Feb. 3, 1970 A. T. HUMAN 3,493,966

ELECTRONIC AUDIBLE ALARM DEVICES HAVING PLURAL OSCILLATORS

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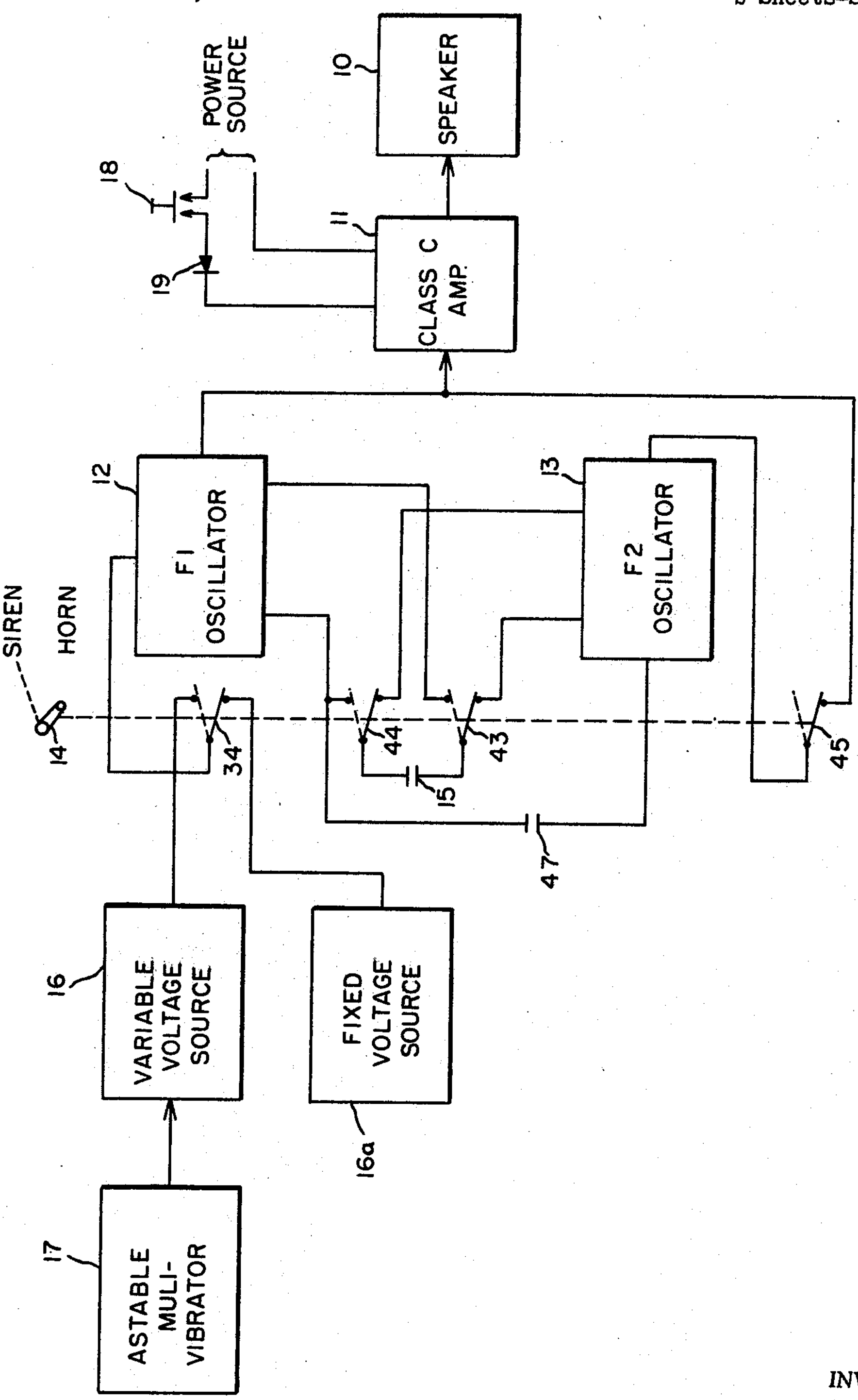

FIG. 1

INVENTOR.
A.T. HUMAN

BY

HIS ATTORNEY

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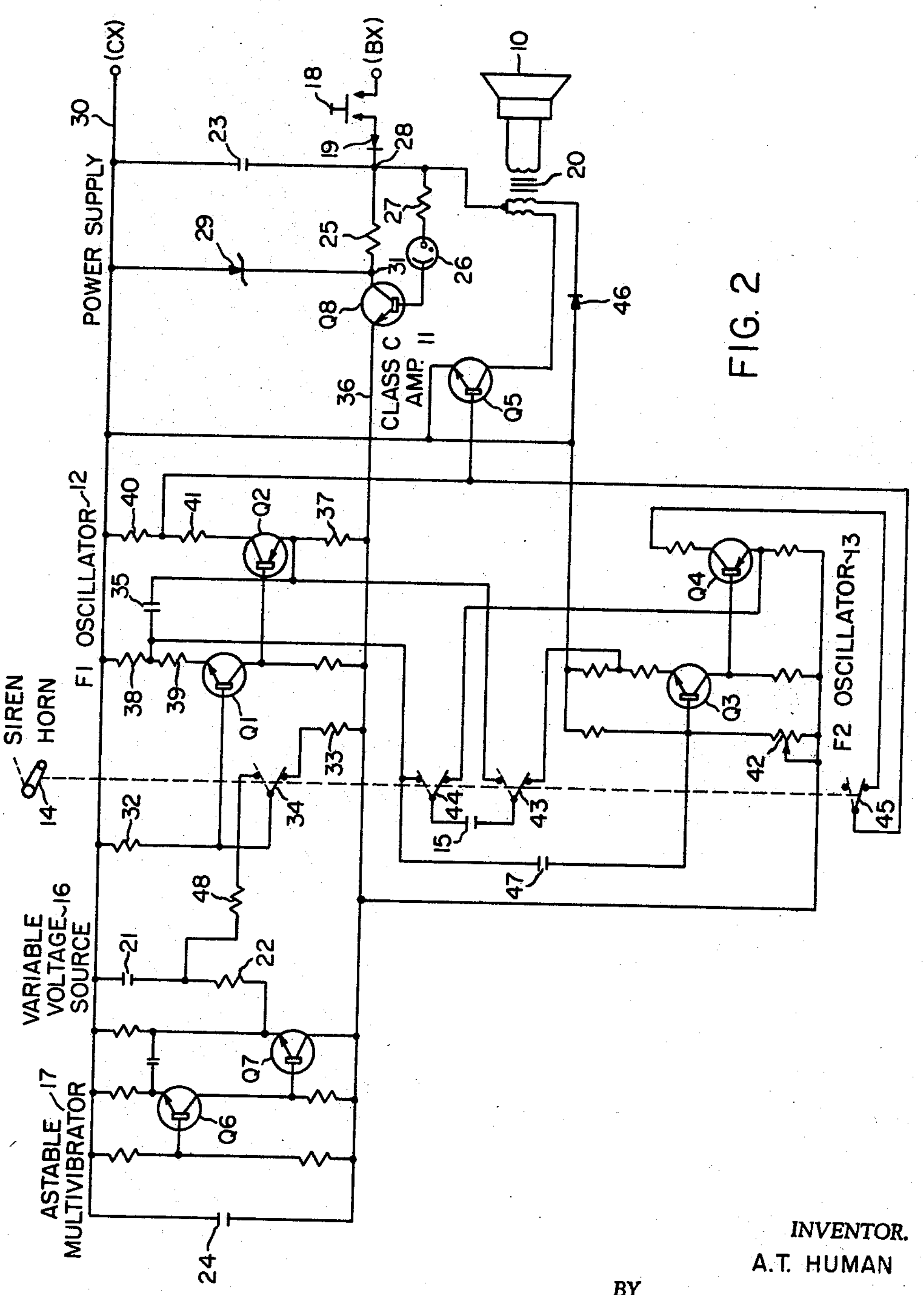

FIG. 2

INVENTOR.
A.T. HUMAN
BY
HIS ATTORNEY

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ELECTRONIC AUDIBLE ALARM DEVICES HAVING PLURAL OSCILLATORS

Arthur T. Human, Southport, Conn., assignor to Edwards Company, Inc., Norwalk, Conn., a corporation of Connecticut

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ABSTRACT OF THE DISCLOSURE

A speaker is operable as either a horn or a siren as selected by a two position switch. As a horn, two oscillators having different frequency outputs are connected in multiple and applied to a speaker through a Class C single transistor amplifier. The oscillators are locked by a connecting capacitor in a fixed relationship. As a siren, one oscillator is disabled, and the fundamental frequency of the other oscillator is reduced. The siren effect is obtained by a variable voltage source connected to the oscillator, the variable source being controlled to alternately rise and fall by an astable multivibrator.

BACKGROUND OF THE INVENTION

This invention relates to electronic audible alarm devices, and it more particularly pertains to electronic audible alarm devices that can be selectively operated as a horn or as a siren.

Electronic sirens commonly used in practice are generally less efficient than they should be because a near squarewave signal of practically constant power is applied to the loudspeaker at a varying repetition rate to give the siren effect. An electromechanical siren gives out very little acoustic power or loudness except at its higher speeds (and frequency).

SUMMARY

In the system according to the present invention, the application of a relatively constant pulse width signal of varying repetition rate to a loudspeaker reduces the average input power to the speaker used in a siren application, leading to longer speaker life, and gives better carrying power due to higher order harmonics at the lower repetition rates.

By keeping the duty cycle of the signal applied to the loudspeaker below 50% at even the highest frequency or repetition rate, greater harmonic energy and sound carrying ability is always obtained compared to the common squarewave approach. Squarewave or near squarewave signals applied to a loudspeaker sound more musical as they contain practically no even harmonic power.

The use of a single power output transistor in a saturated switching mode, commonly called Class C operation increases the total efficiency of the electronic audible device.

This invention provides a combination horn and siren wherein, when its operation as a horn is selected, a speaker is operaed by outputs of two oscillators in multiple which are operating at different frequencies. The oscillators are locked in fixed relationship to provide a steady output sound from the speaker. When the device is selected to operate as a siren, switching means changes the fundamental frequency of one of the oscillators, disables the other oscillator, and automatically varies the off time between pulses in an alternately increasing and decreasing manner to provide a siren sound output of the speaker.

An object of the present invention is to electronically control a loudspeaker selectively as a horn or a siren.

Another object of the present invention is to operate

the speaker as a horn in accordance with the outputs of two oscillators operating at different frequencies and being locked in fixed relationship.

Another object of the present invention, in switching from horn to siren operation of the speaker, is to disable one oscillator and reduce the fundamental frequency of the other oscillator.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference is made to the accompanying drawings wherein corresponding parts are identified by the same reference characters in the different figures, and wherein;

FIG. 1 is a block diagram of an electronic audible alarm device constructed according to one embodiment of the present invention; and,

FIG. 2 is a schematic diagram illustrating in detail the circuit organization of the embodiment of the present invention illustrated in FIG. 1.

With reference to FIG. 1, an electronic audible alarm according to one embodiment of the present invention comprises a loudspeaker **10** driven by the output of an amplifier **11** which is preferably adjusted for Class C operation. The amplifier **11** has its input governed in part by an oscillator **12** generating a frequency F1 and in part by an oscillator **13** generating a frequency F2.

A two position manually operable switch **14** is provided for selecting as to whether the electronic audible alarm device is operable as a horn or as a siren. When in its lower position, the switch **14** connects the output of both oscillators **12** and **13** to the input of the amplifier **11**. The oscilators **12** and **13** both generate different fundamental frequencies in a desired ratio, such as in approximately a five to three ratio, wherein the higher frequency can be about 1800 c.p.s. The combined "ON" time of both oscillators is kept below 50% duty cycle to insure high harmonic content of the output. The speaker **10** is therefore driven by the combined outputs of the two oscillators when the switch **14** is in its lower position. If the switch **14** is operated to its upper position, only the output of F1 oscillator **12** is applied to the speaker, and the fundamental frequency of oscillator F1 is lowered by connecting capacitor **15** in multiple with a capacitor in the F1 oscillator **12**.

When operating as a siren, the frequency of F1 oscillator **14** rises and falls in accordance with a variable voltage source **16** to cause speaker **10** to have a siren type sound output. An astable multivibrator **17** is provided for controlling the variable voltage source **16** to cause it to increase and decrease alternately at a predetermined rate. The operation of the speaker **10** is rendered effective by the closing of a power control switch **18**. Assuming the device is to be operated from an alternating current power supply, a diode **19** is connected in series with the power supply to provide for half wave rectification. Filter capacitor **23** is deliberately chosen to be small so that ripple voltage imparts additional modulation and stridency of tone in the output signal.

With reference to FIG. 2, a speaker **10** is operated through a speaker transformer **20**. Input to the transformer **20** is from the output of transistor Q5, which is preferably operated as a Class C amplifier. The transistor Q5 has as its input the combined outputs of the F1 and F2 oscillators **12** and **13** respectively, when the device is operated as a horn. F1 oscillator **12** comprises a NPN transistor Q1 and a PNP transistor Q2. Similarly, F2 oscillator **13** comprises a NPN transistor Q3 and a PNP transistor Q4. The variable voltage source **16** comprises a capacitor **21** that is alternately charged and discharged through a resistor **22** as governed by the astable multivibrator **17** having transistors Q6 and Q7.

Capacitors **23** and **24** are provided as power filter capacitors, and a lower voltage power supply for operation of the transistors is provided by a Zener diode **29** and a series resistor **25**. The transistor Q8 has its base connected through a gas tube **26** and a resistor **27** to a point **28** to which energy of a positive polarity is supplied through diode **19**. The Zener diode **29** is connected between a negative power wire **30** and a point **31** between resistor **25** and the collector of transistor Q8. Transistor Q8 acts as a switch to abruptly start and stop the tone oscillators. Transistor Q8 keeps the oscillators off until the supply voltage is above the firing voltage of gas tube **26**. When switch **18** is opened, capacitor **23** discharges and gas tube **26** stops conducting, turning off transistor Q8 and the oscillators before Zener diode **29** allows the supply voltage for the tone oscillators to become unregulated. This is an effective way of preventing transient tones from reaching the loudspeaker at the times of connecting and disconnecting power to the unit.

The following circuit values, for example, may be used for the circuit shown in FIG. 2, but these values are not to be considered to in any way limit the scope of the invention.

Capacitors:		
15	microfarads	.68
21	do	22
23	do	50
24	do	15
35	do	.68
47	picofarads	5
Resistors:		
22	ohms	10K
32	do	22K
33	do	47K
37, 38, 40	do	470
39	do	1K
41	do	120
48	do	15K

Having thus described the general organization of the electronic alarm device, consideration will now be given more specifically to the circuit organization upon consideration of the modes of operation of the device.

When the device is operating in a horn mode, the switch **14** is in its lower position, and when in this position, the base of transistor Q1 has a fixed voltage level determined by its connection to a point between voltage divider resistors **32** and **33**. It will be noted that connection to resistor **33** is through contact **34** of switch **14** in its lower position. Before the horn button **18** is depressed, the entire system is deenergized. Upon depression of button **18**, capacitor **35** of oscillator **13** becomes an effective short circuit across the DC low voltage power wires **36** and **30**. The charging circuit for capacitor **35** extends from (+) at wire **36** through resistor **37**, capacitor **35** and resistor **38** to (−) at wire **30**.

When the capacitor **35** becomes charged to a predetermined level, it makes the emitter of transistor **1** sufficiently negative to cause transistor Q1 to turn on, and in turn, to turn on transistor Q2, the base of which is connected to the collector of transistor Q1. The turning on of transistor Q2 causes the application of a negative pulse through capacitor **35** to the emitter of transistor Q1 to drive transistor Q1 into saturation. A discharge circuit is now closed for the capacitor **35** through the emitter-base circuit of transistor Q2, the collector-emitter circuit of transistor Q1 and resistor **39**. This discharge circuit through resistor **39** maintains transistor Q1 substantially saturated for a time interval determined by the time constant of the discharge circuit. When the capacitor **35** is substantially discharged, the output of transistor Q1 decreases, and in accordance therewith, the transistor Q2 is turned off. This terminates the output pulse which has

been applied to the base of transistor Q5 from a point between resistors **40** and **41** in a voltage divider circuit including the emitter-collector circuit through transistor Q2. With the capacitor **35** substantially discharged, the transistor Q1 turns off to complete a cycle of operation of the F1 oscillator **12**.

This cycle has generated an output pulse that has been initiated by the turning on of transistor Q2 and has been terminated by the turning off of transistor Q2. The time space between pulses is governed by the charging time of capacitor **35** before the transistor Q1 becomes turned on. The respective charge and discharge times for the capacitor **35**, which corresponds to the respective on and off times of the oscillator output, are preferably so adjusted that the charging time is much greater than the discharging time for capacitor **35**, and thus relatively short output pulses are generated which are spaced by relatively long time intervals. The time intervals are adjustable over a wide range by adjusting the level of the base of transistor Q1, while the duration of the pulse can be maintained substantially constant over a wide range of frequencies. Thus a wide range of frequencies can be selected by adjustment of the potential applied to the base of transistor Q1, such adjustment varying the time space between pulses while maintaining the duration of the pulses substantially constant.

When the device is operated in a horn mode, the oscillator **13** is operable at the same time as the oscillator **12** to apply its output pulses to the base of transistor Q5 the same as has been described in detail relative to the oscillator **12**. If the oscillator **12** is operated in a horn mode at 1800 c.p.s., for example, the oscillator **13** can be adjusted by a variable resistor **42** to operate at a frequency of about 1100 c.p.s., thus maintaining a ratio of about 5 to 3 for the frequencies generated by oscillators **12** and **13**. In the oscillator **13**, the capacitor **15** is comparable to the capacitor **35** of oscillator **12** and it is connected to oscillator **13** through contacts **43** and **44** of switch **14** in its lower position. The output of oscillator **13** is applied to the base of transistor Q5 through a contact **45** of switch **14** in its lower position, so that the output of oscillator **13** can be disconnected from the base of transistor Q5 when the device is operated as a siren.

The speaker output transformer **20** has a bifilar wound primary for close coupling between transistor Q5 and diode **46**. When base drive to output transistor Q5 is suddenly removed, the collector voltage would tend to instantaneously rise to a very high voltage limited only by circuit losses and loudspeaker loading. The bifilar winding and diode **46** prevent this. When the voltage at the collector of Q5 reaches twice the voltage across capacitor **23**, the voltage at the diode end of the transformer is zero. The voltage at the collector cannot exceed twice the supply voltage as the diode **46** then conducts and clamps the collector voltage to this value.

This technique serves three useful purposes. First, the transistor is protected against voltages higher than twice the supply voltage. Second, this clamping action makes the output waveform more nearly rectangular, thus imparting a more complex tone characteristic. Third, the clamping action returns a portion of the stored magnetic energy in the transformer to capacitor **23** and reduces the overall power drain.

Because of operating the oscillators **12** and **13** at different frequencies, when the system is in a horn mode, the sound output of the speaker **10** will vary from time to time depending upon the relative phase relationship of the oscillators **12** and **13** unless some means is provided for locking the oscillators **12** and **13** into a predetermined relationship. Obviously the oscillators **12** and **13** cannot be synchronized because they are purposely operated at different frequencies, but they are locked into a predetermined phase relationship by a small capacity coupling capacitor **47**, which is connected between the base of transistor Q3 of oscillator **13** and a point between resistors 38 and 39 in the collector-emitter circuit of transistor Q1.

By this arrangement, the oscillator 12 is the controlling oscillator, and it applies a relatively weak negative pulse through capacitor 47 to the base of transistor Q3 each time the oscillator 12 turns off. This pulse is not strong enough to turn the transistor Q3 of oscillator 13 on unless a point in the cycle of operation of oscillator 13 is reached where the capacitor 15 is partially charged and its charge would be able shortly to turn on Q3. Thus the coupling between oscillators 12 and 13 does not change the frequency of oscillator 13 substantially, but rather the oscillator 13 is intermittently turned on in response to the turning off of oscillator 12 so that the oscillator 13 maintains a fixed phase relationship relative to oscillator 12. This provides for a uniform sound output of the speaker 10.

If it is desired to operate the device in a siren mode, the switch 14 is first operated to its upper position before closing the switch 18. Such operation disconnects the output of oscillator 13 from the transistor Q5. Also, by movement of switching contacts 43 and 44, the capacitor 15 is disconnected from the oscillator 13, and is connected in multiple with the capacitor 35 of oscillator 12 so that the fundamental frequency of oscillator 12 is reduced to provide the desired fundamental frequency for siren operation. The operation of the switch 14 also disconnects the base of transistor Q1 from the resistor 33 and connects it through a resistor 48 to capacitor 21 so that the potential applied to the base of transistor Q1 can be varied as the potential changes across the capacitor 21. The capacitor 21 is alternately charged and discharged by an obvious switching circuit including the astable multivibrator 17.

The variation of the potential applied to the base of transistor Q1 in oscillator 12 causes the frequency of the oscillator 12 to vary because of variation in the potential across the capacitor 35 that is required to cause transistor Q1 to be turned on. In other words, the variation of the potential applied to the base of transistor Q1 causes the time during which the capacitor 35 charges to be varied, and this in turn varies the frequency output of the oscillator 12, that is applied through the amplifier Q5 to the speaker 10. It is therefore provided that when the device is operated as a siren, a substantially true siren effect is generated in the speaker 10 because of receiving relatively short pulses from the oscillator 12 separated by progressively varied time spaces in accordance with the variable voltage source 16 applied to the base of transistor Q1 in the oscillator 12.

Although the electronic audible alarm device of this invention has been shown in its preferred embodiment as a combined horn and siren, it is obvious that the general principles embodied in this invention may be equally applicable in improved systems for the operation of horns and sirens respectively, in accordance with the requirements of practice.

What is claimed is:

1. An electronic audible alarm device having a speaker and a two position switch for selecting the operation of the speaker as a horn or a siren comprising,
(a) a plurality of oscillators operable to generate different output frequency signals respectively,
(b) means for applying the output signals of the oscillators in multiple to the speaker when the switch is in one position for operating the speaker as a horn,
(c) a varying source of energy,
(d) means governed by operation of the switch to its other position to permit the speaker to be energized by output signals of only one of the oscillators, and
(e) means controlled by the varying voltage source for varying the output signal frequency of said one oscillator when the switch is in said other position to operate the speaker as a siren.

2. An electronic alarm audible device according to claim 1 wherein means is provided for shifting the fundamental frequency of said one oscillator to a lower frequency in response to operation of the switch from said one position to said other position.

3. The invention according to claim 1 wherein means is provided for locking the oscillators in fixed operational relationship.

4. The invention according to claim 1 wherein a capacitor is used in determining the frequency of the output signal generated by one or another of the oscillators in accordance with whether the switch is in said one position or said another position.

5. The invention according to claim 1 wherein the varying source of energy comprises a capacitor and a resistor connected in series and electronic switching means for alternately causing the charging and discharging of the capacitor at a predetermined rate.

6. The invention according to claim 1 wherein the combined horn and siren comprises a Class C amplifier having its input connected to the output of the oscillators and having its output connected to the speaker whereby the speaker is operated by time spaced pulses that are all of the same polarity.

7. The invention according to claim 1 wherein each of the oscillators generates time spaced output pulses and the duration of the time space between pulses is substantially greater than the duration of the pulses.

8. The invention according to claim 7 wherein each of the oscillators comprises a PNP transistor and a NPN transistor and timing circuit means comprising a capacitor and a resistor wherein time of discharging the capacitor determines the duration of each output pulse of the oscillator and time of charging the capacitor determines the duration of the time space between pulses of each oscillator.

9. The invention according to claim 8 wherein the charging time of the capacitor for each oscillator is constant when the switch is in said one position and is varied for said one oscillator by the varying source of energy when the switch is in said another position.

10. An electronic audible alarm device comprising,
(a) a loudspeaker for generating an audible signal,
(b) a plurality of oscillators operable simultaneously to generate different frequency output signals respectively,
(c) coupling means including a capacitor for locking the oscillators in fixed operational relationship,
(d) speaker energizing means for applying the output signals of the oscillators in multiple to the speaker.

11. The invention according to claim 10 wherein the speaker energizing means comprises a single transistor Class C amplifier having its input governed by the output signals of the oscillators in multiple and having its output applied to the speaker.

12. The invention according to claim 10 wherein each of the oscillators comprises a PNP transistor and a NPN transistor and means for turning both of these transistors on at substantially the same time to generate an output pulse, and bias control means comprising a capacitor wherein charging time of the capacitor determines a time interval between output pulses and discharging time of the capacitor determines the duration of an output pulse.

13. The invention according to claim 12 wherein the capacitor is connected between the emitter of one transistor and the emitter of the other transistor through a resistor.

14. An electronic siren comprising,
(a) loudspeaker for generating an audible signal,
(b) an oscillator comprising,
(i) means including a pair of transistors, one of which is of the PNP type and the other of which is of the NPN type for turning both these transistors on at substantially the same time to generate a signal output pulse,
(ii) biasing control means for the transistors comprising a capacitor connected through a resistor

between one element of one transistor and another element of the other transistor for turning the transistors on when the capacitor becomes charged to a particular value and for turning the transistors off when the capacitor becomes discharged to another particular value,

(c) variable voltage biasing means for governing the charging time of the capacitor,

(d) means for applying the output signals of the oscillator to the speaker, and

(e) means including an astable multivibrator for alternately varying the voltage of the variable voltage biasing means.

15. The invention according to claim **14** wherein the speaker energizing means comprising a signal Class C amplifier having its input governed by the output signal

of the oscillator and having its output applied to the speaker.

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HAROLD I. PITTS, Primary Examiner

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