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ELECTROMAGNETIC RELAY
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1,964,505

FIG. 1

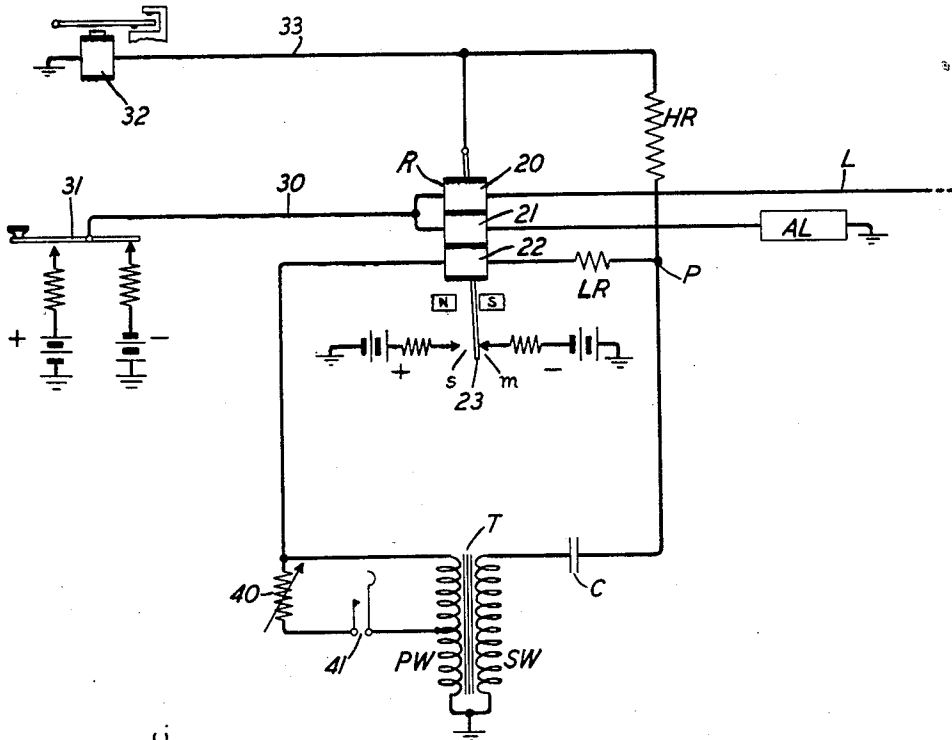
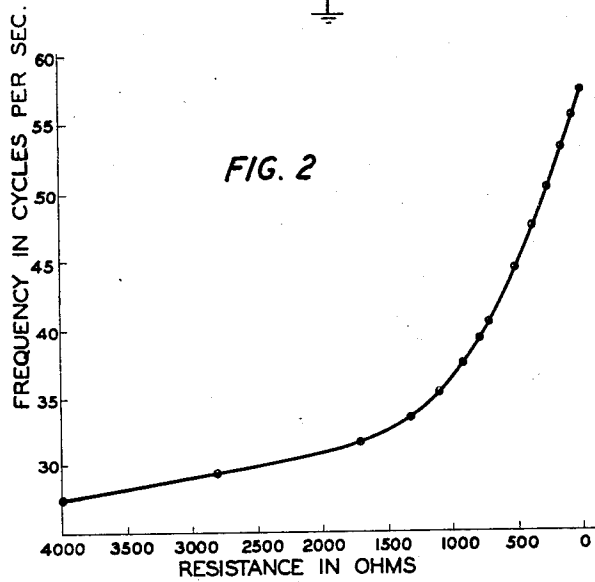


FIG. 2



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ELECTROMAGNETIC RELAY

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3 Claims. (Cl. 178-70)

This invention relates to electro-magnetic relays and particularly to vibrating relays for use in high speed telegraph repeaters.

An object of the invention is to make it possible to conveniently adjust the relay for operation at different frequencies within a wide range without impairment of its efficiency.

Relays of this type are used in systems in which the signals are composed of positive and negative impulses as well as in systems in which the signals comprise periods of openings and closures of the line circuit. The relay is provided with operating windings connected in one line circuit and an armature with contacts responsive to impulses through the operating windings to impress corresponding impulses upon a second line circuit. In the case of the first type of system, referred to above, the operating windings are effective in operating the armature to one side in response to a plus impulse and to the other side in response to a minus impulse; in the case of the other type of system an impulse through the operating windings will operate the relay to one side overcoming biasing means which, in the absence of an impulse, operate the armature to the other side. For examples of both of these types of systems with the corresponding two types of relays reference may be had to the disclosure in my Patent 1,701,100 issued on February 5, 1929.

The vibrating type of relay is provided with an accelerating winding which is included in a vibrating circuit made self-interrupting by being connected through the armature and its contacts to suitable sources of potential, which ordinarily also supply the current impulses to the second line circuit referred to above.

The invention is particularly adaptable to a vibrating relay of the type, such as is shown in my Patent No. 1,701,100, issued February 5, 1929. In accordance with the arrangement shown in that patent the vibrating circuit besides the accelerating winding includes a condenser and a transformer having primary and secondary windings. In the absence of current in its operating windings the relay would vibrate at a frequency determined by the constants of the vibrating circuit. In the presence of impulses through the operating winding, the vibrating circuit, as is well known, aids in the quick and reliable operation of the armature, when the relay is operated at a signaling frequency approximately equal to or below the periodicity of the vibrating circuit.

It would be convenient to supply vibrating relays of this type in a standard form for use in

telegraph systems operating at different frequencies, such systems in accordance with standard practice working at frequencies of twenty-seven cycles per second or at thirty-six cycles per second. A limited variation in the periodicity of the vibrating circuit may be obtained by varying the condenser, which however would have the disadvantage of distorting undesirably the current in the accelerating winding and therefore to impair the efficiency of the circuit.

In accordance with the invention means are provided for readily adjusting the characteristics of the vibrating circuit for operation at different frequencies within a wide range. The frequency control means are adapted to reduce the inductance included in the vibrating circuit and in the preferred forms comprise a by-pass for at least a portion of the transformer windings and switching means for changing the by-pass and thereby changing the effective inductance of the transformer and correspondingly changing the frequency of the vibrating circuit. By providing a resistance by-pass for a portion of the primary winding of the transformer which may be opened or closed by means of a manually operated key, a wide change in frequencies may be obtained without the disadvantage of distortion referred to above.

In the following description of the details and operation of the invention as exemplified by a preferred form, reference will be made to the attached drawing in which:

Fig. 1 is a diagrammatic representation of a telegraph repeater station of a conventional type employing a vibrating relay in accordance with the invention; and

Fig. 2 is a curve showing the relation between the resistance by-pass and the periodicity of the relay when used with a particular transformer.

Referring first to Fig. 1, the vibrating relay R is of the polarized type having line windings 20 and 21 and accelerating winding 22 for the operation of armature 23 between the marking contact *m* and the spacing contact *s* connected respectively to negative and positive sources of potential. The line windings 20 and 21 are connected in a well known manner into a differential duplex system comprising a line circuit 30 connected to an impulse transmitting device 31 and a line L running to a distant station, with equipment similar to that of the station shown in the drawing. The transmitter 31 may be located at the same station as the relay R or may be at a re-

note station and it may be of any convenient design for impressing positive and negative impulses upon the operating windings of relay R in accordance with a telegraph code.

5 When no signals are being transmitted, transmitter 31 and the distant transmitter both apply a negative potential to the line, so that no line current flows in winding 20; current in the local circuit through winding 21 holds the armature in marking position. When transmitter 31 is operated to apply positive potential to the line, the local current through winding 21 reverses but the line current through winding 20 being of double the strength of the local current still holds the armature in its marking position; the relay 10 this is not operated by outgoing signals from transmitter 31. With the distant transmitter applying positive potential to the line the relay will remain in spacing position since, when transmitter 31 applies positive potential to the line, the line winding 20 would be without current and winding 21 would move the armature to spacing, and when transmitter 31 applies negative potential to the line the winding 21 would receive reversed current but would be overpowered by the line winding receiving current of double the strength of the local current to hold the armature in spacing position. A receiving device 32, which may be a polarized sounder or a recording device 15 located at this station or at a remote station, is connected over the line circuit 33 to the armature 23 and thus will receive positive or negative impulses in accordance with similar impulses received over the line L.

20 The accelerating winding 22 is connected into a vibrating circuit, a portion of which comprises a closed circuit through condenser C, secondary winding SW and primary winding PW, in series, of transformer T, accelerating winding 22 and low resistance LR. At the point P a supply circuit is connected to this closed circuit over high resistance HR, armature 23 and contacts *m* or *s* to negative or positive sources of potential respectively. The connecting point between the 25 primary and secondary winding is grounded to provide a return path to the negative and positive sources at contacts *m* and *s*.

30 Assuming the condition shown in the drawing according to which the armature 23 is held against the marking contact by a negative potential applied to the line at the distant station, negative potential is supplied to the vibrating circuit over high resistance HR, condenser C, secondary winding SW to ground, thereby maintaining a charge upon the condenser C; another circuit may be traced from the point P over low resistance LR, accelerating winding 22, primary winding PW to ground. The accelerating winding under this condition opposes the operating 35 windings and tends to move the armature toward the spacing contact with a force which, however, is not sufficient to overcome the force of the operating windings.

40 Assuming now that a positive impulse arrives over the line L through the winding 20, the armature 23 will move away from the marking contact and the negative potential will be removed from the vibrating circuit. The energy stored in transformer T and condenser C discharges through the accelerating winding 22 which continues to act on the armature in the direction toward the spacing contact, thus aiding the line windings in this operation. When the armature reaches the spacing contact, all three windings 45 act to place the armature firmly against the con-

tact for a short interval. A positive potential is now applied over the high resistance to point P and the condenser C will be charged in the opposite direction of its previous charge and the transformer T similarly stores energy in the reverse direction of the previously stored energy over the circuit through low resistance LR, accelerating winding 22 and primary winding PW. The current through accelerating winding 22 thus having been reversed, this winding tends to move the armature towards the marking contact in opposition to the operating windings and the whole circuit now is in condition for repeating the operations just described in the opposite direction when a negative impulse arrives over the line L. 80 85 90

For given mechanical dimensions of the relay the periodicity of the vibrating circuit is mainly determined by the inductance of the transformer windings and the accelerating winding and by the capacity of condenser C, and this natural periodicity of the circuits adapts the relay for most efficient operation at signaling frequencies deviating but slightly therefrom. 95

In order that a relay circuit of this type may readily be used with high efficiency under different circumstances and particularly in systems having different signaling frequencies or in systems in which the frequency is changed for certain periods of the day, provision is made for readily adjusting the periodicity of the vibrating circuit for operation at different frequencies. For this purpose an adjustable resistance 40 is bridged across a portion of the primary winding of transformer T and a key 41 serves to connect or disconnect this by-pass from the transformer winding. By means of this resistance by-pass a certain fraction of the current through the accelerating winding is diverted from a portion of the primary winding, thereby changing the mutual inductance between the transformer windings and consequently reducing the natural periodicity of the relay. 100 105 110 115

In general telegraph practice frequencies of twenty-seven and thirty-five cycles per second are frequently used. The relay with its associated transformer and condenser may be designed to operate at twenty-seven cycles per second when the key 41 is left open, and the resistance 40 may be adjusted to change the frequency of the vibrating circuit to thirty-five cycles when the key 41 is closed. In this manner the relay circuit may readily be used universally in both types of systems. 120 125

For the sake of illustrating the effect of the resistance by-pass upon the frequency of the relay, observations taken from experiments with a given relay are shown in Fig. 2, in which the curve represents the relation between the resistance values of resistance 40 and the corresponding periodicities of the relay. This curve shows that with a resistance of 1000 ohms a frequency of about thirty-five cycles would be obtained, and that the frequency of about twenty-five or twenty-six cycles is approached as the resistance is increased to infinity. The curve further shows that by still further reducing the resistance of the by-pass the frequency may be increased considerably. 130 135 140 145

It is, of course, possible to attain the desired result by different arrangements of by-pass and transformer windings which readily would suggest themselves to those skilled in the art. Thus the resistance by-pass may bridge any fraction of the primary winding or the total winding, and different taps may be taken between resistance 150

and transformer windings with switching means in each tap for obtaining a plurality of periodicities; the principal object being to reduce the inductance of the transformer circuit, the resistance by-pass may be connected at other points of the transformer to serve this purpose, such as between points on the primary and secondary windings.

As has been stated above the invention is applicable to relays used in systems in which the signals comprise current and no-current impulses; in this case only one line winding would be used and a biasing winding may be provided for reversing the operation of the armature during no-current intervals in the line winding; this well known arrangement is described and illustrated in my Patent 1,701,100. The ampere turns of the biasing winding would ordinarily be about one-half the ampere turns of the line winding and the ampere turns of the accelerating winding would be still less than those of the biasing winding in order to insure that the relay will not operate when the accelerating winding is opposed to the biasing winding. In all other respects the arrangement and its operation would be similar to the arrangement described above.

What is claimed is:

1. An electrical relay comprising an armature for effecting circuit changes, an operating winding to operate said armature, accelerating means to control the operating speed of said relay including a winding for aiding and opposing said operating winding in the operation of said armature and also including circuit means having capacity

and inductance, and means for changing the operating speed including a by-pass for at least a portion of said inductance and switching means for said by-pass.

2. A polarized electrical relay for operation at a plurality of signaling frequencies comprising an armature for effecting quick circuit changes, an operating winding to operate said armature in response to signal impulses through said winding, an accelerating winding to aid said operating winding in operating said armature, a vibrating circuit for said accelerating winding including a condenser and a transformer having a winding, a source of current for said circuit adapted to be interrupted from said circuit by the movements of said armature, a resistance by-pass for at least part of said transformer winding, and means for varying the resistance of said by-pass to vary the periodicity of said vibrating circuit.

3. In a telegraph repeater, a vibrating relay having operating and accelerating windings and an armature for effecting changes in an outgoing circuit in accordance with signals received by said operating winding, an accelerating circuit for said accelerating winding including said armature, a condenser and a transformer having primary and secondary windings, a resistance by-pass for at least a portion of said primary winding, and contact means for opening and closing said by-pass to change the periodicity of said relay from one value to another substantially different value.

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