June 21, 1938. A. E. MELHOSE 2,120,985

ELECTROMAGNETIC DEVICE

Filed Sept. 19, 1936

FIG. 1

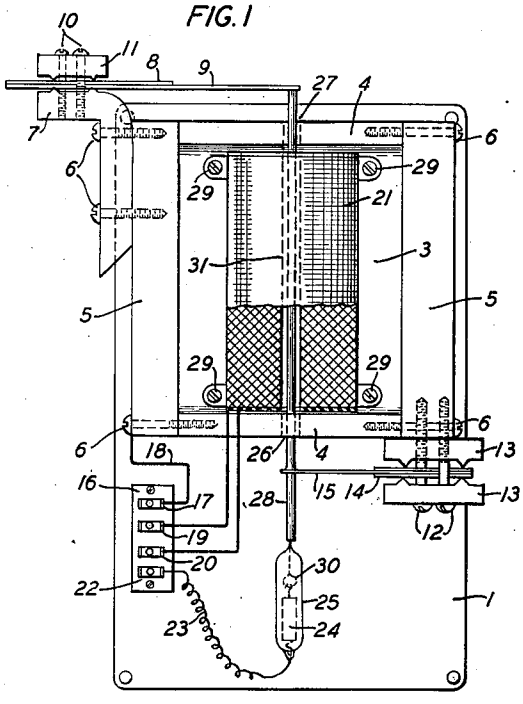
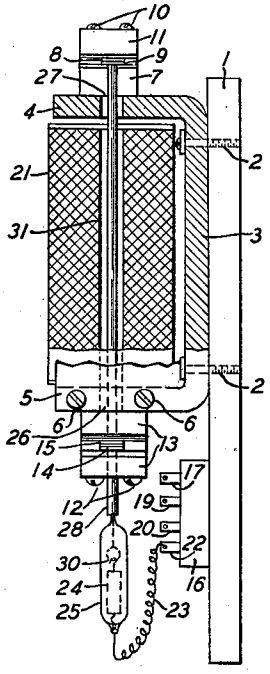


FIG. 2



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ELECTROMAGNETIC DEVICE

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7 Claims. (Cl. 200—90)

This invention relates to electromagnetic devices and more particularly to a device for reproducing current variations such as are ordinarily encountered in telephone transmission, such devices being commonly termed telephone relays or repeaters.

It is an object of this invention to utilize, in a telephone relay which operates on currents within the voice frequency range, that property of certain magnetic materials by virtue of which a change in length is produced by means of variations in the intensity of the magnetizing force to which such piece of material is subjected. This property of magnetic materials is generally termed "magneto-striction" and will be utilized, in the present invention, by a core or rod having this magneto-strictive property supported within an energizing coil and free to undergo changes in dimension under the influence of a variable current traversing the coil.

Ordinarily, when a rod is stimulated magnetically by the exciting field, it becomes slightly mechanically deformed or distorted by magneto-striction. The resulting increment of deformation may be a lengthening, or a shortening, or some other distortion, depending on the material and on the polarity of the magnetic field. The mechanical deformation of the rod is produced by exciting reversible internal stresses therein and the rod readily recovers upon withdrawal of the deforming forces. If the current is alternating, the electromagnetic field created thereby will also be alternating and the rod will increase and decrease in length (let us say) many times a second, every variation in the current producing its stimulative effect on the rod. The rod will, in consequence, vibrate mechanically by magneto-striction with a period of vibration equal to the period of the alternating electromotive force. Ordinarily these vibrations will be quite small, but when the alternating frequency is close to, or substantially the same as, the natural frequency of the rod, the amplitude of vibration of the rod, though still small, becomes relatively quite large, with the result that the resonant response of the rod is very sharp and pronounced. In telephone relays which are adapted to respond to currents within the voice range, the frequency of the current is relatively high and a relay which would utilize a magneto-strictive element for longitudinal resonance would be of prohibitive length. Thus a relay tuned to respond to a current of 1200 cycles per second would require a vibrating element 45 inches in length. One of the objects of this invention, therefore, is to avoid this difficulty by coupling a magneto-striction vibrating element of much smaller dimension and necessarily having a smaller natural frequency, to one or more reeds having natural frequencies of vibration in the audible range, the whole producing a vibrating system having a mechanical resonance point equal to the frequency of the exciting current.

Another object of the invention is the use of a pair of inertia contacts in combination with the vibrating magneto-striction element of the relay in order that the relay may be extremely sensitive in controlling, through these contacts, a secondary circuit at the frequency of the current to which the magneto-striction element responds. To attain this object, a sealed receptacle, preferably of glass, is suitably affixed to the unsupported end of the magneto-striction element or rod which has within it a looped conducting terminal electrically continuous with the magneto-striction rod and with a binding post to which one side of a controlled circuit may be extended, and a loose contact member freely suspended from said terminal and connected to a lead-in wire extending to another binding post to which the other side of said controlled circuit may be extended. When the rod vibrates in response to the train of magnetic oscillations set up by the current traversing the coil of the relay, it will have the effect of causing the looped conducting terminal to be violently agitated at the frequency of the rod thereby opening the controlled circuit at the same frequency and causing the current therein to fluctuate at the same period as the current traversing the coil.

A clearer conception of the scope and purpose of the invention may be had by considering the following description and attached drawing in which

Fig. 1 shows a front elevation of one embodiment of the relay of my invention; and

Fig. 2 shows a right side view of Fig. 1 with the portion above the lower end of the coil cut away to show the relation between the magnetic structure, the coil and the magneto-striction rod.

Considering the figures in which identical designations in each of the figures refer to identical parts, 1 shows a rectangular base of insulating material to which, by means of screws 2—2, is centrally secured the soft iron magnetic bracket 3 having the polar extensions 4—4, the upper extension of which may be aligned, if desired, with the top edge of the base. Each side of the bracket is rigidly braced by non-magnetic metallic members 5 secured thereto by screws 6, the

purpose of said braces being to avoid the effect of resonance of the structure on the vibration of the reeds, as more particularly described hereinafter. To the left upper side of the left brace 5 is rigidly attached, also by means of screws 6, the bracket member 7 having two knife-edge supports upon which the spring 8 and the reed 9 are clamped by screws 10 extending through the clamping plate 11, also having two knife edges, into bracket member 7. To the lower edge of the right brace 5 are rigidly attached, by means of screws 12, the rectangular clamping plates 13, each provided with two knife edges between which the spring 14 and the reed 15 are clamped.

On the lower left-hand side of the base is further secured the binding post panel 16 carrying the binding post 17 which is connected to the metallic frame of the relay by means of conductor 18, the binding posts 19 and 20 which are connected to the coil 21 of the relay, and the binding post 22 which, by means of lead-in conductor 23, is connected to the suspended contact member 24 inclosed in the receptacle 25.

Within the two polar projections 4—4 of the magnet bracket 3 and centrally secured to the base 1 by means of the four screws 29 is the coil 21 provided with a central sleeve 31 aligned with the openings 26 and 27 in the polar extensions 4 of the bracket 3.

The magneto-strictive element 28 is a long thin core or rod of suitable magnetic material whose change in length accompanies the variations in the intensity of the magnetizing force produced by the current traversing the coil 21. It extends through the sleeve 31 and the aligned openings 26 and 27 and is secured at its upper end to the end of the tuned reed 9 and near its lower end to the tuned reed 15. Attached to the lower end of the rod 28 is a tubular sealed receptacle 25, preferably of glass, which may be simply sealed, or which may be evacuated or may contain a gas as desired to reduce the effects of atmosphere and dust and to prevent oxidation of the parts inclosed therein. Within the receptacle is a looped contact element 30 which is electrically continuous with the rod 28 and, therefore, with the binding post 17 because of the continuity of the metallic parts and of conductor 18 connected to the left brace 5. From the loop 30 the contact bob 24 is suspended by a hooked conductor, the other end of said bob being connected to one end of a sealed-in conductor 23 which extends to binding post 22. The weight of the bob is such that when the rod 28 increases in length upon vibration and the contact element 30 breaks the connection with the suspension hook of the bob 24, the inertia of the bob will be sufficient to cause it to remain momentarily suspended without support and without dropping from its position until it can be re-engaged again by the contact element 30 when the rod 28 shortens in length on the reversal of the magnetizing force.

When the relay structure above described is placed in a circuit that supplies the coil 21 with an alternating current, say within the voice frequency range, the alternations in the current will produce changes in length in the magneto-striction rod 28, and if the natural frequency of the entire vibrating system comprising the tuned reed 9 and associated spring 8, the rod 28, the tuned reed 15 and the associated spring 14, is resonant with the frequency of the current, the contact loop 30, being attached to the rod, will vibrate at the same frequency as the rod and break the continuity of any circuit established through the contact element 30 and the bob contact 24 at the same frequency. Inasmuch as the time of contact is very small, the current alternations will cause the loop contact 30 to re-establish connection with the bob contact 24 before the force of gravity can disturb the vertical position of the latter, thus causing a vibration of the "repeated" or secondary circuit controlled through the contacts to be established and broken at the same frequency as the current traversing the coil.

The natural period of the vibrating system can, of course, be varied by changing the tuning of the reed 9 or 15 by means of their respectively associated springs 8 and 14, which can be done by increasing or decreasing the pressure of the clamps 7, 10 and 13 or by shortening the length of each of the springs. In this way the vibrating system of the relay can be suitably adjusted to resonate at any other frequency desired, resonance of the magnetic structure being prevented by the braces 5 secured to either side of the magnet bracket 3.

What is claimed is:

1. In an electromagnetic apparatus, the combination with a coil, of a mechanical system adapted to vibrate at the frequency of an alternating current traversing said coil and comprising a magneto-striction rod held coaxially within said coil by two reed supports, and a contact receptacle attached to one end of said rod having inclosed within it one electrode electrically integral with said rod and another electrode suspended from said first electrode and adapted to break contact therewith on the vibration of said rod.

2. In an electromagnetic device, the combination with an energizing coil, of a rod adapted to resonate at the frequency of the current traversing said coil, a contacting element integral with said rod and a gravity contact freely suspended from said contacting element having a weight adapted to cause it to remain stationary by inertia when said contacting element vibrates with said rod.

3. In an electromagnetic device provided with an energizing coil and a magneto-striction rod adapted to vibrate at the frequency of the current which traverses the coil, an evacuated chamber secured to one end of said rod, a first electrode within said chamber electrically continuous with said rod, a second electrode within said chamber suspended from said first electrode, and conducting means for extending connections from both of the electrodes outside of said chamber.

4. In an electromagnetic device, an energizing coil, a mechanical system comprising a magneto-striction rod and a plurality of reeds for supporting said rod coaxially within said coil, and adjustable members for tuning said reeds whereby said mechanical system may be tuned to the frequency of the current which traverses said coil.

5. In an electromagnetic device, an energizing coil, a mechanical system comprising a magneto-striction rod and a plurality of reeds for supporting said rod coaxially within said coil, damping springs overlying said reeds, and means for varying the effective lengths of said damping springs for tuning said reeds whereby said mechanical system may be tuned to the frequency of the current which traverses said coil.

6. In an electromagnetic device, a base, a

magnet yoke secured thereto and having two polar extensions, non-magnetic braces joining said polar extensions, an energizing coil mounted between said polar extensions, a vibratory system comprising a magneto-striction rod and a plurality of reeds for supporting said rod for free movement within said coil and through aligned apertures in said polar extensions, and clamping means secured to said braces for supporting said reeds.

7. In an electromagnetic device, a base, a magnetic yoke secured thereto and having two polar extensions, non-magnetic braces joining said polar extensions, an energizing coil mounted between said polar extensions, a vibratory system comprising a magneto-striction rod and a plurality of reeds for supporting said rod for free movement within said coil and through aligned apertures in said polar extensions, damping springs overlying said reeds the effective lengths of which may be varied to tune said reeds whereby said mechanical system may be tuned to the frequency of the current which traverses said coil, and clamping means secured to said braces for supporting said reeds and associated damping springs.

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