United States Patent [19]

Sato et al.

[11] **3,887,914**

[45] **June 3, 1975**

[54] **CONTACTLESS BUZZER**

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[21] Appl. No.: **431,811**

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Mar. 22, 1973 Japan ..... 48-35310[U]
Mar. 22, 1973 Japan ..... 48-35309[U]

[52] **U.S. Cl.** ..... **340/384 R**; 340/391
[51] **Int. Cl.** **G08b 3/00**
[58] **Field of Search** ..... 340/384 R, 391, 392, 401, 340/402, 388, 8 S

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Primary Examiner—Donald L. Yusko
Assistant Examiner—William M. Wannisky
Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn and Macpeak

[57] **ABSTRACT**

In a buzzer assembly having an electromagnet having a core and a coil, a driving electronic circuit unit for the latter, a mechanical vibrator unit for being driven periodically by said electromagnet for performing a vibratory movement, and a mechanical resonator unit for receiving vibratory movement from the vibrator unit, all the foregoing units being mounted on a stationary base plate, the improvement resides in that the core and at least a pillar-like supporting member are fixedly mounted at a predetermined and precise mutual relationship for serving as guide means for successive assembly of all the said units excepting the core, and said vibrator and resonator units are fixedly mounted on said pillar-like supporting member or -members.

5 Claims, 21 Drawing Figures

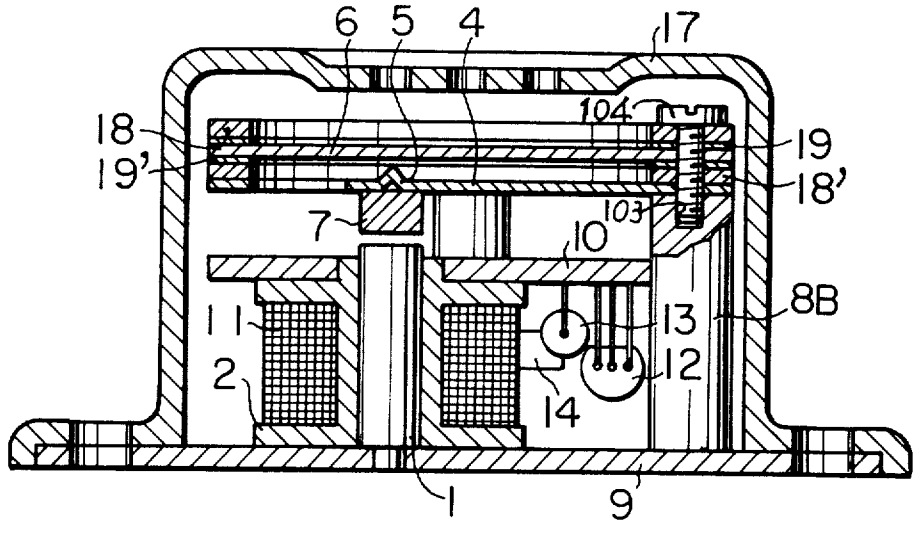


FIG. 1

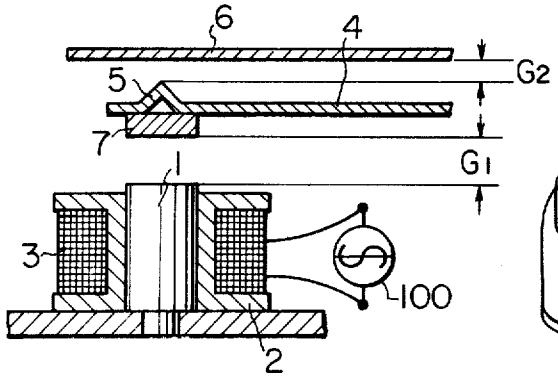


FIG. 2

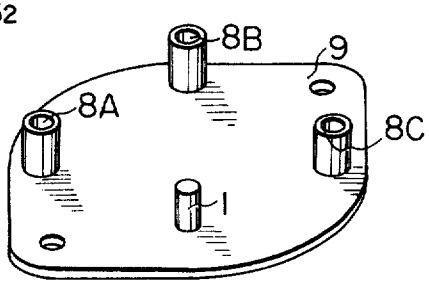


FIG. 3

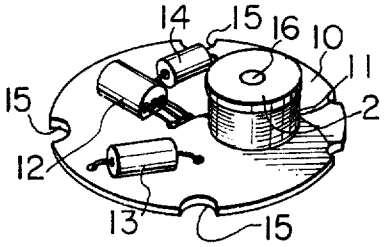


FIG. 17

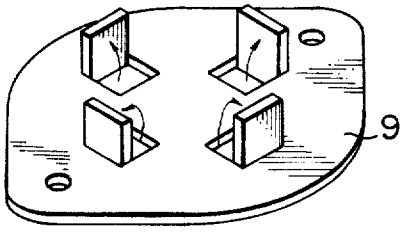


FIG. 4

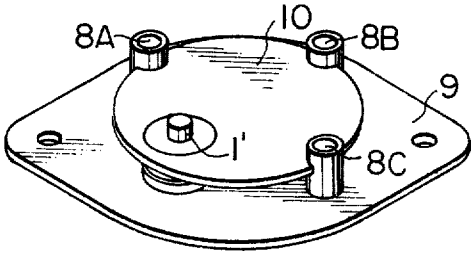


FIG. 18

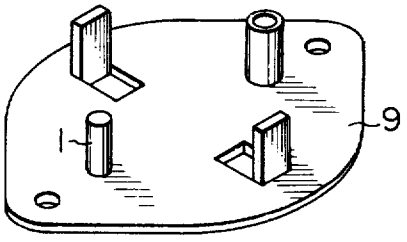


FIG. 5

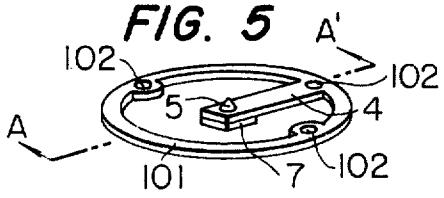


FIG. 19

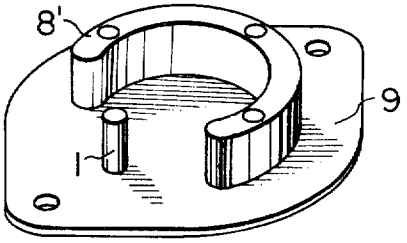


FIG. 6

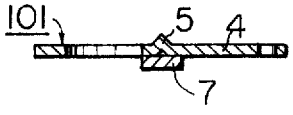


FIG. 7

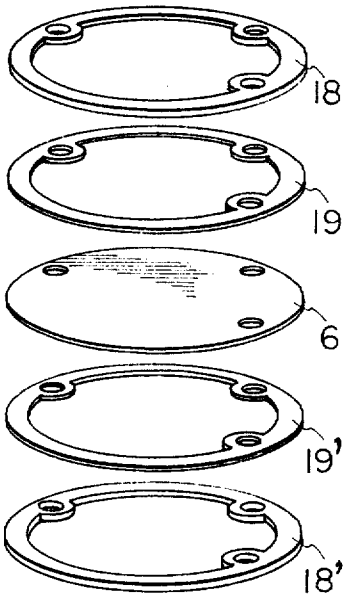


FIG. 8



FIG. 20

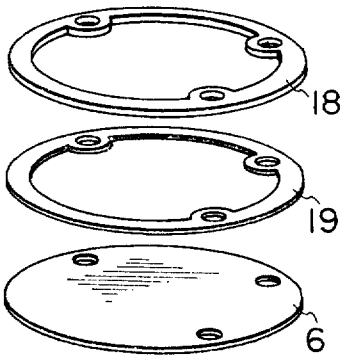


FIG. 21



FIG. 9

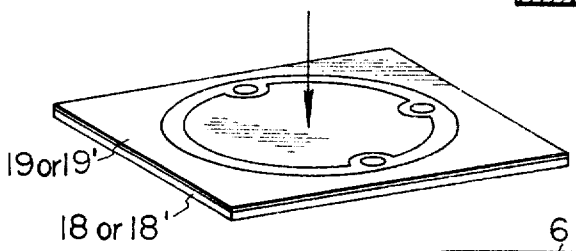


FIG. 10

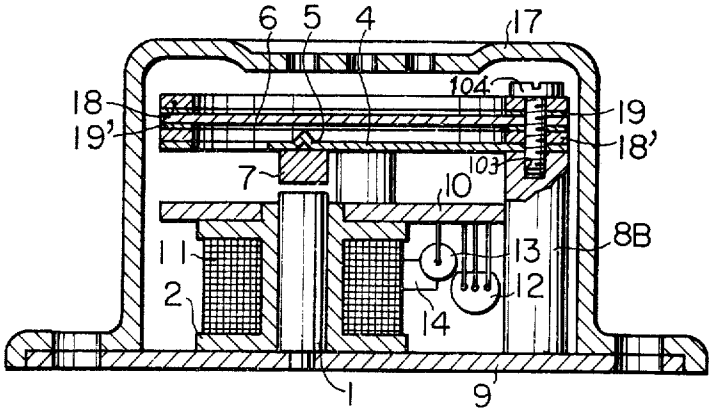


FIG. 12

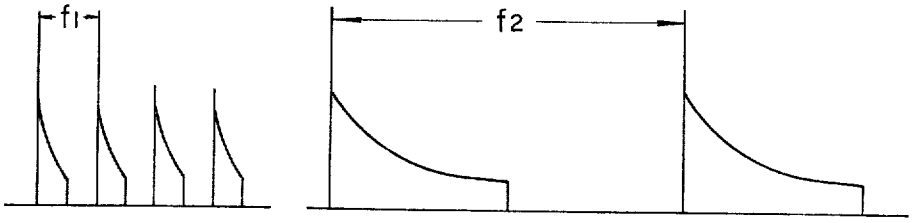


FIG. 13

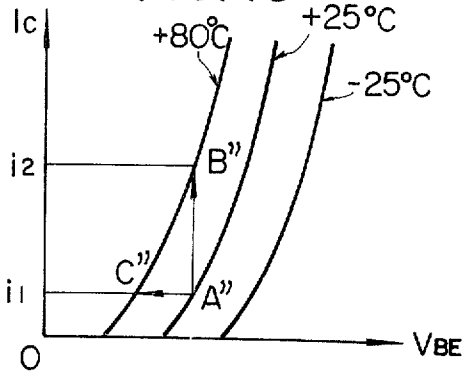


FIG. 11

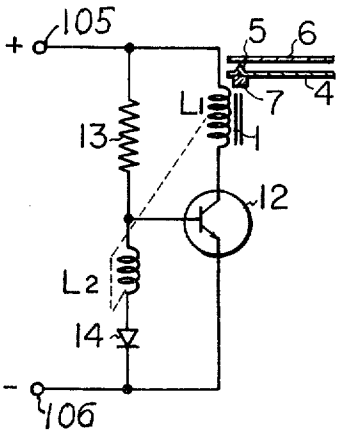


FIG. 14

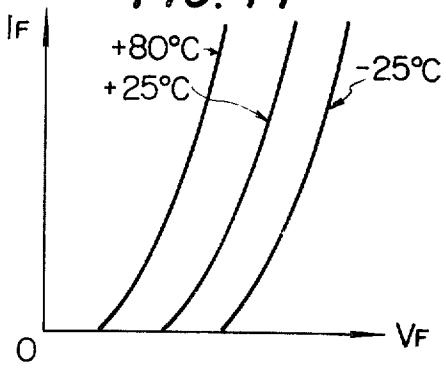


FIG. 16

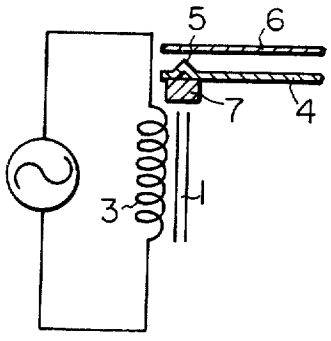
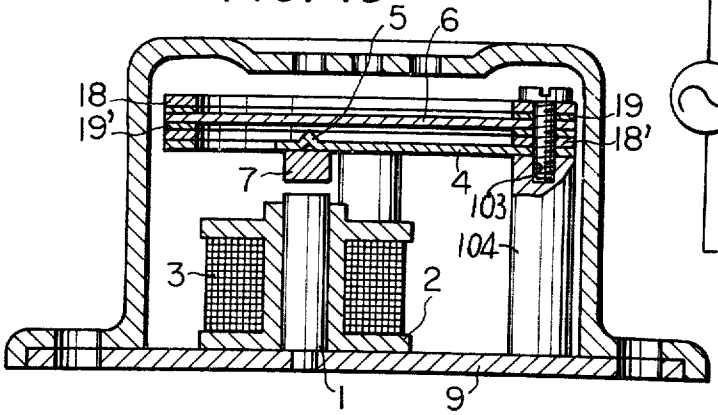


FIG. 15



CONTACTLESS BUZZER

BACKGROUND OF THE INVENTION

The present invention relates to improvements in and relating to a contactless buzzer unit having a resonant sheet for delivery of audible alarm sounds in response to mechanical vibration transmitted resonantly thereto from a vibrator when the latter is brought into vibration by energization of a cooperating electromagnet.

As is commonly known, there are two general categories of buzzers which are naturally converters adapted for converting electric energy into mechanical vibration. The first one is of the traditional contactor type having electrical contacts on-off controlled mechanically. The second one is of the rather modern contactless type having no such mechanically controlled electrical contacts. The first type buzzer is rather economical, but it represents a fatal defect of shorter durable life due to considerable wear of the contacts. While the second type buzzer has no such drawback as above and is reliable in its operation, it is highly expensive.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a contactless buzzer having an improved and reliable tone quality.

A further object is to provide a contactless buzzer of the above kind which is highly adapted for mass production.

These and further objects of the invention will appear more apparent when reading the following detailed description of the invention, together with the related known principles of the art and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic section of a contactless buzzer for the illustration of its main constituent parts and its basic working principles.

FIG. 2 is a perspective view of a base plate as a constituent of the contactless buzzer of the present invention.

FIG. 3 is a perspective view of an electromagnetic drive circuit block employed therein.

FIG. 4 is a perspective view of a semi-assembly of the block shown in FIG. 3 with the base plate shown in FIG. 2.

FIG. 5 is a perspective view of a vibratory member employed.

FIG. 6 is a diametral section of the vibratory member, taken along a section line A – A' shown in FIG. 5.

FIG. 7 is an exploded perspective view of several constituent parts of a mechanical resonator.

FIG. 8 is an axial section of the mechanical resonator having its several constituent parts shown in FIG. 7, assembled together.

FIG. 9 is a perspective view illustrative of a procedure for economizing the assembly job for the resonator.

FIG. 10 is an axial section of the buzzer according to the sole embodiment of the invention and shown in its assembled entirety.

FIG. 11 is a wiring diagram of the circuit part of the buzzer according to this invention.

FIG. 12 is a wave form chart showing several electric

wave forms appearing at several points of the buzzer.

FIG. 13 is a chart showing several characteristic curves of a transistor employed.

FIG. 14 is a chart showing characteristic curves of a diode employed.

FIG. 15 is a similar view to FIG. 10, showing a slightly modified buzzer from the foregoing, operate on the a.c. principle in place of the d.c. principle.

FIG. 16 is a wiring diagram of an a.c.-circuit employed in the modified embodiment of the buzzer shown in FIG. 15.

FIGS. 17 – 19 are several perspective views of modified base plates from that shown in FIG. 2.

FIG. 20 is an exploded perspective view of a modified resonator from that shown in FIG. 7.

FIG. 21 is an axial section of the modified resonator the constituent parts of which have been shown in FIG. 20.

DETAILED DESCRIPTION OF THE INVENTION

In the following, a main embodiment of the invention, together with several modifications thereof, will be described in detail by reference to the drawings.

In FIG. 1, showing a contactless a.c.-type buzzer, numeral 1 represents a core which is fitted with a bobbin 2 mounted thereon and having an operating coil 3 connected with an a.c. power source 100 which may be replaced, however, by a pulse generator although not shown. By the alternating or on-off energization of the coil 3, a resilient vibrator 4 supported fixedly at its root end, not shown, is electromagnetically brought into vibration, and thus, the electromagnet 1, 2 and 3 acts as a kind of converter for converting the fed electrical energy into electromagnetic one, so as to vibrate mechanically the vibrator 4. At the tip or operating end of the vibrator arm, a projection 5 is provided for mechanically and periodically striking a mechanical resonator 6 positioned in proximity of the arm 4, thereby delivering alarm sounds. At the opposite surface of the vibrator arm to the said projection, an iron or permanent magnet piece 7 is fixedly attached to the arm for improving the attraction of the arm by and towards the core 1. In this way, the vibrator arm 4 can generate alarm sounds. By properly selecting the spring force of arm 4 and the electromagnetically attracting force, the vibrator arm can vibrate without any contact of the piece 7 with the core.

In the above-kind of buzzer, a first gap distance G1 between the top end of core 1 and the lower surface of piece 7, and a second gap distance G2 between the top end of projection 5 and the lower surface of resonator 6, play an important role on sound quality as well as sound pressure to be delivered and thus, these distances should be set precisely to respective design values.

With G2 larger than G1, the piece 7 will strike against the core top during operation of the buzzer and the projection 7 will strike against the resonator 6 only in a weakened way, thereby the sound pressure being correspondingly weakened disadvantageously.

When G2 is equal to G1, the projection 5 and piece 7 will strike against the resonator and core top, respectively, during operation of the buzzer, thereby, however, the striking action upon the core being highly unstable. Thus, in this case, generation of unpleasant knocking sounds and unstableness in alarm noise delivery can not be avoided.

With G2 being smaller than G1, the reversed and favorable sound generating conditions can be realized. However, in this case, the ratio between G1 and G2 should be set in the order of 4 : 1, as being determined by our practical experiments on our commerciallized products. According to the present invention, variation of gap dimensions at G1 and G2 can be set to a possible minimum and otherwise necessary after adjustments of these gaps can be obviated even in a large scale production of the buzzers concerned, as will become more clear as the description proceeds.

Now, referring to FIG. 2, a plurality of, herein three, stud sleeves 8A, 8B and 8C and core piece 1 are fixedly mounted on a punched-out base plate 9 by press fit partially into corresponding or occasionally reduced perforations punched through the material of said base plate 9 in respective positions as shown. As will be mentioned more specifically, the assembly job is carried out by reliance on these pillar-like members 1; 8A; 8B and 8C.

In FIG. 3, an electromagnetic circuit block is shown, as having a printed circuit board 10, the arrangement of the printed circuit applied thereon being, however, omitted from the drawings, because it does not constitute part of the present invention. In this block, a bobbin 2 which is similar to that shown in FIG. 1, carrying a coil 11 similar to that denoted 3 shown therein, is fixedly mounted on the board 10 which further mounts fixedly a transistor 12, a resistor 13 and a diode 14. Lead means connecting them mutually and to corresponding parts of the printed circuit are shown only schematically for establishing necessary electrical connections and/or for providing fixed mounting of these constituent parts.

A plurality of, herein three, circumferential recesses 15 are formed on the periphery of board 10 in angular correspondence with said three studs 8A, 8B and 8C.

The assembled mode of these two semi-assemblies shown in FIGS. 2 and 3 is illustrated in FIG. 4. The assembly job is carried out from upper by reliance on the respective engagement of studs 8A, 8B and 8C with the respective recesses 15. Bobbin 2 is formed with a central opening 16 axially passing therethrough for reception of the core 1 when assembled. In this case, the head of the bobbin 2 is attached fixedly to the base 9 by previous application of a proper adhesive resin binder. In this way, an electromagnetic drive unit can be provided. In this case, the length of the core 1 is so selected that the top end at 1' of the core 1 slightly projects above the upper surface of board 10 when assembled.

Upon further assembly, as will become more apparent as the description proceeds, the piece 7 of iron or permanent magnet material and carried on the free end of vibratory arm 4 is positioned in close proximity of the top-end 1' of core 1.

By the provision of the peripheral recesses 15, the semiassembly shown in FIG. 4 has a strong rigidity in the lateral direction, in addition to the easy and accurate assembly capability mentioned above.

As shown in FIGS. 5 and 6, the root end of the vibrator arm 4 is united with a ring support 101 having three angularly separated perforations 102 adapted for snugly engaging with top parts of studs 8A, 8B and 8C, respectively, when assembled from upper with the semiassembly shown in FIG. 4.

The vibrator 4; 101 is fabricated from a sheet stock by punching out. Thanks to the above structure of the vibrator 4; 101, an erroneous positioning of the piece 7 relative to core can be positively prevented without execution of any after-adjustment thereagainst. In this case, the pillar-like studs 8A, 8B and 8C will serve well for this purpose by providing best guidance means.

A mechanical resonator comprises several parts shown in FIG. 7 and is shown in its semiassembled state in FIG. 8. In these figures, numeral 6 represents a resonator as before, which has been formed into a disc sheet; 18 and 18' carrier rings for the latter; and 19 and 19' ring-shaped adhesive layer materials, respectively.

The adhesive layer material may preferably be a shaped elastomer or synthetic rubber. By adopting this kind of elastomer, higher harmonics may be effectively absorbed, thereby improving and stabilizing the tone quality of the alarm sounds. If necessary, however, the adhesive layer ring sheets 19 and 19' may be replaced by a liquid adhesive.

As a convenient measure, a sheet stock 18 or 18' before punching out the rings 18 or 18', is applied with adhesive elastomer sheet 19 or 19' before punching out the corresponding rings and the thus formed semiassemblies are then punched as to provide respective rings, as may be easily supposed from FIG. 9.

As shown in FIG. 7, each of the disc and rings 18; 19; 6; 19' and 18' is formed with three angularly spaced, small perforations, so as to engage with three studs 8A, 8B and 8C, respectively, when assemblying together.

For providing the resonator semiassembly shown in FIG. 7, the said disc and rings are compacted together by placing the disc 6 at the middle center, by pressing them under pressure, upon properly and mutually centering by use of said small perforations as guide means for this purpose.

The resonator semiassembly shown in FIG. 8 is further assembled from upper with the foregoing semiassembly shown in FIG. 4, together, by placing the resonator on the top ends of the pillar-like studs 8A, 8B and 8C having tapped top inside openings, respectively, as representatively shown at 103 in FIG. 10 for the appearing specific stud 8B and then, all the thus assembled semiassembly units are fixed rigidly in their relative position by set screws as at 104 threaded into said tapped openings.

Finally, a flanged and cup-shaped cover housing 17 is bolted to the base 9, so as to house the said semiassemblies comprising the electromagnetic driver unit, vibrator unit and resonator unit, as shown in FIG. 10.

In the wiring schema shown in FIG. 11, numeral 12 represents a transistor; 13 a resistor; and 14 a temperature-compensating diode; L1 and L2 represent drive and sensing coil elements, respectively, wound on the core 1 in the conventional bifilar mode, so as to provide the coil mass 3. The aforementioned several circuit elements are connected electrically one after another as shown in FIG. 11, for providing a kind of conventional blocking oscillator. This buzzer circuit has terminals 105 and 106 which are connected to a d.c.-power source, although not shown.

When source voltage is applied through the terminals 105 and 106 to the buzzer circuit shown in FIG. 11, a positive feedback action will occur between coil elements L1 and L2, thus the circuit being kept in oscillation. By this blocking oscillation, current will be applied intermittently to the collector terminal of transis-

tor **12** and thus, core **1** is energized intermittently in the corresponding way. When core **1** is intermittently energized, iron or permanent magnet piece **7** is attracted toward the core **1**, together with the piece-carrying free end of the vibrator arm **4** while, when the core is deenergized, such attracting force will disappear and return to its original position due to its inherent resiliency, thereby said arm being kept in vibration. When the vibrator arm initiates such vibratory movement, the oscillation frequency, f1 of the buzzer circuit will become synchronized with the resonance frequency f2 of the vibrator arm by virtue of the thus modified magnetic resistance, thus a stabilized oscillation being continued. This stabilized relationship is shown in FIG. **12.**

In the buzzer circuit, there is inserted a temperature-compensating diode **14**, and its operation will be described by reference to FIGS. **11, 13** and **14.**

FIG. **13** represents a characteristic chart, V_{BE} and I_C, of the transistor **12**, while FIG. **14** represents a characteristic chart, $V_F - I_F$, of the diode **14.**

If the diode **14** is dispensed with, and when it is assumed that the operating point of the transistor at 25°C. positions at the point A'' in FIG. **13.** When it is further assumed that the temperature rises up to 80°C, then the operating point will shift to a certain point as at B'', thus an excess current i_2 flows through the transistor, and the oscillating operation will be interrupted. In this stage, the transistor conducts.

In the following, the state of the buzzer circuit fitted with the diode **14** will be considered. In this case, the shifting directions of the $V_F - I_F$-curve and V_{BE}-I_C-curve, being caused by the temperature rise, are same with each other, and the shift will be made from point A'' to point C'', thus a stabilized oscillation being obtained in spite of the temperature rise. A similar compensation will be made when encountered with a temperature drop.

In this way, an adverse temperature influence can be substantially obviated.

As was referred to hereinbefore, energization and deenergization of the coil L1; L2 will bring core **1** and oscillator arm **4** into electromagnetic cooperation with each other, so as to perform a highly stabilized oscillation, with the projection **5** striking the resonator sheet **6** periodically.

In the modified embodiment operating with a.c.-current and shown only schematically in FIG. **15,** the foregoing printed circuit board **10** has been omitted. Other constituents of the buzzer assembly and the buzzer circuit are shown in FIGS. **15** and **16** with same reference numerals as before, and thus, the structure and operation of this modified buzzer of the a.c.-mode can easily be understood without further analysis thereof.

From the foregoing detailed description of the buzzer according to this invention, the relative precise arrangement and position of all the constituent parts can be determined when assemblying, by the precise dimensioning and machining of the core and the pillar-like studs on the base plate. The required precise dimensioning of the aforementioned gaps G1 and G2 can be realized in the same way, thus after-adjustment thereof being dispensed with. The arrangement and positioning of the mechanical resonator can also be performed in the similar manner.

By this feature, an automatic assembly of the buzzers can be realized easily, in addition with the stabilized and uniform sound delivery function.

The embodiments of the invention in which an exclusive property or privilege is claimed are as follows:

1. A contactless buzzer comprising a base, a plurality of spaced apart pillars secured to said based perpendicular thereto, vibrator arm means having a free end extending in parallel spaced relation to said base and including supporting means mounted on the tops of said pillars, resonator means disposed parallel to said base in contiguous relation to the upper surface of said supporting means and including a resonator disc and a pair of annular supporting rings disposed on opposite sides of said disc adjacent the circumference thereof and electro magnet means mounted on said base and including a coil and a core with said core being disposed perpendicular to said base in alignment with the free end of said vibrator arm means.

2. A contactless buzzer as set forth in claim **1** wherein said pillars are disposed along the arc of a circle, said supporting means for said vibrator arm means is comprised of an arcuate member having the same radius as said circle, and said annular supporting rings have the same radius as said circle; said supporting means and said annular supporting rings having aligned apertures disposed in alignment with said pillars and means extending through said apertures to secure said vibrator arm means and said resonator means to said pillars.

3. A contactless buzzer as set forth in claim **2** further comprising a circular circuit board having a plurality of peripheral notches corresponding to and cooperating with said pillars and having an aperture through which said core extends whereby said circuit board is supported by said coil and located relative to said pillars by means of said notches.

4. A contactless buzzer as set forth in claim **1** further comprising ring-shaped adhesive members disposed between said annular supporting rings and said resonator disc.

5. A contactless buzzer as set forth in claim **1** wherein said coil comprises a driver coil element and a sensor coil element and further comprising an electronic drive circuit having a transistor, said buzzer being characterized in that one end of said driver coil element is connected to the collector electrode of said transistor and the other end thereof is connected to the positive side of a voltage source, the base electrode of said transistor being connected with a resistor and said sensor coil element, the opposite end of said resistor being connected to said positive side of a voltage source, the opposite side of said sensor coil element being connected through a temperature-compensating diode to the emitter diode of said transistor.

* * * * *