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ALTERNATING CURRENT RELAY

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FIG. 1

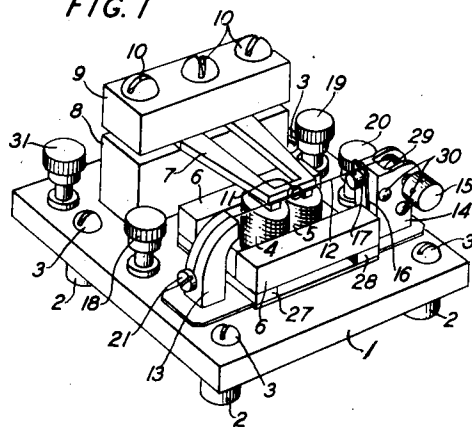


FIG. 2

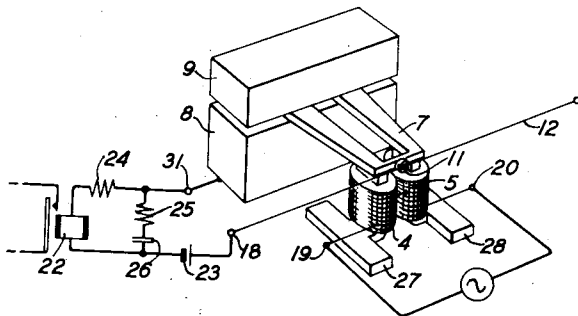


FIG. 3



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ALTERNATING CURRENT RELAY

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4 Claims. (Cl. 200—91)

This invention relates to frequency selective alternating current relays and has for its object to improve the functioning of such relays.

More specifically, the invention provides a relay in which a tensioned wire acts as a mating contact for a vibratory magnetic armature or reed.

In order to increase the period of contact, the armature is provided with a bifurcated contact element which makes contact with the tensioned wire twice during each cycle of the exciting current. Furthermore, the wire is tuned to a frequency much higher than that of the reed.

The invention will be more clearly understood from a consideration of the following description in connection with the accompanying drawing, in which:

Fig. 1 is a showing, in perspective, of one embodiment of the invention;

Fig. 2 shows the working parts of the relay with circuit connections; and

Fig. 3 is an enlarged showing of the contact elements.

Referring first to Fig. 1, the relay comprises a base 1 of brass supported on legs 2 secured thereto by screws 3. The base 1 supports a magnet assembly, similar to a polarized telephone receiver magnet, consisting of coils 4 and 5 which are positioned on the core extensions of pole-pieces 27 and 28 oppositely polarized by the permanent bar magnets 6, 6. The pole-pieces and bar magnets may be secured together and to the base 1 by screws, not shown. The vibratory magnetic armature 7 is held in position over the magnet coils 4 and 5 by means of blocks 8 and 9 which are clamped together and to the base 1 by screws 10. At the free end of the armature 7 is welded a contact stud 11. As shown more clearly in Fig. 3, this stud, which is made of contact metal, has a slot cut across the face of it. The relative positions of supports 13 and 14 and the blocks 8 and 9 on the base permit tuning the armature 7 to the desired input frequency.

Insulatedly secured to the base 1 are two supports 13 and 14 for a tungsten wire 12. One end of the wire is engaged in a groove in the upper face of the support 13 and is secured to the support 13 by the screw 21. The other end of the wire passes over the notched end of the tuning spring 16 secured to the base of support 14 and is attached to and wound around the spool 29 positioned between the two arms of the support 14 and secured to the spindle 15. By turning the spindle the required tension is given

to the wire, this tension then being maintained by tightening the screws 30 to clamp the ends of the spool between the arms of the support. The wire can then be tuned by the adjustment of the upper end of spring 16 with respect to the support 14 by turning the screw 17. The wire is so positioned with respect to the slot in the stud 11 secured to the armature that the wire is normally out of contact with the stud when the magnet coils are deenergized.

In preparing the relay for use, it is necessary that the wire be tuned to a frequency higher than the natural frequency of the armature. No hard and fast rule can be laid down but it has been found that a ratio of 1 to between 2 and 5 between the frequency of the armature and the frequency of the wire is satisfactory. In general, the best results are obtained when the wire is tensioned to its maximum safe stress as, for example, by tuning the wire to a frequency of 3840 cycles when the armature is tuned to a frequency of 960 cycles.

For making circuit connections four binding posts are furnished. Binding posts 19 and 20 are insulatedly secured to the base 1 and are connected to the outside terminals of magnet coils 4 and 5. Binding post 18 is also insulatedly secured to the base 1 and is electrically connected to the support 13 and thus to the wire 12 and binding post 31 is conductively secured to the base 1 and is thus conductively connected to the armature 7 and to the stud 11.

Referring now to Fig. 2, the output circuit of the relay includes direct current relay 22, battery 23 and resistance 24. As the armature 7 vibrates under the control of coils 4 and 5, the stud 11 makes contact with wire 12 at each half cycle of the exciting current. The tuning of wire 12 prolongs these closures so that they are sufficient to hold the contact of relay 22 closed. However, to insure a firm closure and quick response, condenser 26 and resistance 25 are connected around the winding of relay 22. During the brief interruptions of the circuit of relay 22 while the armature 7 passes between its extreme positions, the condenser tends to discharge through the relay winding and helps to hold the relay contact closed.

In determining the relative proportions of the relay, the following considerations are to be taken account of. In order to make the time interval during each cycle that the wire 12 is in contact with the stud 11 as large as possible, the wire 12 is tuned to a frequency several times as great as the frequency of the vibrating ar-

mature 7. If the frequency of the wire is lower than that of the armature, the percentage of contact is very low, because the wire presents a mass reactance to the armature and the impact throws the wire away from the contact, whereas in the other case the elastic restoring force of the wire is greater than the accelerating force and the wire is thus forced against the stud.

Let the effective mass and stiffness of the wire be m and k , respectively, the armature amplitude A , armature frequency f_1 , wire frequency f_2 and the normal clearance between the reed and the contact stud be X_0 , then the accelerational force tending to throw the wire off is

$$F_a = \omega_1^2 m A |\sin \omega_1 t|$$

where $\omega_1 = 2\pi f_1$. The elastic force tending to keep the wire on the contact is

$$F_e = k[A|\sin \omega_1 t| - X_0].$$

The wire will make contact when

$$F_e - F_a > 0.$$

Since

$$f_2 = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

this can be written as

$$A|\sin \omega_1 t| \left(1 - \frac{f_1^2}{f_2^2}\right) - X_0 \geq 0$$

Then, if $f_2 < f_1$ the inequality cannot be satisfied, and theoretically the wire will make contact only for an exceedingly short time. But if $f_2 > f_1$, that is, the natural frequency of the wire is higher than that of the driving armature, the inequality can be satisfied and contact will be made if the driving amplitude is large enough. The ratio of time p during which contact is made to the period of one complete oscillation of the reed is

$$p = \frac{2}{\pi} \cos^{-1} \frac{X_0}{A \left(1 - \frac{f_1^2}{f_2^2}\right)}$$

It is a well-known fact that collision of moving bodies entails a loss of kinetic energy. Under certain conditions, the cyclic impact of two vibrating systems may give rise to so much dissipation of energy that the structure becomes unusable for purposes of selectivity. The greatest damping occurs when the two bodies are of equal mechanical impedance. For this reason, it is desirable to make the mechanical impedance of the wire 12 small as compared to the impedance of the armature 7, that is, to use as fine a wire as practical conditions permit.

In order that relay 22 be continuously operated, the relation between the resistances 24 and 25 must be selected with certain requirements in mind, viz:

That the current through the relay 22 must never fall below the release value, which in turn

implies that the discharge of the condenser is not oscillatory. To this end the circuit must be at least critically damped, that is

$$R_1 + R_2 \geq 2\sqrt{\frac{L}{C}}$$

where resistance 24 = R_1 ; resistance 25 = R_2 ; capacity of condenser 26 = C ; inductance of relay 22 = L .

That the minimum permissible value of capacitance is that which will tune the inductance of the relay 22 to the frequency of the interruptions or twice the frequency of the reed. Hence if the reed vibrates at pulsation ω_1 , it is necessary that

$$C \geq \frac{1}{4\omega_1^2 L}$$

Practical experience shows that the most reliable condition of operation is obtained if the damping resistances 24 and 25 are selected on the basis of the minimum capacitance required and the condenser 26 is selected to be double this minimum value. It is also desirable, but not necessary, that

$$R_1 = R_2 = \sqrt{\frac{L}{C}}$$

This has the advantage that the circuit impedance is a pure resistance which eliminates sparking at the vibratory contact.

What is claimed is:

1. A frequency selective relay comprising an energizing coil, a massive reed tuned to a particular frequency, a bifurcated contact on said reed, a light vibratory wire mounted between the bifurcations of said contact in position to be engaged by said contact when said reed is vibrated.

2. A frequency selective relay comprising an energizing coil, a massive reed tuned to a particular frequency, a bifurcated contact on said reed, a light vibratory wire positioned between the bifurcations of said contact, and means for tensioning said wire to give it a natural frequency much higher than that of said reed.

3. A frequency selective relay comprising an energizing coil, a massive reed tuned to a particular frequency, a contact on said reed, and a light vibratory wire mounted at right angles to the direction of vibration of said reed and in position to be engaged by said contact when said reed is vibrated.

4. A frequency selective relay comprising an energizing coil, a massive reed tuned to a particular frequency, a bifurcated contact on said reed, and a light vibratory wire mounted at right angles to the direction of vibration of said reed and positioned between the bifurcations of said contact, said wire tuned to a frequency at least twice said particular frequency.

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