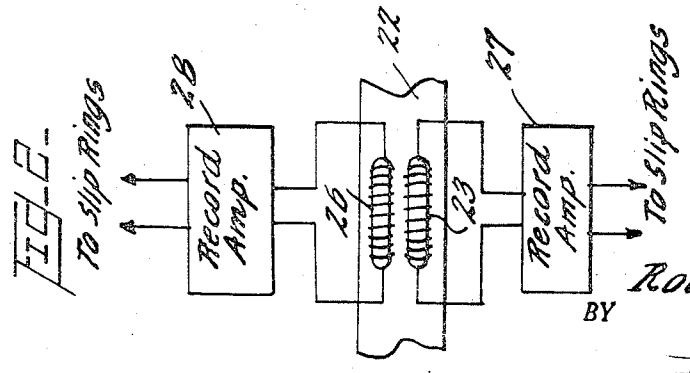


FIG. 2.

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METHOD OF AND APPARATUS FOR TIME ADJUSTMENT OF INFORMATION

This invention relates to a method of and an apparatus for time adjustment of information.

The relationship of speaking rate to effective communication has been studied using a variety of methods. Time compression and expansion of speech to alter speaking rate produces distorted speech. A time transformation, t**t', of a speech signal, S(t), represented in the time domain, S(t)**S(t'), results in a frequency transformation since frequency is inversely related to time. The frequency distortion is demonstrated by altering the playback rate of a prerecorded speech signal. Replaying at slower than normal speed produces a reduced bandwidth signal, as well as a time-expanded signal.

Speech can be expanded or compressed by several methods without shifting frequencies. For example, time-compressed speech can be created by using a manual tape-splicing technique to remove sections of the recorded speech. (W. D. Garvey, "The Intelligibility of Abbreviated Speech Patterns," The Quarterly Journal of Speech, Volume 39, 1953, pages 296-306). Other methods have been developed which use filtering and heterodyning techniques. One such method is to divide the speech spectrum into three contiguous bands. Then, using modulators, divide each band-pass output frequency by 2. The outputs are then band-limited to half the original bandwidths and added for transmission. (B. P. Bogert, "The Vobanc - A Two-to-One Speech Bandwidth Reduction System," The Journal of Acoustical Society of America, Volume 28, No. 3, May 1956, pages 399—404).

Also, Pat. No. 2,886,650, granted May 12, 1959 to Fairbanks et al., discloses a mechanical means for implementing the Garvey technique. In the Fairbanks et al. device, a mechanical rotating head recording device automatically discards portions of the speech signal for time compression.

Again, various modifications of the described prior art are possible, as for example, passing the speech through numerous band-pass filters, each with a specific bandwidth. The filter bank can be designed to separate the harmonics of the voice speech for frequency division. By recording the reduced spectral information at one rate and replaying it at a faster rate, the original frequencies could be restored with an associated time compression. (M. R. Schroeder, B. F. Logan, and A. J. Prestigiacomo, "New Methods for Speech Analysis-Synthesis and Bandwidth compression," 4th International Congress on Acoustics, Paper G 41, Congress Report 1, Copenhagen (1962)).

The prior art devices for compression of speech, although they do not shift frequencies, have the disadvantages of discarding some aspects of the information contained in the original signal. The discarding results in increased difficulty in comprehending compressed speech. For example, the method of time compression shown in the patent grant to Fairbanks et al. uses a rotating four-head playback device which discards alternate segments of the speech signal and abuts the remaining segments to produce a time-shortened playback. The alternate discarded segments represent that portion of the information contained in the speech which is lost.

It is, therefore, an object of the invention to provide a method of and an apparatus for time adjustment of information.

It is another object of this invention to provide a means for effective time or frequency compression-expansion of speech.

It is still another object of this invention to provide a means for time or frequency compression-expansion of speech which minimize the information which is lost from the original signal.

With these nd and other objects in view, a method for time or frequency compression-expansion of speech may embody the sectioning of a train of information into two groups of information with a subsequent abutting of the sectioned information in each of the two groupings. Each grouping is, therefore, a continuous series of sections. These two groupings of information may then be channeled simultaneously to separate listening means.

More specifically, this method may be made more effective by utilizing alternate segments in each series of groupings. In addition, the transition between each segment in each of the groupings may be offset in time from each other. That is, when channeling each of the two groupings of information to separate listening means, the transition from one abutted segment to the next occurs in each of the two groupings at different points in time. This means that a transition can occur only in one listening means at any time.

One possible apparatus embodying the invention includes a two- or four-track tape recorder with the same speech signal recorded in phase on each of the two tracks. Each track is sampled by a quadripole transducer permanently fixed on a shaft. The quadripole transducers are fixed so as to be offset with respect to each other, and the output from each transducer is recorded on magnetic tape. As a result, the magnetic tape contains two different compressed groupings of information. Finally, the information is detected by two pickups and channeled to separate listening means.

Naturally, a computer can be programmed which produces the same result as the mechanical means described above.

A complete understanding of the invention may be obtained from the following detailed description of a specific embodiment thereof, when taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a diagrammatic representation of the mechanical apparatus;

FIG. **2** is a diagrammatic representation of the compressed signal recording means;

FIG. **3** is a diagrammatic representation of the two quadripole transducer heads;

FIG. **4** is a diagrammatic representation of the compressed signal pickup e means; and

FIG. **5** is a diagrammatic representation of the original speech and the compressed signal to both the left and right ears.

Referring now to the drawings, wherein like reference numerals designate similar elements in the various views, and more particularly to FIG. **1**, which illustrates a diagrammatic representation to of the mechanical apparatus. A magnetic loop tape **1** is positioned on two idler drums **2** and **3** respectively. The tape is driven by a drive roller **6** which is powered by a variable speed motor, not shown. A movable roller **7** clamps the magnetic tape **1** against the drive roller **6**, thereby providing the necessary friction so that movement may be imparted to the magnetic tape **1**. The movable roller **7** may be moved to provide a slack in the magnetic tape **1** so that it may be easily removed from the apparatus.

An erase head **8**, in conjunction with a high frequency alternating source **11**, erases any information that is on the magnetic loop tape. The erase head is sufficiently wide to remove information from the entire width of the magnetic tape. Subsequent to erasure, a signal is recorded on the magnetic tape by means of a recording head **12**. The recording head is of the type which permits a signal to be simultaneously recorded on two tracks of the magnetic tape. Any desired signal is fed into a recording amplifier **13** wherein it is amplified and used as the input to the recording head.

A recording drum **16** supports two quadripole transducers **17** an and **18**. The recording drum and transducers are set on a shaft **31** which is powered by a variable speed motor, not shown. The quadripole transducer **17** is mounted on the front of the recording drum, and the quadripole transducer **18** is mounted on the rear of the recording drum and is shown with dashed lines. This arrangement of the transducer heads permits each quadripole transducer to pick up a signal from one of the two tracks. Each of the quadripole transducer heads is mounted on the drum in offset relation with respect to the other. This offset feature is more fully explained below.

It should be understood that at no time is the peripheral speed of the recording drum **16** equal to the linear speed of the recording drum **16** equal to the linear speed of the magnet loop tape **1**, and at all times there is a relative movement between the magnetic loop tape and the recording drum to

permit a changing magnetic field to be set up in the pickup heads of quadripole transducers 17 and 18.

Each quadripole transducer head is made up of four pickups. The pickups have each have a winding which is connected in series with the next succeeding winding. Each of the series windings is connected to one of two recording amplifiers 27 and 28 via slip rings, not shown. The amplification and recording of the sampled signal, which is the output from the two quadripole transducer heads, is best shown in FIG. 2.

Referring to FIG. 2, a magnetic recording tape 22 passes under two recording heads 23 and 26. Recording heads 23 and 26 are powered by an amplified signal from the two recording amplifiers 27 and 28 respectively. The input to the recording amplifiers is the output from the quadripole transducer head 17 and 18. The quadripole transducer head 17 has its output fed to the input of the recording amplifier 27 via slip rings, not shown, and the quadripole transducer head 18 has its output fed to the input of the recording amplifier 28 via slip rings, not shown. In this manner, the magnetic recording tape 22 has the sampled outputs of the information recorded on the magnetic loop tape 1 recorded on separate tracks. The information sampled by the quadripole transducer head 17 constitutes the information recorded on one track of the magnetic tape 22, and the information sampled by the quadripole transducer head 18 constitutes the information recorded on the second track of the magnetic recording tape 22.

Now, referring to FIG. 3, two quadripole transducer heads 17 and 18 are both set on the shaft 31 shown as a dashed line. The shaft 31 is powered by a variable speed motor, not shown. The variable speed motor imparts an equal rotational motion to the quadripole transducer heads 17 and 18. Each quadripole transducer head four pickups designated A, B, C, and D.

The quadripole transducer heads 17 and 18 are positioned on the shaft 31 in an offset manner with respect to each other. That is, for example, the pickup head A2 is advanced in the clockwise direction a number of degrees ahead of the pickup head A1. Therefore, in the course of operation, the pickup head A2 would come to a point of information recorded on the magnetic loop tape 1 before the pickup head A1. Consequently, the information recorded on the tracks of the magnetic recording tape 22 from each of the pickup heads A1 and A2 would be different at any point in time. A2 would pick up a segment of information recorded on one of the tracks of magnetic loop tape 1, and A1 would pick up a segment of information recorded on the second track of magnetic loop tape 1. However, since the two tracks of information have recorded on them the same signal in phase, the segment of information picked up by the recording head A1 would be a segment that was recorded later in time than the segment of information picked up by the recording recording head A2. This above discussion, of course, assumes that the recording drum 16 is being driven by the variable speed motor in the clockwise direction and the magnetic loop tape 1 is being driven across the recording drum from left to right. In other words, both the recording drum 16 and the drive roller 6 are being driven by their respective variable speed motors in the same direction. When the recording drum and the tape are driven as indicated, a compressed sample signal could would result. If, however, recording drum 16 were driven in a counterclockwise direction an expanded signal would result.

At no time is there a discontinuity of pickup by quadripole transducer heads 17 and 18. The pickup heads of the quadripole transducers are arranged in a fashion to permit only one pickup of each transducer to be in a relative position where it will be receiving information from magnetic loop tape 1 at any point in time. At an instant in time, when one of the pickup heads of a quadripole transducer is no longer able to receive information from the magnetic loop tape 1, a second pickup head on the same quadripole transducer has moved in a position where it will pick up information recorded on the magnetic loop tape 1. In this manner, each quadripole transducer is continuously picking up information recorded on that track of magnetic loop tape 1 it is scanning.

The result of the above-described procedures is that an original speech signal has been sectioned into two groups of information with a subsequent abutting of the information in each of the two groupings so that each grouping is a continuous alternate series of segments recorded on the magnetic recording tape 22. Each of the groupings is recorded on a separate track of the magnetic recording tape. It is now necessary to provide pickup and listening apparatus for an individual to recover the information from the magnetic recording tape 22.

Referring now to FIG. 4, the magnetic recording tape 22 is driven by a variable speed motor, not shown, past two pickup heads 32 and 33. Each pickup head is positioned so that it will pick up information recorded on one of the two recording tracks of the magnetic recording tape 22. The pickup signal is fed to two pickup amplifiers 36 and 37 where it is amplified and fed to two listening means 38 and 41, shown in FIG. 5. As the linear speed of the loop tape 1 is equal at all points on the loop, the relative speed of the tape, with respect to the recording head 12 and the transducer heads 17 and 18, is different. As a result, the information recorded on the magnetic recording tape 22 has undergone a frequency transformation. Therefore, tape 22 is driven under the pickup heads 32 and 33 at an adjusted speed to reverse the frequency transformation.

Referring now to FIG. 5, the original speech is represented as having been divided into several segments. Each segment represents a bit of information which has been recorded simultaneously and in phase on the magnetic loop tape 1 on each of its two tracks. Each segment is so small that it does not constitute a sound unit; that is, it does not constitute any portion of an expression which, if missing, would interfere with the intelligence of the whole expression. These segments are then alternately abutted and are represented as a compressed signal. It will be noted that the compressed signals are the groupings of information which have been recorded on each of the two tracks of the magnetic recording tape 22, 22; the compressed signal to the left ear having been recorded on one track, and the compressed signal to the right ear having been recorded on the second track. The Segments of information are positioned on the magnetic tape 22 in such a fashion that the transition, as for example, the transition from segment 1 to segment 3, will not occur simultaneously with the transition from one segment to another in the second track of information.

Each grouping of compressed information is channeled to a separate listening means 38 and 41. One compressed signal is channeled to a listening means associated with the left ear of the listener, and the second compressed signal is channeled to a listening means associated with right ear of the listener. In this way, there is provided two groupings of compressed information simultaneously channeled to separate listening means with the transition from one abutted segment to the next occurring in each of the two groupings at different points in time.

Many modifications may be made to the present invention without departing from the spirit and scope thereof. For example, the pickup heads of each transducer carried on the recording drum could be more or less than four in number. Or, for example, a reel of magnetic recording tape could be used instead of a magnetic loop tape. It is, therefore, to be understood that the above arrangement is simply illustrative of an application of the principals of the invention, and any other modification may be made without departing from the invention.

I claim:

1. A method for time adjustment of information comprising:

sectioning a train of information into two different groupings of information, each of said two groupings being a series of alternate sections;

abutting the sectioned information in each of said two groupings of information so that it is a continuous grouping of alternate sections; and

simultaneously channeling each of said two groupings of information to separate listening devices.

2. A method for time adjustment of information comprising:

sectioning a train of information into two different groupings of information, each of said two groupings being a series of alternate sections;

abutting the sectioned information in each of said two groupings of information so that it is a continuous grouping of alternate sections; and

simultaneously channeling each of said two groupings of information to two separate listening devices so that transitions between sections of information in each of said two groupings occur at different points in time.

3. Apparatus for time adjustment of information comprising:

an information recording element having two recording tracks with a continuous train of information recorded in phase on each of said tracks;

two transducer devices, each having a plurality of pickup heads, each transducer device being positioned for sequential and continuous pickup of alternate intermittent portions of the information recorded on one of said tracks at a frequency different from the original frequency at which recorded; and

means for providing relative movement between said recording element and said transducer devices.

4. The apparatus of claim 3 wherein there is provided means for restoring the original frequency to said intermittent portions.

5. The apparatus of claim 4 wherein there is provided means for listening to said frequency-restored intermittent portions.

6. The apparatus of claim 5 wherein said means for listening comprises two listening devices, one listening device adapted to pick up frequency-restored intermittent portions of one transducer device, and the other listening device adapted to pick up frequency-restored intermittent portions of the other transducer device.

7. Apparatus for time adjustment of information comprising:

an information recording element having two recording tracks with information recorded in phase on each of said tracks;

two transducer devices, each having a plurality of pickup heads, each transducer device being positioned for sequential and continuous pickup of intermittent portions of the information recorded on one of said tracks at a frequency different from the original frequency at which recorded;

means for providing relative movement between said recording element and said transducer devices;

means for restoring the original frequency to said intermittent portions;

means for listening to said frequency-restored intermittent portions; and

means for mounting said two transducer devices so that said plurality of pickup heads associated with one of said transducer devices is offset with respect to said plurality of pickup heads associated with the other transducer device.

8. The apparatus of claim 7 wherein said means for listening comprises two listening devices, one listening device adapted to pick up frequency-restored intermittent portions of one transducer device, and the other listening device adapted to pick up frequency-restored intermittent portions of the other transducer device.

9. Apparatus for time adjustment of information comprising:

an information recording element having two recording tracks with information recorded in phase on each of said tracks;

two transducer devices, each having a plurality of pickup heads, each transducer device being positioned for sequential and continuous pickup of intermittent portions of the information recorded on one of said tracks at a frequency different from the original frequency at which recorded;

means for providing relative movement between said recording element and said transducer devices; and

means for mounting said two transducer devices so that said so that said plurality of pickup heads associated with one of said transducer devices is offset with respect to said plurality of pickup heads associated with the other transducer device.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,555,203 Dated January 12, 1971

Inventor(s) Robert J. Scott

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the specification, column 1, line 9; change "t**t'" to --t→t'--

line 11; change "S(t)**S(t')" to --S(t)→S(t')--

In the specification, column 2, line 73; delete "the recording drum 16 equal to the linear speed of".

In the claims, column 5, line 8; delete the word "two".

Signed and sealed this 11th day of May 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER,
Commissioner of Paten