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ELECTRONIC SIRENS

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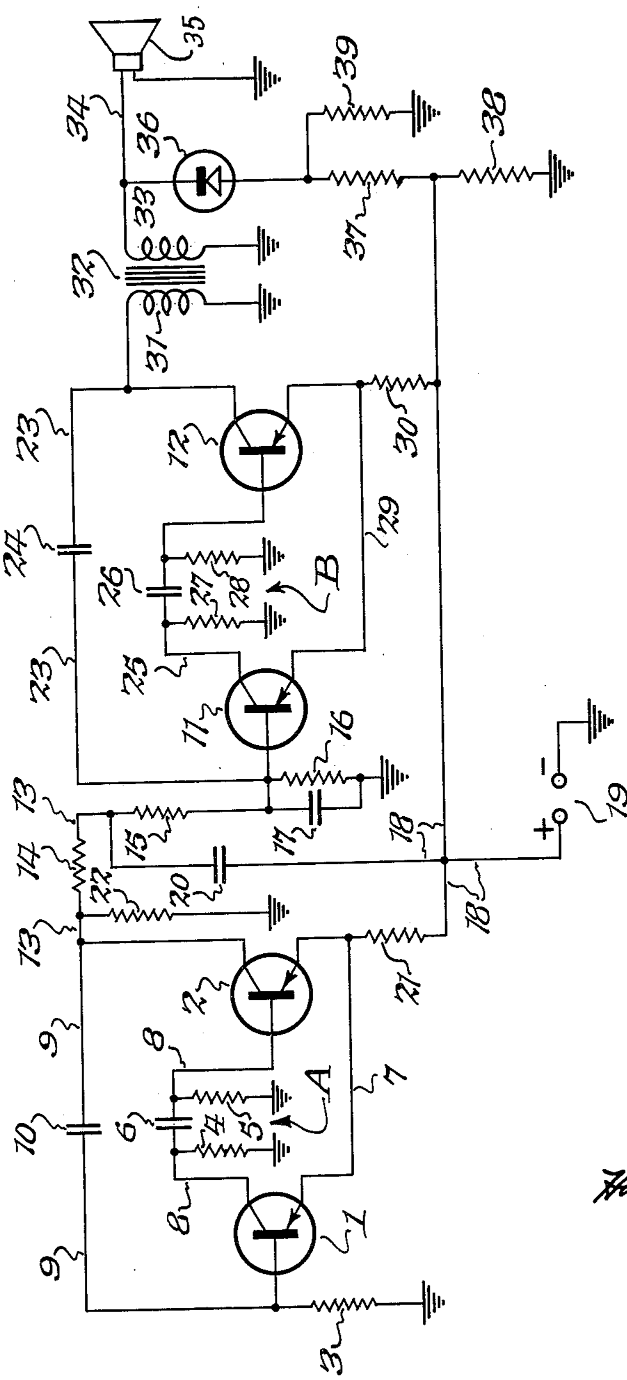

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ELECTRONIC SIRENS

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This invention relates to warning systems such as are used to create siren-like or wailing sounds for public warning, and particularly to warning systems used by civil defense, law enforcement and fire departments, especially on vehicles used by such departments. Such systems are desired to simulate somewhat the sounds produced by mechanically operating sirens.

Mechanical types of sirens create audible siren sounds by mechanism employing a heavy flywheel that is rotated at varying speeds by a motor. Such flywheels usually have vanes or serrations which trap air and produce a fairly steady sound which is audible. The siren effect of tones of varying pitch is produced by alternately energizing and deenergizing the driving motor. The primary fault or shortcoming of such mechanical sirens is that they depend on moving parts to function. Another difficulty arising from such mechanical sirens is that they employ an otherwise balanced flywheel which is rotated at a relatively high speed and creates a gyroscopic or inertia effect in that when mounted on a moving vehicle, inertia of the siren with its heavy flywheel tends to carry it forward in a straight line as such vehicle changes direction. This makes necessary a heavy mounting structure for it. Moving parts, particularly parts moving at high speeds, require precision bearings for them, particularly for the flywheel, and also frequent lubrication and maintenance. The driving motor, usually an electric motor, must have a high starting torque, and such motors require high starting currents that are a severe strain on operating batteries.

An attempt to replace mechanical sirens with an entirely electronic system employed a tone generator with neon or other gaseous tubes in the form of a relaxation oscillator. While this avoided the objections to mechanical sirens, it created problems unique in itself, such as the comparatively high voltage necessary to operate a relaxation oscillator, and in some instances the use of memory circuits for energizing and deenergizing the siren oscillator. High voltages reduce the overall efficiency of the system.

An object of this invention is to provide an electronic siren which is free of the objections to prior sirens, which can produce audible siren or wailing sounds rich in harmonic structure that enables them to be heard very clearly, which may be used with conventional audio power amplifiers or as a unit that triggers or by bias controls the frequency of a basic oscillator that is capable of driving directly a loudspeaker or other transducer, which requires little or no servicing or maintenance for long periods of time, which employs a minimum of operating current, and which is relatively simple, practical, compact, efficient, durable, trouble-free, and inexpensive.

Other objects and advantages will appear from the following description of one embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

The accompanying drawing illustrates a simple siren system employing transistors in place of electronic tubes and constructed in accordance with this invention to illustrate one embodiment thereof.

In the illustrated embodiment of the invention, a pair of semi-conducting transistors **1** and **2** are connected together to form a low frequency, astable or free-running, control multivibrator A. This vibrator includes resistors **3**, **4** and **5** and a capacitor **6**. The resistor **3** connects

the base of the transistor **1** to ground. The emitters of the transistors **1** and **2** are connected together by a wire **7**. The collector of the transistor **1** is connected by a wire **8** to the base of the transistor **2**, but has the capacitor **6** in series therein. The sides of capacitor **6** are connected through separate resistors **4** and **5** to ground, one resistor such as **4** being connected to one side of the capacitor **6** and the other resistor such as **5** being connected to the other side of the capacitor **6**. The base of transistor **1** is connected by wire **9** to the collector of the transistor **2** and has a capacitor **10** in series therein.

Another pair of transistors **11** and **12** are connected together to form another astable or free-running, basic multivibrator B. The collector of transistor **2** is connected by wire **13** and part of wire **9** through resistors **14** and **15** in series to the base of transistor **11**. The base of transistor **11** is connected to ground in parallel through a resistor **16** and a capacitor **17**. The wire **13** in the portion between the resistors **14** and **15** is connected by wire **18** to a source **19** of positive D.C. potential and has a capacitor **20** in series therein. Wire **18** is also connected by a branch wire having a resistor **21** in series therein to wire **7** of vibrator A. Wire **13**, at a point between the collector of transistor **2** and the resistor **14**, is connected through a resistor **22** to ground. The base of transistor **11** is connected by wire **23**, with a capacitor **24** in series therein, to the collector of transistor **12**. The collector of transistor **11** is connected by wire **25**, with capacitor **26** in series therein, to the base of transistor **12**. One side of capacitor **26** is connected to ground through a resistor **27**, and the other side of capacitor **26** is connected to ground through a resistor **28**. A wire **29** connects the emitters of transistors **11** and **12**, and this wire is connected through a resistor **30** to a branch of wire **18** and source **19** of positive D.C. potential.

The primary winding **31** of a transformer **32** is connected at one end to ground and at its other side through wire **23** to the collector of transistor **12**. The secondary winding **33** of transformer **32** at one end is connected by a wire **34** to one terminal of a transducer or loudspeaker **35** and at its other end is connected to ground. Wire **34** is also connected to the output terminal of a diode **36**, and the other terminal of diode **36** is connected through a resistor **37** to wire **18** and source **19** directly. A resistor **38** connects wire **18** and source **19** to ground. The positive terminal of diode **36** is also connected through a resistor **39** to ground. The other terminal of transducer or loudspeaker **35** is also connected to ground. The negative terminal of the source **19** of D.C. potential is connected to ground. By the term ground I mean any common conductor or reference potential, which could, for example, be the vehicle frame or the housing of the apparatus or a voltage reference level.

The circuit including resistors **3**, **4**, **5**, **14**, **22**, and **21**, the transistors **1** and **2**, and capacitors **6** and **10** represent one example of a very low frequency, astable or free-running multivibrator. The transistors **1** and **2** are coupled together by capacitor **6** in a conventional manner employing resistance-capacitance coupling.

Each transistor **1** and **2** is used as an amplifier wherein resistor **3** provides the bias for the base of transistor **1**. The resistor **4** provides the collector load for transistor **1**. Capacitor **6** provides an A.C. coupling between the collector of transistor **1** and the base of transistor **2**. Resistor **5** provides bias for the base of tarnsistor **2**. Resistor **22** provides the collector load for the transistor **2**. Resistor **21** provides the transistors **1** and **2** with a degree of negative feed-back to stabilize the overall circuit. Capacitor **10** provides the circuit with positive feedback and ultimately causes the circuit to oscillate. The value of capacitor **10** and the value of resistor **3** determine the operating frequency of oscillation of vibrator A.

The value of resistor **3** is selected to provide suitable bias for transistor **1**, and the value of capacitor **10** is selected after selection of resistor **3** value so that the time constant formed will provide the desired low frequency of operation of vibrator A. Resistor **22** has an effect on this frequency as do all the values of all other components in this low frequency oscillator. An analytical study of the parameters involved will provide the correct and desired frequency and proper voltage output of oscillator A.

The circuit including transistors **11** and **12**, resistors **15, 16, 27, 28** and **30**, capacitors **17, 24** and **26**, and primary winding **31** is the actual siren oscillator B because it generates the basic tones of the siren, and is in effect another astable or free-running multivibrator wherein, as in the oscillator A, two amplifier stages that are resistance-capacity coupled are provided with a suitable positive feedback to cause it to oscillate. The main differences between the two oscillators A and B are that the siren or basic oscillator B operates on a frequency similar to the frequency of conventional sirens, and its frequency is controlled by the time constant circuit or bias formed by capacitor **24** and resistor **16** and also by the application of the output voltage to the existing change across capacitor **20**.

In the operation of this embodiment of the electronic siren, transistor **11** is biased for operation by resistor **16**. Resistor **27** provides the collector load for transistor **11**. Capacitor **26** provides an A.C. coupling to transistor **12**. Resistor **28** provides a base bias for transistor **12**. Resistor **30** provides a degree of negative feedback for both transistors **11** and **12**, thus stabilizing the operation of the circuit. Capacitor **24** provides the necessary positive feedback for the circuit to oscillate. The values of capacitor **24** and resistor **16** determine the operational frequency. Other component values also affect the frequency but they are selected by analytical studies of the parameters involved. The primary winding **31** of the transformer **32** forms the collector load and serves to couple the produced signal to the clipper stage.

The varying frequency of the oscillator B is controlled by the existing charge across capacitor **20**. During the time that transistor **2** in the low frequency oscillator is conducting, current flows through resistor **22**, producing a voltage difference to appear across resistor **22**, which voltage is coupled through resistor **14** to capacitor **20**. The other side of capacitor **20** is connected to the positive voltage side or terminal of the source **19**. The difference between the voltage on the collector of transistor **2** and the source voltage on the other side of capacitor **20** determines the bias on the base of the transistor **11** in conjunction with the bias developed by resistor **16**. This bias has a very marked effect upon the oscillation frequency of the siren or basic oscillator B. This bias voltage or charge voltage is coupled to the base of transistor **11** through resistor **15**. The function of capacitor **17** is mainly to filter out any spurious signal that might trigger the siren oscillator B. As the low frequency oscillator A changes to the next phase of operation, the voltage drop across resistor **22** also changes. This change is transferred to the charge across the capacitor **20**. The change of, and the transfer of, this voltage is not immediate and is determined or controlled by a time constant unit formed of resistor **14** and capacitor **20**. Thus a sudden change of voltage at the collector of transistor **2** which does exist in operation, would not result in a sudden change of the siren or basic oscillator's frequency. The change which is relatively slow results in a directly proportional change in the frequency of oscillator B. While this change in frequency has been stated to be directly proportional, it is not intended to state that the rise in bias voltage vauses a rise in frequency in the particular circuits illustrated.

The output of the siren or basic oscillator B which is coupled by transformer **32** to the transducer **35** would normally have a waveform in a shape similar to a sawtooth. However, a squarewave would be much more desirable in audibility when amplified, is much richer in harmonic structure, and results in a sound which is more penetrating to the human ear than is a sawtooth wave. The sawtooth wave is converted to a form approximating, or having many of the characteristics of, a squarewave by means of the diode **36** and the resistors **37, 38** and **39**. The polarity of the diode **36** would be determined by the particular waveform obtained in actual practice. The diode **36** should not be considered as shown in any particular polarity, nor is it intended that this diode and its related resistors **37, 38** and **39** function solely as a clipper. The resistors **37, 38** and **39** function as a voltage divider so that it provides a conductance plateau for the diode **36** and its resultant clipping action.

The vibrator A operates at a very low frequency of only a few cycles per second, and through the time constant set up by the resistor **14** and capacitor **20** it controls the bias on the base of transistor **11** and thereby controls the frequency of the siren sound delivered by the basic oscillator or multivibrator B to the transducer. The signals in their travel from the oscillator B to the transducer in the illustrated embodiment have their waveforms converted into waveforms with a broad top, approaching a square waveform. While the diode and the resistors **37, 38** and **39** are considered advantageous to improve the harmonic structure of the siren waves, as explained above, in simplified and less expensive embodiments they may be omitted, and the secondary winding **33** will in such a case be connected to the transducer.

Multivibrators have been used in pairs in conjunction with each other, but one was always used to trigger the other, in which case one multivibrator has a definite frequency relationship with the other. This is used in standard television receivers to keep the horizontal scan in synchronism. In contrast therewith, my use of two multivibrators is to use the conductance of one transistor of the first oscillator or vibrator A to bias, not trigger, one of the transistors in the other basic oscillator or multivibrator B. There is no uniform frequency relationship between the two oscillators or multivibrators A and B. While other oscillators can be used with the bias, not triggering, between them, the size and cost of units so constructed would make them impractical and less desirable. The multivibrators are preferred because they provide unlimited low frequency oscillations and high harmonic output, and a relatively small change of the conductance of one of the amplified devices creates a large change in frequency. I have found that relaxation oscillators are less desirable because the neon tubes used in them required a comparatively high voltage to operate.

It will be understood that various changes in the details and arrangements of parts, which have been herein described and illustrated by way of example, to explain the nature of the invention may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. In an electronic system for creating audible siren sounds the combination for operating a sound producing transducer comprising, a pair of astable transistor multivibrators, each having two transistors and each transistor having a base, collector and emitter element, one of which multivibrators is a basic oscillator, and the other of which is a control oscillator having a very low frequency, less than the frequency of that of the basic, the output circuit of said control oscillator having connected in series therein a source of direct current, a first resistance, said emitter, said collector and a second resistance, a parallel path connected between the junction of said first resistor and source and the junction of said collector and said second resistor including in said parallel path a third resistance and a capacitor, means connecting the base element of the input one of said transistors of said basic oscillator

to the junction between said third resistance and said capacitor, and means including said transducer connected to the output of said basic oscillator for converting the variable frequency output of said basic oscillator in audible siren sounds.

2. The system as set forth in claim 1, wherein said last means includes a diode clipper for converting the variable frequency output into a signal with a waveform approaching a square wave.

3. The system as set forth in claim 2, further including a fourth resistance and a bypass capacitor disposed between said second mentioned junction and said base element of said input one of said basic oscillator transistors for providing a fixed bias therefor.

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