

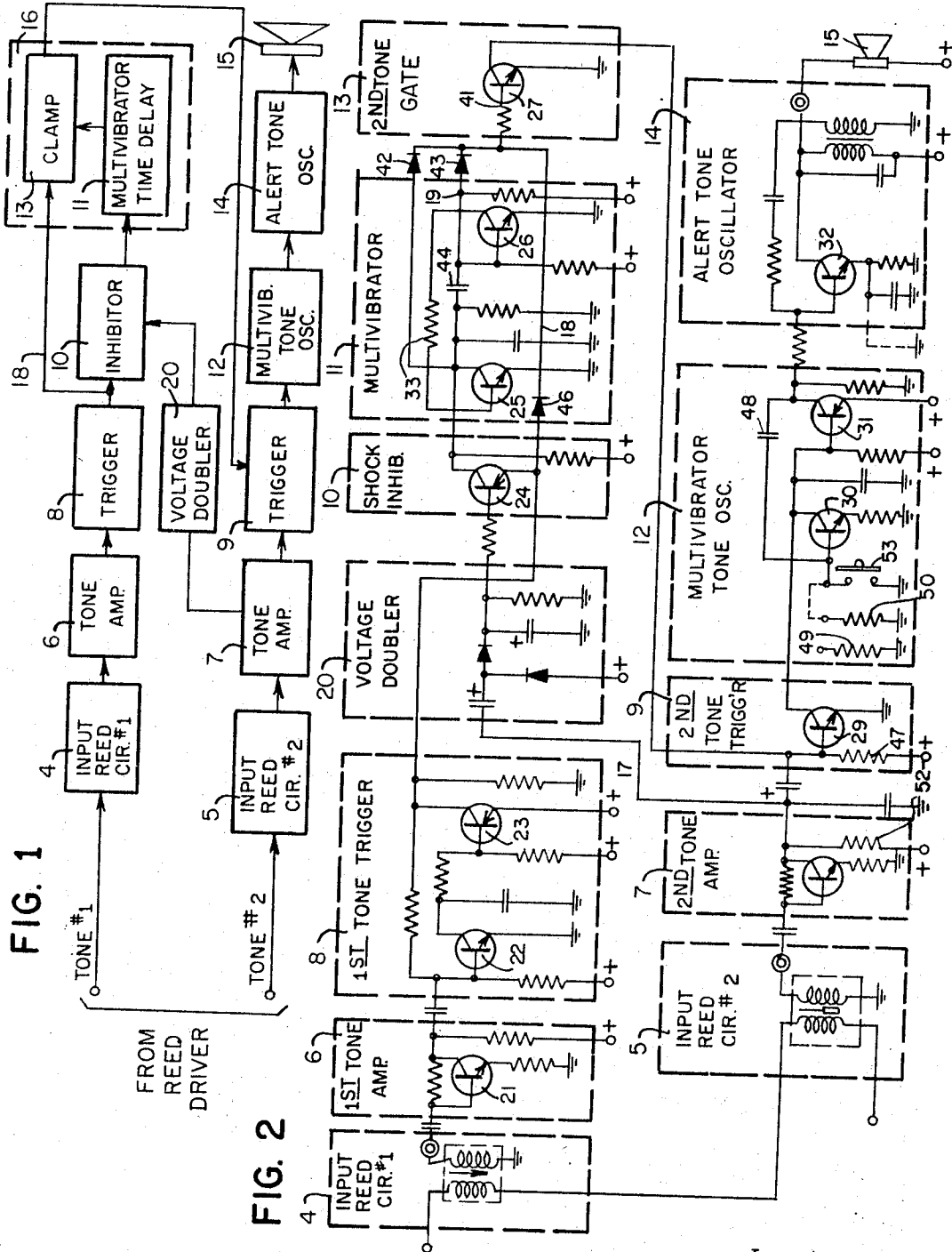
May 27, 1969

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3,447,133

TONE INHIBITOR CIRCUIT FOR PLURAL TONE RECEIVER

Filed March 7, 1966



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3,447,133 TONE INHIBITOR CIRCUIT FOR PLURAL TONE RECEIVER

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Filed Mar. 7, 1966, Ser. No. 532,342

Int. Cl. H04q 3/00

U.S. Cl. 340—171

9 Claims

The present invention relates generally to decoder circuits and more particularly to a tone decoder circuit responsive to calling tone signals transmitted in a predetermined sequence to produce an alerting tone at a loudspeaker or the like.

In the past various types of circuits have been employed to respond only to tones transmitted in a particular coded sequence to energize an alerting device such as a loudspeaker. Among these circuits are those which employ vibrating reeds in a mechanical filter arrangement as the input frequency selective device. The reed vibrates strongly upon reception of signals at the resonant frequency of the reed, thus providing electromechanical coupling between input and output coils of the filter. Thus, the reed reconstitutes the input paging tone.

These prior art circuits have not proved entirely satisfactory in that they often produce false outputs from repetitive mechanical shocks during decoder standby periods and in response to reed shocking in combination with tone signals forming part but not all of the complete tone sequence to which the paging circuit is matched.

It is an object of the present invention to provide an improved tone decoder or pager circuit that does not respond to mechanical shocks and give false alerting tones.

It is another object of the invention to provide a novel tone decoder circuit that operates to insure that only tone signals received in a predetermined time sequence produce an alerting tone at the decoder circuit output.

A feature of the invention is the provision of first and second tone receiving channels including frequency selective means in each channel for passing tones arriving in a predetermined sequence, with an alerting device connected in the output of the second channel and adapted to be energized by the final tone in the coded sequence. A timing circuit is connected between the two channels and enables the final tone to energize the alerting device only within a particular time duration after the termination of a first tone signal.

Another feature of the invention is the provision of a decoder of the type described including a clamping circuit connected between the output of the timing circuit and a triggering circuit in the second channel for clamping the triggering circuit at ground potential at all times with the exception of a particular time period during the switching of the timing circuit by a first tone signal, thereby enabling the second channel to pass a final tone signal to an alerting device only within the time period.

Another feature of the invention is the provision of a shock inhibitor circuit connected between the input of the first receiving channel and the timing circuit and circuit means connecting the first frequency selective device to the clamping circuit and connecting the second frequency selective device to the shock inhibitor circuit to totally disable both first and second channels by simultaneous signals resulting from accidental shock of the vibrating reeds of both the first and second frequency selective elements.

The invention to be described is illustrated in the accompanying drawings wherein:

FIG. 1 is a block diagram of the two channel decoder circuit; and

FIG. 2 is a detailed schematic diagram of the decoder

circuit showing the corresponding functional blocks of FIG. 1 enclosed by dotted lines.

Briefly described, the tone decoder according to the present invention includes, as previously mentioned, first and second tone receiving channels including, respectively, first and second frequency selective means for receiving tones arriving in a predetermined sequence. Each of the channels includes a trigger circuit adapted to be triggered by the first and second tones respectively applied to the two channels, and a tone alerting device is connected in the output of the second channel and adapted to be energized when the triggering circuit in the second channel is triggered by a second tone signal. A timing circuit is connected in the output of the first channel and includes a monostable multivibrator adapted to be switched by a first tone signal. A clamping circuit is connected between the monostable multivibrator and the trigger circuit in the second receiving channel, and when the decoder is in a standby position, the clamping circuit clamps the second channel trigger circuit to ground potential. Upon the application of a first tone signal and a subsequent monostable switching action of the multivibrator, the clamping circuit is momentarily cut off to enable the second channel trigger circuit only for a particular time duration. If the second tone signal is present during the particular time duration, the second channel trigger circuit will be triggered and energize a tone oscillator in the output of the second channel to provide an alerting tone signal for driving a loudspeaker or the like to alert the person paged.

Referring now in detail to FIGS. 1 and 2 of the drawing, there is shown a pair of input reed circuits 4 and 5, each including input and output coils for coupling the reed circuits to a reed driver (not shown). Each of these reed circuits is activated by a particular tone frequency and the tones must arrive in a proper sequence to produce an alerting tone at the speaker 15. In one paging system having a 5 second call rate, a first tone is transmitted for 1 second, followed within 300 milliseconds by a second tone transmitted for 3 seconds. This example is given only by way of illustration, however, and each paging circuit performs a selection and timing function that is matched to a particular code.

When the initial tone is transmitted, the first tone decoding circuits connected to the output of the reed circuit 4 begin a timing action that enables a subsequent tone signal appearing in the output of the reed circuit 5 to energize the alert tone oscillator 14 provided that the second tone arrives at the reed circuit 5 within a particular time duration as will be explained later.

The resonant reeds used in circuits 4 and 5 are of the two-coil, single tine type. If a tone applied to the input coil is equal in frequency to that of the mechanical resonance of the reed, the reed vibrates strongly, acting as an electromechanical coupling device between input and output coils. Therefore, each reed can be considered to be a very narrow bandpass filter which passes only the desired paging tone.

The input reed circuits 4 and 5 are driven by the output of a discriminator (not shown) which is amplified by a reed driver (not shown) to provide signals having an amplitude sufficient to activate the reed circuits. A first tone is coupled through the first reed circuit 4 to the first tone amplifier circuit 6. Here the first tone is amplified by transistor 21 and applied to the first tone trigger circuit 8 including transistors 22 and 23. In the standby condition, both transistors 22 and 23 are cut off with the collector of transistor 22 at some positive voltage and the collector of transistor 23 essentially at ground. When a first tone is present, the positive swing of the signal biases transistor 22 into conduction and the resultant drop of its

collector voltage is a forward bias to transistor 23. This forward bias causes transistor 23 to conduct and its collector voltage goes positive. The positive voltage at the collector of transistor 23 applies additional bias to the base of transistor 22 and the transistors 22 and 23 are driven "on" through regenerative coupling.

The collector of transistor 23, which is the output of the first tone trigger circuit 8, remains at some positive voltage during the presence of the first tone at the input of reed circuit 4 and for a period after the termination of the first tone until the resonant reed in circuit 4 stops vibrating. The time during which the first tone is actually present will be referred to hereinafter as time t_1 and the time beginning with the termination of the initial tone and ending with the termination of the reed vibration will be referred to as time t_2 . At the end of time t_2 the first tone trigger circuit 8 returns to its standby condition with the output at zero volts.

The positive pulse output of the first tone trigger circuit 8 is coupled through transistor 24 in the shock inhibitor circuit 10 to the collector of transistor 25 in the multivibrator time delay circuit 11. During normal operation, the shock inhibitor can be considered a series gate or switch in the closed position, permitting a tone signal to pass. Its operation to prevent false paging from mechanical shocks of the reeds in the input circuits 4 and 5 is explained later in the specification.

Transistors 25 and 26 form the multivibrator time delay circuit 11, and transistor 25 is cut off and transistor 26 is conducting in the standby condition. A tone gate or clamp circuit 13, including transistor 27, is connected through resistor 41 and diodes 42 and 43 respectively to the outputs of transistors 25 and 26. This gate or clamp 13 is also saturated when the circuit is in a standby condition. Before the initial tone is received, the positive collector potential of transistor 25 is resistively coupled through resistor 41 to the base of transistor 27 to provide a forward bias therefor and allow transistor 27 to conduct to saturation. The multivibrator time delay circuit 11 and the clamping circuit 13 are represented as a single timing circuit 16 in the block diagram of FIG. 1. As will be described hereinafter, the timing circuit 16 serves both to (1) provide the proper timing function for channel two when first and second tones are received in a predetermined sequence and (2) provide inhibiting action for channel two when a first tone is received by coupling the positive pulse output from first tone trigger 8 through line 18 and diode 46 to the input of the clamp 13.

The path of conduction for clamp 13 when the decoder circuit is in standby condition is through the transistor 27 collector and resistor 47 in the base of the second tone trigger transistor 29 to the positive terminal 52 of a positive voltage supply. The collector of 27 is essentially at zero volts and clamps the base of the second tone trigger transistor 29 sufficiently below cutoff to prevent activation by any tone signal that might be present at the input reed circuit 5 in channel 2 of the decoder. Additionally, the saturated clamp 13 presents a very low impedance to and virtually shorts out any signal coupled to the base of transistor 29. Therefore, the alerting tone oscillator 14 cannot be activated solely by a tone in channel 2.

During the positive pulse output from the first tone trigger which is coupled through transistor 24 to the collector of transistor 25, the voltage at the collector of 25 increases slightly. At the end of time t_2 , however, the collector of 25 tends to return to its initial voltage prior to the application of a first tone signal, and this decrease in voltage generates a negative transition which is coupled through capacitor 44 to the base of transistor 26, cutting 26 off. With 26 cutoff, its collector rises to some positive potential which is coupled to the transistor clamp 27 to keep it conducting. This positive potential at the collector of 26 is also coupled back to the base of transistor 25 via feedback resistor 33 and drives tran-

sistor 25 into conduction for the first time. At this point the collector of 25 approaches zero, dropping almost instantaneously from its positive voltage during non-conduction. This change in potential is also coupled through capacitor 44 to the base of transistor 26 driving it far below cutoff. As capacitor 44 discharges exponentially, the base voltage of 26 begins to rise until it again reaches the turn on point for transistor 26. When 26 begins to conduct, its negative going collector voltage is coupled to the base of 25 tending to cut off transistor 25. However, as transistor 25 is driven to cutoff, its collector potential cannot immediately rise to a voltage sufficiently positive to keep clamp 27 conducting since capacitor 44 must be recharged. This is the first time that either the collector of transistor 25 or the collector of transistor 26 have not been able to apply a positive voltage through diodes 42 and 43 to the base of transistor 27 sufficient to keep transistor 27 conducting. Thus, transistor 27 is "unclamped" until the capacitor 44 has had time to charge and until the collector of 25 can again reach a positive potential sufficient to drive transistor 27 into conduction.

With the transistor 27 unclamped, the second tone trigger 9 is enabled, and a positive tone signal at the base of unclamped trigger transistor 29 will drive this trigger into conduction. When 29 conducts a negative pulse is produced at the collector thereof and is applied to the multivibrator 12, including transistors 30 and 31. These transistors form a monostable multivibrator circuit similar to the time delay multivibrator 11 in channel 1.

In the standby condition both transistors 30 and 31 are cutoff, the collector of 30 being at some positive potential and the collector of 31 being at substantially ground potential. When the second tone trigger 9 applies a forward bias to transistor 31, transistor 31 is driven into conduction and the resultant regeneration in multivibrator 12 drives both transistors 30 and 31 to saturation and applies a forward bias to the base of transistor 32 in the tone oscillator audio output stage 14. Transistor 32 produces an alerting tone in the speaker 15 as long as this forward bias remains.

The second channel multivibrator 12 returns to its initial state and the alerting tone at the loudspeaker 15 ceases when capacitor 48 becomes discharged through resistor 49 or resistor 50, whichever is connected in the base circuit of transistor 30. This alerting tone period may be varied substantially by changing the jumper connection to resistors 49 and 50. An operator may end the alerting tone sooner, however, by pushing the switch 53 to ground the base of transistor 30.

The level of the alerting tone at the output of the loudspeaker 15 can be decreased by adding resistance in the emitter circuit of transistor 32 to sharply reduce transistor current.

When the pager is initially turned on, a strong steady alerting tone is temporarily produced to indicate that the battery voltage is sufficient for pager operation. This is due to the fact that voltage transients momentarily trigger transistor 31 into conduction when a battery voltage is first applied, and regeneration through capacitor 48 sets the second multivibrator 12 into operation, just as if a paging signal were received.

The shock inhibitor circuit 10 takes advantage of the fact that both reeds in circuits 4 and 5 vibrate when shocked, but only one reed at a time vibrates during normal paging signal reception. In order to understand the function of the shock inhibitor, consider the situation when both reeds are simultaneously shocked. Upon such condition, the tone in the first channel actuates the first tone trigger 8 and couples an output signal via line 18 to the base of transistor clamp 27, keeping it saturated and disabling the second tone trigger 9 as previously described. At the same time, a tone in channel 2 is coupled from the tone amplifier 7 through a voltage doubler rectifier circuit 20 and applied to the base of

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the transistor 24 in the shock inhibitor circuit 10. This biases the shock inhibitor 10 to cutoff and prevents a tone signal from entering the multivibrator time delay circuit 11 so that the gating pulse is not generated thereby. Thus, both the first and second channels are simultaneously blocked at the inhibitor 10 and trigger 9 respectively when the reeds in the input reed circuits 4 and 5 are caused to resonate due to accidental shocks. On the other hand, for normal operation an initial tone in channel 1 is coupled to the first tone trigger 8 and passed by transistor 24 in the shock inhibitor circuit 10 to energize the multivibrator time delay circuit 11. When the first tone ends, a second tone received in channel 2 is coupled through the voltage doubler 20 to the base of transistor 24 and biases the shock inhibitor 10 to cutoff. This assures that the first multivibrator 11 input signal ends promptly upon the reception of a second tone in channel 2.

Thus, the combination of the shock inhibiting action in both channels 1 and 2 and the unique time delay feature provided by channel 1 to enable channel 2 only for a particular time duration after the termination of a tone signal in channel 1 insures that the decoder circuit will only produce an alerting tone at speaker 15 when a proper coded sequence of tone signals is received.

We claim:

1. A tone decoder including in combination: first tone receiving channel means including first frequency selective means for passing a first tone signal of a first predetermined frequency, second tone receiving channel means including second frequency selective means for passing a second tone signal of a second predetermined frequency, alerting means coupled to said second tone receiving channel means and adapted to be energized by said second tone signal, enabling means coupled between said first and second channels and acting normally to disable said second tone receiving channel means, said enabling means being responsive to said first tone signal for enabling said second tone receiving channel means to pass said second tone signal from said second frequency selective means to said alerting means only within a particular time duration after the termination of said first tone signal at the input of said first frequency selective means, and inhibiting means coupled to said second receiving channel and to said enabling means and being responsive to said second tone signal to prevent said first tone signal from being coupled to said enabling means.

2. The decoder according to claim 1 wherein said first and second frequency selective means includes: first and second electromechanical filters respectively, each of said first and second electromechanical filters having a reed and input and output coils coupled to said reed whereby input tone signals at said input coils cause said reeds to vibrate strongly when said tone signals have a frequency equal to the resonant frequency of said reeds and to thereby produce output tone signals in said coils which exceed a predetermined amplitude.

3. The decoder according to claim 1 wherein said enabling means includes: switching means coupled to said first tone receiving channel means and normally in a first conductive state, said switching means being responsive to the termination of said first tone signal in said first tone receiving channel means to change the conductive state of said switching means to a second conductive state, said switching means remaining in said second conductive state for a predetermined time period, said switching means further acting to change to said first conductive state at the end of said predetermined time period and to develop a control signal for a particular time duration, said enabling means further including clamping means coupling said switching means to said second tone receiving channel means and normally acting to disable the same, said clamping means being responsive to said control signal to enable said second tone receiving channel

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means to pass said second tone signal to said alerting means only within said particular time duration.

4. The decoder according to claim 3 wherein said switching means includes a monostable multivibrator comprising a pair of semiconductor devices adapted to be switched between said first and second conductive states, a capacitor coupled between said semiconductor devices and adapted to charge and discharge during monostable switching action of said multivibrator when a first tone signal is applied to one of said semiconductor devices, said decoder further including, circuit means coupling said capacitor to said clamping means and responsive to said change in said conductive state from said second to said first conductive state to provide a voltage change at said clamping means proportional to the charge time of said capacitor, said clamping means changing its conductive state during said voltage change to enable said second receiving channel means to pass said second tone signal only until said capacitor is charged to a predetermined voltage.

5. A tone detector including in combination: a first tone receiving channel including first frequency selective means for passing a first tone signal of a first predetermined frequency, a second tone receiving channel including second frequency selective means for passing a second tone signal of a second predetermined frequency, first and second trigger means coupled to said first and second frequency selective means respectively, said first trigger means being responsive to said first tone signal to generate a first trigger signal, alerting means, circuit means coupling said second trigger means to said alerting means, said alerting means being responsive to a second tone signal applied to said second frequency selective means to develop an alerting tone, timing circuit means, shock inhibiting means coupled to said second frequency selective means and coupling said first trigger means to said timing circuit means, said timing circuit means including clamping means coupled to said second trigger means for normally disabling the same, said timing circuit means being responsive to said first trigger signal to generate a control signal for a particular time duration a predetermined time interval after the termination of the first trigger signal, said clamping means being responsive to said control signal to enable said second trigger means whereby said second tone signal received during said particular time duration actuates said alerting means, said shock inhibiting means being responsive to said second tone signal to block the coupling of said first trigger signal to said timing circuit means to thereby prevent the generation of said control signal.

6. The decoder according to claim 5 wherein said timing circuit includes: a monostable multivibrator circuit coupled to said clamping circuit and normally in a first conductive state, said monostable multivibrator being responsive to the termination of said first trigger signal to assume a second conductive state and to remain therein for a predetermined time interval, said multivibrator further acting to return to said first conductive state at the end of said predetermined time interval and to generate said control signal for said particular time duration upon said return to said first conductive state.

7. The decoder according to claim 6 wherein: said second trigger means includes a first transistor having a base electrode coupled to said second frequency selective means, and said clamping means includes a second transistor coupled to said monostable multivibrator and normally biased to a conductive state thereby, said second transistor being coupled to said base electrode of said first transistor, said second transistor in its conductive state acting to bias said first transistor to non-conduction and to bypass signals appearing on said base electrode of said first transistor whereby said second trigger circuit is disabled, said second transistor being responsive to said control signal to become non-conductive, said second transistor acting in its non-conductive state to bias said first

transistor to conduction whereby said second trigger circuit is enabled.

8. The decoder according to claim 6 wherein said shock inhibitor means includes transistor means coupling said first trigger means to said monostable multivibrator means, said transistor means normally being in a conductive state, voltage doubler means coupling said second frequency selective means to said transistor means, said voltage doubler means and said transistor means being responsive to said second tone signal to bias said transistor means to non-conduction whereby said first trigger signal is prevented from actuating said monostable multivibrator means.

9. The decoder according to claim 5 wherein circuit means couples said first trigger means to said clamping

means for applying said first trigger signal thereto, said clamping means being responsive to said first trigger signal to maintain said second trigger means in said disabled condition.

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