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SINGLE-FREQUENCY CARRIER CURRENT CONTROL SYSTEM

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Fig. 1.

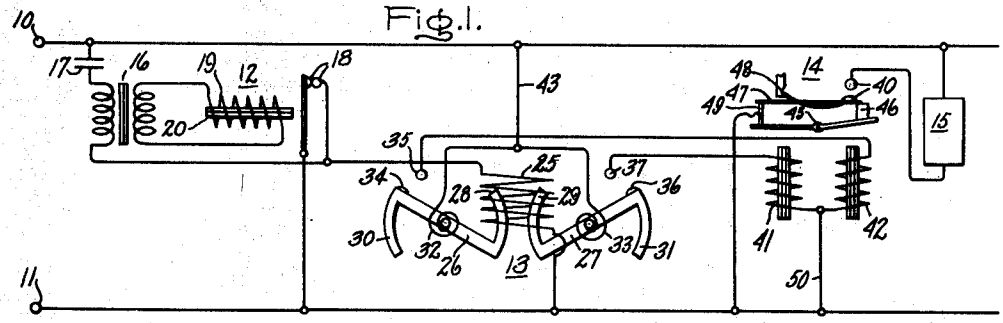
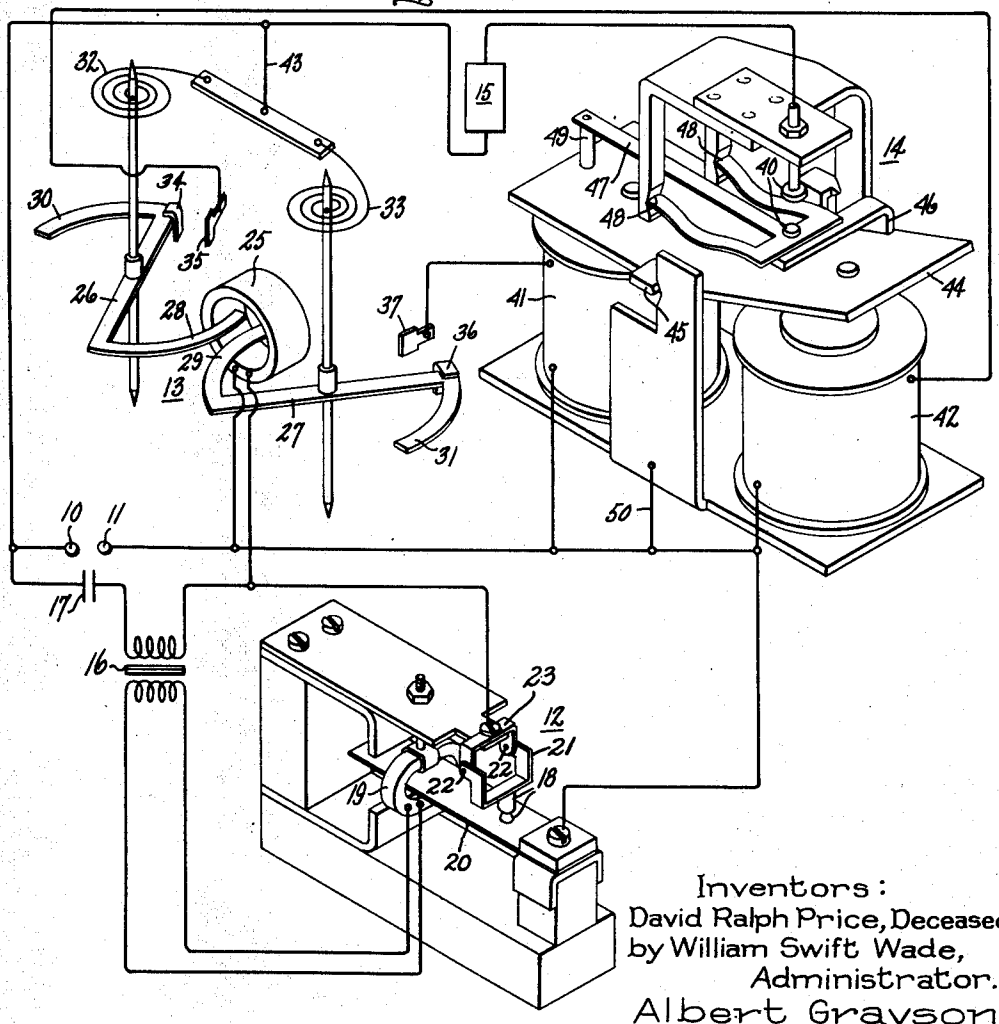


Fig. 2.



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SINGLE-FREQUENCY CARRIER CURRENT CONTROL SYSTEM

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5 Claims. (Cl. 175—320)

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This invention relates to electrical remote control systems of the kind providing for the performance of one or more control operations at one or more receiving locations on an electrical power supply line or network by the transmission of electrical energy at a particular carrier frequency or frequencies injected into or superimposed on each line or network.

Systems of this kind are for example applicable for the centralized control of street lights, shop window lights, electric water heaters, and other loads which are required to be connected to the supply only at specific times, for example during off-peak load periods, and for signalling purposes such as in protective gear.

Electrical remote control systems of the kind above referred to have previously been proposed in which superimposed current of a certain carrier frequency is interrupted, pulsed, or otherwise subjected to modulation of a rhythmic or pulsating kind at a frequency lower than the frequency of the superimposed current. With such arrangements a large number of different control operations, selectable at will, can be provided since, for example, it is in general practicable to arrange for injected current of one frequency to be modulated at many different lower frequencies. The additional advantage is obtained that the arrangement tends to prevent false operation of apparatus such as due to surges or harmonics of the power frequency, since it is necessary for the response of the receiving apparatus that the latter shall receive, not only current of the predetermined frequency or frequencies, but that the reception of this current shall be interrupted or modulated at the predetermined lower frequency. The extent to which this advantage can be utilized, however, has generally heretofore been limited by the sharpness of tuning of the receiving apparatus to the frequency of the superimposed current and the frequency of modulation of the envelope of said current. The present invention has for a main object to provide improved selectivity of the receiving apparatus in a single-frequency carrier current control system of this general type.

According to the present invention, receiving apparatus in or for a remote control system of the kind specified comprises resonance relay means tuned mechanically to the carrier frequency of the superimposed current, said relay means having contacts arranged for governing the energization from the power supply lines of further resonance relay means which are tuned to respond to the lower modulation frequency

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above referred to, and these second relay means are arranged for controlling the connection of the controlled apparatus with the supply line or network. It will be seen that with this arrangement the operation of the low frequency resonance relay means is obtained by power derived substantially from the supply system and not from the superimposed current, so that the low frequency resonance responsive means may be energized at substantially constant voltage, the high frequency resonance relay means not being called upon to provide the energy for causing oscillation of the low frequency relay means but serving merely to control the connection of the latter with the supply lines.

The controlling or transmitting apparatus may comprise any suitable means known to the art for interrupting or otherwise modulating the superimposed or injected current at the necessary periodicity.

In carrying out the invention the high frequency relay means may be arranged to respond to a single frequency of superimposed or injected current or to the concurrent reception of two or more different frequencies in said current. It is contemplated that in practice the use of only one frequency of said current for each control station will provide a sufficient number of different control operations.

In carrying out the invention, since the performance of any particular control operation depends upon the injection of a particular frequency and the modulation of said frequency at a different and lower frequency, the selective operation of a plurality of different control operations can readily be obtained by the allocation of particular value of said lower frequencies to each operation.

According to a further feature of the invention, in the application of the arrangement to a plurality of interconnected supply systems or networks, particular frequencies of superimposed current are allocated to the several networks or systems respectively, while the receiving apparatus for performing different control operations are made dependent in each network or power system on the modulation at respective difference frequencies of the injected currents.

For additional objects and advantages, and for a better understanding of the invention, attention is now directed to the following description and accompanying drawings, and also to the appended claims in which the features of the invention believed to be novel are particularly pointed out.

In the drawings:

Fig. 1 is a schematic circuit diagram of a single-frequency carrier receiving station adapted to effect two different control operations in accordance with the principles of the invention; and

Fig. 2 is a more detailed representation of the apparatus of Fig. 1 showing certain mechanical details of various relay elements in perspective view. Corresponding elements in the two figures of the drawing have been indicated by the same reference numerals.

The illustrated system comprises a pair of input terminals 10 and 11 which are adapted to be connected across a suitable alternating current supply system of commercial frequency (not shown). Relatively high frequency carrier control voltages may be superimposed on the system from a suitable carrier current transmitting apparatus (also not shown). In accordance with the invention it is contemplated that these high frequency voltages may in turn be interrupted, pulsed or otherwise modulated at any one of a plurality of selected low frequencies in accordance with the number of control operations to be performed at the receiving station. The details and arrangement of the system connections and of the carrier current transmitting and modulating apparatus form no part of the present invention and are therefore not illustrated.

The receiving station comprises three relays 12, 13 and 14 which are operated in sequence in a predetermined manner in order to control the connection or disconnection of any desired load device 15 from the supply line. As previously indicated, the load device 15 may for example comprise street lights, shop window lights, electric water heaters, or any other electrical load which is to be connected to the supply system only at specific times and in accordance with the control signals from the remote carrier transmitting apparatus.

The high frequency carrier control signal is impressed upon the primary winding of a transformer 16 through a circuit which may initially be traced from the upper terminal 10 through a coupling capacitor 17, primary winding of transformer 16, the normally-closed contacts 18 of relay 12, to the lower supply terminal 11. This circuit is tuned to resonance at the carrier frequency in order to provide maximum carrier voltage on transformer 16. However, for reasons shortly to be explained, coupling capacitor 17 is also large enough to pass substantial current at the lower commercial frequency of the supply system.

The secondary winding of transformer 16 is connected in circuit with operating coil 19 of relay 12. Relay 12 comprises a mechanical resonance relay which may be of the type generally illustrated in British Patent 517,971. This type of relay comprises a reed member 20 which is mechanically tuned to cause operation of the relay in response to the high frequency carrier signal. Reed 20 carries the lower one of a pair of contacts 18. As shown, the upper contact 18 is mounted on a U-shaped bracket 21 which is in turn pivotally supported on pivot pins 22 for rotation with respect to a fixed bracket 23. The contacts 18 are normally closed when reed 20 is not vibrating, since the weight of bracket 21 and upper contact 18 maintains them in engagement. As is generally explained in British Patent 517,971, if coil 19 is now energized at the proper frequency to cause substantial vibration of reed 20, the upper contact 18 is driven upward and, due to the inertia of the pivoted assembly, is unable to follow the vibrations of reed 20. Upon energization of relay 12, the contacts 18 are therefore driven apart and only make occasional contact so that they are in effect separated, thereby removing the short circuit across an operating winding 25 of relay 13. Winding 25 is now energized from the system in response to current of the commercial frequency through capacitor 17 and primary of transformer 16.

Relay 13 comprises a pair of pivoted armatures 26 and 27 having respective arcuate extensions 28 and 29 which normally extend partially within the operating winding 25 in their deenergized positions. The axis of symmetry of coil 25 lies in a common plane with the armatures 26 and 27. The armatures may also include diametrically-opposite arcuate portions 30 and 31, respectively, in order to provide proper mechanical balance.

Angular movement of the armatures 26 and 27 in either direction is opposed by means of suitable spiral springs 32 and 33, as is best shown in Fig. 2. The armature 26 carries a movable contact 34, on the opposite side of the pivot from the arcuate portion 28, which is adapted to engage a stationary contact 35 when the arcuate portion 28 is withdrawn a sufficient distance from the operating coil 25. A similar pair of contacts 36, 37 is associated with armature 27.

The relay 14 has a snap action and either closes or opens a pair of contacts 40 depending upon whether a first operating coil 41 or a second operating coil 42 is momentarily energized. It will be observed that both of the armatures 26 and 27 of relay 13 are connected to power supply terminal 10 through the respective springs 32, 33 and a conductor 43. When contacts 34 and 35 are closed, winding 42 of relay 14 is energized; and when contacts 36 and 37 are closed, winding 41 of relay 14 is energized.

As is shown in greater detail in Fig. 2, the operating coils 41 and 42 attract opposite ends of a magnetic armature 44 when energized. Armature 44 has a central pivot 45. When coil 41 is energized, a projection 46 lifts a spring member 47, carrying the lower contact 40, sufficiently to raise it above the center line through a pair of pivots 48, permitting the spring member to close contacts 40 with a snap action. When coil 42 is energized, a pin 49 at the opposite end of armature 44 lifts the end support for spring member 47 sufficiently to cause contacts 40 to open with a snap action.

The load device 15 is connected across the power supply terminals 10 and 11 when contacts 40 are closed. A power circuit may then be traced from the upper terminal 10, through load device 15, contacts 40, spring member 47 and a conductor 50 to the terminal 11.

In order that the operation of the receiving system may be better understood, let it be assumed that the transmitting apparatus at a remote control station includes suitable generating means for impressing high frequency signals upon a commercial power transmission line connected to terminals 10 and 11 and that it also comprises means for periodically interrupting or modulating this high frequency signal at a plurality of relatively low frequency rates in accordance with the number of different control

operations to be performed. The generating means at the transmitter may, for example, produce a carrier frequency in the range between 300 to 3000 cycles per second (preferably of the order of 400 to 800 cycles per second) while the rate of interruption or modulation may for example occur at very low frequencies of the order of .5 to 2.5 cycles per second, well below the commercial power frequency. It will be understood, however, that the invention in its broader aspects is not limited to any particular range of said frequencies.

When the high frequency carrier signal is impressed upon the input terminals 10 and 11 at the receiving station, relay 12 will be energized to open contacts 18, thereby causing operating winding 25 of relay 13 to be energized from the lower frequency commercial power lines. Let it now be further assumed that this high frequency signal is interrupted at one of two particular low frequencies at which the armatures 26 and 27 respectively are mechanically resonant. For example, the current in operating coil 25 might first be interrupted at a rate corresponding to the natural period of oscillation of armature 27. The contacts 18 will now be intermittently opened and closed at this interruption rate and the extension 29 on armature 27 will tend to be drawn into the coil 25 during each pulse of high frequency current. The armature 27 will consequently begin to oscillate with increasing amplitude until contacts 36 and 37 are momentarily closed. When this occurs, as previously explained, an energizing circuit at power line frequency is impressed upon operating coil 41 of relay 14 causing contacts 40 to be closed and the load device 15 to be connected in circuit.

During the above-described cycle of operation, the extension 28 of armature 26 will also tend to be drawn into coil 25 during each pulse of high frequency current, but it will not build up any substantial amplitude of oscillation since it is designed to have a different natural frequency of oscillation.

Let it next be assumed that it is desired to disconnect the load device 15 from the supply source. In this case, the high frequency carrier signal is again impressed upon the system but interrupted at the low frequency corresponding to the natural period of oscillation of armature 26. The winding 25 is then intermittently energized at this low frequency rate, resulting in the build-up of oscillations in armature 26 until contacts 34 and 35 are closed, momentarily energizing winding 42 of relay 14 and disconnecting the contacts 40.

It will readily be appreciated that the receiving system might be further modified to provide for more than two independent control operations, all responsive to the same high carrier frequency, but to different rates of interruption or modulation. It will also be apparent that a plurality of different high frequency carrier signals may be employed at the transmitting station in order to control any one of a plurality of different receiving systems of the type shown and described, each of these systems having the series-resonant circuit 16, 17 and the relay 12 responsive to a different carrier frequency.

When the carrier frequency is described as being "modulated" in the appended claims, it is to be understood that this includes interrupting, pulsing, or otherwise varying the envelope amplitude of the carrier signal sufficiently to cause high frequency relay 12 to open and close contacts 18 at the modulation rate.

While a specific embodiment has been shown and described, it will of course be understood that various modifications may be made without departing from the invention. The appended claims are therefore intended to cover any such modifications within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A carrier current control system adapted to be energized from a commercial frequency power line and to be controlled by a relatively high-frequency superimposed carrier signal selectively modulated at one of a plurality of different, relatively low frequencies, comprising a first relay having a pair of contacts, means for energizing said relay in response to said carrier signal, said relay being arranged to open and close said pair of contacts at any selected modulation frequency, a second relay comprising a control winding, means for connecting said winding in circuit with said commercial frequency power line when said contacts are closed, said second relay further comprising a plurality of cooperating armatures, each of said armatures being resiliently mounted and having a natural mechanical period of vibration corresponding to a different one of said low modulation frequencies, contact means controlled by each armature and arranged to be closed in response to a predetermined amplitude of armature vibration, controlled apparatus comprising a plurality of circuits, and means for energizing each of said circuits in response to closure of one of said contact means.

2. A carrier current control system adapted to be energized from a commercial frequency power line and to be controlled by a relatively high-frequency superimposed carrier signal selectively modulated at one of a plurality of different, relatively low frequencies, comprising a first relay having a pair of contacts, means for energizing said relay in response to said carrier signal, said relay being arranged to open and close said pair of contacts at any selected modulation frequency, a second relay comprising a control winding, means for connecting said winding in circuit with said commercial frequency power line when said contacts are closed, said second relay further comprising a plurality of pivoted armature assemblies, each assembly having a natural mechanical period of oscillation corresponding to a different one of said low modulation frequencies and arranged to be excited into oscillation when said winding is intermittently energized at the corresponding frequency, contact means controlled by each armature and arranged to be closed when said armature reaches a predetermined amplitude of oscillation, and a plurality of controlled devices, each of said device being arranged to be actuated by closure of one of said contact means.

3. A carrier current control system adapted to be energized from a commercial frequency power line and to be controlled by a relatively high-frequency superimposed carried signal selectively modulated at one of a plurality of different, relatively low frequencies, comprising a first relay having a pair of contacts, means for energizing said relay in response to said carrier signal, said relay being arranged to open and close said pair of contacts at any selected modulation frequency, a second relay comprising a control winding,

means for connecting said winding in circuit with said commercial frequency power line when said contacts are closed, said second relay further comprising a plurality of pivoted armatures, each armature being spring-biased to a neutral position against rotation in either direction and arranged to be deflected in one direction when said winding is energized, each said armature having a natural period of oscillation corresponding to a different one of said low modulation frequencies, a movable contact carried by each armature and a stationary contact cooperating with each movable contact, said pairs of contacts being arranged to be closed intermittently when the oscillations of the associated armature build up to a predetermined amplitude, and a corresponding plurality of controlled devices each arranged to be energized by closure of one of said pairs of said contacts.

4. A carrier current receiving system adapted to connect or disconnect a load device from a commercial frequency power supply system in response to a relatively high-frequency carrier signal which is selectively modulated at one of two different control frequencies both substantially lower than said commercial frequency, comprising a high-frequency resonance relay having a pair of contacts, means for energizing said relay in response to said modulated carrier signal, said relay being arranged to open and close said contacts at either of said selected control frequencies when said modulated signal is applied, a low-frequency resonance relay comprising an operating winding and a pair of resiliently-mounted armatures, means controlled by said high-frequency relay contacts for intermittently energizing said winding from said power supply system at a rate equal to the selected control frequency, each of said armatures being arranged to be excited into vibration when said winding is energized and each having a natural period of vibration equal to a different one of said control frequencies, switching means including a member movable between circuit-closing and circuit-opening positions for controlling the energization of said load device from said source, and means responsive to vibration of each armature of predetermined minimum amplitude for actuating said member to one of said positions.

5. A carrier current receiving system adapted to connect or disconnect a load device from a commercial frequency power supply system in response to a relatively high-frequency carrier signal which is selectively modulated at one of the two different control frequencies both substantially lower than said commercial frequency, comprising a high-frequency resonance relay having a pair of contacts, means for energizing said relay in response to said modulated carrier signal, said relay being arranged to open and close said contacts at either of said selected control frequencies when said modulated signal is applied, a low-frequency resonance relay comprising an operating winding and a pair of resiliently-mounted pivoted armatures, means controlled by said high-frequency relay contacts for intermittently energizing said winding from said power supply system at a rate equal to the selected control frequency, each of said armatures being arranged to be rotated in one direction when said winding is energized and each having a natural period of oscillation equal to a different one of said control frequencies, a third relay for controlling the energization of said load device from said system, said third relay having a stable circuit-closing position and a stable circuit-opening position and a pair of control windings for actuating it between said respective positions, and contact means actuated in response to oscillation of each armature of predetermined minimum amplitude for energizing a corresponding one of said control windings.

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