

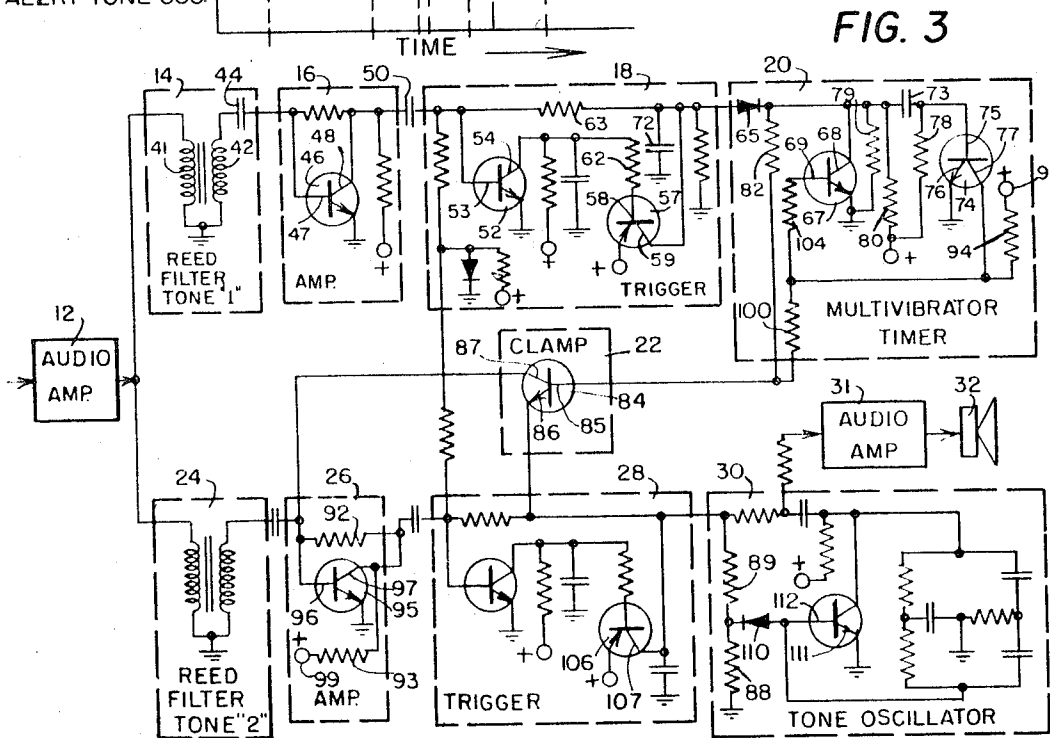
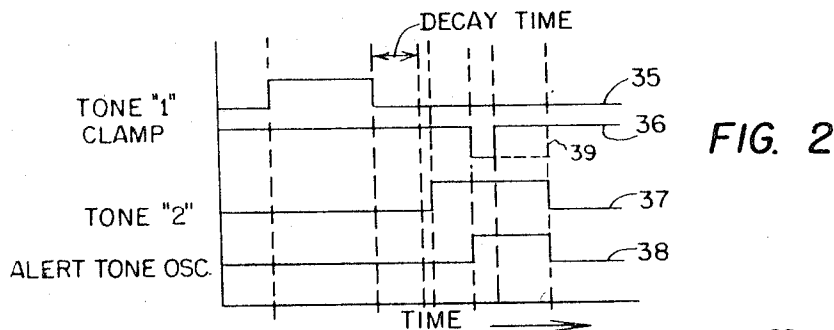
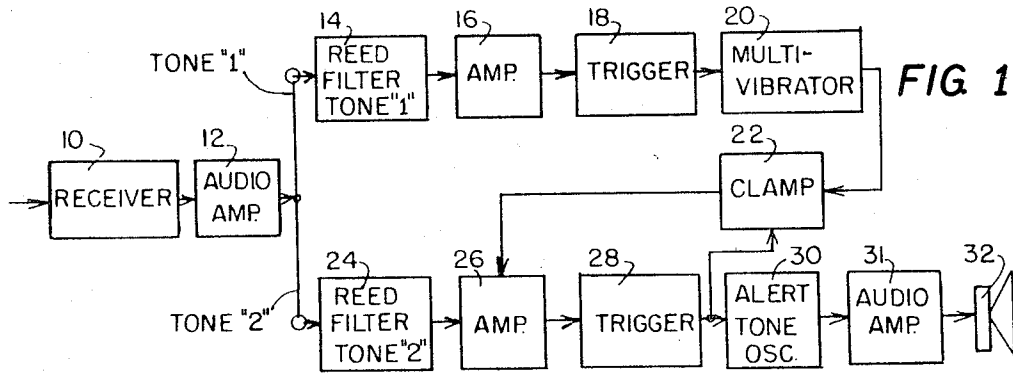
Sept. 2, 1969

R. D. CARSELLO ET AL

3,465,294

PLURAL CHANNEL FREQUENCY DETECTING CIRCUIT

Filed March 7, 1966



INVENTORS

RICHARD D. CARSELLO

RICHARD E. LUNQUIST

BY

Mueller, Nichols & Baumer

ATTYS.

1

3,465,294

PLURAL CHANNEL FREQUENCY DETECTING
CIRCUIT

Richard D. Carsello and Richard E. Lunquist, Chicago,
Ill., assignors to Motorola, Inc., Franklin Park, Ill., a
corporation of Illinois

Filed Mar. 7, 1966, Ser. No. 532,359

Int. Cl. H40q 1/18

U.S. Cl. 340—171

10 Claims

This invention relates to decoder circuits and in particular to a tone decoder circuit responsive to tone signals transmitted in a predetermined sequence to produce an alerting tone in a loudspeaker.

In the past various types of circuits have been employed which 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 an electromechanical filter arrangement as the input frequency selective device. The reed vibrates strongly upon reception of signals at the resonant frequency of the reed, providing coupling between the input and output coils of the filter. Thus the reed electromechanical filter acts to couple a tone of a particular frequency to the tone decoder circuit.

Reed electromechanical filters have not proved entirely satisfactory in that they are sensitive to shock and may produce false outputs when the equipment in which they are used is subjected to mechanical shocks. A mechanical shock causes the reed to vibrate thus simulating the reception of the tone of the proper frequency. Thus, the mechanical shocking of a paging unit in which reed filters are used can cause annoying false alerts which may cause the user of the paging unit to believe that he is being paged when such is not the case.

It is, therefore, an object of this invention to provide an improved tone decoder circuit that does not respond to mechanical shocks to give false alerting tones.

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

A feature of this invention is the provision of a tone decoder circuit having first and second tone receiving channels 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 to enable the second tone channel only during a particular time duration which occurs a predetermined time after the termination of the first tone signal.

Another feature of this invention is the provision of a tone decoder circuit having a clamping circuit coupled to the second channel and to the timing circuit to inhibit the operation of the second channel at all times except during said particular time duration.

The invention is illustrated in the accompanying drawings wherein:

FIG. 1 is a block diagram of a tone decoder circuit;

FIG. 2 is a curve illustrating the timing sequence used in the tone decoder of FIG. 1; and

FIG. 3 is a partial schematic and partial block diagram of the tone decoder of FIG. 1.

In practicing this invention, a tone decoder is provided having first and second tone channels for receiving first and second tones arriving in a predetermined sequence. The second tone channel is coupled to an alerting circuit which develops an alerting signal when the second tone is coupled thereto by the second channel. A clamping circuit is provided which normally clamps the second channel in an in-

2

hibited or inoperative condition so that any tones received by the second channel will not operate to energize the alerting circuit. Further, the clamping circuit prevents the generation of any tones within the second channel because of mechanical shock to the circuit. The first channel includes a monostable multivibrator timing circuit which is normally in a first or stable state. The multivibrator is coupled to the clamping circuit to provide a potential thereto to cause said clamping circuit to inhibit the second channel. Reception of a first tone by the first tone channel causes the multivibrator to be switched to a second state upon de-energization of the first channel. The multivibrator is maintained in said second state for a predetermined period of time after which it reverts to its first state. While in its second state, the multivibrator maintains the proper potential on the clamping circuit to inhibit the operation of the second channel. Upon return to its first state, the potential from the multivibrator is changed for a particular time duration to remove the clamping action of the clamping circuit from the second channel, thereby permitting a second tone received during this particular time duration to energize the alerting means.

The output from the electromechanical filters decays during a time period after the energization applied to the filter ends. The energization may be by a tone signal of the proper frequency or by mechanical shock. During this decay period the filters produce an output which is sufficient to cause false operation of the tone decoder. By making the predetermined time period during which the multivibrator is maintained in its second state longer than the decay period of the filter, false operation of the tone decoder circuit is prevented.

Referring to FIG. 1 there is shown a block diagram of a circuit incorporating the tone decoder. A carrier modulated by tone signals is received by receiver 10 and detected to develop audio tones. The tones are amplified in audio amplifier 12 and coupled to both reed filter 14 and reed filter 24. Reed filters 14 and 24 develop output signals if tones of the proper frequency are applied thereto.

The output signal from reed filter 14 is coupled to amplifier 16 where it is amplified and coupled to trigger circuit 18. When the output of amplifier 16 reaches a predetermined threshold voltage, trigger 18 is actuated. At the end of the reception of the first tone and after the output of reed filter 14 decays, trigger 18 reverts to its normal state and produces a signal which causes monostable multivibrator 20 to switch to its second or unstable state.

The output of multivibrator 20 is coupled to clamping circuit 22 which applies a clamping potential to amplifier 26. When the clamping potential from clamping circuit 22 is not present, the second channel, including reed filter 24, amplifier 26 and trigger 28, operates in the same manner as the first channel including reed filter 14, amplifier 16 and trigger 18. Upon the reception of a tone signal of the frequency to which reed filter 24 is tuned, an output signal is developed from trigger 28 which energizes tone oscillator 30. The output of tone oscillator 30 is amplified in audio amplifier 31 and reproduced by speaker 32.

As previously described, when monostable multivibrator 20 is in its first or stable state, a potential is developed which is coupled to clamping circuit 22 to cause that circuit to inhibit the operation of the second tone channel. When monostable multivibrator 20 is switched to its second state, at the termination of the reception of a first tone signal, a potential is developed which maintains clamping circuit 22 in its clamping condition. Thus, the operation of the second tone channel is inhibited both before and during the reception of the first tone signal. When the first tone signal transmission ends, monostable multivibrator 20 switches to its second state for a prede-

terminated period of time and then switches back to its first or stable state. During this predetermined time period, the second tone channel is maintained in an inhibited condition by the clamping action of clamping circuit 22. Thus, the reception of a second tone frequency during this time will not cause operation of tone oscillator 30.

When monostable multivibrator 20 switches from its unstable to its stable state, the output potential from multivibrator 20, applied to clamping circuit 22, changes for a particular time duration to cause clamping circuit 22 to remove its clamping action from the second tone channel. During this particular time duration, the second channel is fully operative and a second tone frequency received during this particular time duration will energize tone oscillator 30.

The timing sequence of the tone decoding circuit is illustrated in FIG. 2. Curve 35 shows the time duration of the reception of the first tone. Curve 36 shows the clamping action of clamping circuit 22 of FIG. 1 as it would be if no second tone were transmitted. This clamping action is present before the reception of the first tone, during the reception of the first tone and for a predetermined time period after the reception of the first tone. At the end this predetermined time period, multivibrator 20 returns to its stable state causing clamping circuit 22 to remove its clamping action from the second channel as shown in curve 36. Curve 37 shows the time duration of the reception of the second tone. The second tone is received before the end of the predetermined time period but, as shown in curve 38, it is inoperative to energize the tone oscillator 30. When the clamping action of clamping circuit 22 is removed from the second channel, as shown in curve 36, the reception of the second tone causes tone oscillator 30 to be energized as shown in curve 38. This energization continues until the end of the reception of the second tone. The reception of a second tone during the period when the clamping action is removed caused this "no-clamp" period to be extended as shown by the dotted curve 39.

As an example of the time intervals used in a practical embodiment of this circuit, the first tone may have a time duration of approximately 1 second followed by the second tone which may have a time duration of approximately 3 seconds. The interval between the first and second tones may be approximately 300 milliseconds. Multivibrator 20 may be set to return to its stable state approximately 700 milliseconds after the end of the first tone and the decay of the reed filter output to produce an output which unclamps the second channel for a time duration of approximately 60 milliseconds.

A partial schematic and partial block diagram of the circuit of FIG. 1 is shown in FIG. 3. Audio amplifier 12 couples the tone signals to reed filters 14 and 24. Reed filters 14 and 24 have reeds which are set to vibrate mechanically at a particular tone frequency. Received tones are coupled to input coil 41 of reed filter 14. When a tone of the frequency at which the reed of reed filter 14 is resonant is received, the signal flowing through coil 41 causes the reed to vibrate strongly. This vibration develops an output signal in coil 42 which is coupled to tone amplifier 16.

In normal operation, reed filter 14 develops an output signal only when a tone of the proper frequency is coupled thereto. However, mechanical shocks, such as may be caused by vibration or dropping of the unit containing filter 14 may cause the reed to vibrate. This vibration may develop an output signal in coil 42 sufficiently large to actuate trigger circuit 18.

When the first tone is received it is detected by reed filter 14 and coupled to base 47 of transistor 46 through capacitor 44. The tone signal is amplified and coupled from collector 48 of transistor 46 to base 53 of transistor 52 through capacitor 50.

Transistors 52 and 57 form a trigger circuit and are both normally cut off. When the amplified tone signal is

received at base 53 of transistor 52, transistor 52 begins to conduct and the potential on collector 54 goes negative. This negative transition is coupled through resistor 62 to base 58 causing transistor 57 to conduct, whereby the potential at collector 59 becomes more positive. This positive transition is coupled through resistor 63 to base 53 of transistor 52 increasing its forward bias and causing greater conduction. The positive potential at collector 59 of transistor 57 biases diode 65 in the forward direction thereby applying the potential on collector 59 of transistor 57 to collector 68 of transistor 67. Capacitor 72 acts as a filter keeping the potential at the anode of diode 65 relatively constant during the positive and negative going cycles of the first tone transmission.

Transistors 67 and 74 form a monostable multivibrator circuit with transistor 67 normally cut off and transistor 74 normally conducting. Prior to the conduction of diode 65 the potential at collector 68 of transistor 67 is established at a positive value by the resistor divider network consisting of resistors 79 and 80. This voltage is coupled through resistor 82 to base 85 of transistor 84. This positive potential applied to base 85 provides a forward bias for transistor 84 allowing it to conduct to saturation. The path of conduction for transistor 84 is from ground through resistors 88, 89, emitter 86, collector 87 of transistor 84, and through resistors 92 and 93 to terminal 99 which is coupled to the B+ supply. Thus, base 96 of transistor 95 is effectively clamped to approximately 0.1 volt through transistor 84 thereby cutting off transistor 95. With transistor 95 cut off, trigger 28 cannot operate which in turn keeps tone oscillator 30 deactivated. Since tone oscillator 30 is deactivated until the first and second tones arrive in the proper sequence, false operation of tone oscillator 30 is prevented.

When diode 65 conducts the voltage at the collector 59 of transistor 57 is coupled to the collector 68 of transistor 67 increasing the potential. As noted previously, transistor 74 is normally conducting and remains conducting throughout the increase in potential at collector 68 of transistor 67. A fixed forward bias is established at base 75 of transistor 74 through base 75, emitter 76 junction and resistor 78. Thus, as the potential at collector 68 of transistor 67 increases the potential across capacitor 73 increases.

Multivibrator 20 will remain in its first or stable state for the remainder of the first tone transmission and also the time period shown as decay time on curve 35 of FIG. 2. The decay time is the period required for the reed to stop vibrating after the first tone ceases. At the end of the decay period, trigger circuit 18 will return to its former condition, that is, both transistors 52 and 57 cut off. The potential on collector 59 of transistor 57 will return to zero and diode 65 will again be back biased. When this occurs, the potential on collector 68 of transistor 67 will drop, thus generating a negative going transition which is coupled through capacitor 73 to base 75 cutting off transistor 74. With transistor 74 cut off, the potential on collector 77 rises toward the B+ supply potential. This positive potential is coupled through resistor 100 to base 85 of transistor 84 sustaining the forward bias previously established through resistor 82. This will, as described previously, keep amplifier 26 cut off and trigger 28 and tone oscillator 30 deactivated.

The positive transition at collector 77 of transistor 74 is also coupled through resistor 104 to base 69 of transistor 67 driving transistor 67 into saturation. The potential on collector 68 of transistor 67 will then approach zero and capacitor 73 discharges through transistor 67 and resistor 78. When the potential at base 75 of transistor 74 rises to the point where transistor 74 is biased on, collector 77 will again return to zero potential and transistor 67 will be cut off. With transistor 67 cut off, the potential on collector 68 of transistor 67 rises to its normal cut off potential. However, due to the charging time of capacitor 73, this action is not accomplished instantaneously. There-

fore, with collector 77 of transistor 74 at zero potential and collector 68 of transistor 67 in transition from zero potential, a short period of time exists when there is no positive forward bias applied to transistor 84. During this time duration, transistor 84 will be cut off and transistor 95 is biased for normal operation.

If a second tone is received during this time duration it is detected by reed filter 24 and amplified by amplifier 26. The operation of amplifier circuit 26 and trigger 28 is essentially the same as described previously for amplifier 16 and trigger 18. However, as transistor 106 conducts its collector 107 goes positive applying a reverse bias to emitter 86 of transistor 84 sustaining its cut off condition thus permitting the second tone channel to continue functioning throughout the duration of the second tone transmission.

As collector 107 of transistor 106 goes positive, diode 110 is cut off removing a clamping voltage from base 112 of transistor 111. This permits tone oscillator 30 to oscillate. The tone generated by tone oscillator 30 is then coupled to audio amplifier 31 where it is amplified and coupled to speaker 32 to produce an alerting tone.

During the reception of the second tone, multivibrator circuit 20 will return to its first or stable state with transistor 67 cut off. Collector 68 of transistor 67 will become positive applying a positive potential to base 85 of clamping transistor 84 through resistor 82. However, the reverse bias condition on emitter 86 of transistor 84, established by the conduction of transistor 106, exceeds the positive base potential and transistor 84 is kept in its cut off state for the remainder of the second tone transmission. At the conclusion of the second tone transmission, transistor 84 will again conduct clamping base 96 of transistor 95 and thus deactivating trigger 28 and oscillator 30.

Thus, a tone decoder circuit has been described in which particular tones arriving in a predetermined sequence are required to operate a tone oscillator to produce an alerting signal. Vibrating reed electromechanical filters are used to distinguish between the tones. Provision is made to prevent the false operation of the decoding circuit in the event that the reed electromechanical filters are actuated because of mechanical shock to the unit.

We claim:

1. A tone decoder including in combination; first tone channel means including first frequency selective means for receiving and translating a first tone signal of predetermined frequency, said first tone channel means being responsive to said first tone signal to develop a control signal a predetermined time after the termination of said first tone signal, said control signal having a particular time duration, second tone channel means including second frequency selective means for receiving a second tone signal of predetermined frequency, alerting means coupled to said second tone channel means and adapted to be energized by said second tone signal, inhibiting means coupled between said first and second tone channel means and being normally operative to prevent said second tone signal from energizing said alerting means, said inhibiting means being responsive to said control signal to become disabled whereby said second tone signal received during said particular time duration energizes said alerting means.

2. The tone decoder according to claim 1 wherein, said first tone channel means includes timing means coupled to said first frequency selective means and to said inhibiting means, said timing means being responsive to said first tone signal to produce said control signal only during said particular time duration.

3. The decoder according to claim 1 wherein, said inhibiting means includes clamping means for establishing a portion of said second tone channel means at a first potential whereby said second tone signal is blocked from said alerting means, said clamping means being responsive to said control signal to establish said second tone

channel portion at a second potential during said particular time duration whereby said second tone signal is coupled to said alerting means.

4. The tone decoder according to claim 2 wherein said timing means includes switching means coupled to said inhibiting means, said switching means being normally in a first state and being responsive to said first tone signal to assume a second state, said switching means acting to return to said first state a predetermined time after the end of said first tone signal, said switch means further acting to generate said control signal for said particular time duration upon said return of said switching means to said first state.

5. The tone decoder according to claim 4 wherein said first and second frequency selective means includes first and second electromechanical filters respectively, said first electromechanical filter having first mechanical vibratory means resonant at the frequency of said first tone signals and responsive thereto to produce a first output tone signal exceeding a predetermined amplitude, said second electromechanical filter having second mechanical vibratory means resonant at the frequency of said second tone signals, and responsive thereto to produce a second output tone signal exceeding said predetermined amplitude, said timing means being responsive to said first output tone signal to develop said control signal, said alerting means being responsive to said second output tone signal to be energized, said mechanical vibratory means further being susceptible to mechanical shock to produce said first and second output tone signals, said second output tone signal acting to decay below said predetermined amplitude after said mechanical shock during a time interval less than said predetermined time, whereby said alerting means is not energized by said output tone signals produced by said mechanical shock.

6. A tone decoder including in combination, a first tone receiving channel having first frequency selective means for passing a first tone signal, second tone receiving channel having second frequency selective means for passing a second tone signal, first and second amplifier means coupled to said first and second frequency selective means respectively for amplifying said first and second tone signals, first and second trigger means coupled to said first and second amplifier means respectively and responsive to said first and second tone signals to produce first and second trigger signals, oscillator means coupled to said second trigger means and responsive to said second trigger signal to produce an alerting signal, timing means coupled to said first trigger means and responsive to said first trigger signal to produce a control signal a predetermined time after the termination of said first trigger signal, said control signal having a particular time duration, clamping means coupled to said timing means and said second amplifier means and normally acting to clamp said second amplifier means whereby said second tone signal is blocked from said second trigger means, said clamping means being responsive to said control signal to unclamp said second amplifier means whereby said second tone signal is coupled to said second trigger means.

7. The decoder according to claim 6 wherein, said timing means includes first and second transistors capacitively coupled to form a monostable multivibrator circuit, said monostable multivibrator circuit normally being in a stable state and developing a first potential, said multivibrator being responsive to the termination of said first trigger signal to assume an unstable state and to develop a second potential, said multivibrator returning to said stable state at the end of said predetermined time and acting to develop a third potential for said particular time duration upon said return to said stable state, circuit means coupling said multivibrator to said clamping means for applying said first, second and third potentials thereto, said clamping means being responsive to said first and second potentials to clamp said second amplifier means

7

whereby said second tone signal is blocked from said second trigger means, and said clamping means being responsive to said third potential to unclamp said second amplifier means whereby said second tone signal is coupled to said second trigger means.

8. A tone decoder including in combination; first tone channel means for translating a first tone signal of predetermined frequency, said first tone channel means including means responsive to the first tone signal to develop a control signal a predetermined time after the termination of said first tone signal, with said control signal having a particular time duration, second tone channel means for translating a second tone signal of predetermined frequency, alerting means coupled to said second tone channel means and adapted to be actuated by said second tone channel means in response to the second tone signal, inhibiting means coupled between said first and second tone channel means and being normally operative to prevent said second tone channel means from actuating said alerting means, said inhibiting means being responsive to said control signal to become disabled whereby said second tone signal received during said particular time duration causes actuation of said alerting means.

9. The tone decoder according to claim 8 wherein said first tone channel means includes timing means coupled to said inhibiting means and having switching means nor-

8

mally in a first state and responsive to the first tone signal to assume a second state, said switching means acting to return to said first state a predetermined time after the end of the first tone signal, said timing means acting to develop said control signal and apply the same to said inhibiting means upon said return of said switching means to said first state and for said particular time duration thereafter.

10. The tone decoder according to claim 8 wherein said inhibiting means includes clamping means for establishing a portion of said second tone channel means at a first potential to block the second tone signal, said clamping means being responsive to said control signal to establish said portion of said second tone channel means at a second potential during said particular time duration to translate the second tone signal to said alerting means.

References Cited

UNITED STATES PATENTS

3,387,212 6/1968 Kaufman ----- 340—311 X

JOHN W. CALDWELL, Primary Examiner

HAROLD I. PITTS, Assistant Examiner

U.S. Cl. X.R.

340—164, 167, 311, 312