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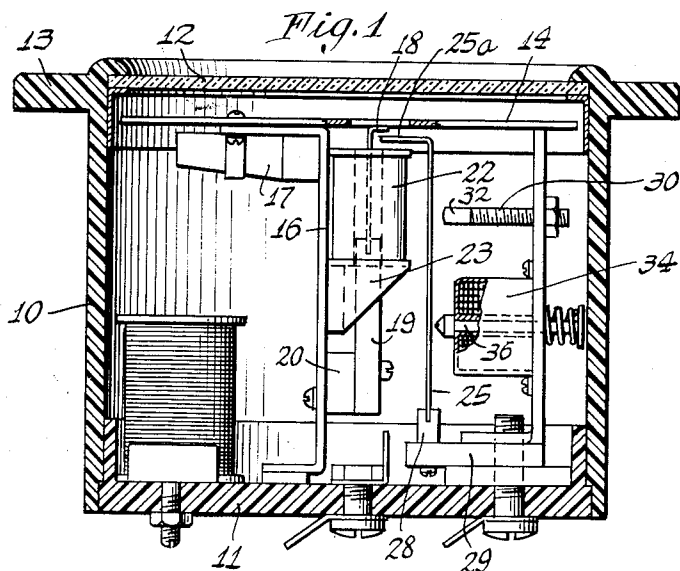
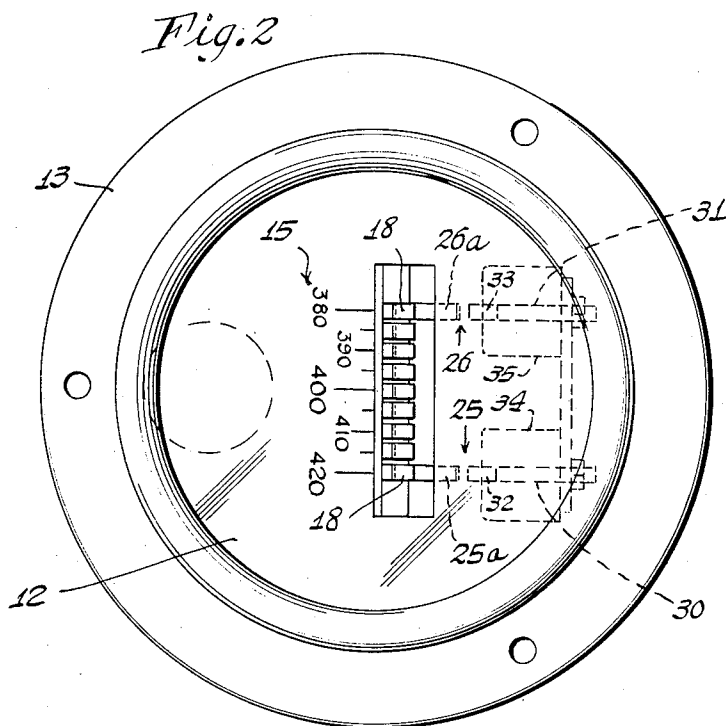
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FREQUENCY-RESPONSIVE RELAY AND INDICATOR

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2 Sheets-Sheet 1



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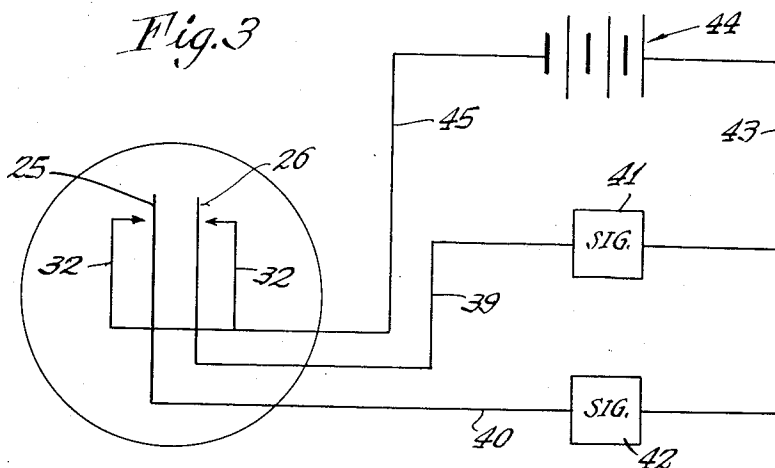
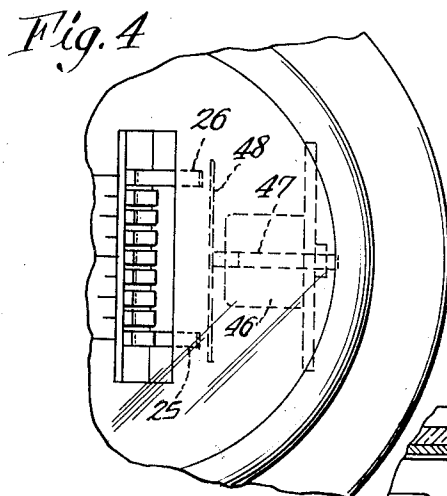
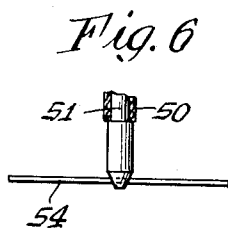
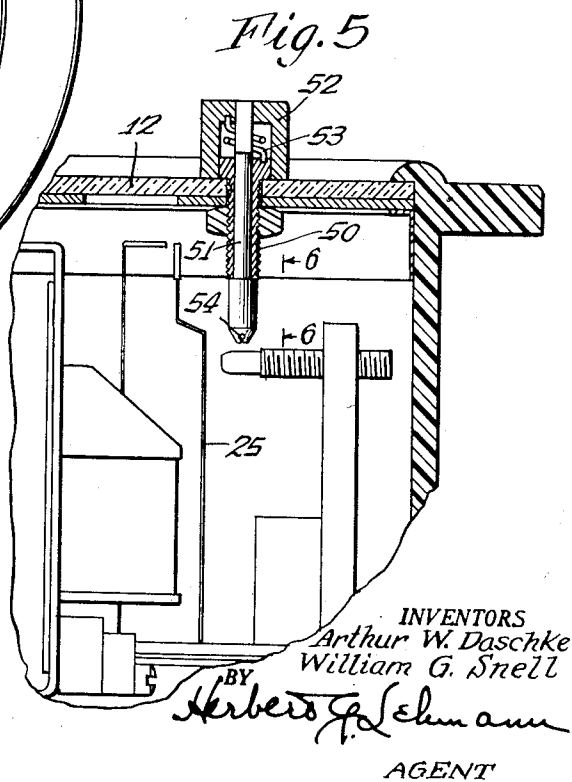
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FREQUENCY-RESPONSIVE RELAY AND INDICATOR

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18 Claims. (Cl. 324—80)

This invention relates to frequency-responsive devices, and more particularly to frequency-responsive electrical relay mechanisms.

In the past there have been provided a number of electro-responsive devices intended to effect a control when the frequency of impressed energy attained a certain value. Some devices intended for this purpose have been in the nature of frequency meters having vibratile reeds, and having incorporated therein electrical contacts adapted to be actuated whenever the impressed energy has a given frequency. Such devices are subject to a number of drawbacks. For one thing, the action of the contacts is of necessity characterized by extremely light pressure, and accordingly may at times be unreliable. For another thing, all contacts of necessity have a certain weight and mass, and this must be accurately determined and accounted for in the vibratile system, in order that the accuracy in the indication and reliability of the control be maintained.

A still further drawback of these prior devices resided in the fact that the contact was of an intermittent nature and not steady, and accordingly allowance had to be made or further equipment had to be provided, if such operating characteristic were not suitable for the desired end result.

The above drawbacks and disadvantages of these prior frequency-responsive devices or relays are obviated by the present invention, and one object of the invention is to provide a novel and improved frequency-responsive relay which provides a positive, firm and steady electrical contact, to effect the desired condition or control.

Another object of the invention is to provide an improved relay device as above set forth, wherein dependence is not had on lightly-touching or intermittently-touching contacts.

A further object of the invention is to provide an improved frequency relay as above set forth, which is characterized by constantly closed or constantly open electrical contacts associated with but not carried by the vibratile elements, the organization being such that no permanent mechanical connections to said elements is necessary nor permanent engagement therewith by any movably mounted parts or components.

Still another object of the invention is to provide an improved relay device of the type having vibratile elements, wherein there are no adverse effects on the resonant period of said elements by such factors as impact forces or sticking between engaging contacts.

Yet another object of the invention is to provide a novel and improved vibratile-element type of frequency-responsive relay which is devoid of all contacts on the said elements.

A further object of the invention is to provide an improved frequency-responsive relay wherein an indication or control is effected by contacts which are separate from the vibratile elements and are under the influence of magnetic flux.

A still further object of the invention is to provide an improved frequency-responsive relay as above set

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forth, which incorporates a frequency meter movement by which both an indication and control is had, in response to frequency changes in a source of electrical energy.

An important feature of the invention resides in the provision of a frequency-responsive relay having magnetically influenced contacts as above set forth, wherein there is minimized the effects on the contacts of stray flux from the driving coil for the vibratile elements.

Another feature of the invention resides in the provision of an improved frequency-responsive device of the above type, which is relatively small and compact, requiring but little space.

Other features of the invention reside in the provision of an improved frequency-responsive meter and relay device as above characterized, which has high sensitivity, is extremely simple in its construction, economical to fabricate, and reliable in operation.

Still other features and advantages will hereinafter appear.

In the drawings accompanying this specification, similar characters of reference indicate corresponding parts wherever possible in the several views, in which:

Figure 1 is an axial sectional view of a frequency-responsive relay and meter made in accordance with the invention.

Fig. 2 is a front elevational view of the device shown in Fig. 1.

Fig. 3 is a schematic circuit diagram of a signal system embodying the improved frequency relay and meter.

Fig. 4 is a fragmentary front elevational view on the order of Fig. 2, but illustrating another embodiment of the invention, wherein a single reset solenoid is employed.

Fig. 5 is a fragmentary axial sectional view somewhat like Fig. 1, but illustrating a wholly mechanical or manual type of reset device.

Fig. 6 is a fragmentary elevational view taken on line 6—6 of Fig. 5.

As shown, the improved frequency meter and frequency-responsive relay of the present invention comprises a casing 10 having a transverse rear or back wall 11 and a transparent front window 12, the latter being disposed within a peripheral mounting flange 13.

Within the casing 10 and behind the window 12 there is provided a scale 14 having indicia 15 indicating frequency values or other desired data.

The scale 14 is carried by U-shaped brackets 16 mounted as shown on the rear transverse wall 11 of the casing 10. Also carried by the brackets 16 is a permanent magnet 17 adapted to provide a magnetic field or flux pattern for a plurality of vibratile reeds 18 carried by mounts 19 secured by means of a block 20 to the brackets 16. The reeds 18 may be of any usual number, nine being shown in Fig. 2, corresponding respectively to five cycle intervals in a frequency band of from 380 to 420 C. P. S.

The reeds 18 thus constitute a set, having respective resonant periods five cycles apart. To actuate the reeds 18 there is provided a driving coil 22 encircling the same and carried by a coil bracket 23 secured to the U-shaped brackets 16.

In accordance with this invention there is provided a novel and improved, greatly simplified and yet extremely effective relay or circuit-controlling means adapted to be actuated when either of the extreme end reeds 18 of the set is caused to oscillate by virtue of the frequency of such reed occurring in the coil 22. Thus, an indication or a control may be had at a remote point, whenever the frequency impressed on the coil 22 drops to 380 C. P. S. or rises to 420 C. P. S. This improved circuit-controlling or relay means is independent of all permanent connections to the reed 18 yet is adapted to have certain forces or impulses transmitted to it momentarily

by such reeds during substantial oscillations of the latter. The circuit controlling means is characterized by contacts which are magnetically influenced or operated, both for closing the circuit and also thereafter for opening the circuit.

As shown, we provide a pair of movable contact members 25 and 26 which are preferably also vibratile and are carried by means of mounting blocks 28 and 29 on the rear transverse wall 11 of the casing 10. The vibratile contacts 25 and 26 are in the nature of reeds extending forwardly from the transverse wall 11 substantially parallel to the reeds 18 and at their front extremities having angularly bent end portions 25a and 26a extended toward the end reeds 18 and adapted to be struck by the latter when either of said reeds is oscillating in synchronism with a frequency applied to the driving coil 22. Normally, as shown in Fig. 1, the meter reeds 18 and the bent extremities 25a and 26a of the members 25 and 26 are spaced apart a certain distance. However, should either of the two end reeds 18 oscillate appreciably, it will strike the associated one of the members 25, 26 and cause the latter to be deflected.

By the present invention, such deflection is utilized to effect a continuous closing of an electrical circuit, and in accomplishing this we provide a pair of electrical contact members 30 and 31 carrying permanent bar magnets 32 and 33 respectively, said magnets being in close proximity to the members 25 and 26. Also, the said members 25 and 26 are made magnetic, so as to be attracted by the magnets 32 and 33. Normally, when there is no activity of the end reeds 18 of the meter, the contact members 25 and 26 will remain spaced from the contacts 30 and 31. However, upon either of the end reeds 18 vibrating and striking the associated member 25, 26, the deflection imparted to said member will be sufficient to enable the magnetism from the magnets 32 or 33 to attract and shift the member, causing engagement of the latter with the magnet and therefore with the contact member 30 or 31 carrying the magnet. Thus a circuit will be closed between either of the members 25, 26 and the associated contact member 30, 31 as a consequence of one of the end reeds 18 being set into synchronous vibration. The attractive force of the magnets 32, 33 will retain the contacts thus established, maintaining the circuit closed even though the end reed 18 which has caused said closure should stop vibrating. Thus a latching effect is had, and the present frequency-responsive relay may thus be considered as a latching relay.

For the purpose of separating the members 25, 26 from their associated magnetic contacts 32, 33 there are provided solenoids 34 and 35, having plungers 36 adapted to engage and drive the members 25, 26 from right to left, as viewed in Fig. 1. Thus energization of either of the solenoids 34 or 35 will be effective to open the circuits controlled by the members 25, 26, at the will of the operator.

We have found that, by the above organization, there is provided an extremely simple, effective and reliable latching-type relay which is highly sensitive and responsive to certain predetermined frequencies. With the instrument as shown, frequencies of either 380 or 420 C. P. S. impressed on the driving coil 22 will cause closure of one or the other of the controlling circuits associated with the members 25, 26. Thus a remote indication may be had of the shift of frequency, or a control to reverse the frequency shift, in accordance with well-known procedures. The control for reversing the frequency shift may also be utilized to energize momentarily the proper one of the solenoids 34, 35, thereby to again interrupt and open the controlling circuit.

It is preferred that the members 25 and 26 have a frequency substantially different from that of the end reeds 18 which impart forces to said members, the frequencies of said members being preferably of a lower

order of magnitude so as to prevent undue influence on the members of stray flux from the driving coil 22.

A circuit illustrating the use of the frequency relay of the invention is shown in Fig. 3, wherein the contact reeds 25 and 26 are connected with leads 39 and 40 respectively leading to "high" and "low" electrical signals 41, 42, said signals being connected to a supply wire 43 energized by a battery 44. A common lead joins the contacts 32 and 33 to the battery 44. It will be understood that the signals 41, 42 may be electric bulbs, buzzers or any other desired type of signal means.

Another embodiment of the invention is shown in Fig. 4, wherein the reset comprises a single solenoid 46 having a plunger 47 to which there is attached a reset bar 48 adapted to engage the contact reeds 26 and 25. Energization of the solenoid 46 will cause movement of the reset bar 48 from right to left, as viewed in Fig. 4, thereby to disengage whichever one of the contact reeds 25 or 26 is being held by the associated magnet contact.

A still further embodiment of the invention is illustrated in Figs. 5 and 6, wherein a wholly mechanical or manual reset device is provided instead of the solenoid-actuated reset devices shown in the preceding figures.

Referring to Fig. 5, the window 12 has secured to it a bearing bushing 50 in which there is turnably carried a spindle 51 having a manually-engageable knob 52 which is normally held in a predetermined rotative position by a torsion spring 53. The spindle 51 carries a reset bar 54 arranged to engage either one or the other of the contact reeds 25, 26, to disengage the same from its associated contact upon a proper turning movement being imparted to the knob 52. Upon release of the knob 52, the spring 53 will, of course, return the reset bar 54 to a neutral position wherein either of the reeds 25, 26 may engage its associated contact.

It will be understood that with the improved contact organization as provided by this invention, an appreciable current capacity is available to handle the signals 41 and 42 without requiring further relays or amplification. This is because the inertia of the contact reeds 25, 26 does not enter into the vibration characteristics of the indicating reeds 18, and therefore the contact reeds may be designed to obtain the full benefit of a relatively large current carrying capacity.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

We claim:

1. A frequency-responsive relay comprising a vibratile member adapted to vibrate at a given frequency, said member having portions of low and high amplitude of vibration; means for causing vibration of said vibratile member; a movable member normally held in a given position spaced from the vibratile member when the latter is at rest, said movable member having portions of low and high amplitude of vibration; means for moving said movable member in a direction away from said given position and holding said member in a second position in response to initiation of movement of said member toward said second position said means including a third member at all times at least closely spaced from said movable member; circuit controlling means actuated in response to movement of said movable member between said positions; and means for imparting force to said movable member in response to vibration of the vibratile member at its given frequency whereby the movable member is continuously held in said second position, said force-imparting means including a driving connection between the high-amplitude portions of said members, said connection being substantially inoperative to impart force when the movable member is in its said second position, the vibratile member being thereby substantially wholly free for substantially unhampered high-amplitude vibration as a consequence of its initial vibration at its said given frequency.

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2. The invention as defined in claim 1 in which there is an optionally-operable means for returning the said movable member from the said second-mentioned position to the said given position.

3. The invention as defined in claim 2 in which the optionally-operable means comprises a solenoid having a plunger adapted to actuate the said movable member.

4. The invention as defined in claim 1 in which the movable member is vibratile and adapted to vibrate in response to impulses applied to it.

5. The invention as defined in claim 4 in which the movable member has a resonant frequency substantially removed from the frequency of the vibratile member.

6. The invention as defined in claim 5 in which there is a driving coil for causing vibration of the vibratile member, and in which the said movable member is magnetic and disposed in the field of influence of the said driving coil.

7. The invention as defined in claim 5 in which the vibratile member and the movable member comprise reeds disposed in spaced, parallel relation to each other, and in which there is a driving coil disposed at one side of the movable member and surrounding the vibratile member to impart oscillations to the latter.

8. The invention as defined in claim 7 in which the means for moving and holding the movable member comprises a permanent magnet disposed adjacent the side of said member which is away from the driving coil, and in which there is a second permanent magnet disposed adjacent the driving coil and located remote from said first-mentioned magnet, said second permanent magnet providing a field for the said vibratile member.

9. The invention as defined in claim 4 in which the means for moving and holding the movable member comprises magnetic material thereon and a permanent magnet adapted to attract said magnetic material.

10. The invention as defined in claim 9 in which the circuit controlling means comprises contacts respectively on the movable member and permanent magnet.

11. The invention as defined in claim 1 in which the means for moving and holding the movable member comprises a permanent magnet and a magnetic armature therefor.

12. The invention as defined in claim 2 in which the movable member comprises a reed anchored at one end, in which the means for moving and holding the movable member comprises a permanent magnet disposed adjacent the free end of the member, and in which the optionally-operable means comprises a solenoid disposed adjacent the anchored end of the member.

13. A frequency-responsive relay device comprising a set of juxtaposed vibratile members having different resonant frequencies, each of said members having different portions of low and high amplitude of vibration; a scale having indicia to which said members may be referred; means for causing vibration of said vibratile members; a pair of movable members associated respectively with two vibratile members of said set, each of said movable members having different portions of low and high amplitude of vibration, said members being normally held in given positions spaced from the respective vibratile members when the latter are at rest, the high-amplitude portions of said vibratile and movable members being juxtaposed; means for moving said high-amplitude portions of said movable members in directions away from said given positions and holding said portions in second positions in response to initiation of movements of said members toward said second positions, said moving means including a pair of third members respectively associated with said movable members and at all times at least closely spaced therefrom; circuit controlling means actuated in response to movements of said high-amplitude portions of the movable members between said positions; and a pair of means for imparting forces respectively to said movable members in response to vibra-

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tion of the vibratile members at their given frequencies, to cause the said initial movements of the movable members whereby the same are in consequence continuously held in their said second positions, said force-imparting means including driving connections between the high-amplitude portions of said vibratile and movable members, said connections being substantially inoperative to impart force when the movable members are in their said second positions, the vibratile members being thereby substantially wholly free for substantially unhampered high-amplitude vibration as a consequence of their initial vibration at their said given frequencies.

14. A combined frequency meter and frequency-responsive relay device comprising a set of juxtaposed vibratile reeds having free ends and having different resonant frequencies; a driving coil surrounding said reeds; a scale having indicia, to which said reeds may be referred; a pair of flexible strips disposed outside of the driving coil and associated respectively with two vibratile reeds of said set, said flexible strips being spaced from the vibratile members when the latter are at rest and being normally held in given positions; means for moving said strips in directions away from said given positions and holding said strips in second positions in response to initiation of movements of said strips toward said second positions, said means including magnets at all times at least closely spaced from said strips respectively; circuit controlling means actuated in response to movements of said strips between said positions; and means for imparting forces to one or the other of said strips to cause the said initial movement thereof in response to vibration of one or the other of the said two vibratile reeds at its given frequency, the high-amplitude portions of said reeds and strips being juxtaposed and engageable with each other when the strips are in the said given positions, said reeds vibrating freely at high-amplitude and being out of contact with said strips when the latter are in their second positions.

15. The invention as defined in claim 2 in which the optionally operable means for returning the movable member comprises a movably-mounted operable part having an extension adapted to actuate the said movable member.

16. The invention as defined in claim 13 in which there is an optionally-operable means for returning said strips from the second-mentioned positions to the said given positions, said optionally operable means comprising a movably-mounted, manually-operable member having a pair of extensions adapted to respectively engage said strips.

17. A combined frequency meter and frequency-responsive relay device comprising a vibratile member adapted to vibrate at a given frequency, said member having different portions of low and high amplitude of vibration; a driving coil surrounding said vibratile member; a scale having indicia, to which said vibratile member may be referred; a movable member disposed outside of the driving coil and associated with said vibratile member, said movable member having different portions of low and high amplitude of vibration and being normally held in a given position wherein the high-amplitude portion thereof is spaced from the vibratile member when the latter is at rest, both high-amplitude portions of said vibratile and movable members being juxtaposed; means for moving the high-amplitude portion of the movable member in a direction away from the said given position and for holding said portion in a second position in response to initiation of movement of said high-amplitude portion toward said second position, said moving means including a third member at all times at least closely spaced from said movable member; circuit-controlling means actuated in response to movement of said high amplitude portion of the movable member between the said positions; and means for imparting force to said movable member in response to vibration of the vibratile

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member at its given frequency, to cause the said initial movement of the movable member whereby the same is in consequence continuously held in said second position, said force-imparting means including a driving connection between the high-amplitude portions of said members, said connection being substantially wholly free for substantially unhampered high-amplitude vibration as a consequence of its initial vibration at its said given frequency.

18. A combined frequency meter and frequency-responsive relay device comprising a set of juxtaposed vibratile members adapted to vibrate at different given resonant frequencies, each of said members having different portions of low and high amplitude of vibration; a driving coil surrounding said members; a scale having indicia, to which said members may be referred; a pair of movable members disposed outside of the driving coil and associated respectively with two vibratile members of said set, each of said movable members having different portions of low and high amplitude of vibration and being normally held in a given position spaced from its associated vibratile member when the latter is at rest, the high-amplitude portions of said vibratile and movable members being juxtaposed; means for moving the high-amplitude portions of said movable members in directions away from said given positions and for holding said portions in second positions in response to initiation of movements of said high-amplitude portions toward said second positions, said moving means including a pair of third members respectively associated with said movable

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members and at all times at least closely spaced therefrom; a circuit-controlling means actuated in response to movements of said high-amplitude portions of the movable members between the said positions thereof; and a pair of means for imparting forces respectively to said movable members in response to vibration of the vibratile members at their given frequencies, to cause the said initial movements of the movable members whereby the same are in consequence continuously held in their second positions, said force-imparting means including driving connections between the high-amplitude portions of said vibratile and movable members, said connections being substantially inoperative to impart force when the movable members are in their said second positions, the vibratile members being thereby substantially wholly free for substantially unhampered high-amplitude vibration as a consequence of their initial vibration at their said given frequencies.

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