

[54] **INTEGRATED CIRCUIT DECODER
RESPONSIVE TO TWO SEQUENTIAL
TONES, WITH GROUP CALL
PROVISIONS**

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[58] Field of Search**340/171, 171 A, 171 PF, 312; 325/64**

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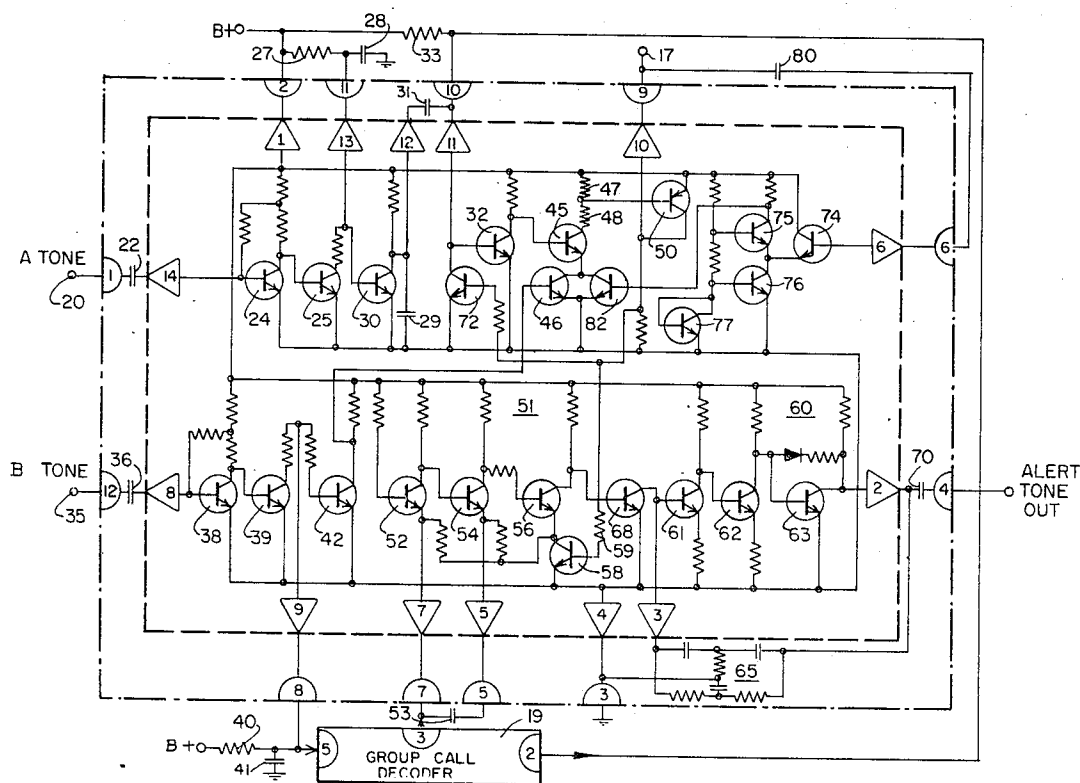
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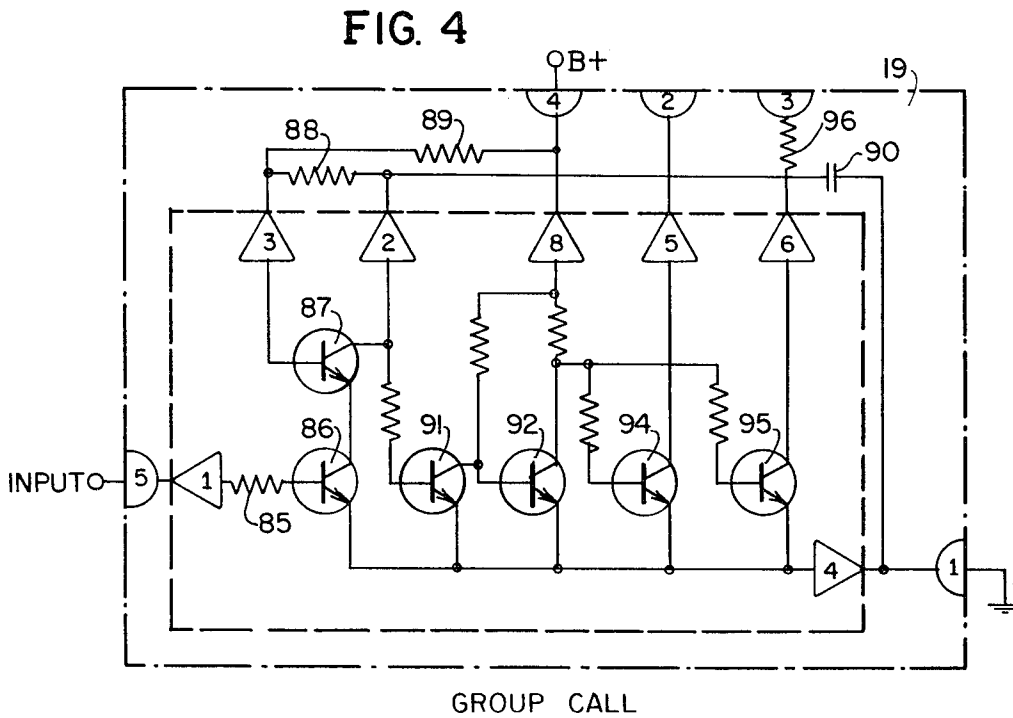
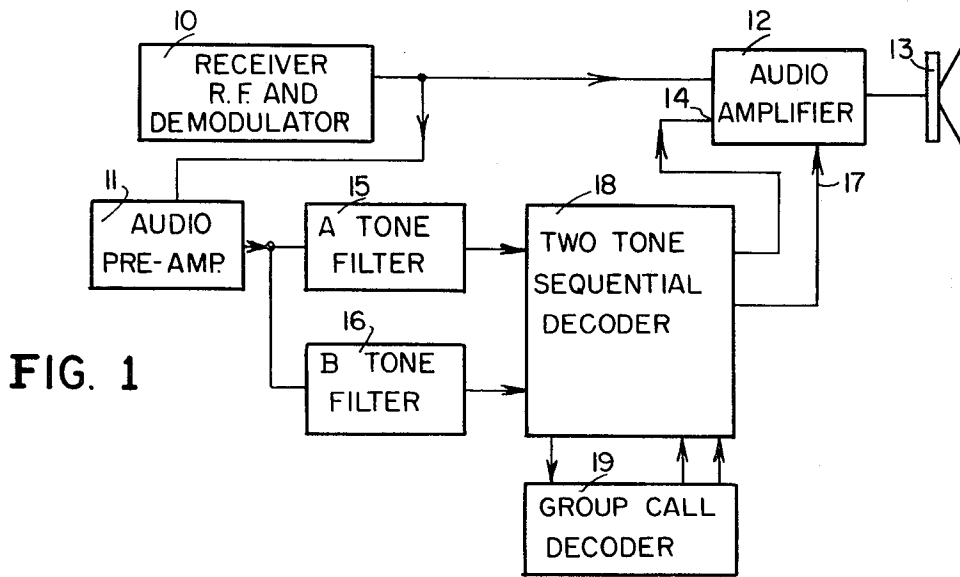
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[57] **ABSTRACT**

Decoder circuit for use with two tone sequential calling signal, which responds only to two tones of predetermined frequencies, amplitudes, durations and time spacing. The circuit is constructed in integrated circuit form with the components critical to the timing of the tones provided as external components to facilitate use of the decoder in different systems. The circuit includes a series AND gate which actuates an alert tone output in response to tones of the specified frequencies and time relationships. An auxiliary circuit provides group call operation in response to a single tone of long duration. The alert tone can be intermittent or continuous and of different time durations.

15 Claims, 4 Drawing Figures





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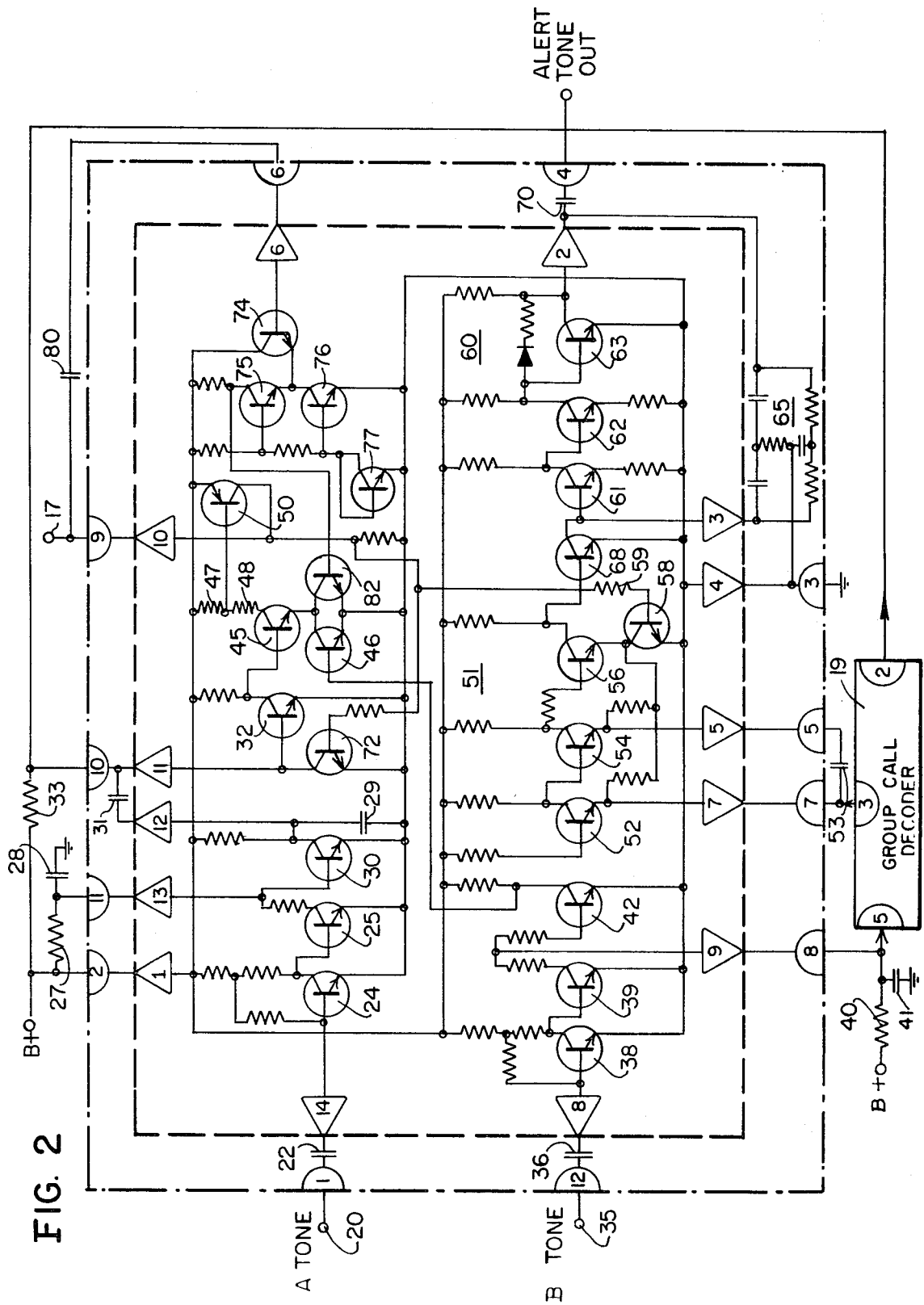
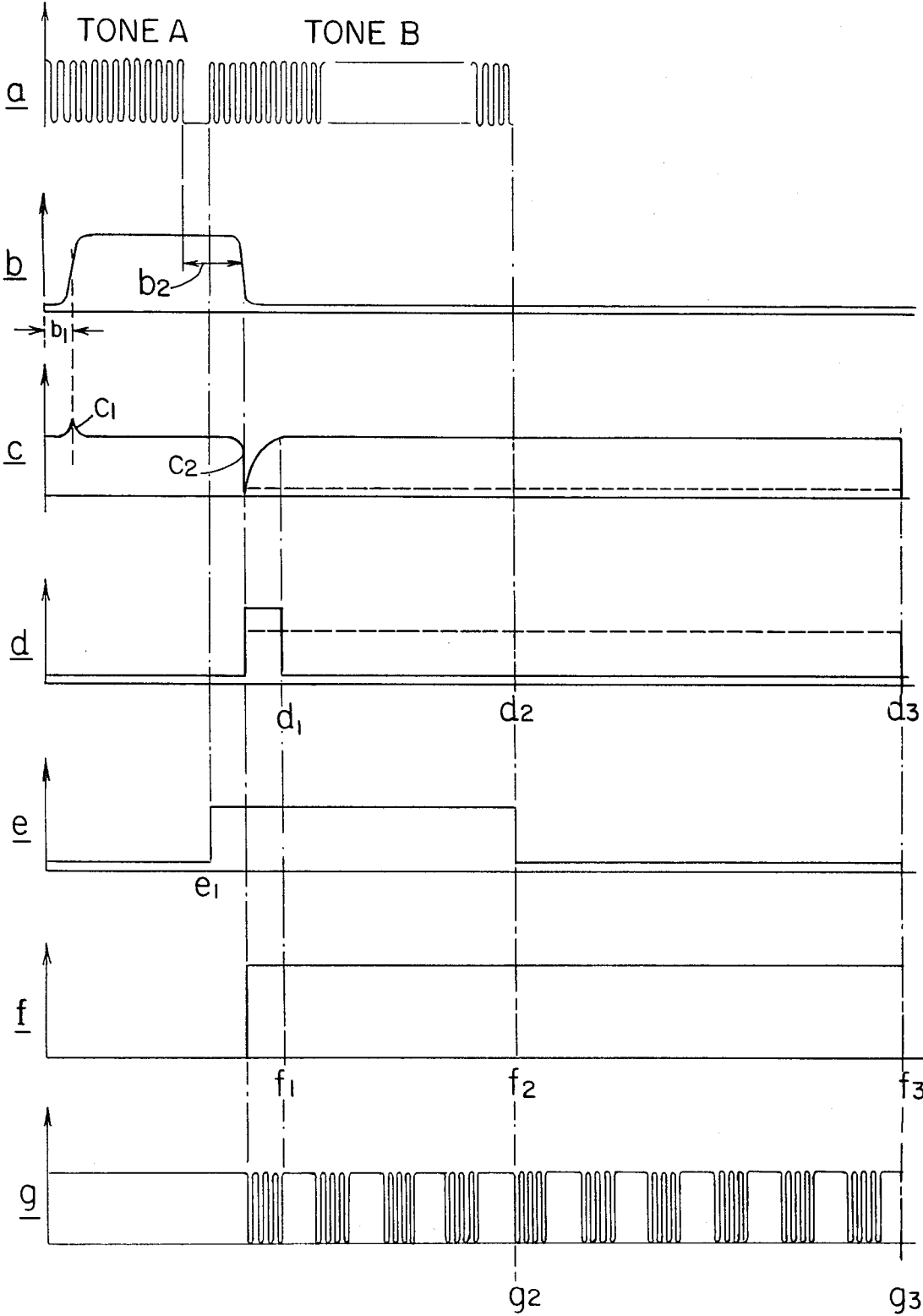


FIG. 3



INTEGRATED CIRCUIT DECODER RESPONSIVER TO TWO SEQUENTIAL TONES, WITH GROUP CALL PROVISIONS

BACKGROUND OF THE INVENTION

In various radio and paging systems, audio frequency tones have been used to operate selective decoder devices to enable particular receivers, or produce indications or alarms at particular receivers. Although a single tone can be used for selective operation in a simple system, to provide a larger number of calls a plurality of tones may be used in various combinations. To provide a relatively simple reliable system, two audio frequency tones in sequence can be used. However, such a system is subject to falsing as the two tones might appear in the transmission of voice or music and unintentionally operate the decoder. To reduce this possibility, the tones used can have particular time durations and spacing and the decoder can exclude tones having different time relationships. An example of such a system is described in U.S. Pat. No. 3,465,294, issued Sept. 2, 1969 to Richard D. Carsello and Richard E. Lundquist, and assigned to Motorola, Inc.

As the selective decoding devices may be used in small electronic equipment, such as portable radio receivers and pagers, it is necessary that these devices be provided in a small space, and require a minimum of electrical power for energization. To meet these requirements the decoder may be constructed in integrated circuit form. However, in order to obtain the advantage of low cost resulting from large volume production, it is desired that a construction be used which is suitable for use in many different applications.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved tone decoder circuit for responding to two tones in sequence, and which is not subject to false operation.

Another object of the invention is to provide a decoder circuit for use with two sequential tones, which operates in response only to tones having a particular time relation, and which is constructed in integrated circuit form with the timing components provided external to the integrated circuit.

Still another object of the invention is to provide a tone decoder circuit for a miniature radio receiver which operates from low battery voltage, and which operates satisfactorily over a range of battery voltages.

A further object of the invention is to provide a decoder circuit for operating in response to two sequential tones, and which is also responsive to a group call which may be a single tone of longer duration.

A still further object of the invention is to provide a decoder circuit responsive to an individual call signal and also to a group call signal, and which provides an interrupted alert tone in response to the individual call signal and a continuous alert tone in response to the group call signal.

In practicing the invention, a decoder circuit responsive to two sequential tones for indicating a call at a pager, or other radio receiver includes first and second tone filters for selecting two specific tone frequencies. The tone filters may be active filters which can be pro-

vided in integrated circuit form, or electromechanical frequency selective devices. The tones from the filters are applied to a decoder provided as a hybrid module including an integrated circuit on a base which provides circuit connections and additional circuit components. The decoder includes a threshold detector for each tone which applies a voltage to an integration circuit to shape the resulting control voltage. The control voltages are processed and applied to a series AND gate which is arranged to produce an output when the tones are received in the correct sequence, with sufficient amplitudes, and with a given spacing between the tones. Under such conditions, the series AND gate is actuated to apply a signal to the tone alerting system. The AND gate is latched so that it remains operative as long as the second tone is received. A monostable circuit may also be provided to hold the alert tone for a predetermined length of time after the second tone stops. The tone alerting system includes a tone oscillator and an astable circuit to pulse the oscillator so that an intermittent tone is produced.

The decoder circuit may include a group call decoder section which is coupled to the integration circuit of the second tone channel of the two tone decoder. This section provides an input to the AND gate in response to a second tone of sufficient time duration, in place of the input provided by the first tone, to cause the tone alerting system to operate. The group call section can interrupt the astable circuit of the tone alerting system so that a continuous tone is produced when the group call circuit operates. The group call decoder can be provided as a hybrid module separate from the two tone decoder module, or can be placed within the same module as the two tone decoder.

The two tone decoder is designed to operate from a low battery voltage, which can be in the range from 1.0 to 1.5 volts. The group call decoder is also operable from such a voltage.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating the decoder of the invention in a paging receiver or the like;

FIG. 2 is a circuit diagram of the decoder circuit provided as a hybrid module including an integrated circuit on a thick film base;

FIG. 3 is a set of curves illustrating the operation of the circuit of FIG. 2; and

FIG. 4 is a circuit diagram of a second hybrid module adapted to be coupled to the module of FIG. 2 for group call operation.

Referring now to FIG. 1, there is illustrated in block diagram form a paging receiver including the decoder system of the invention. Block 10 represents the receiver radio frequency and demodulator stages, which may be of known construction. The receiver may be a frequency modulation receiver of the superheterodyne type, with a local oscillator and mixer for reducing the frequency to an intermediate frequency. The demodulator derives the frequency modulation from the intermediate frequency wave. The demodulator output is applied to audio pre-amplifier 11 and to audio amplifier 12. For voice operation, the amplified audio signal is supplied from the audio output stage of amplifier 12 to the speaker 13.

Paging tones are transmitted on the radio wave, and are applied from the audio pre-amplifier 11 to the tone filters 15 and 16. These filters may be active filters provided in integrated circuit form, or electromechanical resonant devices, such as reed selectors. The tone frequencies selected by the filters 15 and 16 are applied to the two tone sequential decoder 18 which produces an audio alerting tone which is applied to input 14 of the audio output stage 12 for reproduction by the loud-speaker 13. The decoder 18 can also provide a direct current control voltage to the amplifier to provide squelch operation, as shown by the connection 17. A group call decoder 19 is coupled to the decoder 18 for causing the same to produce the alerting tone in response to a group call. The decoders 18 and 19 will be described in more detail in connection with FIGS. 2 and 4.

As previously stated, the two tone sequential decoder of the invention is illustrated as a hybrid module including an integrated circuit on a thick film base. The circuit is shown in FIG. 2, with the integrated circuit shown within the dashed lines, and the thick film shown within the dot-dash lines. The terminals of the integrated circuit are shown as triangles, and the terminals on the thick film are shown as half circles. Components which are external to the hybrid module are shown outside the dot-dash lines. The circuit is designed to operate from a battery which in various conditions of charge provides a voltage varying from 1.0 volt to 1.5 volts.

Considering now the circuit on FIG. 2, the A tone, passed by filter 15 of FIG. 1, is applied to input 20 which is connected to the module terminal No. 1. The tone is passed through capacitor 22 on the thick film to terminal No. 14 of the integrated circuit. The tone is amplified by the stage including transistor 24, which is normally conducting. With transistor 24 conducting, the voltage applied from its collector to the base of transistor 25 is below the turn on voltage of transistor 25, so that this transistor is normally in a state of low conduction. When the tone signal applied to the base of transistor 24 reaches a certain peak-to-peak amplitude, the conductivity of transistor 24 is periodically reduced to the extent that the voltage at its collector rises and is sufficient to periodically turn on transistor 25. The circuit arrangement of transistors 24 and 25 is such that a direct current bias change is applied to transistor 25 to compensate for the change in gain of transistor 24 due to a change in supply voltage. This provides threshold stability with reference to change in the low voltage direct current supply voltage.

The signal at the collector of transistor 25 is integrated by the circuit including resistor 27 and capacitor 28. These elements are provided outside the hybrid module so that they can be changed to provide the desired time constant depending upon the duration and spacing of the tones to be used in the system. Capacitor 28 is charged toward B+ through resistor 27 when transistor 25 is in a state of low conduction, and applies a voltage to the base of transistor 30 to hold the same conducting. Transistor 30 is turned off as capacitor 28 discharges through transistor 25, when it is rendered conducting in response to the tone. At the termination of the tone, capacitor 28 charges again through resistor 27 to provide a voltage to the base of transistor 30 to turn it on again.

The collector of transistor 30 is coupled to the base of transistor 32 by capacitor 31, which is provided on the thick film. Transistor 32 is normally held conducting by the potential applied from B+ through resistor 33 to the base thereof. When transistor 30 is rendered conducting after the termination of tone A, the transistor 30 grounds capacitor 31 so that heavy charging current is drawn through resistor 33. This increases the voltage drop across resistor 33 and drops the potential on the base of transistor 32 to turn off this transistor. The collector of transistor 32 therefore rises to a voltage approaching the B+ voltage. Transistor 32 is turned off in this way for only a short time, determined by the values of capacitor 31 and resistor 33.

Considering now the circuit for the B tone, this tone is applied from the B tone filter 16 (FIG. 1) to input terminal 35, which is connected to the terminal No. 12 of the thick film. The B tone is applied through capacitor 36 to the terminal No. 8 on the integrated circuit, which is connected to the tone amplifier including transistor 38. The circuit including transistors 38 and 39 form a threshold detector which may be identical to that for the A tone provided by transistors 24 and 25, and which has previously been described. The collector of transistor 39 is connected to an integrating circuit including resistor 40 and capacitor 41. This integrating circuit may have a much shorter time constant than that provided by resistor 27 and capacitor 28 for the A tone, as it is not necessary to delay the B tone, as will appear shortly. The voltage across capacitor 41 is applied to the base of transistor 42, which is normally conducting. The collector of transistor 42 is therefore normally at a low voltage above ground, the saturation voltage of transistor 42. When the tone is received and transistor 39 is rendered conducting, capacitor 41 discharges through transistor 39 to turn-off transistor 42. The collector voltage of transistor 42 therefore rises.

A series AND gate circuit is provided which is operated by the action of the A tone trigger circuit including transistors 25 and 30 and the B tone trigger circuit including transistors 39 and 42. The AND gate includes transistors 45 and 46 connected in series with each other and with resistors 47 and 48 between the B+ supply and ground. When transistor 32 is cut-off in response to the A tone, so that a voltage pulse is developed at its collector, transistor 45 will have a turn on bias applied to its base. Similarly, when transistor 42 is cut-off by the B tone, so that a voltage pulse is developed at its collector, transistor 46 will be turned on. This completes the circuit path to transistor 45 so that it will conduct. Accordingly, simultaneous trigger pulses produced in response to the A and B tones will render the series circuit including transistors 45 and 46 conducting so that current will flow through resistors 47 and 48. The resistor 48 is much smaller than resistor 47 so that the voltage applied to the base of transistor 50 drops to a value causing transistor 50 to conduct. Transistor 50 when conducting will apply the B+ potential to terminal 17, which may be connected to the audio amplifier 12 of FIG. 1, to turn on this amplifier. This potential also acts to turn on the alert tone, as will be described.

Referring now to FIG. 3, the operation of the trigger circuits and the AND gate are illustrated. Line a on FIG. 3 shows the tones which are used in the system to

provide the selecting operation. Tone A is of a first frequency and may have a duration of the order of one second. Tone B is of a second frequency and may have a time duration of the order of three seconds. A short interval, which can be of the order of 300 milliseconds, may be provided at the termination of tone A prior to the start of tone B, but such an interval is not essential to the operation of the decoder. Tones of a wide range of frequencies can be used in the system described. In some applications it is desirable to use frequencies in the range of 50-200 cycles, below the frequencies needed for voice reproduction. Higher frequencies extending above the audio frequency range can also be used.

Line b shows the voltage at the collector of transistor 30. As transistor 30 is normally conducting, the initial voltage will be only slightly above ground, by the saturation voltage of the transistor 30. Before tone A starts, capacitor 28 is charged. As the tone continues, conduction of transistor 25 discharges capacitor 28 until it reaches a value low enough to turn off transistor 30. The time required for the capacitor to discharge to this value is indicated on line b as b1. This time delay provides protection against a false indication resulting from noise or voice signals of short duration which may be present. When tone A terminates, transistor 25 will turn off allowing capacitor 28 to charge through resistor 27. When the capacitor charges to a certain value, transistor 30 will again turn on. The time required for the capacitor 28 to charge to a sufficient value to turn on transistor 30 is indicated in FIG. 3 by the time b2.

The operation of transistor 32 is illustrated by lines c and d in FIG. 3. As previously stated, transistor 32 is normally conducting because of the voltage applied to its base by resistor 33, which is shown by line e. When transistor 30 turns off, the charge on capacitor 31 will slightly increase the potential applied to the base of transistor 32, as shown by the pulse c1 in line c. When transistor 30 turns on again, a charging path is completed thereby for capacitor 31 through resistor 33. This will cause a larger voltage drop through resistor 33 to drop the voltage at the base of transistor 32, as shown by c2 in line c of FIG. 3. This will drop the voltage sufficiently to turn off transistor 32 so that its collector voltage increases, as shown by line d. Normally the collector voltage is at a low voltage above ground, being the saturation voltage of the transistor 32. When transistor 32 turns off, the voltage at its collector will rise sharply to the B+ voltage. This voltage drops at time d1, which is determined by resistor 33 and capacitor 31. The dotted lines shown in c and d indicate the condition when the B tone follows the A tone, as when a page is received.

Curve e of FIG. 3 shows the operation of the B tone trigger transistor 42. As has been described, this transistor is normally conducting so that its collector is near the saturation voltage, as shown. The time constant of the integrating circuit for the B tone is adjusted so that transistor 42 will turn off ahead of the pulse produced at the collector of the A tone transistor 32, which is shown in line d of FIG. 3. Cut off of transistor 42 causes its collector voltage to rise (e1) and this turns on transistor 46 of the series AND gate. When transistor 32 turns off to render transistor 45 conduct-

ing, the series circuit including transistors 45 and 46 will apply a voltage to the base of transistor 50 to turn it on. The conduction of transistor 50 is illustrated by line f in FIG. 3. This turns on the audio amplifier, as has been described.

Returning to the circuit of FIG. 2, an astable multivibrator circuit 51 is formed by transistors 52, 54 and 56. Transistor 58 selectively provides a conductive path to the three transistors 52, 54 and 56 to render the circuit operative. The base of transistor 58 is connected to the collector of transistor 50 through resistor 59. When transistor 50 turns on in response to the A and B tone trigger voltages, transistor 58 is rendered conducting to enable the transistors forming the astable multivibrator. The time period of the multivibrator 51 is controlled by capacitor 53, which is connected between the emitters of transistors 52 and 54. This connection is made through terminals 5 and 7 of the thick film, which are connected to terminals 5 and 7 of the integrated circuit. The capacitor 53 is provided as an external component so that the period of the multivibrator can be changed as desired.

The multivibrator 51 controls the alert tone oscillator 60 which is formed by transistors 61, 62 and 63 and the twin-T filter 65. As shown in the drawing, the transistors 61, 62 and 63 are provided by the integrated circuit, and the twin-T filter 65 is provided on the thick film. The astable multivibrator 51 controls the oscillator 60 through transistor 68, which functions as an inverter to turn the alert tone oscillator on and off. The alert tone is applied from the terminal No. 2 of the integrated circuit through capacitor 70 to terminal No. 4 of the thick film. The alert tone output may be coupled to the audio amplifier 12 of the receiver, as shown in FIG. 1, for amplification and reproduction by a speaker 13. The action of the alert tone oscillator is illustrated by line g in FIG. 3.

It is desired to hold the tone oscillator on for the period during which the second or B tone is received. To do this, it is necessary that both transistors 45 and 46 of the series gate be held conducting to hold transistor 50 conducting. Transistor 46 will be held conducting by the B tone trigger voltage from transistor 42. However, as shown in FIG. 3, the A tone trigger transistor 32 will be held cut-off for only a short period of time by the circuit responding to the A tone. To hold transistor 32 cut-off for the duration of the B tone, a latch circuit is provided which includes transistor 72. Transistor 72 is rendered conducting when transistor 50 conducts, and causes the voltage through resistor 33 to drop to a value to hold transistor 32 cut-off, so that transistor 45 will remain conducting. The alert tone will therefore be provided as long as the B tone is received. This is illustrated in FIG. 3 by the period from d1 to d2 in line d, and by the corresponding period in lines e, f and g.

In order to produce an indication that the pager is operating properly, the circuit is arranged to actuate the alert tone oscillator when the pager is turned on. Capacitor 29, which is connected across the emitter and collector electrodes of transistor 30, will start to charge when the B+ potential is applied. This acts to cut-off transistor 32 to provide the turn on bias for transistor 45 of the series AND gate. Transistor 46 will also be rendered conducting since the charging of

capacitor 41 holds transistor 42 cut-off so that current flows through the series circuit including resistors 47 and 48 to turn on transistor 50. This provides the B+ potential from the collector of transistor 50 to terminal 17 to turn on the audio amplifier, and will also turn on the alert tone oscillator, as previously described. Transistor 50 will remain conducting for only a short time, the duration being controlled by the time constant of resistor 40 and capacitor 41.

It may be desired to hold the alert tone oscillator operative for a period of time after the termination of the second or B tone. To provide such operation, a monostable multivibrator is provided on the integrated circuit chip. This includes transistors 74, 75, 76 and diode connected transistor 77. Capacitor 80 is connected from the collector of transistor 50 through integrated circuit terminal No. 10 and thick film terminal No. 9, and is connected to the base of transistor 74 through thick film terminal No. 6 and integrated circuit terminal No. 6. Capacitor 80 is initially discharged and when transistor 50 turns on, the voltage at the collector of transistor 50 is applied to the base of transistor 74. Transistors 74 and 75 share the current source provided by transistor 76. When the voltage applied to the base of transistor 74 exceeds the reference voltage at the base of transistor 75, the conduction will shift to transistor 74, cutting off transistor 75. Cut-off of transistor 75 will cause its collector voltage to rise and this voltage is connected to the base of transistor 82 to render the same conducting. Transistor 82 is connected in parallel with transistor 46 and cooperates with transistor 45 to form the series AND gate to hold the transistor 50 conducting. Inasmuch as transistor 45 is held conducting through the latch circuit including transistor 72, the gate circuit will remain conducting until transistor 82 is turned off. Capacitor 80 will charge as transistor 74 conducts, so that the voltage applied to the base of transistor 74 will fall below the voltage required to hold transistor 74 conducting to terminate the period of the alert tone oscillator. This additional period of alert tone is shown by the period from f_2 to f_3 in line f of FIG. 3, and by the corresponding period in line g . The audio amplifier will also be held operative during this period by the voltage at terminal No. 17. The use of transistor 76 in the emitter circuit of transistor 74 causes the impedance at the terminal No. 6 to be very high so that a long time interval can be easily obtained.

In FIG. 2, the connections of the group call decoder 19 to the two tone sequential decoder circuits are shown. The complete circuit diagram of the group call decoder is shown in FIG. 4, with the same terminal numbers being used. The group call decoder is also illustrated as constructed as a hybrid module with an integrated circuit provided on a thick film base.

Input terminal No. 5 of the group call module of FIG. 4 is connected to terminal No. 8 of the decoder module in FIG. 2. When the B tone is not received, a voltage is applied from terminal No. 5 to terminal No. 1 of the group call integrated circuit. This voltage is applied through resistor 85 to the base of transistor 86 in the group call circuit to hold this transistor conducting. This provides a conducting path for transistor 87, the collector of which is connected to B+ through resistors 88 and 89. Transistors 86 and 87 are connected in

shunt across capacitor 90, which is connected in series with resistors 88 and 89 between the B+ potential and ground. When the B tone signal is received, the voltage applied to the input of the group call decoder drops, and transistor 86 is cut-off. This opens the shunting path through transistors 86 and 87 across capacitor 90. Capacitor 90 previously held at a starting voltage determined by the collector voltage of transistor 87, starts to charge through resistors 88 and 89, and the voltage across capacitor 90 is applied between the base and emitter of transistor 91. When capacitor 90 charges to a sufficient voltage, it turns on transistor 91, and this causes the collector voltage of transistor 91 to drop. This collector voltage is applied to the base of transistor 92, and when the voltage drops it turns transistor 92 off. When transistor 92 turns off, its collector voltage rises, and this voltage is applied to the base electrodes of transistors 94 and 95 to turn on these two transistors.

The collector electrode of transistor 94 is connected through terminal No. 5 of the group call integrated circuit and terminal No. 2 of the group call module to terminal No. 10 of the two tone decoder module and through terminal No. 11 of the integrated circuit to the base of transistor 32. This grounds the base of transistor 32 to turn off this transistor so that its collector voltage rises to turn on transistor 45 of the series AND gate. Since the B tone is being received, transistor 46 of the AND gate will be on, and turn on of transistor 45 will operate the AND gate to render transistor 50 conducting. This will cause the astable to actuate the alert tone oscillator, as previously described.

The collector electrode of transistor 95 is connected through the group call integrated circuit terminal No. 6, resistor 96 and group call module terminal No. 3, and through terminals No. 7 of the two tone decoder to the emitter of transistor 52 of the astable multivibrator. This voltage interrupts the astable so that it will not pulse the alert tone oscillator, and the tone oscillator will produce a continuous alert tone. Accordingly, a group call is obtained by applying the B tone alone for a longer time interval than for a normal paging call, such as for five seconds, and the group call decoder will cause the series AND gate to operate to turn on the alert tone oscillator. As the oscillator operates continuously, a group call can be distinguished from an individual call.

The time constant of capacitor 90 and resistors 88 and 89 is such that the voltage across capacitor 90 is not sufficient to turn on transistor 91 until the tone has been applied for a time, such as five seconds, so that it will not be triggered by a normal page. This prevents operation of the group call circuit by the B tone alone in a normal individual page. The time duration of the B tone for a group call is made stable in the presence of supply voltage variations by offsetting changes in charging time due to variation in the supply voltage by changes in the initial voltage across capacitor 90. This eliminates the need for an excessively long group call tone transmission thus conserving on channel usage.

The decoder circuit which has been described has been found to be highly stable and provides the operations required for use in a miniature paging receiver. Since it is constructed as a hybrid module including an integrated circuit, the decoder, the alert tone oscillator,

and the controls therefore can all be provided by a very small unit. The two tone decoder can be used alone or with the group call decoder.

We claim:

1. In a tone decoder which responds to first and second tones of different frequencies which are received sequentially, and wherein the first and second tones are applied to first and second terminals respectively, the combination including:
 - a first circuit connected to the first terminal including threshold detector means for receiving the first tone, integration circuit means including capacitor means, and first trigger circuit means, said threshold detector means being coupled to said capacitor means and causing the same to change its state of charge following termination of the first tone so that the voltage thereacross reaches a predetermined value at a given time following the termination of the first tone, and said trigger circuit means being coupled to said capacitor means and producing a first voltage pulse in response to a voltage across said capacitor means of the predetermined value;
 - a second circuit connected to the second terminal including threshold detector means for receiving the second tone, and trigger means coupled to said detector means and producing a second voltage pulse in response to the second tone; and
 - AND gate means including a first portion coupled to said first circuit and a second portion coupled to said second circuit, said AND gate means producing an output voltage in response to simultaneous occurrence of said first and second voltage pulses.
2. The combination of claim 1 wherein said first and second circuits are adapted to operate from a supply voltage within the range from 1 volt to 1.5 volts.
3. The combination of claim 2 wherein said capacitor means causes said threshold detector to respond only to said first tone which continues for a specified time, and acts to delay said first pulse until after the termination of said first tone.
4. The combination of claim 1 wherein said first circuit, said second circuit and said AND gate means are formed as a hybrid module including an integration Circuit and a thick film base therefor, and wherein said integration circuit means is formed by discrete components external to said hybrid module.
5. The combination of claim 1 wherein said AND gate means includes said first and second transistors connected in series, and further including a control transistor coupled to said AND gate means and operating in response to conduction of said first and second transistors to provide said output voltage.
6. The combination of claim 5 further including latching circuit means coupled to said control transistor and to said first circuit means for causing said trigger circuit thereof to operate to continue said first voltage pulse during the period of operation of said control transistor.
7. The combination of claim 5 further including alert tone generator means, and means coupling said control transistor to said alert tone generator means for rendering the same operative.
8. The combination of claim 7 wherein said alert tone generator means includes a plurality of amplifier

stages each including a transistor and a feedback circuit including a twin-T filter, and wherein said transistors of said AND gate means, said control transistor, and said transistors of said tone generator means are provided on an integrated circuit which is supported on a thick film base, and said twin-T filter is formed by components on said thick film base.

9. The combination of claim 7 wherein said means coupling said control transistor to said alert tone oscillator is an astable multivibrator for providing intermittent operation of said alert tone oscillator.

10. The combination of claim 9 wherein said astable multivibrator has an element for controlling the timing thereof, and said first circuit, said second circuit, said AND gate means, said alert tone generator means, and said astable multivibrator are formed as a hybrid module including an integrated circuit on a thick film base, and said integrator means and said element for controlling the timing of said astable multivibrator are formed as discrete components external to said module.

11. The combination of claim 5 further including timer means coupled to said control transistor and operating for a predetermined time period after operation of said control transistor, and means coupling said timer means to said AND gate means for causing the same to produce said output voltage during said predetermined time period.

12. The combination of claim 1 further including an auxiliary circuit coupled to said second circuit for producing a third voltage pulse in response to the second tone upon continuance thereof for a given time period, and means coupling said auxiliary circuit to said first circuit to apply said third voltage pulse to said trigger means thereof to cause the same to produce said first voltage pulse, whereby said gate means operates to produce said output voltage in response to the second tone alone upon continuance thereof for said given time period.

13. The combination of claim 12 wherein said auxiliary circuit includes capacitor means, and means for changing the charge of said capacitor means rendered operative in response to the second tone, with the value of said capacitor means being related to said charging means so that the voltage on said capacitor means reaches a predetermined value upon continuation of the second tone for said given time period, and switch means coupled to said capacitor means and rendered operative in response to said capacitor means charging to a voltage of said predetermined voltage to produce said third voltage pulse.

14. The combination of claim 12 wherein said auxiliary circuit is provided as a hybrid module including an integrated circuit and a thick film base, and wherein said capacitor means is provided on said thick film base.

15. The combination of claim 12 further including alert tone generator means and astable multivibrator means coupling said control transistor to said alert tone generator means for causing intermittent operation thereof, and means coupling said auxiliary circuit to said astable multivibrator means to disable the same in response to operation of said auxiliary circuit, whereby said tone generator means produces a continuous tone.

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