

[54] APPARATUS AND METHOD FOR
DETECTING TONE SIGNALS OCCURRING
WITHIN A PREDETERMINED FREQUENCY
RANGE

[75] Inventor: Theodore Titus, IV, Atlanta, Ga.

[73] Assignee: Lanier Electronic Laboratory, Inc.,
Atlanta, Ga.

[22] Filed: Nov. 15, 1972

[21] Appl. No.: 306,544

[52] U.S. Cl. 360/137; 307/233; 328/140;
340/171 A; 360/69; 360/79

[51] Int. Cl. G11b 5/00; H03k 5/20; H03d 13/00

[58] Field of Search 179/100.2 S; 360/71, 72,
360/74, 79, 80, 78, 137, 69; 328/140;
307/233; 340/171 A

[56] References Cited
UNITED STATES PATENTS

3,509,549	4/1970	Omta et al.	179/100.2 S
3,581,217	5/1971	Issacs	328/140

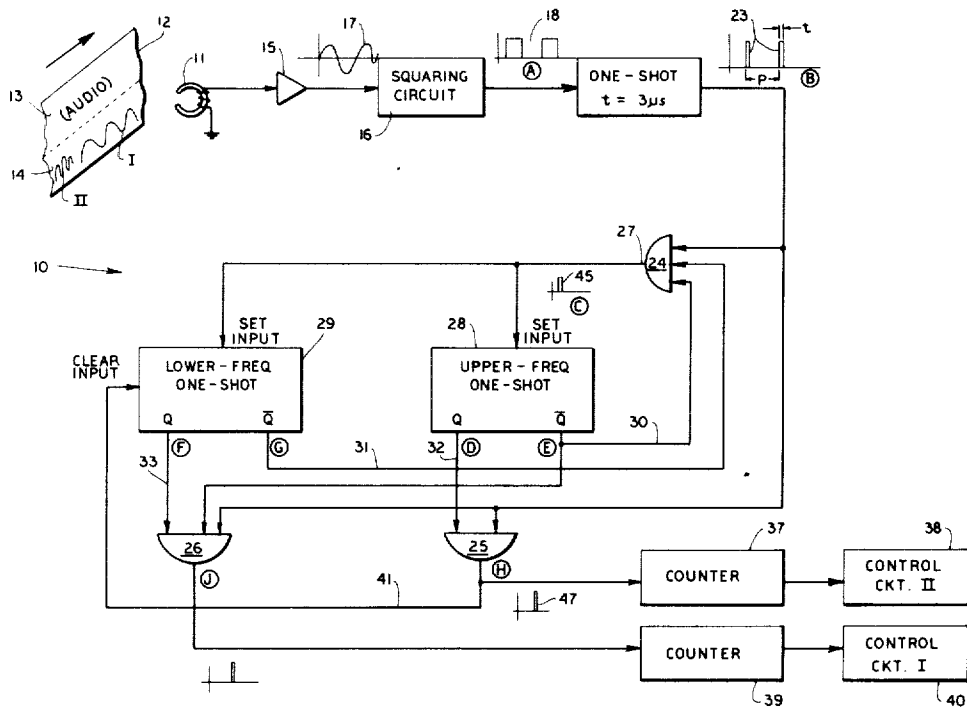
3,678,221 7/1972 Miller 179/100.2 S

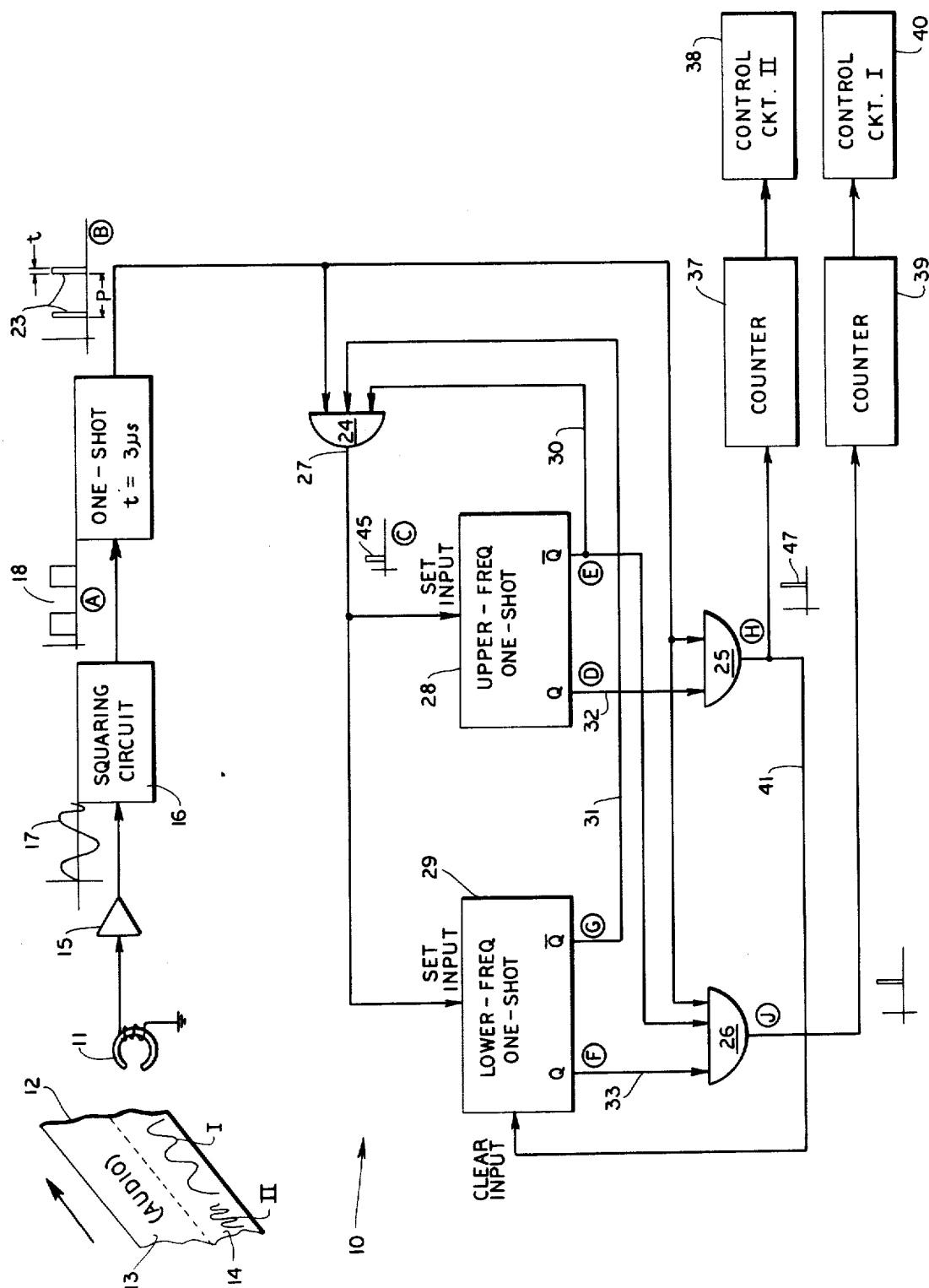
Primary Examiner—Bernard Konick
Assistant Examiner—Robert S. Tupper
Attorney, Agent, or Firm—Jones, Thomas & Askew

[57] ABSTRACT

Method and apparatus for detecting tone signals selectively occurring at plural discrete frequencies. The disclosed embodiment is used in conjunction with tape record-playback apparatus which records certain tone signals at a record-playback tape speed and which is required to detect these tone signals at relatively greater fast-forward or fast-reverse speeds. Separate time periods are established bearing a relation to the respective periods of each tone frequency to be detected at fast tape speed. The occurrence of tone signal pulses in a number of consecutively-occurring corresponding time periods, each such pulse corresponding to a cycle of the tone frequency, provides an indication of playback occurrence of the desired particular tone signal.

13 Claims, 6 Drawing Figures





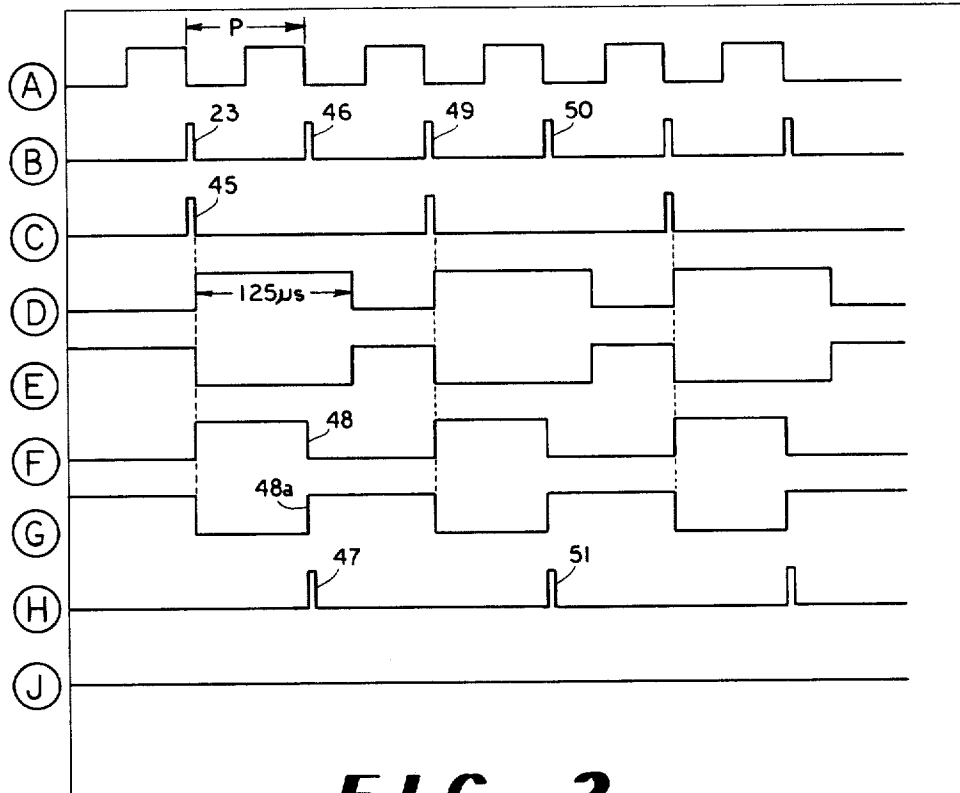


FIG 2

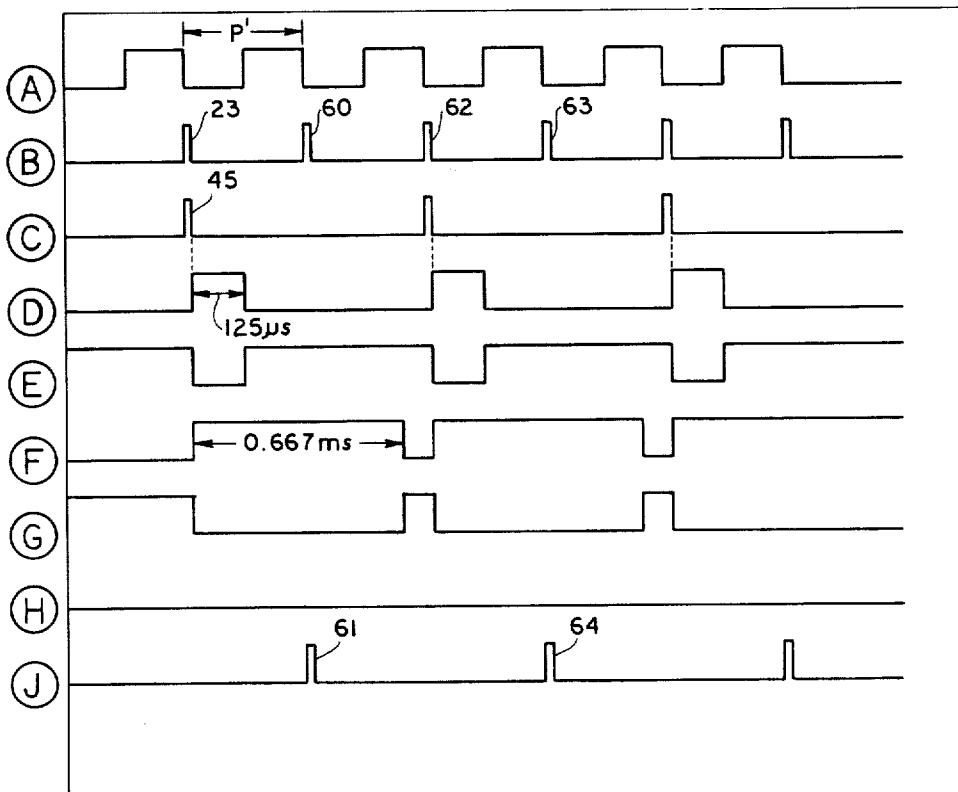


FIG 3

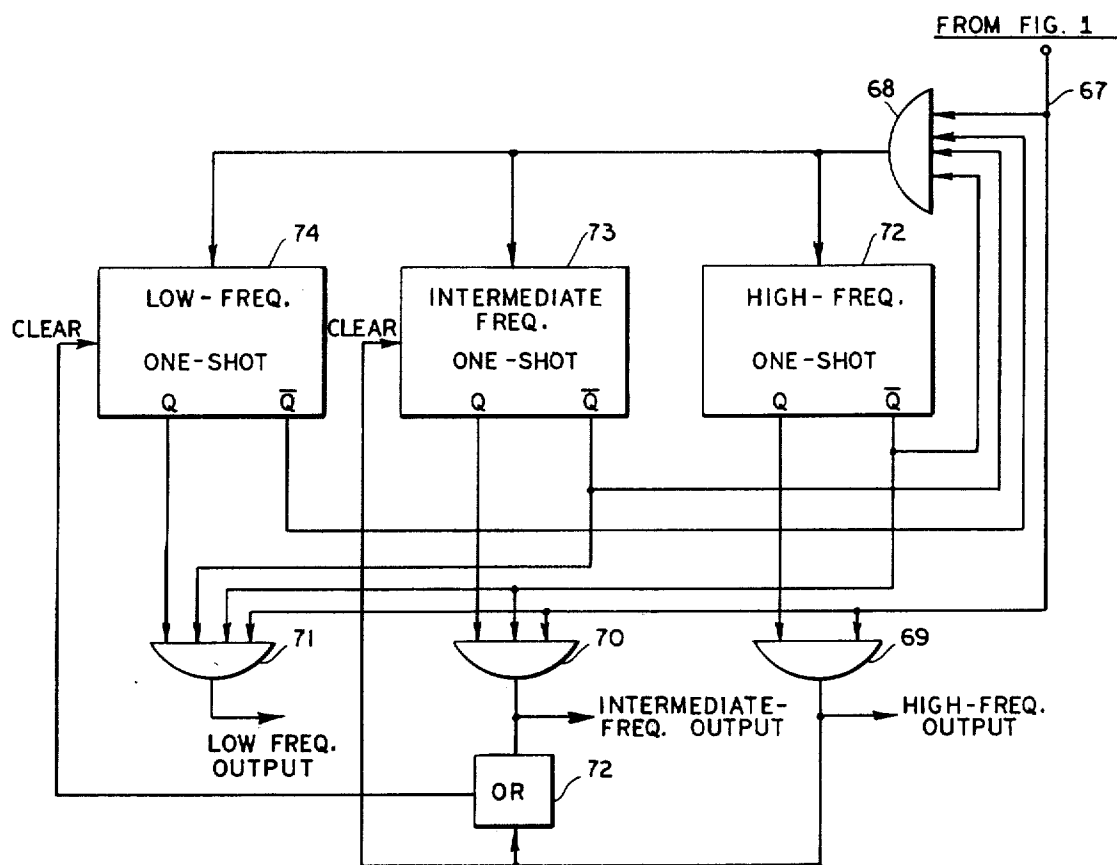


FIG 5

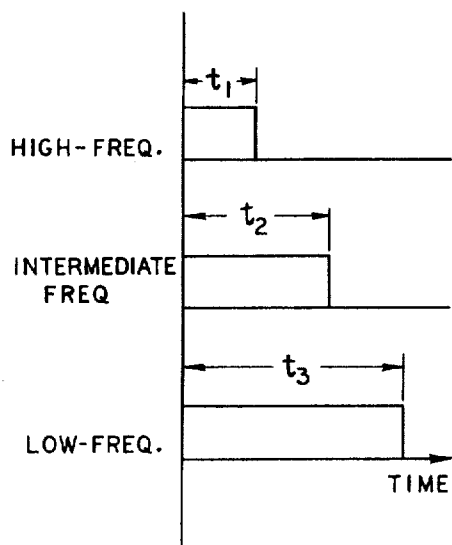


FIG 6

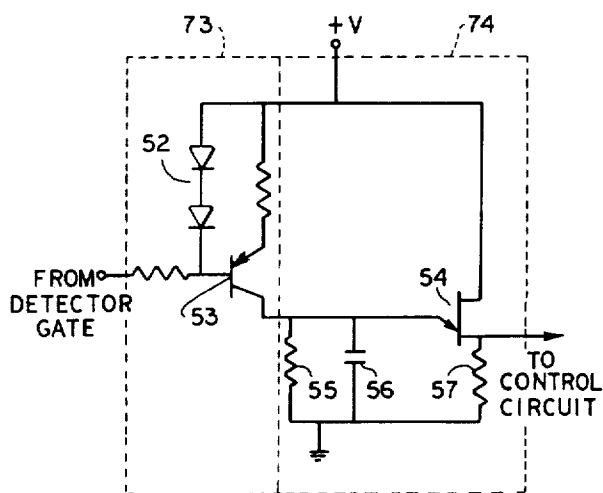


FIG 4

APPARATUS AND METHOD FOR DETECTING TONE SIGNALS OCCURRING WITHIN A PREDETERMINED FREQUENCY RANGE

This invention relates in general to frequency detection and in particular to a method and apparatus for detecting a plurality of tone frequency signals which were recorded at a first recording speed and which are reproduced at a different speed of the recording medium for detection and utilization.

Prior art requirements for apparatus capable of separating one or more tone signals of discrete frequency from a signal source possibly containing a plurality of discrete signals and/or other extraneous information have generally called for the design of various types of filters including resistance, inductance, and capacitance in arrangements to provide the desired frequency response. Such prior art filters include high-pass, low-pass, band-pass, and band-elimination filters, the design and operation of which are known to those skilled in the art. Such filters can be provided with relatively steep skirts, providing a high degree of selectivity, through appropriate circuit design and by providing a number of filter stages connected in series.

While such prior art tone signal detection techniques are generally satisfactory for many applications, the requirements of inductance and/or capacitance frequently present problems of physical size and expense of filter components, especially where multiple numbers of filters must be provided within a relatively small package to detect and separate desired tone signals from a multiple available number of such signals. One example of such a situation is found in the apparatus described in the copending U.S. patent application Ser. No. 391,685, filed Aug. 27, 1973, which is a continuation of U.S. patent application Ser. No. 149,480, filed June 3, 1971, now abandoned, describing dictation-transcription apparatus in which a number of discrete tone signals are recorded on one or more tracks of a magnetic recording medium, such as recording tape, to signify the occurrence of certain events. These tone signals, which may be recorded on one or more tracks separate from the tape track used for recording the audio dictation message, typically signify the occurrence of dictation events such as an index mark, a mark denoting the end of a dictated message, or other desired events. It will be appreciated that these tone signals are recorded on the tape while the tape is moved at a constant forward speed appropriate for recording dictation. As is apparent from the foregoing copending application, however, these recorded tone signals are typically utilized to control various dictation and/or transcription functions during fast-forward or fast-reverse modes of operation, with the tape being moved past the transducer at an average speed 15 times greater than the constant record-playback tape speed. Furthermore, the actual instantaneous tape speed during fast-forward or fast-reverse typically varies from between ten times to twenty times the record-playback speed, depending upon the amount of tape already wound onto the tape reel which is being driven in the fast mode. This means that a tone signal of 250 cps for example, which was recorded on the tape during the normal record mode must be detected in a fast-playback mode over an expected frequency range of 2500-5000 cps. Similarly, a tone signal of 1 kc recorded onto the tape must be detected during fast-playback over an expected range of 10-20 kc. More-

over, the presence of an additional tone signal of 60 cps, for example, recorded on the tape for another purpose must be ignored by the apparatus which is seeking to detect the occurrence of the 250 cps and 1 kc tone signals.

While band-pass filters according to the prior art could be designed to have the frequency response characteristics necessary to detect and separate two or more discrete tone signals over separate frequency ranges as described above, it is apparent that the physical size and cost of such filters will be undesirable, particularly in the environment of dictation-transcription apparatus. Moreover, conventional band-pass filters which even approach the size and cost limitations imposed by the commercial considerations of the market for dictation-transcription equipment frequently lack the steep skirts which are necessary for error-free signal detection in situations where the tape speed and other factors place the reproduced tone signal near the edge of the particular pass-band for that tone.

Accordingly, it is an object of the present invention to provide improved method and apparatus for detecting tone signals.

It is another object of the present invention to provide improved tone signal detection apparatus and method for use in conjunction with recorded tone signals which are reproduced over a range of possible frequencies.

It is still another object of the present invention to provide record-playback apparatus utilizing recorded and reproduced tone signals.

Other objects and many of the attendant advantages of the present invention will become apparent from the following description of the disclosed embodiment thereof, including the annexed drawing, in which:

FIG. 1 shows a schematic diagram of a first embodiment of the present invention;

FIG. 2 shows a number of waveforms encountered in a first mode of operation of the embodiment depicted in FIG. 1;

FIG. 3 shows a number of waveforms encountered in a second mode of operation of the embodiment depicted in FIG. 1;

FIG. 4 shows a schematic diagram of an embodiment of a counter circuit useful in conjunction with the present invention;

FIG. 5 shows a schematic diagram of a second embodiment of the present invention; and

FIG. 6 shows a timing diagram applicable to the operation of the disclosed embodiment as shown in FIG. 5.

Stated in general terms, tone separation and detection is accomplished according to the present invention by establishing a plurality of time periods corresponding in number to the number of discrete tone frequencies to be detected. Each of these time periods is established to be approximately as long as the maximum period in the expected playback frequency range of the particular tone frequency signal corresponding to that time period. Pulses corresponding to the cycles of the playback signals are examined to determine whether a pulse occurs during the shortest time period, i.e., the time period corresponding to the highest frequency tone being detected. If no such coincidence occurs, the pulses are examined to determine whether a pulse occurs during the time period corresponding to the next highest frequency to be detected, and so on, until the final one of the time periods has been examined for

possible coincidence with an incoming pulse. A number of consecutive pulse coincidences may be required as assurance that the coincident signal was in fact one of the tone signals and not a noise signal of some sort.

Stated more particularly and with reference taken to the disclosed embodiment as shown in FIG. 1, there is shown a tone signal detection circuit indicated generally at 10 and including a transducer 11 positioned to be in signal transducing relation with a recording medium such as the magnetic tape shown fragmentarily at 12. The tape 12 is illustrated as including a first track 13, which may exclusively contain audio or other message signals, and a second track 14, which may contain one or more of plural tone signals represented by the waveforms I and II shown on the second track. As explained previously, the tone signals I and II are assumed to have been applied to the tape 12 in the course of dictating the audio or other message portions contained on the first track 13 of the tape. By way of specific example, the tone signal I may comprise a 250 cps tone burst signifying an index mark applied during dictation, and the tone signal II may comprise a 1 kc tone burst signifying the end of dictation. The tone signals I and II are mutually exclusive of each other in the illustrated embodiment, and it will be understood that additional tone signals, such as the aforementioned 60 cps tone signal, corresponding to additional data could be selectively recorded on the second track 14. It will also be understood that the portions of the tape playback apparatus for reproducing the audio message form no part of the present invention and are omitted from the disclosed working embodiments for clarity of description.

The signals developed in the transducer 11 are connected to an amplifier 15 to be amplified and then supplied to a squaring circuit 16. Assuming that the tone signals I and II recorded on the tape 12 have a sinusoidal waveform, the input to the squaring circuit 16 may be symbolically represented by the waveform 17. The squaring circuit 16 functions to produce an output waveform 18 consisting of a train of square-wave pulses corresponding to the positive-going portions of the input waveform 17, with the repetition rate of the square-wave pulses being equal to the frequency of the signal detected by the transducer 11 and with the width of each of the square-wave pulses being a function of the period of the sinusoidal input signal. The squaring circuit 16 can be provided by a conventional circuit such as the well-known Schmitt trigger circuit. The square-wave output of the squaring circuit 16 is shown as waveform A on FIGS. 2 and 3.

The train of square-wave pulses from the squaring circuit 16 is applied to the input of a timing one-shot multivibrator 22, which functions in the conventional manner to produce an output pulse 23 of predetermined, certain duration t in response to the occurrence of each square-wave pulse received from the squaring circuit. The output of the one-shot 22 is shown as the waveform B in FIGS. 2 and 3, and it can be seen that the timing one-shot 22 is triggered by the trailing edge of each square-wave pulse in the waveform A. The output pulses 23 produced by the one-shot 22 are referred to hereinafter as timing pulses, and each of these timing pulses may have a duration t of three microseconds and a repetition rate corresponding to the frequency of the signal developed by the transducer 11. The period p of the timing pulses is the reciprocal of the repetition rate.

The timing pulses from the timing one-shot 22 are supplied as an input to the timing gate 24 and also as an input to each of the detector gates 25 and 26. Each of these three gates 24, 25, and 26 can be provided by AND circuits of conventional design. The output 27 of the timing gate 24 is connected to provide a "set" input for each of the one-shot multivibrators 28 and 29, which may be respectively identified as the upper-frequency one-shot 28 and the lower-frequency one-shot 29. Each of the one-shots 28 and 29 has a pair of outputs Q and $\bar{Q}$. An output signal is present at the $\bar{Q}$ output of each one-shot 28 or 29 when that one-shot is in its normal or quiescent state. It will be appreciated by those skilled in the art, however, that a suitable set signal applied to the input of either of the one-shots 28 and 29 causes the output signal to be removed from the $\bar{Q}$ output and concurrently causes an output to appear at the Q output for a predetermined length of time, after which the outputs of the one-shot again revert to the normal or quiescent state. The time for the one-shot 28 is chosen to be 125 microseconds and the time for the lower-frequency one-shot 29 is chosen to be 0.667 millisecond, with these particular times chosen in the disclosed embodiment of the invention for a reason which becomes apparent below. The two outputs of the upper-frequency one-shot 28 are shown as waveforms D and E on FIGS. 2 and 3, while the two outputs of the lower-frequency one-shot 29 are shown on those Figures as waveforms F and G.

The $\bar{Q}$ outputs from the two one-shots 28 and 29 are connected through lines 30 and 31, respectively, to provide inputs to the timing gate 24. The Q outputs of the two one-shots 28 and 29 are supplied through the lines 32 and 33 to the respective detector gates 25 and 26. It will be seen that the detector gate 26 is supplied with a third input connected to receive the $\bar{Q}$ output of the upper-frequency one-shot 28.

The output of the detector gate 25 is supplied to a counter 37 which functions as described in greater detail below to provide an output to a control circuit 38 when a predetermined number of consecutive pulses corresponding to concurrent inputs to the detector gate 25 have been received by the counter 37. Similarly, the output of the detector gate 26 is connected to a counter 39 which operates a suitable control circuit 40 upon counting a predetermined number of consecutive outputs from the detector gate 26. The outputs of the detector gates 25 and 26 are shown as waveforms H and J on FIGS. 2 and 3.

The output of the detector gate 25 is also supplied through a line 41 to the "clear" input of the lower-frequency one-shot 29. A signal appearing at the clear input from the line 41 causes the lower-frequency one-shot immediately to assume its normal or quiescent state, thereby interrupting any time period which may be operational in that one-shot and resetting to the $\bar{Q}$ output. A one-shot of the type represented at 29 and having a clear input may be provided by an available component such as Texas Instruments SN74123 or the like.

Considering now the operation of the embodiment as described thus far, it is assumed that the tape 12 having a tone signal II, recorded on the second track 14 at a nominal recording frequency of 1 kc, is moving at a fast-forward or fast-reverse speed past the transducer 11. If the parameters of the particular tape transport mechanism produce fast tape winding at a speed range

of 10–20 times as fast as the tape recording speed, it can be seen that the playback signal developed by the transducer 11 has a frequency in the range of 10–20 kc, and this playback signal as applied to the squaring circuit 16 produces a waveform A consisting of a train of square-wave pulses having a repetition rate in the range of 10–20 kc and having a period p ranging between 50–100 microseconds. The output waveform B of the timing one-shot 22 correspondingly consists of a series of timing pulses 23 having the aforementioned pulse width t of 3 microseconds and having a period p between adjacent pulses in the range of 50–100 microseconds.

The timing pulses are applied to one of the inputs of the timing gate 24. Since both of the one-shots 28 and 29 are assumed to be quiescent at this time, the $\bar{Q}$ output signals of these one-shots are applied along respective lines 30 and 31 to the timing gate 24, and so the coincident presence of signals at all of the inputs of the timing gate causes an output pulse 45, as shown on the waveform C, to appear on the output line 27 and to be applied to the set inputs of the two one-shots 28 and 29. Each of these two one-shots functions to commence its respective period of time in response to the trailing edge of the output pulse 45. Referring to the waveforms D and F as shown on FIG. 2, it is seen that the Q outputs of both one-shots 28 and 29 are initiated coincident with the trailing edge of the pulse 45; at the same time, as shown by the waveforms E and G of FIG. 2, the $\bar{Q}$ outputs of the one-shots 28 and 29 disappear.

Consider now the next timing pulse 46 of the waveform B, corresponding to the next positive-going pulse of the signal produced by the transducer 11. Since the period p between timing pulses does not exceed 125 microseconds in the example under discussion, the next timing pulse 46 is applied as an input to both of the detector gates 25 and 26. The timing pulse 26 is also applied to the timing gate 24, but the absence of a $\bar{Q}$ signal at each of the other two inputs of that gate prevents an output pulse from appearing from the output 27. Similarly, removal from the detector gate 26 of the Q output from the upper-frequency one-shot 28 prevents an output from occurring at that detector gate. Since the next timing pulse 46 occurs within the duration of the 125-microsecond time of the upper-frequency one-shot 28, however, this timing pulse 46 and the output Q are concurrently present at the detector gate 25, and so an output pulse 47 appears at the gate 25 to be applied to the counter 37. At the same time, the output pulse 47 is applied along the line 41 to the clear input of the lower-frequency one-shot 29, causing the output Q to terminate as shown at 48 on waveform F and the output $\bar{Q}$ to recommence as shown at 48a on waveform G, both of FIG. 2. The upper-frequency one-shot times out at the end of 125 microseconds, and so both one-shots 28 and 29 become in the quiescent state awaiting the next output pulse 45 from the timing gate 24.

Referring to FIG. 2, it will be seen that the third timing pulse 49 causes both of the one-shots 28 and 29 to commence their respective timing periods, as seen from the $\bar{Q}$ outputs D and F, and that the fourth timing pulse 50 arriving during the duration of the 125-microsecond time of the one-shot 28 causes a second output pulse 51 to appear at the output H as seen at the detector gate 25. Accordingly, every other one of the timing pulses 23 can be considered as opening a "window" having a duration at least of sufficient time to in-

clude the expected arrival time of the next pulse which would occur in a tone signal of the upper frequency being detected. Thus, the first timing pulse 23 opens a 125-microsecond window during which the second timing pulse 46 occurs, and this occurrence is marked by the generation of the first output pulse 47. Similarly, the third timing pulse 49 opens another 125-microsecond window during which the fourth timing pulse 50 occurs, as marked by the generation of the second output pulse 51. The resulting output waveform H, as applied to the counter 37, consists of a train of pulses 47, 51, . . . having a repetition rate one-half the repetition rate of the timing pulses 23.

The counter 37 is provided to require reception of a consecutive number of output pulses in the waveform H, so that a single output pulse caused by the random occurrence of noise or another unwanted signal during a window period does not automatically actuate the control circuit 38 or otherwise provide a false indication of a tone signal II. The counter 37 may be advantageously provided by the circuit shown in FIG. 4, including a constant-current charging circuit 73 connected to receive the output pulses from one of the detector gates and a unijunction counting circuit 74 including the unijunction transistor 54. The constant-current charging circuit 73 includes a transistor 53 connected to operate with a fixed base-emitter voltage developed across the diodes 52, so that each output pulse from the corresponding detector gate turns on the transistor 53 to permit a current pulse to flow through the collector circuit including the parallel-connected resistance 55 and capacitance 56. The time constant provided by 55 and 56 is selected so that a single current pulse through the resistance 55 does not charge the capacitance 56 to the level necessary to fire the unijunction transistor 54. A consecutive series of output pulses, however, provides corresponding incremental charges to the capacitance 56, raising the voltage on the unijunction transistor 54 to the level where this transistor fires, and the resulting voltage developed across the resistance 57 provides a control signal which can be used for any appropriate purpose, such as operating an index marking device associated with the dictation-transcription equipment. The charging circuit 73 insures that each output pulse from the detector gate causes a fixed current flow through the resistance 55 irrespective of any charge accumulated on the capacitance 56 from previous pulses.

If the frequency of the recorded signal scanned by the transducer 11 and producing the timing pulses 23 is too low to produce a second timing pulse 46 within the 125-microsecond time of the upper-frequency one-shot 28, this one-shot will time out and revert to its quiescent state without producing an output signal from the detector gate 25. The output Q disappears from the line 32, and so no subsequent timing pulse 23 can produce an output from the detector gate 25. Simultaneously, the output $\bar{Q}$ of the upper-frequency one-shot 28 reappears and is supplied to the detector gate 26.

If the tone signal I having a recorded frequency of 250 cps is being detected at a fast-playback speed in the range of 10–20 times as fast as the recording speed, the signal developed by the transducer 11 has a frequency in the range of 2500–5000 cps and a period ranging between 0.4–0.2 milliseconds. Obviously, no timing pulse 23 caused by the tone signal I can arrive during the 125-microsecond time period established by the upper-frequency one-shot 28.

Turning now to the waveform diagram shown in FIG. 3, the output Q of the lower-frequency one-shot 29 remains applied to the detector gate 26 during the remainder of the 0.667-millisecond time period, and the next-occurring timing pulse 60 (corresponding to a cycle of the tone signal I) applied to the detector gate 26 causes an output pulse 61 to appear at this detector gate, as shown in waveform at J on FIG. 3. It can thus be seen that a lower-frequency window is open for a period of time commencing with the termination of the time period provided by the upper-frequency one-shot 28 and ending with the termination of the time period provided by the lower-frequency one-shot 29. As seen in FIG. 3, the next timing pulse 62 provides another output pulse from the timing gate 24 to recommence the timing cycle, and the next-occurring timing pulse 63 occurs within the lower-frequency window to cause another output pulse 64 to be produced. Each of these lower-frequency windows permits an output pulse 61 to be produced in response to a tone signal I playback frequency occurring in the range 1500-8000 cps, which includes the expected playback frequency range of 2500-5000 cps. The output waveform J thus consists of a pulse train having a repetition rate one-half the tone signal I playback frequency. This pulse train is preferably applied to a counter 39 of the type shown in FIG. 4 to protect against a false indication arising from the random occurrence of a noise pulse during a single window.

Although tone signal detection according to the present invention is described above with regard to a system which detects one of two possible tone frequencies, it will be seen that other than two timing windows can be provided to discriminate between a corresponding number of possible tone frequencies. Considering another embodiment of the present invention as shown in FIG. 5, for example, the timing pulses of the waveform B are applied to a four-input timing gate 68 and also to three detector gates 69, 70, and 71; the timing gate 68 and each of the aforementioned three detector gates may be provided by conventional AND circuits. Output pulses from the timing gate 68 are applied to commence timing of three one-shot devices 72, 73, and 74, each of which has a different time period as illustrated in FIG. 6 and which respectively define timing windows for a high frequency, intermediate frequency, and low frequency tone signal to be detected. For example, tone signals of 60 cycles, 250 cycles, and one kc, as recorded, could be selectively detected in timing windows determined by an appropriate selection of the times provided by the three one-shots 72, 73, and 74.

The Q outputs of each of the three one-shots in FIG. 5 are connected to a corresponding one of the detector gates 69, 70, and 71. It can be understood that an initial timing pulse applied on the line 67 causes each of the three one-shots to commence its respective timing period. If the next timing pulse on the line 67 occurs during $t-1$, the coincidence of such pulse and the Q state of the high frequency one-shot 72 causes an output pulse to be delivered from the detector gate 69. If this immediate next timing pulse occurs after the conclusion of $t-1$ and before the conclusion of $t-2$, the coincidence of signals at the detector gate 70 causes an output pulse to be produced from that gate. Similarly, if the immediate next timing pulse on the line 67 occurs after the conclusion of $t-2$ but before the conclusion of $t-3$, an output pulse is produced at the detector gate 71.

The occurrence of an output pulse on the detector gate 69 causes a clear signal to be applied to the intermediate-frequency one-shot 73 and also, through the OR gate 72, to the low-frequency one-shot 74; the one-shot 74 is additionally connected to be cleared by application of an output pulse from the detector gate 70 through the OR gate 72. The relative durations of the timing periods $t-1$, $t-2$, and $t-3$ produced by the three one-shots 72, 73, and 74 is shown in FIG. 6.

It will be understood that each of the detector gates 69, 70, and 71 may be connected to corresponding counters similar to that shown in FIG. 4 hereof, so that a number of consecutive output pulses of the respective detector gates can be counted to initiate a control signal.

It will be apparent that the practice of the present invention is not limited to the use of two or three time periods for detecting two or three tone signals, since time periods totaling more or less than three in number can be provided along with the appropriate logic circuitry to insure that no more than one time window is opened at any particular time in a cycle of operation.

Moreover, it will be apparent that the foregoing relates only to preferred embodiments of the present invention, and that numerous alterations and modifications therein can be made without departing from the spirit and the scope of the invention as set forth in the following claims.

I claim:

1. Apparatus operative to detect a recorded tone signal within a predetermined playback frequency range, comprising:

means responsive to playback of a recording medium bearing at least one recorded tone signal of predetermined frequency to provide an output signal comprising repetitive pulses at a playback frequency determined by said predetermined recording frequency and by the relationship between the recording speed and the playback speed within a predetermined range of playback speeds of the recording medium;

first timing means operative in response to an output signal pulse to produce a first timing signal for a first period of time having a duration no less than the period of the lowest frequency in said predetermined range of playback frequencies;

coincidence means responsive to said first timing signal and to said repetitive pulse output signals to produce a first control signal when the next pulse of said output signal occurs coincident with said first time signal; and

first control means responsive to said first control signal to produce a control output signal only in response to the consecutive occurrence of at least a predetermined plurality of said control signals coincident with a corresponding plurality of consecutive first periods of time.

2. Apparatus as in claim 1, further comprising:

means for providing relative movement of the recording medium and a transducing means at said predetermined recording speed to selectively record at least said one tone signal at a certain recorded frequency; and

said movement means being operative to provide relative movement of the recording medium and a transducing means at a second speed which is variable over said predetermined range of playback

speeds to reproduce said at least one recorded tone signal at said playback frequency within said range of playback frequencies.

3. Apparatus as in claim 1, wherein said first control means includes:

charge storage means operative to receive a substantially uniform charge current in response to each of said control signals; and

switch means operatively responsive to the accumulated charge on said charge storage means to produce said control signal when a predetermined charge is present on said charge storage means.

4. Apparatus as in claim 1, wherein said first control means includes:

constant current means responsive to each said control signal to provide a counting pulse having substantially certain pulse current amplitude;

charge storage means connected to receive each of said counting pulses and operative to assume a quantity of electrical charge therefrom;

bleed means operatively connected with said charge storage means to bleed said electrical charge from said charge storage means at a predetermined rate, and

switch means operatively responsive to said charge storage means to produce said control signal when a predetermined accumulated electrical charge is present on said charge storage means.

5. Apparatus operative to detect either of two tone signals of different frequencies recorded on a recording medium and reproduced within certain ranges of playback frequencies; comprising:

means responsive to playback of the recording medium to provide an output signal comprising repetitive pulses at a first playback frequency within a certain first range of playback frequencies determined by one of said predetermined recording frequency and by the relationship between the recording speed and the playback speed within a predetermined range of playback speeds of the recording medium, and further providing repetitive signal pulses at a second playback frequency within a certain second range of playback frequencies determined by the other of said predetermined recording frequencies and by said relationship between recording speed and playback speeds;

said ranges of playback frequencies being mutually exclusive, and said second range of playback frequencies being lower in frequency than said first range of playback frequencies;

first timing means operative in response to an output signal pulse to establish a first timing signal for a first period of time having a duration no less than the period of the lowest frequency in said first range of playback frequencies;

second timing means operative in response to said output signal pulse to establish a second timing signal for a period second of time having a duration no less than the period of the lowest frequency in said second range of playback frequencies;

first coincidence means responsive to said first timing signal and to said repetitive pulse output signals to produce a first control signal when the next pulse of said output signal occurs coincident with said first time signal; and

second coincidence means responsive to said first and second timing signals and to said repetitive

pulse output signals to produce a second control signal when the next pulse of said output signal occurs after said first period of time and during said second period of time.

6. Apparatus as in claim 5, wherein:

said second coincidence means is inoperative to produce said second control signal during said first period of time.

7. Apparatus as in claim 6, wherein:

said second timing means and said second coincidence means are operatively connected to commence said second period of time in response to the termination of said first timing signal condition and the continuation of said second timing signal condition.

8. Apparatus as in claim 5, wherein:

said first timing means comprises a first timing circuit operative to produce a first enabling signal for said first period of time in response to a timing pulse derived from a pulse of said output signal;

said second timing means comprises a second timing circuit operative to produce a second enabling signal for a period of time equal to the sum of said first and second time periods and also commencing in response to said timing pulse;

said first coincidence means is operative in response to the occurrence of a pulse of said output signal coincident with said first enabling signal to produce said first control signal; and

said second coincidence means is operative in response to the occurrence of a pulse of said output signal coincident with the presence of said second enabling signal and the absence of said first enabling signal to produce said second control signal.

9. Apparatus as in claim 8, wherein:

said second timing circuit is operative in response to the occurrence of said first control signal during the first period of time to terminate said second enabling signal and thus to prevent said second coincidence means from producing a second control signal during the second period of time immediately following said first period of time.

10. Apparatus as in claim 8, further comprising:

circuit means operatively connected between said reproducing means and said first and second timing circuits to supply said timing circuits with timing pulses to commence producing said respective periods of time;

said circuit means including gate means connected to be responsive to said first and second timing circuits to enable a timing pulse to be supplied to said first and second timing circuits only when neither of said timing circuits is producing said corresponding enabling signals.

11. Apparatus as in claim 10, wherein:

said circuit means additionally includes pulse shaping means operative in response to each of said pulses of said output signal to produce a said timing pulse having a leading edge and a trailing edge; and

each of said timing circuits is operative to commence producing the respective enabling signals in response to the trailing edge of a timing pulse supplied through said gate means.

12. Apparatus for detecting at least two predetermined frequency tones occurring within two mutually exclusive frequency ranges, comprising:

means for generating a series of repetitive pulses in response to an input frequency tone, the repetition rate of said pulses being a function of the frequency of said frequency tone;

first timing means responsive to a first pulse of a series of said repetitive pulses to establish a first period of time having a minimum duration sufficient to include the expected occurrence of the next repetitive pulse of the highest frequency in a higher one of said frequency ranges, and having a maximum duration sufficient to include the expected occurrence of the next repetitive pulse of the lowest frequency in said higher range of frequencies; second timing means responsive to said first pulse to establish a second period of time commencing at a time sufficient to include the expected occurrence of the next repetitive pulse of the highest frequency in the lower one of said frequency ranges and terminating at a later time sufficient to include the expected occurrence of the next repetitive pulse of the lowest frequency in said lower range of frequencies;

first coincidence means responsive to said first timing means and to said repetitive pulses to produce a first control signal when said next-occurring one of said repetitive pulses occurs during said first period of time; and

second coincidence means responsive to said first and second timing means and to said repetitive pulses to produce a second control signal when said next-occurring one of said repetitive pulses occurs after said first period of time and during said sec-

ond period of time.

13. The method of detecting either of two tone signals of different frequencies which are recorded on a recording medium and which are reproduced during recording medium movement at a speed which may vary within a range of possible playback speeds to provide playback signals having frequencies which are within two mutually exclusive ranges of playback frequencies, comprising the steps of:

establishing a first period of time which commences in response to the occurrence of a frequency cycle of said playback signal and which terminates after a predetermined certain time not less than the period of the lowest playback frequency within the range of possible playback frequencies corresponding to the higher of said recorded frequencies;

establishing a second period of time which commences no earlier than the termination of said first period of time and which has a predetermined certain duration not less than the period of the lowest frequency of the playback frequency range corresponding to a lower one of said recording frequencies;

detecting the occurrence of the next frequency pulse only during said first period of time to denote the occurrence of a tone signal having said higher recording frequency; and

detecting the occurrence of the next frequency pulse only during said second period of time to denote the occurrence of a tone signal having said lower recording frequency.

* * * * *

35

40

45

50

55

60

65