July 2, 1940. C. S. WEYANDT 2,206,244

ELECTRICAL VIBRATOR

Filed Nov. 1, 1937

Fig.1.

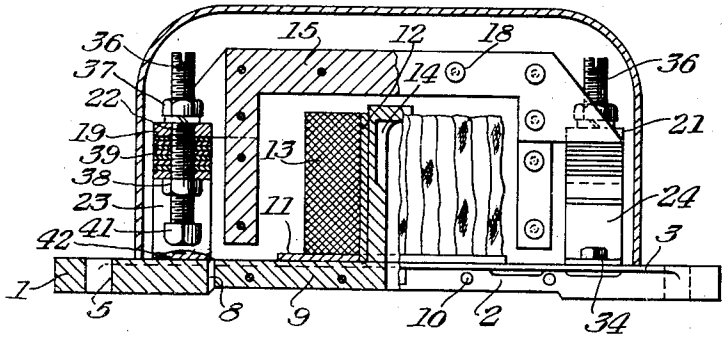


Fig.2.

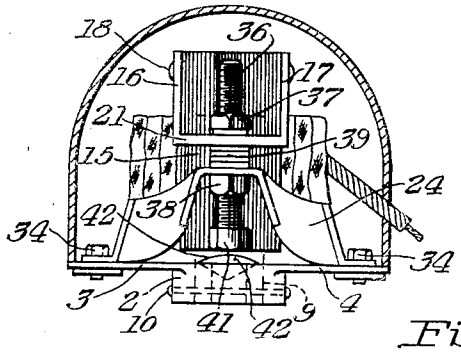


Fig.3.

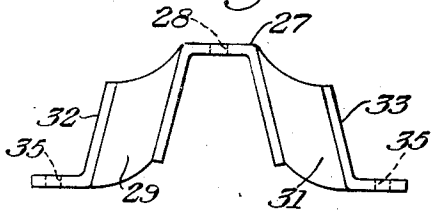


Fig.4.

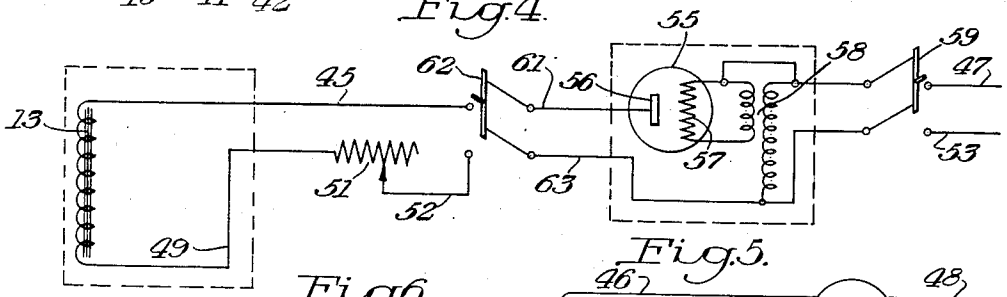


Fig.5.

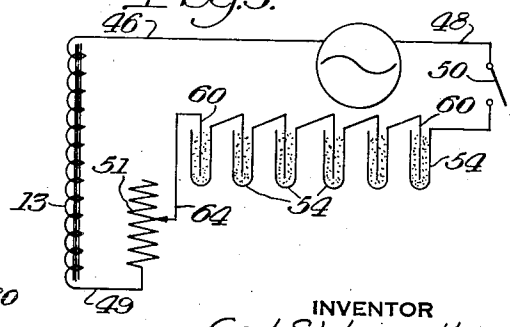
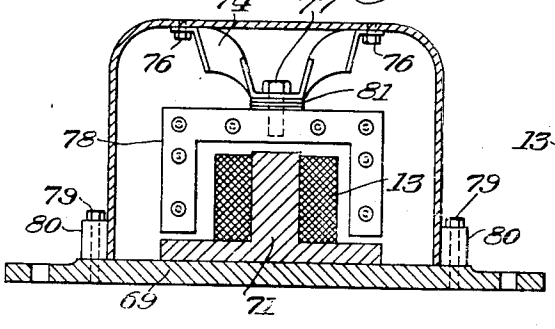


Fig.6.



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UNITED STATES PATENT OFFICE

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ELECTRICAL VIBRATOR

Carl S. Weyandt, Pittsburgh, Pa.

Application November 1, 1937, Serial No. 172,181

5 Claims. (Cl. 172—126)

This invention relates to electrically operated vibrators adapted to be connected to objects of various kinds for vibrating the same. The invention is directed particularly to the construction of such vibrators operated directly from an electrical circuit. This application is in part a continuation of my application for Letters Patent, Serial No. 106,851, filed October 21, 1936, for Vibratory electrical apparatus and methods.

It is an object of the invention to provide a vibrator having the vibrating portion mounted so as to vibrate substantially noiselessly.

Another object is the provision of a vibrator having the vibrating portion mounted on a rubber shear spring.

Another object is the provision of a vibrator operated on the inertia principle in which the vibration of the armature is substantially noiseless and is transmitted to the object to be vibrated.

A further object of the present invention is to provide a vibrator which is of simple construction, relatively inexpensive to manufacture, and which may be operated over long periods of time without requiring any repairs.

A further object is the provision of a vibrator which may be secured to an object to be vibrated and in which the vibration of the armature is maintained substantially in alignment with the pole axis.

Still another object is the provision of a vibrator operated by current impulses separated by substantial zero intervals and in which the vibrating element and spring elements upon which it is mounted has a natural or free periodicity lower than the recurrence periodicity of the current impulses.

A further object is the provision of a vibrator having the vibrating portion mounted on non-magnetic spring elements.

Another object is the provision of a vibrator adapted to be operated directly by alternating current, or by a rectified wave developed through a static rectifier in an alternating current circuit.

Another object is the provision of a vibrator operated by current impulses derived from an imperfect static rectifier interposed in an alternating current circuit, the number of rectifier units being such that a substantial inverse current would flow in the absence of any inductance in the circuit.

According to the present invention, I provide a vibrator adapted to be secured to an object to be vibrated and an electromagnet mounted thereon, the armature of the vibrator being connected by vibratory elements to the base which serve to prevent impact of the armature against the base. The preferred type of vibratory element comprises a rubber spring mounted so as to be substantially in a state of shear when the armature is vibrating. The vibratory elements preferably maintain the reciprocation of the armature in alignment with the axis of the electromagnet. The electromagnet may be supplied directly with alternating current of suitable frequency.

The invention further contemplates supplying the vibrator with current impulses separated by zero intervals, such as are obtained from a rectifier interposed in an alternating current circuit, the natural periodicity of the armature and vibratory element being selected to be about ninety to ninety-five per cent of the recurrence periodicity of the current impulses, depending on the frequency of the alternating current, whereby the maximum amplitude of vibration is obtained without the disadvantage of sensitivity to disturbing forces that occurs when a state of resonance exists. I prefer to employ dry disk rectifiers which are imperfect rectifiers and use the inductance of the circuit to cut down the inverse current so that a lesser number of disks may be employed than would be needed to supply the same current in a non-inductive circuit. The inverse current also may be cut down by cooling the rectifier disks in any suitable manner.

The invention will be described in detail in connection with the accompanying drawing wherein is illustrated a preferred embodiment of the invention by way of example, and wherein:

Fig. 1 is a side view partly in section, showing a preferred embodiment of my invention,

Fig. 2 is an end elevation of Fig. 1, the casing being shown in section,

Fig. 3 is an end elevation of a detail on an enlarged scale,

Fig. 4 is a wiring diagram showing the vibrator operated from an alternating current through one type of rectifier,

Fig. 5 is a wiring diagram showing the vibrator operated from an alternating current through a dry disk type of rectifier, and

Fig. 6 is a side view of a modified vibrator.

Referring to the drawing, the vibrator comprises a base 1 of cast steel or other suitable material and has a thickened central body portion or rib 2 and integral flanges 3 and 4, bolt holes 5 being bored through the ends of the base 1 through which pass suitable bolts by which the vibrator is secured to the body or object to be

moved or vibrated. A rectangular opening 8 is formed centrally of the base 1 and receives a laminated electromagnet core 9 substantially in the shape of an inverted T. The core 9 is secured to the base 1 by cutting the base in half on its long axis, inserting the core 9 in place, and riveting the two halves and the core together by rivets 10 passing through the core and central rib 2. The two halves of the base are then reunited by welding. In this way a very rigid structure is built up in which the magnet core 9 is securely held to the base 1. A cushioning pad 11 of rubber or other suitable material is placed on the base over the core 9, the core being surrounded by a layer of insulation fabric 12 and a coil 13 of insulated wire wound horizontally surrounds the leg of the core. A pair of clips 14 suitably insulated from the coil are bolted to the base 1 to hold the wire coil 13 securely in place to the base.

The armature 15 is of laminated construction and is substantially in the shape of a C on its side. The laminated plates of the armature are enclosed by thicker side plates 16 and 17 on either side which extend part way along the legs of the C and beyond the armature proper, all the plates being held in assembled position by suitable rivets 18. Cross bars 19 and 21 having bolt holes 22 therein are positioned between the side plates 16 and 17 and are welded thereto or otherwise secured thereto.

Adjacent each end of the base are two vibratory members indicated generally by the numerals 23 and 24 serving as spring supports for the armature. As these supports are alike in construction, only one of them will be described in detail. The supporting member 23 comprises an inverted channel shaped metal strip 27 with a hole 28 bored centrally therethrough, and rubber pads 29 and 31 have one of their respective faces secured to each side of the channel strip 27 by vulcanization or in any other suitable manner. The pads are right and left hand and the faces thereof are substantially parallel.

Angle strips 32 and 33 are vulcanized to the opposite faces of the pads 29 and 31 and bolts 34 passing through holes 35 in the angle strips secure the armature supports in place at opposite ends of the core 9. The ends of the pads are formed as a fillet to reduce tension on the joint between the metal and rubber at the ends. The armature is secured to the vibratory members by bolts 36 passing through holes 28 in the strip 27 and holes 22 in cross bars 19 and 21, and by nuts 37 and 38, spacing washers 39 being interposed between horizontal bars 19 and 21 and the tops of channel members 27 to provide the proper air gap between the armature and electro-magnet in assembled position, and the bolts 36 are adjusted so that their heads 41 are not in contact with the base. By reason of the non-magnetic properties of the armature supports 23 and 24 the possibility of the electro-magnetic flux being shunted around the air gap into the armature is eliminated.

When the armature is vibrating the faces of the rubber pads secured to the armature are constrained to move substantially parallel to the faces secured to the base, and consequently the rubber pads are in a state of shear. Rubber in a state of shear or tension has a greater amplitude of movement and longer life than rubber in a state of compression. The resistance of the rubber pads to transverse shear enables them to act as guides to maintain the armature in proper alignment with the magnet, thereby obviating the need for additional guide members, and the vibrator can be used in horizontal, vertical or inclined positions. Thus, a greater amplitude of vibration can be obtained over other known vibratory structures without employing separate guides for the armature. Rubber is representative of a class of materials which have a different modulus of elasticity under compression and under tension and follow a pseudo-harmonic law of vibration, such materials not having the undesirable effects of resonance. Ordinarily, when the armature is vibrating the amplitude of vibration is such that the heads 41 of the bolts 36 do not strike the base 1, and the armature 15 does not strike the electromagnet core 9. Two striking surfaces or buttons 42 of a hard non-magnetic metal, such as "Stellite" or "Studite" or the like are welded in suitable depressions in the cast steel base in line with the bolt heads 41 so that if the amplitude of vibration becomes too great due to accidental increase in the supply voltage the heads will strike these hard surfaces. The bolt heads 41 also may be coated with "Stellite" or any similar hard metal, if desired. The non-magnetic metal coating and button prevent shunting of the magnetic flux when impact occurs.

In Fig. 4 there is shown a wiring diagram for a vibrator operated from an alternating current circuit having a static rectifier interposed therein, whereby the coil receives current pulsations separated by substantial intervals of zero current. The rectifier 55 shown preferably is of the thermionic type, having an anode 56 and a cathode 57. The transformer 58 supplies current from the alternating current source supplied by wires 47 and 53 through switch 59 for heating the cathode of the tube. The anode of the tube is connected by wire 61 to switch 62 and by wire 45 to one end of the coil 13, the other end of the coil being connected by wire 49 through rheostat or variable resistor 51 (which is optional) and wire 52 back to the switch 62 and by wire 63 to the alternating current source. The system has the advantage that a larger amplitude of vibration may be obtained by a given current input.

When the vibrator is operated by the electrical system shown in Fig. 4 and the armature reciprocates without impact, the vibratory mass, which term includes the armature 15 and the vibratory portions of supports 23 and 24 preferably has a natural periodicity of vibration at the preferred amplitude less than the periodicity of the current impulses, the preferred periodicity being about ninety to ninety five per cent of the recurrence periodicity of the current impulses and may be as close as ninety eight per cent of the recurrence periodicity of the current impulse without undesirable sensitivity. However, the periodicity may be selected to as little as two thirds that of the current impulses, if desired. For example, in operating the vibrator by current impulses derived through a rectifier from a 60 cycle alternating current source, I prefer to select the natural periodicity of the armature to be fifty four to fifty seven vibrations per second. The free period of vibration of the armature may be changed readily by replacing the supports 23 and 24 by others having the desired thickness of rubber pads so as to have the desired natural period.

In place of the thermionic rectifier shown in Fig. 4, any other suitable type of rectifier may

be employed, such as copper oxide, cupric, sulphide, mercury arc or electrolytic types. In Fig. 5 I show a wiring diagram employing dry plate rectifiers which may be copper oxide, or any other suitable type. The alternating current source 60 is connected by wire 46 to one end of coil 13 and by wire 48 and switch 50 to one plate 54 of the bank of rectifiers, the other plate 60 being connected in series to the corresponding plate 54 of the second rectifier and so on, the last plate 60 being connected by wire 64 to rheostat or resistor 51 which is connected by wire 49 to the end of coil 13. With this arrangement current impulses separated by zero intervals is supplied to the coil 13. The number of rectifier units is less than would be required to supply the desired current in a non-inductive circuit, as the inductance cuts down the inverse current.

In the modification illustrated in Fig. 6, the base 69 has an electromagnet 71 secured thereto constructed similar to electromagnet 9 and having a coil 13 wound thereon. A vibratory member 74 constructed exactly like member 24 is secured to the cover 75 by bolts 76 and a bolt 77 passing through the central hole of vibratory member 74 is threaded into the C-shaped armature 78. The cover 75 is secured to the base by bolts 79 passing through lugs 80. In this modification only one vibratory unit 74 is employed and when the cover is in position the air gap between the armature and electromagnet is predetermined by the spacing washers 81. Any desired number of such washers may be used to obtain the desired air gap.

The vibrators herein described may, if desired, be operated directly by an alternating current of suitable low frequency. For example, where an alternating current of fifty cycles is available the resilient members will be selected to have a free periodicity of six thousand vibrations per minute, and with an alternating current of twenty five cycles, the free periodicity of the armature would be selected at three thousand vibrations per minute. If desired, the vibrators may be operated to impact, the impacts being transmitted to the object to be vibrated. This may be done by lowering the bolts 36 so that the heads 41 strike the buttons 42 on the base, or the whole armature may be lowered to reduce the air gap.

What I desire to claim as my invention and secure by Letters Patent is:

1. A vibrator comprising a base adapted to be connected to an object to be vibrated, an electromagnet carried by the base, a reciprocable armature adapted to be reciprocated upon actuation of the electromagnet, a central channel member, rubber pads vulcanized by one side respectively to said central member, a plurality of angle members, the other sides of said rubber pads being vulcanized to said angle members respectively, means for securing said angle members to the base, and means for securing said armature to said central channel member.

2. A vibrator comprising a base adapted to be connected to an object to be vibrated, an electromagnet carried by the base, a reciprocable armature adapted to be reciprocated upon actuation of the electromagnet, a central channel member, rubber pads vulcanized by one side respectively to said central member, a plurality of angle members, the other sides of said rubber pads being vulcanized to said angle members respectively, means for securing said angle members to the base, bolts securing the armature to said central channel member, the ends of the bolts limiting movement of the armature toward the electromagnet.

3. A vibrator comprising a base adapted to be connected to an object to be vibrated, an electromagnet carried by the base, a reciprocable armature adapted to be reciprocated upon actuation of the electromagnet, a central channel member, rubber pads vulcanized by one side respectively to said central member, a plurality of angle members, the other sides of said rubber pads being vulcanized to said angle members respectively, means for securing said angle members to the base, bolts securing the armature to said central channel member, the ends of the bolts limiting movement of the armature toward the electromagnet, and a hard non-magnetic metal coating on said base substantially in alignment with said bolts to provide striking surfaces.

4. A vibrator comprising a base adapted to be connected to an object to be vibrated, an electromagnet carried by the base, a reciprocable armature adapted to be reciprocated upon actuation of the electromagnet, a central channel member, rubber pads vulcanized by one side respectively to said central member, a plurality of angle members, the other sides of said rubber pads being vulcanized to said angle members respectively, means for securing said angle members to the base, means securing said armature to said central channel member, and means limiting movement of the armature toward the electromagnet.

5. A vibrator comprising a base adapted to be connected to an object to be vibrated, an electromagnet carried by the base, a reciprocable armature adapted to be reciprocated upon actuation of the electromagnet, rubber bodies having substantialy parallel faces extending generally in the direction of reciprocation of the armature secured by one face to the armature and by the other face to the base, whereby said faces are moved in shear when said armature is vibrated, and means to periodically energize said electromagnet to reciprocate said armature.

CARL S. WEYANDT.