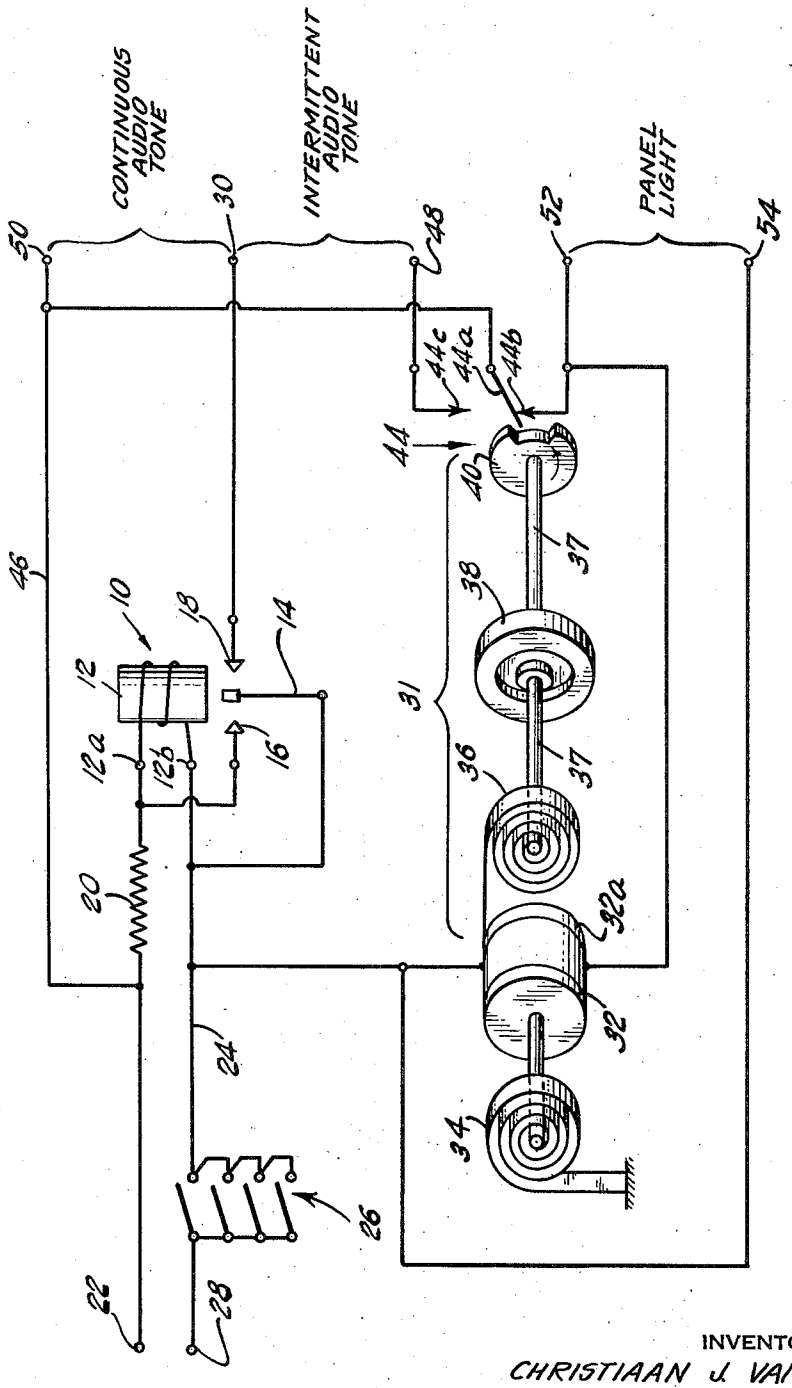
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AUDIO SIGNAL DEVICE

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INVENTOR
CHRISTIAAN J. VAN EYK
BY
Curtis, Morris & Safford.
ATTORNEYS.

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AUDIO SIGNAL DEVICE

Christiaan J. Van Eyk, Byram, Conn., assignor to Seaboard Electric Company, New York, N. Y.

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This invention relates to audio signal devices of the type which may be used, for example, for warning an airplane pilot of the malfunction of any of a number of selected mechanisms in the airplane or of any unsafe condition, or for any of a large number of diverse applications requiring an audible signal.

In complex modern aircraft, it has become common practice to provide a device which will create an audible signal in the pilot's headphones when any of a number of mechanisms in the plane fails to operate properly or when any dangerous condition exists, for example when the landing gear fails to come down properly after actuation of the control switch.

The present invention provides an audio signal device which is simple and relatively inexpensive in construction and foolproof in operation. Moreover, the device provided by the present invention is so constructed that when it is not in operation or when any of its component parts fail, the circuit to the headphones, loud speaker, or other audio transducing device is open so that no voltage will be applied thereto. This latter feature of the invention is of the utmost importance, since it assures that under no circumstances can a failure of the signalling device result in burning out the transducer or in imposing upon it a voltage which will impair its sensitivity to signals from other sources.

Another important feature of the present device is that it develops sufficient audio power to drive the headphones directly. It therefore need not be connected through the airplane's audio amplifier and will operate despite failure of the amplifier.

These features, which may be said to constitute the objects of the present invention, are accomplished by the audio signal device described hereinafter and shown in the accompanying drawing which constitutes a schematic electrical diagram of an audio signalling device embodying features of the invention.

The audio signal device shown in the drawing includes a vibrator generally indicated 10 of a type similar to the vibrators commonly used, for example, in the power supplies of automobile radios to convert continuous direct current to intermittent direct or alternating current. This vibrator 10 includes an iron core coil 12, a vibratory reed 14 mounted for resonant vibratory movement in the electromagnetic field of the coil 12 and a pair of fixed contacts 16 and 18 arranged at either side of the reed 14 in position to be conductively engaged by it at its opposite extremes of vibratory movement.

One terminal 12*a* of the coil 12 is connected through a resistance 20 to one terminal 22 of a D. C. power source (not shown). The other terminal 12*b* of the coil 12 is connected through a conductor 24 and a parallel-connected group of single-pole single-throw warning switches 26 with the other terminal 28 of the D. C. power source. The terminal 12*a* of the coil 12 is also connected to one of the fixed contacts 16 of the vibrator while the other terminal 12*b* of the coil is electrically

connected to the reed 14. The other fixed contact 18 of the vibrator is connected to an output terminal 30 which is adapted to be connected to one terminal of a pair of headphones, or a loudspeaker or other audio transducer.

The signalling device also includes an interrupter, generally designated 31, of the type more fully shown and described in the recently filed copending application entitled "Electro Mechanical Timing Device."

This interrupter includes a rotary solenoid 32 having a rotatable plate 32*a* which is normally urged against a stop (not shown) by a spiral return spring 34. This rotatable plate is also connected to the outer end of a spiral buffer spring 36 the other end of which is connected to one end of an oscillatory shaft 37 carrying a flywheel 38 and having secured at its opposite end a switch actuating arm 40. This cam 40 is arranged to cooperate with the movable contact 44*a* of a single-pole double-throw switch which is generally designated 44 and which is also provided with two fixed contacts 44*b* and 44*c*. The fixed contact 44*b* is normally closed with respect to the movable contact 44*a* and is electrically connected to one terminal of the winding of the rotary solenoid 32 while the other terminal of this solenoid is connected to the aforementioned conductor 24 and thus through the warning switches 26 to the terminal 28 of the D. C. source. The movable contact 44*a* of the switch 44 is connected through a conductor 46 with the other terminal 22 of the D. C. source. The other fixed contact 44*c* of the switch 44 is normally open and is connected to another headphone terminal 48.

The operation of this mechanism is as follows:

When any one of the warning switches 26 is closed, current will flow from the D. C. power source through the resistance 20 and the coil 12 of the vibrator 10 in series, energizing the coil 12. Energization of the coil 12 attracts the reed 14 of the vibrator 10 in the direction of the fixed contact 16. When the reed 14 conductively engages the fixed contact 16, the coil 12 of the vibrator 10 is short-circuited, deenergizing the coil and permitting the resilience of the reed 14 to move it away from the fixed contact 16; the inertia of the reed 14 will carry it into conductive engagement with the fixed contact 18. However, as soon as the reed 14 disengaged the fixed contact 16, the coil 12 will again be energized and the reed will again be urged toward engagement with the fixed contact 16, initiating a repetition of the cycle just described. The reed 14 will thus vibrate at its resonant frequency, engaging the contacts 16 and 18 in alternation at its opposite extremes of vibratory movement. The vibrator 10 is so designed that the reed 14 will vibrate at an audio frequency, for example a frequency on the order of 250 cycles per second.

Meantime, the closure of one of the warning switches 26 will have energized the rotary solenoid 32 of the interrupter 31 by virtue of the fact that one terminal of the solenoid 32 is connected through the conductor 24 and the closed warning switch 26 to one terminal 28 of the D. C. source while the other terminal of the solenoid 32 is connected through the normally closed contacts 44*a*—44*b* of the switch 44 and the conductor 46 to the other terminal 22 of the D. C. source. Energization of the solenoid 32 causes the rotatable plate 32*a* to rotate sharply in the direction indicated by the arrows against the resistance of the return spring 34. This moves the outer end of the spiral buffer spring 36 in the same direction and urges its inner end to follow. However, because of the inertia of the flywheel 40, a finite time will elapse before the oscillatory assembly can follow this rotary movement. When it eventually does so, a shoulder 40*a* on the cam 40 will engage the movable contact 44*a* of the switch 44 and throw it out of engagement with the fixed

contact 44*b* and into engagement with the fixed contact 44*c*. Opening of the fixed contact 44*b* will break the circuit through the solenoid 32 and deenergize the solenoid. This will allow the return spring 34 to rotate the plate 32*a* of the solenoid 32 sharply back to its original position, since the return spring 34 is much stiffer than the buffer spring 36.

The outer end of the buffer spring 36 will thus be moved in the direction opposite to that indicated by the arrows and this will in turn urge the inner end of the spring and the oscillating assembly to follow. Again however, because of the inertia of the flywheel 38, a finite time will elapse before the oscillatory assembly can follow the return movement of the rotary plate 32*a*, during which time the movable contact 44*a* of the switch 44 will remain in engagement with the fixed contact 44*c*. Eventually, however, the oscillatory assembly will return to its original position at which, allowing the movable contact 44*a* of the switch 44 to return into engagement with the fixed contact 44*b*, as shown in the drawing. This again will reenergize the solenoid 32 and initiate a repetition of the cycle just described. The oscillatory assembly will thus oscillate back and forth at a frequency depending upon such factors as the stiffness of the buffer spring 36 and the mass of the flywheel 38. The movable contact 44*a* of the switch will thus be thrown into engagement with the two fixed contacts 44*b* and 44*c* in alternation. The interrupter is so designed that the switch 44 is actuated at a subsonic frequency, for example a frequency on the order of 5 cycles per second.

It may thus be seen that the terminal 30 of the headphones is connected through the contacts 14—18 of the vibrator 10 and the warning switches 26 to one terminal 28 of the D. C. source. The other terminal 48 of the headphones is connected through the contacts 44*a*—44*c* and the conductor 46 to the other terminal 22 of the source. Thus, approximately five times per second an intermittent D. C. voltage having a frequency of 250 cycles will be applied to the headphones. This will cause the headphones to emit pulses of 250-cycle tone at the rate of five pulses per second, whenever any one or more of the warning switches 26 is closed.

The warning switches 26 are arranged so as to be closed whenever any of a number of chosen mechanisms in the aircraft fail to operate properly or when an unsafe condition exists at any of a number of selected points in the aircraft.

If the headphone is connected between the aforementioned terminal 30 and an auxiliary terminal 50 rather than across the terminals 30 and 48 as above described, the interrupter 42 will be bypassed and one terminal of the headphones will be connected directly through the conductor 46 with the terminal 22 of the D. C. source while the other terminal of the headphones is connected through the vibrator contacts 14—18 and the warning switches 26 with the other terminal 28 of the source. When the headphone is thus connected, closure of any of the warning switches 26 will result in a continuous 250-cycle tone in the headphones rather than an intermittent 250-cycle tone as previously described.

A pair of terminals 52 and 54 are provided for connection to an auxiliary panel light, if desired. As may be seen, these terminals are connected across the winding of the solenoid 32, so that whenever the device is energized by closure of one of the warning switches 26, the panel light will be flashed off and on at a rate of approximately 5 cycles per second.

From the foregoing description it will be understood that the mechanism which is shown and described is simple in construction and relatively foolproof in operation. It will also be seen that one terminal 30 of the headphones is connected to the normally open fixed contact 18 of the vibrator while the other terminal 48 of the headphones is usually connected to the normally open fixed contact 44*c* of the interrupter switch 44. Thus the circuit to each of the headphone terminals is normally open so that failure of either the vibrator 10 or the interrupter 31 cannot result in impressing a continuous D. C. voltage on the headphones which might burn out the headphones or reduce their sensitivity to signals from other sources.

It will thus be appreciated that the aforementioned and other desirable objects have been achieved by the present invention. However, it should be emphasized that the particular embodiment of the invention which is shown and described herein is intended as merely illustrative rather than as restrictive of the invention.

I claim:

1. An audio signal device comprising a vibrator having a coil, a reed mounted for vibratory movement under the electomagnetic influence of said coil and a pair of fixed contacts positioned for conductive engagement with said reed at predetermined points in its vibratory movement, at least one of said fixed contacts being normally "open" and out of conductive engagement with said reed at the position occupied by said reed when said vibrator is inoperative, means for connecting a source of electrical current across said coil, said means including said reed and the other of said fixed contacts whereby to reduce the normal flow of current from said source through said coil periodically and produce vibratory movement of said reed at a frequency within the audio range, and means for connecting an audio transducing device across said source, said means including said reed and said normally open fixed contacts, whereby when said vibrator is inoperative the circuit to said transducer is broken and when said vibrator is operative, an audio tone signal will be applied to said transducer.

2. An audio signal device comprising a vibrator having a coil, a reed mounted for vibratory movement under the electromagnetic influence of said coil and a pair of fixed contacts positioned for conductive engagement with said reed at predetermined points in its vibratory movement, at least one of said fixed contacts being normally "open" and out of conductive engagement with said reed at the position occupied by said reed when said vibrator is inoperative, means for connecting a source of electrical current across said coil said means including said reed and the other of said fixed contacts whereby to reduce the normal flow of current from said source through said coil periodically and produce vibratory movement of said reed at a frequency within the audio range, an interrupter having a pair of normally open contacts which are closed at a sub-sonic frequency, and means for connecting one terminal of said source through said reed and the other of said fixed contacts to one terminal of an audio transducer and for connecting the other terminal of said source through said interrupter contacts to the other terminal of said audio transducer whereby when said vibrator and said interrupter are inoperative the circuits to both terminals of said transducer are open and when said vibrator and said interrupter are operative, said transducer will emit an intermittent audio tone.

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