Oct. 11, 1949. C. HUETTEN 2,484,093

VIBRATOR

Filed Aug. 18, 1944

Fig. 1

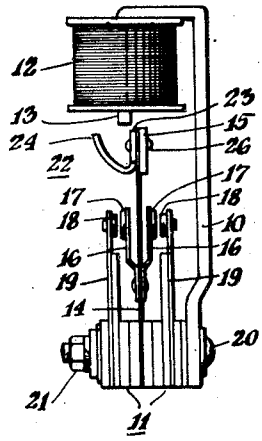


Fig. 2

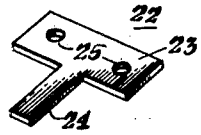


Fig. 4

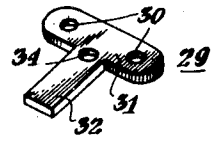


Fig. 3

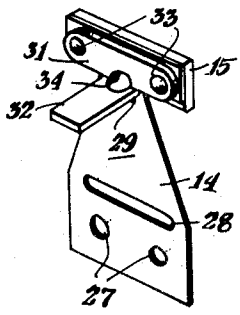


Fig. 5

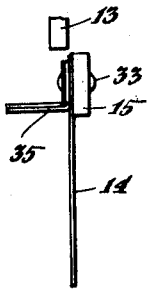


Fig. 6

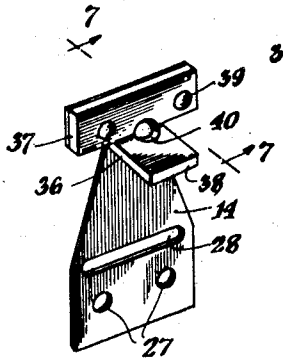


Fig. 7

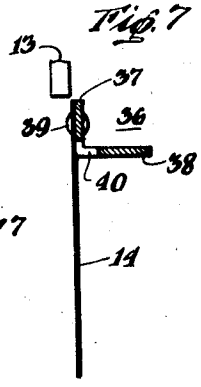


Fig. 8

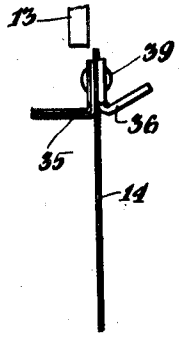


Fig. 9

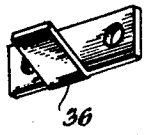


Fig. 10

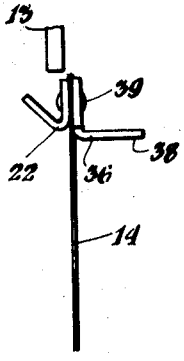


Fig. 11

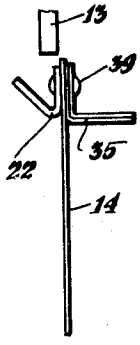
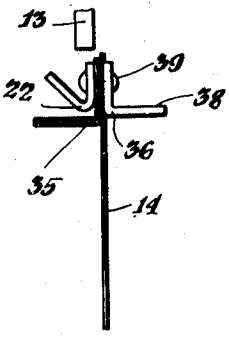


Fig. 12



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Patented Oct. 11, 1949 2,484,093

UNITED STATES PATENT OFFICE

2,484,093

VIBRATOR

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Application August 18, 1944, Serial No. 549,968

8 Claims. (Cl. 172—126)

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The present invention relates to vibrators, and, more particularly, to vibratory electromagnetic interrupters of novel and improved character.

It is an object of the present invention to provide improved control of the operating frequency of vibratory interrupters.

It is another object of the present invention to provide improved vibratory interrupters the operating frequency of which may be maintained substantially constant regardless of changes in temperature, amplitude, and in other variable operating conditions.

It is a further object of the invention to provide vibratory interrupters having means for readily adjusting their operating frequency to a desired value thereby to realize a heretofore unattainable uniformity of the finished product.

It is also within the contemplation of the invention to provide readily adjustable weights for the vibratory system of vibrators, such weights being either manually adjusted after the assembly, or being automatically and continuously adjusted by certain changes in the operating conditions, such as the temperature, whereby desirable operating conditions are obtained and maintained.

The invention also contemplates vibratory interrupters having manually or automatically adjustable weights operatively associated therewith, which combine great structural simplicity, facility of manufacture and heretofore unobtainable operational efficiency.

Other and further objects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawing; in which

Fig. 1 illustrates a side elevational view of a vibrator embodying the principles of the present invention;

Fig. 2 depicts a perspective view of the blank of an adjustable ferromagnetic weight forming part of the vibrator of Fig. 1;

Fig. 3 shows a perspective view of a vibratory reed equipped with a non-magnetic adjustable weight embodying the invention;

Fig. 4 is a perspective view of a blank for the adjustable weight forming part of the structure of Fig. 3;

Fig. 5 is a side elevational view of a modified vibratory reed equipped with a bimetallic weight;

Fig. 6 illustrates a perspective view of a reed structure in which an adjustable weight is integrally formed with a ferromagnetic armature for the reed;

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Fig. 7 depicts a section taken on line 7—7 of Fig. 6;

Fig. 8 shows a side elevational view of a reed structure embodying the invention and including a bimetallic weight and an adjustable ferromagnetic weight;

Fig. 9 is a perspective view of the adjustable ferromagnetic weight forming a part of the reed structure shown in Fig. 8;

Fig. 10 is a side elevational view of a reed structure in which an adjustable ferromagnetic weight, not under the influence of the driver field, is combined with an adjustable ferromagnetic weight under the influence of such field;

Fig. 11 is a side elevational view of a reed structure similar to that of Fig. 10 but including a weight constituted of bimetallic material responsive to changes of temperature; and

Fig. 12 is a similar view of a further modified embodiment of the invention in which the features of Fig. 10 and 11 are combined.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description, and in the claims, parts will be identified by specific names, for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring now more particularly to Fig. 1 of the drawing, a preferred embodiment of the invention essentially comprises a ferromagnetic frame 10 having a conventional stack portion generally denoted by reference character 11 mounted on one end thereof and carrying a driver coil 12 around the other or hook end thereof, the extremity of which constitutes a pole piece 13. The vibratory system of the vibrator is constituted of a vibratory reed 14 clamped in stack 11 at one end thereof and carrying the usual ferromagnetic armature 15 secured to the other or free end thereof. A pair of reed or contact arms 16 are secured to an intermediate portion of the reed and carry at their ends vibratory contacts 17. These contacts cooperate with relatively fixed contacts 18 carried at the ends of side springs 19 likewise clamped in stack 11. The stack is held together by means of conventional stack screws 20 and nuts 21. So far the structure of the vibrator is along conventional lines and, as those skilled in the art know, when the driver coil is properly associated with a source of direct current and with the sys-

tem of vibratory and fixed contacts, the reed will be maintained in continuous vibration, the frequency of such vibration being determined by the mass and the compliance of the several parts and to some extent also by the amplitude of the vibration.

To improve the frequency control, there is secured to the free end of the reed, in the region of armature or weight **15**, an adjustable weight generally denoted by reference character **22** and constituted of a ferromagnetic material. As it will be best observed in Fig. 2, this extension piece is preferably formed in a generally T-shaped configuration, having a transverse portion **23** and a longitudinal portion **24**. In the transverse portion there are provided a pair of apertures **25** through which the member may be secured to the free end of the reed by means of rivets or eyelets **26** extending therethrough and through corresponding openings in reed **14** and in armature **15**. After assembly of the reed structure, the longitudinal portion **24** of member **22** is bent upwards into the indicated position so that its free end comes under the maximum influence of pole piece **13** at the limit of the reed amplitude on the inertia side. It will be readily seen in Fig. 1 that when the driver coil is energized and will attract armature **15**, it will at the same time also attract the end of portion **24** of member **22**. The magnetic effect upon portion **24** will be only a small fraction of that upon the armature, due to its considerably greater distance from the pole piece. Nevertheless, since the adjustable portion **24** is located away from one side of the pole **13** while the armature **15** is situated away from the other opposite side of said pole in the rest position of the armature, the force created by the former will be oppositely directed to that of the attraction of the pole **13** upon the latter and, therefore, the mechanical effect upon portion **24** will be effective in extracting energy from the moving system. This reduction in the driving force will reduce the amplitude of vibration and thereby also the frequency at any particular amplitude. While normally the reed frequency increases with reed amplitude, by means of ferromagnetic member **22** the reed frequency may be caused to decrease with increasing amplitude, or to remain constant, depending on its adjustment with respect to pole piece **13**. To be operative, of course, the extension of member **22** must be under the influence of pole **13** while driver coil **12** is energized. Of particular practical importance is the possibility of so adjusting member or extension **22** as to maintain the operating frequency of the vibrator constant regardless of variations of amplitude because this permits stabilizing the frequency of vibrator operation although the operating voltage may be subject to substantial variations. The practical advantages of such an arrangement will be obvious if it is considered that vibratory interrupters are generally operated from storage batteries, the voltage of which may be subject to considerable variations.

In Fig. 3 a modified embodiment of the invention is illustrated in which an adjustable weight constituted of non-magnetic material, such as soft brass, is used. Reed **14** is identical with that of Fig. 1 and its lower or clamped portion is provided with a pair of apertures **27** through which the stack screws may extend. A transverse slot **28** is punched in the intermediate portion of the reed to provide weakened hinge sections and thereby to increase the compliance of the reed.

The reed has an upwardly tapering shape and ends in a transverse portion having substantially the same width as the stack portion of the reed upon which there is secured ferromagnetic armature or weight **15** and the adjustable weight generally denoted by reference character **29**. As it will be seen in Fig. 4, the adjustable weight is generally T-shaped, with a pair of holes **30** punched into its transverse portion **31** and has a narrow longitudinal portion, or extension, **32**. Adjustable weight **29** is secured to the upper end of reed **10** by means of rivets or eyelets **33** extending through apertures **30** in weight **29** and through corresponding apertures in both the reed and in armature **15**. A small opening **34** may be punched in the midportion of the adjustable weight thereby facilitating bending of longitudinal portion **32** in the desired position.

The adjustable weight illustrated in Figs. 3 and 4 being constituted of non-magnetic material, it is substantially unaffected by the magnetic field of pole piece **13**. Its effect upon the operating frequency of the vibrator is based on its changing the effective mass of the vibratory system. Thus, by bending extension **32** upwards, it will slightly increase the effective mass of the vibratory system, thereby decreasing its frequency, and vice versa. In this manner, it is possible to adjust the frequency of the vibrator after its assembly within the desired range, thereby assuring uniformity of the operating characteristics of vibrators manufactured on a quantity production scale.

The further modified embodiment of the invention shown in Fig. 5 is in most respects identical with the one depicted in Figs. 3 and 4 and similar reference characters have been employed to denote corresponding parts. The difference resides in forming the adjustable weight **35** of a bimetallic plate having the same shape as the non-magnetic adjustable weight **29**. Bimetallic plate **35** is riveted or otherwise secured to the reed and its longitudinal portion extending away from the reed is caused to bend under the effect of temperature changes. In this manner, the operating frequency of the vibrator may be caused to change with temperature changes or may be compensated against the effect of temperature changes. Thus, in general, the operating frequency of a vibrator decreases with increasing temperature. By proper selection of the two metals of which the bimetallic plate is constituted, element **35** may be caused to curve downwards with increasing temperature and thereby to increase the frequency by the same amount, so that the frequency of the vibrator remains constant regardless of temperature changes. In addition to the temperature-responsive effect of bimetallic weight **35**, it may be also manually adjusted by bending, to initially adjust the frequency of the vibrator to a desired value. In view of that fact, however, that the bimetallic plate functions best when its free portion is substantially at right angles to the plane of the reed, this initial adjustment should be kept within a narrow range and when greater range is desired it is preferred to provide a separate adjustable weight in addition to the temperature-responsive weight, as it will be set forth more fully hereinafter.

In all of the previous embodiments of the invention, the armature and the adjustable weight are provided in the form of two independent elements mounted on the free end of the reed. The vibratory structure and its assembly are considerably simplified when the armature and the adjustable weight are combined in a single ferro-

magnetic element, as this is shown in Figs. 6 and 7. Reed 14 is identical with the reed of the previously described embodiments and has adjustable weight 36 secured to its free end, the said weight being generally T-shaped with a transverse portion 37 constituting the armature and a longitudinal portion, or extension 38 constituting the adjustable weight proper. The transverse portion is provided with two apertures through which there may extend rivets 39 to secure the same to the free end of reed 14. A hole 40 is provided in the midportion of weight 36 to facilitate adjustment of extension 38. This combination armature and adjustable weight has been found very satisfactory in practical operation and frequency adjustment within close tolerances has been readily obtained without any detrimental influence on the normal operation of the vibrator. It has been found more satisfactory than other forms of adjustable weights with respect to the range of adjustment, facility of assembly, and freedom from operational interference.

From the foregoing considerations it is clear that manually or automatically adjustable weight may be advantageously employed for the following purposes:

1. Adjustment of frequency.

The frequency of the vibrator may be readily adjusted to the desired value after the assembly by means of the embodiments of the invention shown in Figs. 3 and 4 and Figs. 6 and 7.

2. Frequency-temperature compensation.

The frequency of a vibrator may be maintained constant regardless of temperature changes by means of the embodiment of the invention shown in Fig. 5.

3. Frequency-voltage compensation.

Frequency change with voltage in a vibrator may be greatly reduced or even completely eliminated by means of the embodiment of the invention shown in Figs. 1 and 2.

In some instances it is desirable to combine two, or more frequency-controlling elements of different type in a single vibrator. As it has been set forth in the foregoing, both frequency adjustment and temperature compensation may be obtained by means of a single bimetallic weight initially bent into a desired shape and subjected to further changes in shape by the effect of temperature changes. However, a large decrease in the temperature effect on the bimetallic member is produced if it is initially so adjusted that the extension on said member to too nearly parallel to the reed. In other words, the preferred conditions of obtaining a good temperature control and a good frequency adjustment cannot be easily reconciled. Therefore, it is preferred to provide a separate member for the temperature compensation and for the frequency adjustment. A modified embodiment of the invention accomplishing this result is shown in Figs. 8 and 9. It will be noted that the illustrated structure is simply a combination of Fig. 5 and of Fig. 6, one side of reed 14 carrying the bimetallic weight 35, while the other side thereof is carrying the ferromagnetic adjustable weight 36 combined with the armature. Preferably, the extension of the bimetallic member is adjusted to be normally at right angles to the reed. The operation of this modified embodiment of the invention is obvious and will be readily understood by those skilled in the art without any detailed description.

When it is desired to provide compensation for voltage changes and also adjustment of the frequency, the embodiments of Fig. 1 and of Fig. 6 may be combined in a single vibrator. (Fig. 10.) In this case a ferromagnetic member 22 is mounted at the end of reed 14 and provides compensation for voltage or amplitude changes by initially bending its extension into such a position that it is under the influence of pole piece 13. The frequency may be adjusted by means of another ferromagnetic piece 36, combining the armature and the adjustable weight in a single piece, which is so mounted that its adjustable portion or extension 38 is not under the influence of the pole piece 13.

Fig. 11 shows a further modified embodiment of the invention in which compensation for voltage changes is combined with compensation for temperature changes. This is accomplished by mounting on the free end of reed 14 a ferromagnetic weight 22 of the type shown in Fig. 1, with a bimetallic weight 35 of the type shown in Fig. 5. Finally, in Fig. 12 there is shown a vibratory structure in which provision is made for temperature compensation, voltage compensation and also for initial adjustment of frequency. This embodiment of the invention comprises a ferromagnetic member 22 of the type shown in Fig. 1 with its adjustable portion extending into such a position as to be influenced by the field of pole piece 13. In general, the extension will be adjusted to an angle less than 90 degrees to the reed plane. Temperature compensation is obtained by means of a bimetallic piece 35, the extension of which is preferably at right angles to the plane of the reed. The adjustable weight 36 is constituted of ferromagnetic material but it is so arranged that its adjustable end is not under the influence of the pole piece. It is desirable to provide for adjustment of extension 38 of member 36 through almost 180 degrees in order to obtain the maximum range of control. For this reason, it is preferred to mount it in such a manner as is indicated in Fig. 12 so that the other weights do not interfere with its bending. Members 22, 35, and 36 are provided with registering apertures and are secured to the free end of the reed by means of rivets or eyelets 39.

It will be noted that the principles of the invention provide a number of important advantages. Thus, first of all, means are provided to readily adjust the operating frequency of a vibrator to a desired value without critical parts selection so that uniform operating characteristics may be obtained and maintained in quantity production. Also, the first time in the history of the art, it is made possible to maintain the frequency of a vibrator constant regardless of temperature changes and of changes in operating voltage. Moreover, the structures embodying the invention are extremely simple and inexpensive in character and may be easily applied to conventional vibrators without any expensive changes in the manufacturing equipment or procedure.

While the present invention, as to its objects and advantages, has been described as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A vibratory electromagnetic motor comprising in combination a vibratory reed clamped at one end thereof and carrying a ferromagnetic armature at the other end thereof, a system of contacts operable by said reed, a driver coil adapted to be periodically energized through said

contacts to apply deflecting force to said armature and thus to maintain the reed in vibration, and a deformable ferromagnetic metallic plate having a transverse portion fixed on said reed away from the clamped end thereof and having a longitudinal portion adapted to be bent with respect to the reed to be adjusted in a magnetic sense with respect to said driver coil thereby to control the operating frequency of said interrupter.

2. In a vibratory electromagnetic motor including a reed mounted for vibration with electromagnetic driving means therefor, the improvement which comprises a deformable ferromagnetic metal plate having one end secured to said reed and having a free portion adapted to be bent with respect to the longitudinal axis of the reed and to be adjusted in a magnetic sense with respect to said driving means thereby to vary the operating frequency of the interrupter, and a weakened region in said plate to facilitate bending thereof in such region.

3. A vibratory electromagnetic motor comprising in combination a vibratory reed clamped at one end thereof, a ferromagnetic member having one portion secured to the free end of said reed to constitute an armature therefor and having another portion deformable for adjusting the frequency of vibration of said reed through a combined change of initial reed balance and of magnetic braking, said deformable portion having a differential magnetic effect upon said armature during its motion, a system of contacts operable by said reed, and a driver coil adapted to be periodically energized from a source of current through said contacts thereby to maintain the reed in vibration.

4. A vibratory electromagnetic motor comprising in combination a vibratory reed clamped at one end thereof, a ferromagnetic plate having a transverse portion secured across the free end of said reed and forming an armature therefor and having a deformable longitudinal portion forming an adjustable weight as well as a magnetic break for the reed, said deformable portion having a differential magnetic effect upon said armature during its motion, a system of contacts operable by said reed, and a driver coil adapted to be periodically energized from a source of current through said contacts to apply deflecting force to said armature thereby to maintain the reed in vibration, the frequency of said vibration being adjustable by bending the deformable portion of said weight for a new initial position in a magnetic sense with respect to said coil.

5. A vibratory electromagnetic motor comprising in combination a vibratory reed, a system of contacts operable by said reed, means including a driver coil under the control of said contacts for maintaining the reed in vibration, and a ferromagnetic member secured to said reed and having an extension protruding into a position where it is under the influence of said coil to produce a differential magnetic effect upon said armature during its motion whereby said member will withdraw energy from the vibratory system of said interrupter and will reduce the operating frequency thereof.

6. A vibratory electromagnetic motor comprising in combination a vibratory reed, a system of contacts operable by said reed, means including a driver coil periodically energized under the control of said contacts and a pole piece for maintaining the reed in vibration, and a ferro-magnetic member having one end secured to the free end of said reed and having a portion extending therefrom into a position where it encloses an angle less than 90 degrees with the plane of the reed, said portion being under the influence of said pole piece to produce a differential magnetic effect upon said armature during its motion and thereby being capable of maintaining the operating frequency of the interrupter constant regardless of changes in input voltage.

7. A vibratory electromagnetic motor comprising in combination a vibratory reed, a system of contacts operable by said reed, means including a driver coil periodically energized under the control of said contacts and a pole piece for maintaining the reed in vibration, a ferromagnetic weight secured to said reed and having an extension under the influence of said pole piece to produce a differential magnetic effect upon said armature during its motion stabilizing the frequency of said interrupter against voltage changes, and a temperature-responsive bimetallic weight secured to said reed for changing the initial balance of said reed and for stabilizing the frequency of said interrupter against temperature changes.

8. In a vibratory electromagnetic motor including a reed mounted for vibration and electromagnetic driving means therefor, the improvement which comprises a bimetallic plate having one end secured to said reed near the free end thereof as part of an armature and having its other end extending away from said reed in the form of a balance substantially normal thereto, the free end of said plate responding with changes of shape to temperature changes without changing the armature air gap, the operating frequency of the vibrator being maintained constant by correcting the altered initial balance of said reed due to such temperature changes.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
338,261	Gaiser	Mar. 23, 1886
533,108	Wirt	Jan. 29, 1895
1,202,392	Jepson	Oct. 24, 1916
1,944,487	Bertschi	Jan. 23, 1934
2,061,920	Piffath	Nov. 24, 1936
2,065,597	Mastney	Dec. 29, 1936
2,172,202	Johnson	Sept. 5, 1939
2,280,610	Young	Apr. 21, 1942