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B. M. POTTER

3,277,465

ELECTRICALLY OPERATED AUDIBLE ALARM

Filed Feb. 25, 1963

Fig. 1.

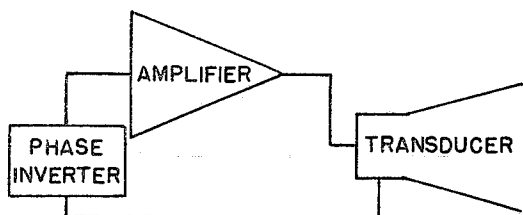


Fig. 1A.

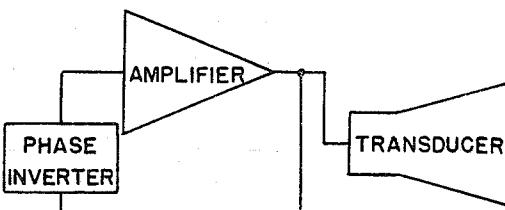


Fig. 3.

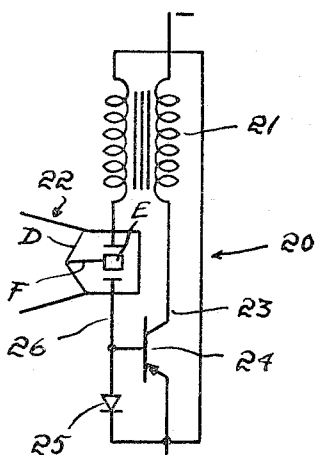


Fig. 2.

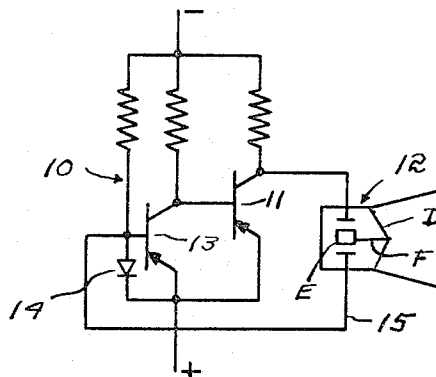


Fig. 4.

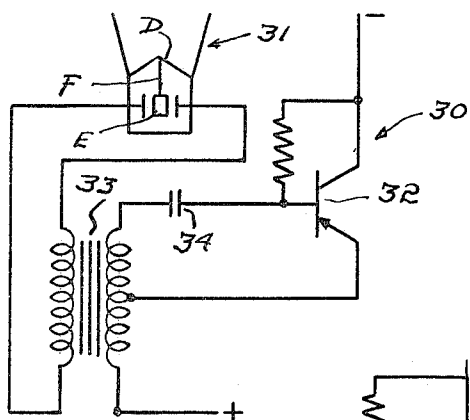


Fig. 5.

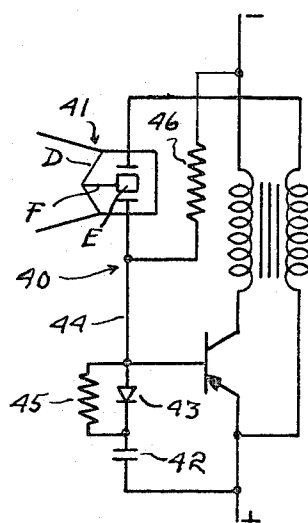
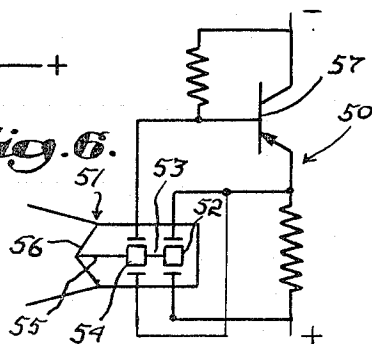


Fig. 6.



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3,277,465
ELECTRICALLY OPERATED AUDIBLE ALARM
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This invention relates to electrically operated audible alarms and signals.

Most transducers for changing electrical energy into sound, loudspeakers, for example, have a frequency at which they no longer behave as linear elements, but as a resonant element. This effect is often described as "tinniness" or "buzz," and every effort is made to reduce it. A device with an extremely sharp critical frequency is the small crystal earphone used in inexpensive hearing aids and transistor radios. In such a device, a piezoelectric element is mechanically coupled to a thin foil diaphragm. The masses involved, the mounting of the piezoelectric element, and the tension of the diaphragm combine to form a system that is sharply resonant. Such a device can be designed to have its resonant or critical frequency in the area of the ear's maximum sensitivity.

The problem of producing audible signals suitable for alarms and indications from small electric currents has heretofore not been dealt with effectively. In general, the problem is that the transducing element requires a low impedance and high driving power in the vacuum tubes or transistors associated with it. The design of circuits is such as to force the transducing element to adhere to the wave shape fed to it, and there is a loss of power in heat because of the energy devoted to overcoming the transducer's characteristics.

In an alarm in accordance with the invention, a transducer, comprising a diaphragm mechanically coupled and driven by piezoelectric means, is incorporated in circuitry in such a way as to permit the natural rate of vibration of the unit as a whole to reflect back into the semiconductor oscillator circuit associated with it, even as the resonant length of an organ pipe reflects back to the stream of air generating the note, thus to cause the alarm to oscillate in a mode of such wave shape and frequency as to contain substantial energy at the critical frequency of the transducer.

In addition, in an alarm in accordance with the invention, the advantages of a peculiar effect can be realized, since good waveshape is of no particular interest; just the opposite, in general, the more ragged the wave shape the more arresting the tone, the transducer can be pulsed with short-duration spikes of current and be made to operate at extremely high efficiency.

In the accompanying drawings, there are shown illustrative embodiments of the invention from which these and other of its objectives, novel features, and advantages will be apparent.

In the drawings:

FIGURE 1 is a block diagram of one type of claim in accordance with the invention,

FIGURE 1A is a block diagram of another embodiment of the invention,

FIGURE 2 is a view of circuitry that may be utilized in the type of alarm shown in FIGURE 1,

FIGURE 3 is a like view of circuitry of the same type but including a transformer,

FIGURE 4 is a view of circuitry that may be utilized in the type of alarm shown in FIGURE 1A,

FIGURE 5 is a view of a circuit for an alarm of the type shown in FIGURE 1 permitting pulsing, and

FIGURE 6 is another circuit for that type of alarm

with a device combining the functions of a transducer and means for effecting impedance matching.

The circuit generally indicated at 10, in FIGURE 2, details the principles demonstrated in FIGURE 1. The circuit 10 has a feedback loop which includes amplifier 11, the transducer 12, and the phase-inverter-amplifier 13. For the purposes of the oscillation in the feedback loop, the transducer 12 can be envisioned as an element that, at a certain frequency, opposes the flow of current less than at any other frequency so that oscillation is maintained at this critical frequency. Biasing and coupling considerations are standard in the transistor circuitry except a diode 14 at the phase-inverter-amplifier 13 permits somewhat louder operation at expense of efficiency by providing a return path for positive voltages appearing at the return lead 15 of the transducer.

In FIGURE 3, the circuit 20 again shows the principles outlined in FIGURE 1. The phase inversion is accomplished by the transformer 21. The transducer 22 has been placed after the phase inverter 21 in the feedback loop to take advantage of the transformer's capacity to multiply the voltages at the collector 23 of the transistor 24, for the purpose of loudness. The diode 25 completes the circuit for positive voltages appearing at the return lead 26 of transducer 22, permitting louder operation at the expense of efficiency.

In FIGURE 4, the generally indicated circuit 30 shows the principles outlined in FIGURE 1A. In the circuit 30, the transducer 31 is outside the feedback loop. In the loop, the transistor amplifier 32, and the transformer 33 matches the output of the amplifier 32 to the input. Because the amplifier is of the common-collector type, no phase inversion is necessary. Capacitor 34 provides coupling between the transformer 33 and transducer 31.

Except for its biasing arrangements, the circuit 40 of FIGURE 5 which includes the transducer 41, is substantially identical to that shown in FIGURE 3. However, in the base circuit, a capacitor 42 has been placed in series with the diode 43 so that the positive voltages appearing at the return lead 44 charge the capacitor 42 over a period of many cycles until sufficient current passes through resistor 45 to halt oscillation. The charge in the capacitor leaks off through resistor 46 over a period corresponding to many cycles until oscillations can recommence.

The transducers 12, 22, 31 and 41 may all be the same. In any event, each is shown as including a diaphragm D and a piezoelectric element E mechanically coupled thereto as at F.

The circuit 50 shown in FIGURE 6 has a transducer 51 which has a driving piezoelectric element 52 mechanically coupled as at 53 to a sensing piezoelectric element 54 which, in turn, is mechanically coupled as at 55 to the diaphragm 56. In the circuit, the feedback and matching are accomplished by the transducer. The driving element 52 is in the output of amplifier 57 and the sensing element 54 is the input thereof. The feedback loop thus contains the coupling between the elements.

I claim:

1. An alerting device comprising a piezoelectric transducer having a vibratory surface from which acoustic energy is radiated and a piezoelectric means operative to drive said surface, said transducer having a predetermined frequency of resonance and operable, when vibrating substantially at said frequency, to radiate substantial audible sound energy substantially within the frequency range of the ear's maximum sensitivity, a circuit for energizing said piezoelectric means, said circuit including

amplifier means with a transistor actuator, means for conducting energy from said amplifier to said piezoelectric means, a feedback path from said piezoelectric means to said amplifier, the circuit including means to provide phasing, biasing, and impedance matching to provide an oscillator whereby the energy input to said piezoelectric means is caused to oscillate substantially at said resonant frequency of said transducer to provide an audible warning.

2. The alerting device of claim 1 wherein said piezoelectric means comprises a piezocrystal included directly in the oscillator feedback loop.

3. The alerting device of claim 1 wherein said circuit includes means for modulating the oscillation of said circuit and the output of said transducer.

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