Aug. 27, 1963 K. OZONE 3,102,214

RESONANT REED RELAY

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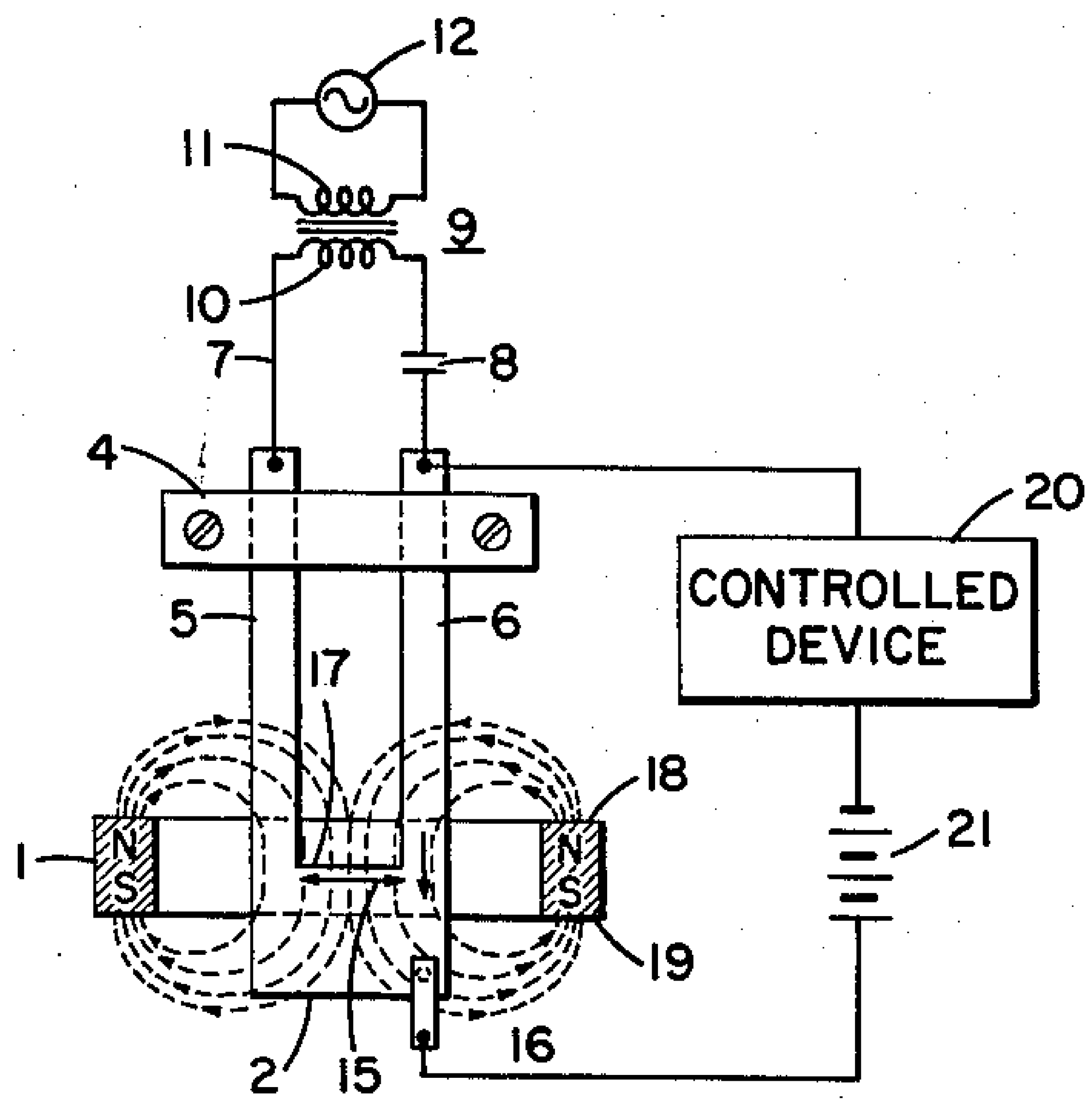

Fig. 1

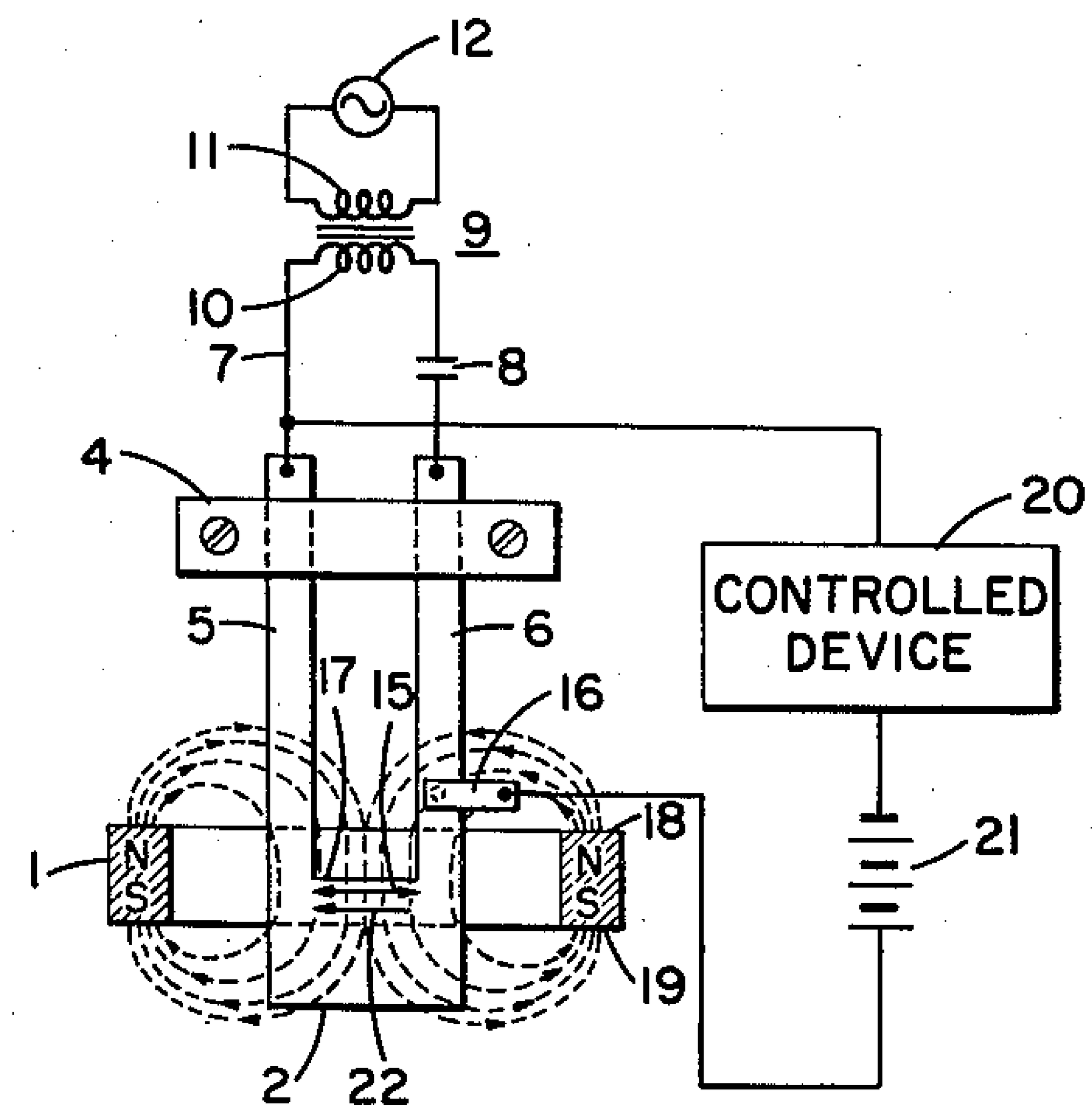

Fig. 3

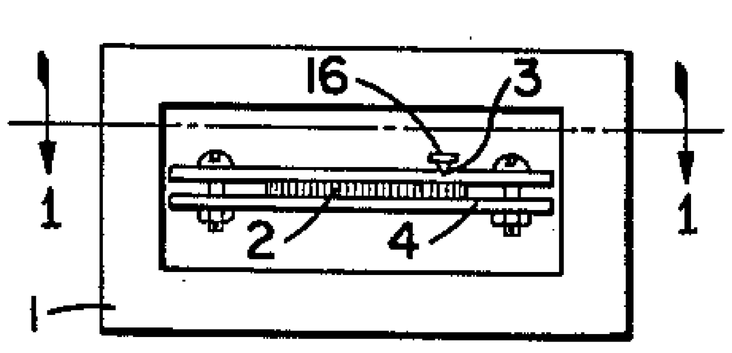

Fig. 2

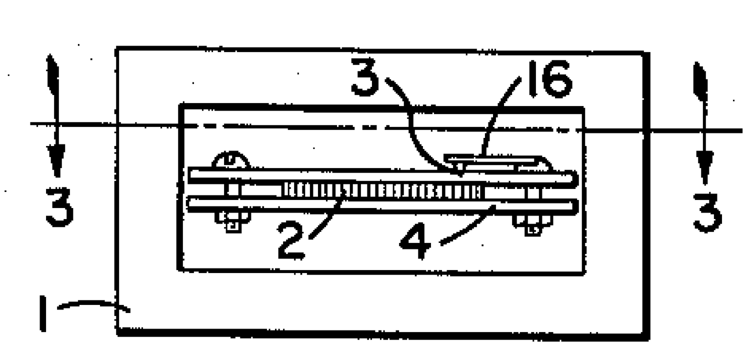

Fig. 4

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RESONANT REED RELAY

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This invention relates to relay devices and more particularly to frequency sensitive relays.

Frequency sensitive relays are widely used in receivers found in selective signaling and selective calling systems. Receivers of these systems have an assigned call signal of a particular frequency or a coded call signal containing a plurality of frequencies and one or more frequency sensitive relays which are tuned to the frequency or frequencies of the assigned call signal.

The resonant reed relays of the prior art are characterized by the inclusion of the resonant reed as one element of the magnetic circuit. Due to the inclusion of the reed within the magnetic circuit, the air gap formed between the vibrating end of the reed and the core structure of the relay presents a variable reluctance in the magnetic circuit which results in a nonuniform relationship between the driving current and the force exerted upon the reed. This nonlinear relation between the driving current and the driving force is evidenced by the relay having an unsymmetrical frequency response curve. This phenomena which is known as the "hook effect" makes it extremely difficult to obtain the required selectivity and stability of resonant frequency. The resonant frequencies of such relays vary in accordance with changes of strength of the permanent biasing magnet, the size of the air gap, and the presence of stray fields.

An object of this invention is to provide an improved frequency sensitive relay using simple and reliable components to thereby insure reliable operation.

It is a further object of this invention to provide a frequency sensitive relay having a stable resonant frequency.

It is a further object of this invention to provide a frequency sensitive relay having a frequency response curve free from the so-called "hook effect."

Further objects and advantages of the invention will become apparent as the description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the drawings in which:

FIG. 1 is a circuit diagram of one form of the invention showing a sectional top view of some of the components taken along line 1—1 in FIG. 2;

FIG. 2 is an end view of the components of FIG. 1;

FIG. 3 is a circuit diagram of a modified form of the invention showing a sectional top view of some of the components taken along line 3—3 of FIG. 4; and,

FIG. 4 is an end view of the components of the modified form of the invention illustrated in FIG. 3.

The present invention contemplates that the call signal, which is to be detected for control purposes, be applied to a resonant metallic reed which is supported for vibration within a constant magnetic field. Thus, when a call signal having a frequency equal to the resonant frequency of the reed is applied to the reed, it will cause it to vibrate at its resonant frequency, due to the motor action of the signal currents within the magnetic field.

According to my invention, it is possible to remove the metallic reed from the magnetic circuit since the signal currents are applied directly to the reed rather than being indirectly applied by a winding upon the core structure. In addition, this arrangement also allows the metallic

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resonant reed to be made of a nonmagnetic metallic conductor. Now, since the reed is located in the steady field of a permanent magnet, a linear relationship will exist between the driving current and the driving forces exerted upon the reed. Thus, according to my invention, a resonant reed relay is provided which is not subject to the hook effect, is extremely simple, and is not affected by stray fields, since the reed utilized within this relay can be made of nonmagnetic material.

According to the form of the invention of FIG. 1, the metallic reed, when vibrating, makes intermittent contact with the stationary contact thus intermittently completing the relay work circuit which includes the contact, contact arm, and the reed; while the modified form of the invention, illustrated in FIG. 3, provides a locking action when energized.

Reference will first be made to FIG. 2 which illustrates the relative position of reed 2, magnet 1, and contact 3, as seen in an end view of these elements. Means are provided for supporting reed 2, in a manner hereinafter to be described, within the aperture of magnet 1 with sufficient clearance being provided on both the top and the bottom of the reed so that it will not strike magnet 1 when it is set into vibration. Contact arms 16 is provided for suporting contact 3 above reed 2 a sufficient distance so that contact 3 will not come into contact with reed 2, unless reed 2 is set into vibration.

Referring now to FIG. 1, source 12 is used to represent any source of call signals, a particular frequency of which is desired to be utilized as a control signal. Thus, when this invention is utilzed in a selective calling or signaling system, source 12 represents the antenna and demodulator circuits for detecting the call signals imposed upon the carrier.

The call signals provided by source 12 are applied to primary winding 11 of transformer 9 which has a step-down turns ratio in order that the current generated in the secondary will be of sufficient magnitude to properly drive reed 2. Reed 2 which consists of a thin strip of metallic nonmagnetic material having a natural resonant frequency equal to the frequency of the call signal has a slot cut in one end thereof, thereby forming legs 5 and 6. Leg 6 is connected to one side of secondary winding 10 by capacitor 8, while leg 5 is connected to the other terminal of secondary winding 10 by conductor 7. Thus, a drive circuit is established for reed 2 from one side of secondary winding 10 through capacitor 8, leg 6, reed 2 at base 17 of the slot, leg 5, and conductor 7 back to the other side of secondary winding 10. Capacitor 8 is provided to resonate with the inductance of winding 10 at the resonant frequency of reed 2 in order that the current flowing in the reed drive circuit will be maximum at that frequency.

The motor action necessary to drive reed 2 is provided by the interaction of the call signal currents flowing in the drive circuit at arrow 15, with the magnetic field at that point. Since the currents passing between legs 5 and 6 of reed 2 will have a major component of current flowing perpendicular to the lines of flux of the field, reed 2 will be set into vibration.

Clamp 4 is provided to support reed 2 within the magnetic field associated with magnet 1, in a manner hereinbefore described with relation to FIG. 2, by clamping legs 5 and 6 of reed 2 in a conventional manner to a supporting surface (not shown). Clamp 4 also provides means to position reed 2 within the aperture of magnet 1 so that the area of maximum current density at arrow 15 lies approximately halfway between back surface 18 and front surface 19 of magnet 1. When reeds 2 is so positioned with respect to the magnetic field, the current at arrow 15 will be within the portion of the field of maximum flux density and consequently will link a maximum number of lines of flux in a perpendicular direction. Thus by positioning reed 2 so that the area of maximum current density intersects the field of magnet at its point of maximum flux density, maximum reed driving forces will be generated.

The series-connected external circuit to be controlled is represented by controlled device 20 and D.C. source 21 which are connected in series with leg 6, the portion of reed 2 at base 17 of the slot, contact 3 and contact supporting arm 16. Due to the blocking action of capacitor 8, no D.C. currents will flow in leg 5. Arm 16 is positioned coaxially with leg 6 so that the D.C. current passing through the field will exert no net forces upon reed 2 to hinder its vibration since the D.C. path is generally parallel to the lines of flux in the area of greatest flux density at arrow 22. In addition, no forces will be exerted upon reed 2 due to the D.C. current linking the lines of flux outside of magnet 1, since the field is generally symmetrical and the forces due to linking flux behind back surface 18 will be equal and opposite to the forces due to linking flux in front of front surface 19. Therefore, the passage of the D.C. control currents through the field does not interfere with the reed driving action of the call signal currents.

Reference will now be made to the embodiment of FIGS. 3 and 4, where the same reference numerals are used to identify elements corresponding with those of the embodiment of FIGS. 1 and 2. In this embodiment, contact supporting arm 16 is positioned so that contact 3 will make with leg 6 when reed 2 is vibrated. The embodiment of FIGS. 3 and 4 differs from the embodiment of FIGS. 1 and 2 since controlled device 20 is connected to leg 5 rather than leg 6. The external series circuit of controlled device 20 and D.C. source 21 is now connected in series with leg 5, reed 2 at base 17 of the slot, a portion of leg 6, contact 3, and supporting arm 16. Thus, the D.C. path within reed 2 will now pass through the area of maximum flux density near base 17. When source 21 is polarized as indicated, current will flow through the region of maximum flux density in a direction indicated by arrow 22. This will result in exerting a force on reed 2 tending to hold it against contact 3. Locking action may thus be accomplished by providing a D.C. current of sufficient magnitude so that the net current linking the lines of flux of the field is sufficient to hold reed 2 during reversals of the call signal currents.

The particular embodiments of the invention illustrated and described herein is illustrative only and the invention includes such other modifications and equivalences as may readily appear to those skilled in the art; for example, capacitor 8 can be dispensed with in both embodiments if sufficient call signal current can be transferred to the reed to exert the necessary reed driving forces. However, if capacitor 8 of FIG. 1 is dispensed with, contact supporting arm 16 should be positioned coaxially with the slot. In this way, any net force that might be exerted on reed 2 due to current from leg 6 linking some lines of flux will be cancelled by an equal and opposite force due to the current of leg 5. If capacitor 8 of FIG. 3 were dispensed with, the voltage of source 21 would have to be increased in order to maintain the locking current at its proper magnitude. It is further noted that I do not intend to be limited to the use of nonmagnetic reeds since the devices of my invention will perform just as well with magnetic reeds as long as they are not subjected to strong stray magnetic fields.

What is claimed is:

1. A resonant reed relay comprising a metallic reed having a natural resonant frequency, said reed having a slot in one end thereof; means for providing a magnetic field; means for applying signals across said slotted end to thereby cause signal currents to flow through said reed; means for supporting said reed in said magnetic field so that signal currents in said reed are substantially perpendicular to said field to thereby cause said reed to vibrate when said signal currents are of a frequency equal to said resonant frequency; a D.C. current path including a contact and said reed and means for supporting said contact a distance from said reed such that said reed will make with said contact when said reed is deflected during vibration to thereby complete said D.C. current path, said contact supporting means being positioned with relation to said reed such that the D.C. current path formed within said reed upon said contact making with said reed will link the lines of flux of said magnetic field in such a manner as to exert no net force upon said reed.

2. A resonant reed relay comprising a metallic reed having a natural resonant frequency, said reed having a slot in one end thereof; means for providing a magnetic field; means for connecting said signal input means across the slotted end of said reed to thereby cause signal currents to flow through said reed; means for supporting said reed in said magnetic field so that signal currents in said reed are substantially perpendicular to said field to thereby cause said reed to vibrate when said signal currents are of a frequency equal to said resonant frequency; a contact; a D.C. current path including said contact and a portion of said reed; means for supporting said contact a distance from said reed such that said reed will make with said contact when said reed starts to vibrate to thereby complete said D.C. current path, said contact supporting means being positioned with relation to said reed such that the D.C. current path formed within said reed upon said contact making with said reed will link sufficient lines of flux of said field so that when current of proper polarity transverses said current path said reed will be maintained against said contact during reversals of said signal currents.

3. A resonant reed relay comprising a metallic reed having a natural resonant frequency, said reed having a slot in one end thereof; means for providing a magnetic field; inductive signal input means; a capacitor; means for connecting said signal input means and said capacitor in series across the slotted end of said reed, said capacitor being of such value to resonate with the inductance of said signal input means at the frequency of resonance of said reed; means for supporting said reed at said slotted end, said supporting means being positioned with respect to said magnetic field so that the signal currents flowing in said reed at the base of said slot are substantially perpendicular to said magnetic field to thereby cause said reed to vibrate when the frequency of the signal currents are equal to the resonant frequency of said reed; a contact; a D.C. current path including said contact and a portion of said reed; means for supporting said contact in proximity to said reed so that said reed will make with said contact when said reed is set into vibration to thereby complete said D.C. current path, said contact supporting means being positioned with relation to said reed such that the D.C. current path formed within said reed upon said contact making with said reed will link the lines of flux of said magnetic field in such a manner as to exert no net force upon said reed when D.C. currents traverse said path.

4. A resonant reed relay comprising a metallic reed having a natural resonant frequency, said reed having a slot in one end thereof; means for providing a magnetic field; inductive signal input means; a capacitor; means for connecting said signal input means and said capacitor in series across the slotted end of said reed, said capacitor being of such value to resonate with the inductance of said signal input means at the frequency of resonance of said reed; means for supporting said reed at said slotted end, said supporting means being positioned with respect to said magnetic field so that the signal currents flowing in said reed at the base of said slot are substantially perpendicular to said magnetic field to thereby cause said reed to vibrate when the frequency of the signal currents are equal to the resonant frequency of said reed; a contact; a D.C. current path including said contact and a

portion of said reed; means for supporting said contact in proximity to said reed so that said reed will make with said contact when said reed is set into vibration to thereby complete said D.C. current path, said contact supporting means being positioned with relation to said reed such that the D.C. current path formed within said reed upon said contact making with said reed will link sufficient lines of flux of said field so that when current of proper polarity transverses said current path said reed will be maintained against said contact during reversals of said signal currents.

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