Jan. 31, 1939. C. F. WALLACE 2,145,821

SELECTIVE RELAY

Filed June 1, 1936 3 Sheets-Sheet 1

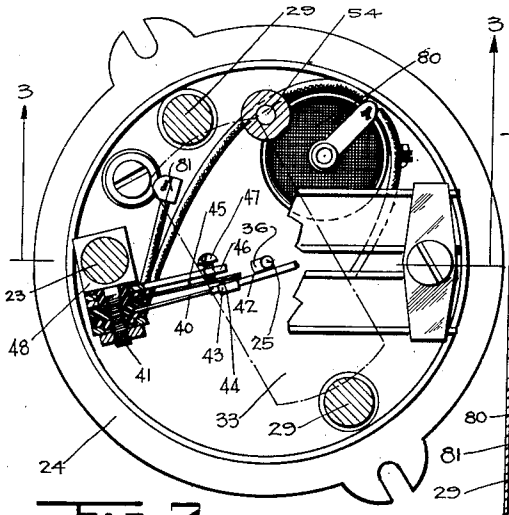


Fig. 2

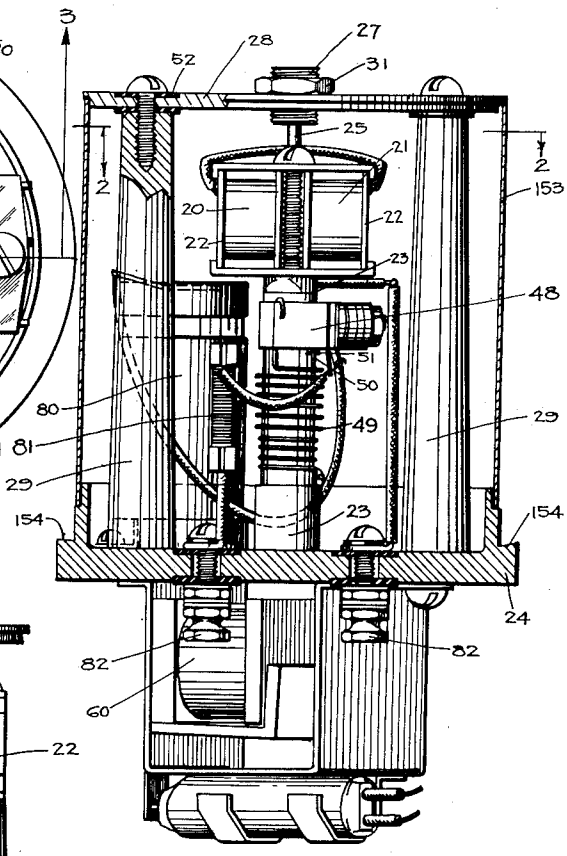


Fig. 1

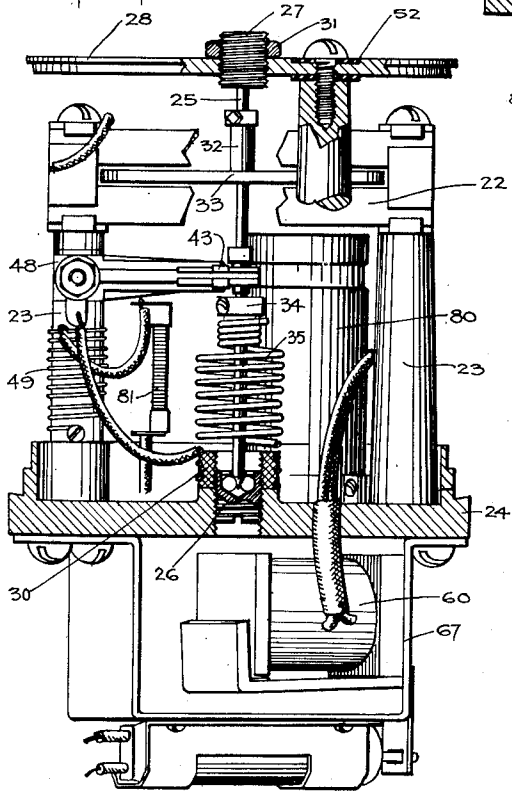


Fig. 3

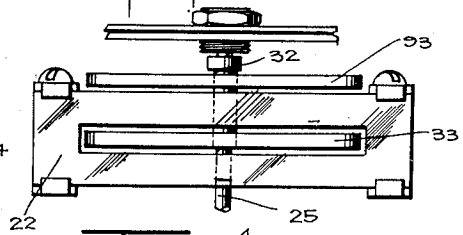


Fig. 4

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SELECTIVE RELAY

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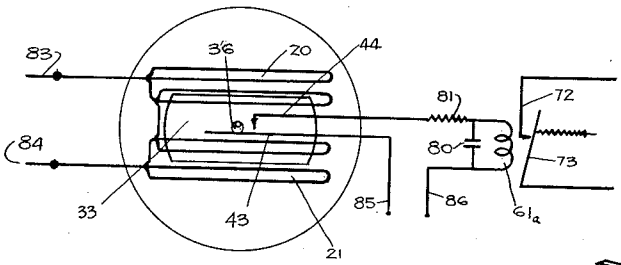


Fig. 5

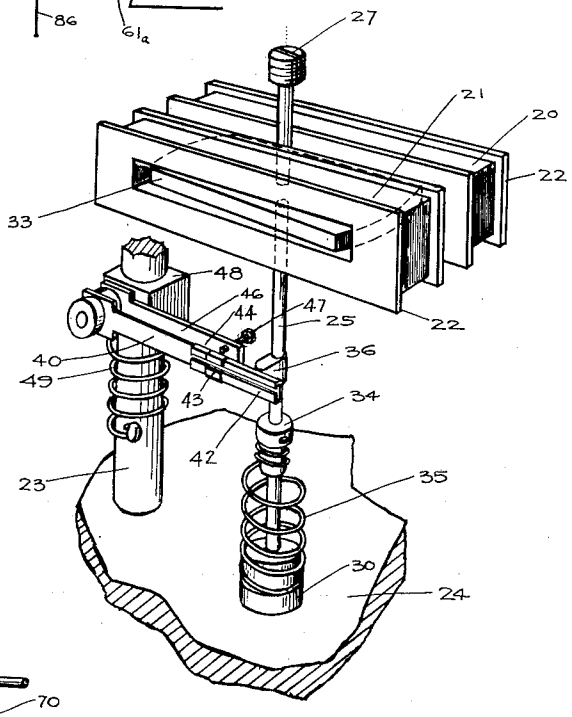


Fig. 6

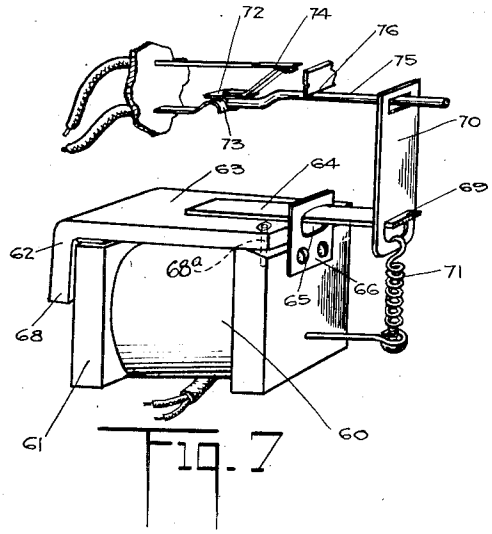


Fig. 7

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SELECTIVE RELAY

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Fig. 8

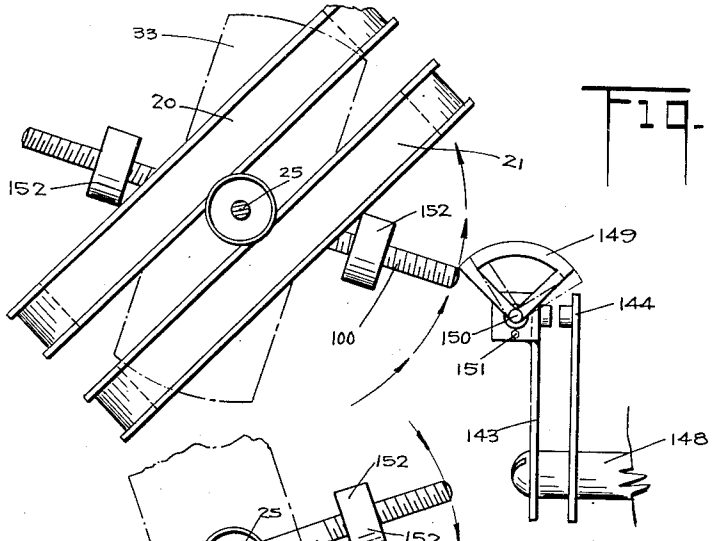


Fig. 9

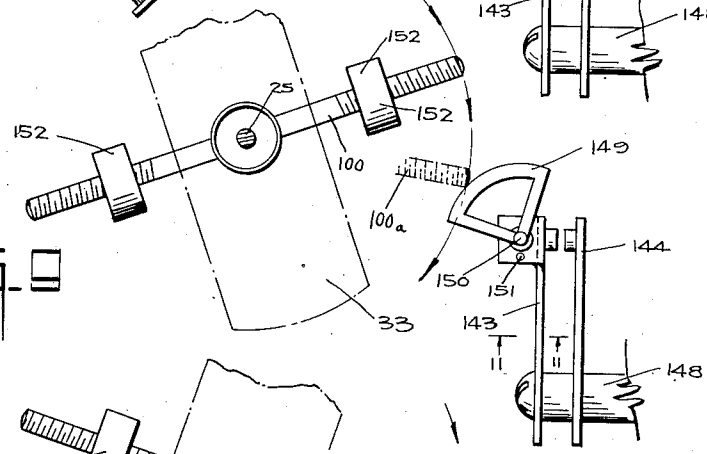


Fig. 10

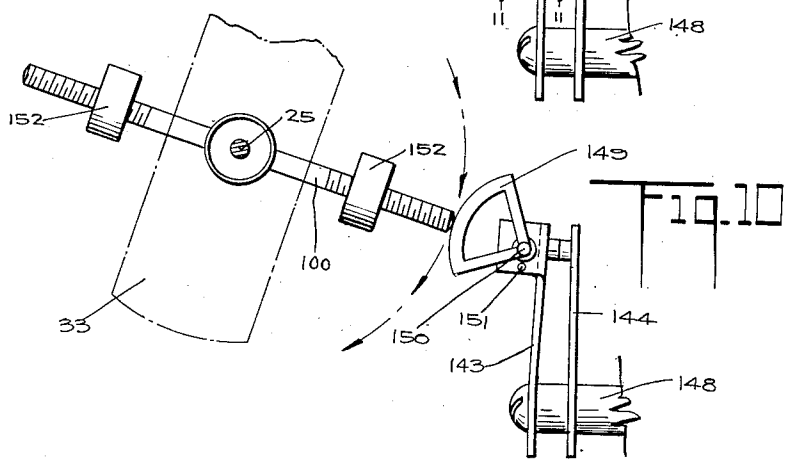
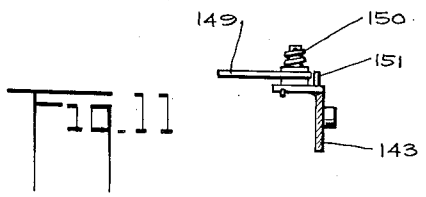


Fig. 11



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Patented Jan. 31, 1939

2,145,821

UNITED STATES PATENT OFFICE

2,145,821

SELECTIVE RELAY

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Application June 1, 1936, Serial No. 82,724. In Canada June 4, 1935. In Great Britain June 4, 1935

18 Claims. (Cl. 200—91)

This invention relates to selective relays and more particularly to relays or kindred translating devices which are adapted for selective response to currents having a predetermined frequency or periodicity.

One of the principal objects of the invention is to provide improved relay apparatus of the character described, which is mechanically tuned for the desired selective response and which is sensitive, accurate and adapted to consume relatively little power for its operation.

Another object is to provide new mechanically tuned relay apparatus which can be very sharply tuned, although capable of adjustment or variation in size or proportions so as to be tuned for response to any of a wide range of frequencies (notably including relatively low frequencies), and which is adapted to maintain its tuning at the predetermined frequency, without being appreciably affected by ambient temperature, humidity, or the like.

Further objects are to provide novel means of the character described which will respond to an alternating current having a predetermined frequency or to a pulsating or periodic direct current having a corresponding predetermined frequency or rate of pulsation; and to provide such apparatus which includes new and efficient instrumentalities or combinations thereof for effecting a continuous or sustained circuit-controlling operation upon response to either type of current; and also to provide new and effective arrangements whereby a continuous or sustained circuit-controlling operation may be performed in selective response to an energizing current having a very low frequency or rate of alternation or pulsation, of the order, say, of five cycles per second.

Still further objects include the provision of relay apparatus of the character described which is relatively simple in operation, having relatively few moving parts, and which is economical to build and operate, and which needs little, if any, attention or adjustment over long periods of time; and the provision of improved selective relay devices and associated instrumentalities which are suitable for effecting automatic response to a calling signal in a receiving station of a signalling system,—for example, as in radio telephone systems where it is desired to operate a call bell only upon reception of a carrier having a predetermined modulation frequency, or for corresponding operation of electrically controlled apparatus in response to a similar signal, as in systems for remote control by radio.

Other objects and advantages will appear as the invention is hereinafter disclosed.

Referring to the drawings, which illustrate what are now considered to be advantageous physical embodiments of the invention:

Figure 1 is an elevation, with one end plate and a part of the other end plate in section, of one type of relay apparatus.

Figure 2 is a horizontal section on line 2—2 of Figure 1, with certain parts shown broken away or in dot and dash lines.

Figure 3 is a side elevation, with certain parts in section on line 3—3 of Figure 2, and other parts removed or shown broken away, of the apparatus shown in Figures 1 and 2.

Figure 4 is a detail elevation, corresponding to a portion of the elevation shown in Figure 3, of a modified form of part of the apparatus.

Figure 5 is a wiring diagram of the apparatus shown in Figure 1.

Figure 6 is a perspective view of certain parts shown in Figure 1.

Figure 7 is a perspective view of the working parts of a supplementary relay device included in the apparatus shown in Figure 1.

Figures 8, 9 and 10 respectively represent, in plan view, different stages in the operation of a modified form of contact operating arrangement adapted for embodiment in apparatus of the type shown in Figure 6.

Figure 11 is a detail section on line 11—11 of Figure 9.

Referring particularly to Figures 1, 2, 3 and 6, the relay apparatus includes a stationary electromagnetic field or stator and an armature or rotor. The field comprises the two coils or electromagnets 20, 21 each of which consists of a coil of wire, of suitable size and number of turns depending on the impedance which it is desired to introduce into the energizing circuit of the relay apparatus for most sensitive response at the predetermined frequency; each of the coils 20, 21 being wound on a frame or spool 22 of appropriate insulating material such as Bakelite. The two coils 20, 21 thus respectively constitute two sections of an air core solenoid, connected in series so as to comprise in electrical and magnetic effect, a single solenoid. The coil sections 20 and 21 are suitably mounted on posts 23 which are conveniently integral extensions of a base plate 24. A vertical shaft 25, passing between the coil sections 20 and 21, is journalled for oscillation in suitable bearings at each end, viz., bearing 26 in the base plate 24 and bearing 27 in an end plate 28 which is in turn secured to a pair of upright posts 29, 29,

themselves conveniently integral extensions of the base member **24**. The bearings **26**, **27** are each so constructed as to constitute a thrust bearing and they are appropriately axially adjustable. As particularly shown in Figure 3, each of these bearings thus comprises a plurality of balls, in the present case three, between which a conical end of the shaft **25** seats. Each of the bearings is externally screw threaded so as to be capable of being advanced into or withdrawn out of the corresponding base or end plate **24**, **28**, lock nuts **30**, **31** being respectively provided to secure the bearings in the desired relative position of axial adjustment.

Secured to the shaft **25**, as by means of the bushing **32** (including a collar and set screw for adjustability), is the armature or rotor **33**, which preferably comprises a permanent magnet, i. e., permanently magnetized or poled so as to have a north pole at one end and a south pole at the other; such permanently magnetized armature is advantageously constructed of metal of the nature of cobalt steel. It will be appreciated that by virtue of the manner in which the armature is mounted on the shaft **25**, and in which the latter is journalled in the end plates, the armature **33** may be accurately positioned with respect to the field or stator, and will oscillate freely about the axis of the shaft, with comparatively little friction at the bearings, and without undesired radial or end-play of the shaft.

Also secured to the shaft as by a collar and set screw **34**, is a torsion spring **35** which conveniently extends helically around the shaft and is secured at its other end to the stationary framework, as by frictional engagement with a helical groove in the outer surface of the lock nut **30**. The helical torsion spring **35** is thus secured to the shaft so as to oppose deflection of the armature **33** from its normal position, and to exercise force to restore it to normal position when it is deflected therefrom by the passage of suitable current through the solenoid **20**, **21**. The weight of the shaft **25** and its appended parts, particularly including the armature **33**, together with the tension of the spring **35**, are so fashioned or adjusted that the assembly carried by and including the shaft **25** constitutes a torsional pendulum having a natural period of mechanical resonance or oscillation equal to the current frequency or periodicity to which the relay is intended to respond.

A set of contacts, to be operated upon appropriate rotation or oscillation of a cam **36**, carried by the shaft **25** are provided, as particularly shown in Figures 1, 2, 3 and 6. This contact set comprises a spring strip **40** carried at one end by a stud **41**, but suitably insulated therefrom (see particularly Figure 2) and provided at its free end with a wear-resistant metallic shoe **42** for engaging the cam **36**. The spring strip **40** is provided also with a contact **43**, preferably constructed of one of the rare metals commonly employed for electrical contacts. By virtue of the inherent resiliency of the strip **40**, contact **43** is biased toward and adapted to engage a similar contact **44**, secured to a metallic strip **45** carried by, but insulated from, the stud **41**; the strip **45** being backed up or reinforced by a comparatively heavy metallic strip **46**, provided with an adjusting screw **47**. The strip **46** is also carried by, but insulated from, the stud **41**. By turning the screw **47**, in one direction or the other, the gap or distance between the contacts **43**, **44** may be adjusted as desired. The stud **41** is secured to a pivot block **48** adapted to oscillate about the standard or post **23**, upon which it is mounted. A helical spring **49** has one of its ends secured to the post and its other end secured to the pivot block **48** whereby the contact assembly is biased or urged by the spring **49** in a counterclockwise direction (Figure 2); the extent of such movement being limited by the engagement of a stop pin **50** secured to the pivot block **48**, with a stop pin **51**, secured to the post **23** (see Figure 1).

This latterly described construction permits the contact assembly to be readily manually swung outwardly, clear of the armature or torsional pendulum assembly, thereby facilitating inspection, adjustment, and cleaning of the contacts, and after performance of any of such operations as may be necessary or desired, the spring **49** automatically returns the contact set to its operative position as determined by the engagement of the stop pins **50**, **51**.

It may be noted that the base member **24**, and the supporting posts **23**, **23** and **29**, **29**, are preferably made of metal in one piece, as by a die casting. The end plate **28**, also conveniently made of metal, can be insulated from its supporting posts **29**, **29**, as by insulating washers **52** (see Figures 1 and 3), so as to obviate losses which might arise if the frame constituted, electrically, a closed loop.

The wear-resisting metallic shoe **42** of the contact assembly is engaged and mechanically operated by the cam **36**, which is constructed of suitable wear-resisting material such as ebonite or Celluloid. Alternatively, the shoe **42** may be made of suitable wear-resistant insulating material and the cam **36** made of wear-resistant metal.

In the apparatus here shown, the arrangement of the contact assembly and cam **36** is such that when the coils **20**, **21** are not energized at the predetermined frequency, the armature is maintained in its normal or "rest" position by the spring **35** (the magnetic axis of the armature **33** being then conveniently at right angles, as shown in Figures 1 and 3, to the magnetic axis of the coils **20**, **21**), and the contacts **43**, **44**, are open. That is, with the armature in such position, the high spot of cam **36** is in engagement with the shoe **42**, keeping the contacts **43**, **44** normally open. Deflection of the armature **33**, under the action of the solenoid **20**, **21**, as hereinafter explained, rotates the high spot of the cam **36** out of engagement with the shoe **42**, so that contact **43** comes into circuit-closing engagement with contact **44**. A stud or stop **54**, extending down from the end plate **28**, intercepts the path of the armature **33**, conveniently at a point directly opposite one side of the solenoid **20**, **21** (see Figures 2 and 6) so as to limit the extent of deflection of the armature **33** in either direction.

For ordinary operation of the apparatus to effect continuous circuit-controlling operations, a supplementary relay is provided. This supplementary relay, generally designated **60**, can be, if desired, mounted on the opposite face of the base plate **24** from the apparatus just described, and may comprise, for example any efficient standard type of relay suitable for effecting the desired circuit control. Preferably, although not essentially in all cases, this relay is non-chattering and is of a slow release type, or of a type involving some lost motion of its armature upon de-energization. The type of relay here shown is adapted to close a single pair of contacts upon energization, but it will be understood that the

same or a different type of relay may be employed to open normally closed contacts, or to perform any number of those or any other kinds of circuit-controlling operation. Referring more particularly to Figure 7, which shows the working parts of the relay **60**, the latter is seen to include a solenoid and core **61**, having an L-shaped armature **62**, of which one arm **63** has secured thereto a rigid operating strip **64** passing through an aperture **65** in an upright member **66** secured to the end of the solenoid core **61**, upon which end the armature is fulcrumed. This upright member **66** may conveniently form a part of a bracket **67** which serves to mount the relay **60** upon the base plate **24** (see Figures 1 and 3). Instead of the edge of the core **61**, the adjacent configuration of the bracket **67** may be such as to provide a fulcrum for the armature **62**, i. e., so that in either case the armature is in effect pivoted at its end opposite the end **68**, for movement downwardly (in Fig. 7) upon energization of the solenoid **61** (attracting portions **68** and **63** of the armature). A pin **68***a*, extending, as shown, through the armature part **63** and a part of that end of core **61** to which member **66** is fastened, loosely secures the armature to the solenoid for preventing lateral displacement of the armature while permitting it to rock downwardly (and back upwardly) as just explained.

The outer end of the rigid strip **64** conveniently engages the upper edge **69** of an aperture in a vertical extending link **70**, which is urged or biased downwardly by the tension of a spring **71**, so as to maintain the end **68** of the armature in a position, for example, as shown, spaced from that which it would occupy upon energization of the magnet **61**. The upper extremity of the link **70** is operatively connected with an operating member of a contact device, so that when the magnet **61** is de-energized, and the link **70** is in a lower position under the tension of spring **71**, the contacts **72**, **73** are opened, but on energization of the magnet **61** and consequent displacement of the armature **63** downwardly (in opposition to the tension of spring **71**), the link **70** is correspondingly moved up by the strip **64**, and the contacts **72**, **73** are closed. Any suitable contact arrangement may be employed; one advantageous type consists of a pair of contacts **72**, **73**, normally biased for closure by the spring **74**, and adapted to be maintained open by engagement of one end of an operating member or lever **75** with the under side of contact **72**. Thus when link **70** is in its lower position, arm or lever **75** is so positioned relative to its fulcrum **76** as to keep the contacts open; upward displacement of link **70** frees the lever **75**, permitting the contacts to close. The contact assembly just described may be conveniently mounted in a sealed glass tube, as shown in Figures 1 and 3, into which the arm **75** extends through a sealed flexible connection permitting the necessary movement of the arm. The interior of the glass tube may contain such vacuum or inert gas as will prevent arcing upon even a very slight opening of the contacts **72** and **73**.

Conveniently mounted within the frame of the apparatus, as shown in Figures 1, 2 and 3, are a condenser **80** and a resistor **81**, connected as will now be described. The base plate **24** of the apparatus may also carry, insulated therefrom (see Fig. 1), such binding posts or terminals **82** as are desired for connection of the apparatus in use.

Referring particularly to Figure 5, which shows a preferred wiring diagram of the apparatus heretofore described, it will be seen that the input **83**, **84** of the relay, viz., the circuit from which the predetermined alternating or pulsating current is to be derived for energization, is connected to the solenoid or field comprising coils **20**, **21**. Contacts **43**, **44** are so connected that upon closure they establish the following circuit to energize relay **60**: From one side of a source of current, such as a battery suitable for energization of relay **60**, through conductor **85**, contacts **43**, **44**, resistor **81**, winding **61***a* of the relay **60** and conductor **86**, back to the other side of the battery. Condenser **80** is advantageously connected in parallel with the winding **61***a* of the relay **60**, as shown. Contacts **72** and **73** are connected, as will now be understood, in the circuit to be controlled upon the desired selective response of the relay apparatus. It will be appreciated that by virtue of the discharge of the condenser **80**, relay **60** will be maintained energized, and its contacts **72**, **73** consequently closed, for an appreciable length of time after an opening of contacts **43**, **44**, and even though these contact may only be closed momentarily. The resistance **81** serves to prevent surges of current, e. g., into the condenser **80**, such as would cause harmful arcing across contacts **43**, **44** when they are opened and closed in rapid succession, i. e., so as to prevent pitting or like injury to these contacts.

It may now be explained that when a periodic current, such as an alternating current, or a periodically varying current, or a periodically pulsating current, or a periodically interrupted current is impressed on the input circuit **83**, **84**, and its periodicity is that of the natural mechanical periodicity of the shaft **25** and assemblage carried thereby, the armature **33** will be swung in synchronism with the current variations (i. e., the current variations traversing the solenoid **20**, **21** through which the armature **33** is adapted to swing) and will reach an amplitude of oscillation sufficient to rotate the high point of cam **36** well away from the shoe **42** and permit a consequent closure of contacts **43**, **44**. Thereafter the contacts **43**, **44** close upon each such swing or deflection of the rotor **33**, in either direction; each such closure of the contacts **43**, **44** energizes the relay **60** and charges the condenser **80**, and the discharge of the condenser **80** maintains the relay **60** energized upon subsequent temporary opening of the contacts **43**, **44** (while the rotor **33** is passing through the central part of its swing from one position to the other). In this manner the contacts **72**, **73** are closed and maintained closed by the effect of current, having the proper predetermined periodicity, flowing through the coil sections **20** and **21**. Current of a different periodicity through the coil sections **20**, **21** will not, however, produce such response because the electromagnetic torque impulses exerted upon the armature **33** will not be in synchronism with the mechanically tuned assemblage including the shaft **25** and the structure carried thereby.

The periodicity of the torsional pendulum comprising the assemblage **25**, **33**, and associated parts is determined generally by suitable relative design of the parts. A finer desired adjustment may be obtained, for example, by adjusting the effective length of the helical spring **35**. Such last mentioned adjustment may be conveniently made by rotating the lower end of the spring in its groove in the nut **30**, and by correspondingly rotating the collar **34** (after loosening the set screw thereof) about the shaft **25** so as to main-

tain the armature 33 in its desired position of rest.

In some cases, as where the relay apparatus is so designed or is so located with respect to other apparatus that eddy currents (set up about the solenoid, 20, 21 and in adjacent metallic parts of the relay or other apparatus) might have some detrimental effect, suitable flux-localizing means may be employed, such as additional soft iron armatures carried by the shaft 25 above and below the solenoid 20, 21. Another arrangement for increasing the sensitivity and reliability of the relay in such cases, is shown in Figure 4. Here, in addition to the armature 33 normally lying within the core of the solenoid 20, 21, the shaft 25 carries an additional permanently magnetized armature 93. This permanent magnet 93, which may be in all respects like the permanent magnet (rotor) 33, is conveniently secured to the bushing 32 so as to be in axial and radial alignment with the rotor 33. The S-pole of the magnet 93 lies adjacent the N-pole of the rotor 33 and the N-pole of the magnet 93 lies adjacent the S-pole of the rotor; the poles being at the ends of the magnet 93 and the rotor 33. The permanent magnets 33, 93, located one within and one outside the coils 20, 21, constitute an astatically balanced system.

Among others, advantages inherent in structures of this character are the minimization of eddy current losses, and at least to a certain extent, the provision, by each magnet, of a "keeper" for the other, so that the magnetism of each is the more permanently maintained. Furthermore, the magnet 93 may constitute in effect a supplemental rotor, and may serve, where desired, to increase the moment of inertia of the torsional pendulum about the axis of shaft 25. Astatically balanced or other flux-localizing arrangements of the types described serve also to prevent deleterious effects due to any nearby iron parts or electromagnetic devices, e. g., such parts or devices as may be present in other relays or like apparatus located near the relay apparatus.

The arrangement shown in Figures 8 to 11 includes certain modifications useful in some instances, particularly with respect to the contact assembly operated by the torsional pendulum. In the modification here shown, the shaft 25 carries a contact operating arm 100, for operating and closing contacts 143 and 144 (otherwise connected and corresponding to contacts 43, 44 of the device previously described), as follows: The electrical contacts 143, 144, suitably insulated from each other, are supported by a stationary bracket 148, which may be conveniently carried by a supporting post, such as one of the posts 23, in lieu of the block 48. The contact arm 143 has pivotally mounted thereon a cam segment 149 which is biased by a spring 150 towards the stop pin 151. When the arm 100 is deflected from its normal position to a sufficient extent it flips idly by the contacts by virtue of the fact that when the end of the arm 100 engages the segmental cam 149, the latter swings away from its back stop without operating the contact arm 143 to close the contacts, as shown in Figure 8. But on the return stroke, i. e., toward normal position, the same end of the arm 100 engages the cam segment 149 (note the so-advanced position of the end of arm 100 as indicated by dotted lines 100a in Figure 9) and causes the contact arm 143 to be moved toward the other contact arm 144 so as to close the contacts (see Figure 10) and so as to permit the arm to pass. The contact arms 143 and 144 are normally separated by virtue of their inherent resiliency.

It will be appreciated that with the arrangement just described, oscillatory movement of the shaft 25 upon energization of the relay apparatus at the predetermined frequency to which it is to respond selectively, will cause closure of contacts 143, 144 with a corresponding periodicity and with very little frictional loss; but with the construction shown, there is only one contact closure for each complete swing of the torsional pendulum assemblage—that is, only upon deflection in one direction—in contradistinction to the arrangement shown in Figures 1, 2, 3 and 6, wherein the contacts are closed upon the arrival of the armature at each end of its swing. In order to provide two contact closures per complete oscillation, as in the previously described arrangement, an additional contact assembly similar to that shown in Figures 8 to 11 inclusive, may be mounted upon another supporting post in such position as to be operated by the opposite end of arm 100 when the latter is swung in an opposite direction to that which effects operation of contacts 143, 144. Such additional contacts, it will now be understood, can be conveniently connected in parallel with contacts 143, 144.

If desired, the shaft 25 may carry such an arm 100, either to operate a contact assembly as shown in Figures 9 to 11 inclusive, or merely to swing free, which carries, as shown in Figures 8 to 9 inclusive, a pair of weights 152, 152. The weights 152, 152 are respectively screw-threaded upon the ends of the arms 100, so that they may be individually and accurately moved toward or away from the shaft 25. Means are thus provided for effecting a delicate adjustment of the balance of the torsional pendulum assembly and also for providing a further adjustment of the periodicity of that assemblage, as by moving both weights 152 toward or away from the shaft to increase or decrease the natural frequency of oscillation of the assemblage.

One form of my invention, including the instrumentalities shown in Figures 8 to 11 inclusive, is disclosed but not claimed per se, in the copending applications of John R. MacKay, Serial Nos. 730,127 and 11,783, respectively filed June 11, 1934 and March 19, 1935, for Communicating systems.

Referring against to Figures 1 to 3, it will be appreciated that a suitable housing for the apparatus may be provided, including a transparent Celluloid casing, one side of which is shown in section at 153 in Figure 1, together with a cup-like closure of Bakelite or the like which will cover the whole of the apparatus shown above the base plate 24 in Figure 1 and may have its open edge fastened down to abut against the shoulders 154, 154 on the base plate.

It will now be appreciated that apparatus of the type described affords a particularly sensitive and efficient selective relay, which is sharply tuned for response only to the desired alternating, pulsating, varying or interrupted current. The mechanical tuning arrangements provide means for maintaining the relay at its desired tuning or resonance irrespective of electrical circuits or conditions and without appreciable effect due to variations in voltage, temperature, humidity or the like. The apparatus is simple in operation, sturdy, and easy of access for inspection, cleaning, repair or adjustment; its

operation involves remarkably little loss due to friction. At the same time, the arrangement of the energizing solenoid **20, 21**, and the torsional pendulum including the magnetized armature **33**, is such as to provide a sustained and vigorous action (with relatively heavy contacting pressure, as at contacts **43, 44**) upon application of the predetermined energizing current, and to prevent, particularly when the spring **35** is made relatively stiff, any minor, harmonic, or inadvertent operation under the control of currents to which the relay apparatus is not intended to respond. Furthermore, the apparatus affords efficient selective response at relatively low frequencies, and obviates the disadvantages in many tuned relays of the vibrating reed or tuning fork types, which are only satisfactory at such high frequencies as to cause rapid wear of their rapidly making and breaking contacts, and which are susceptible of fatigue or are characterized by large temperature coefficients, so that they are apt to "creep" or otherwise depart from the desired tuning.

It will be understood that in some cases contacts **43, 44** may be adapted to open instead of close upon deflection of the torsional pendulum assemblage, or may be adapted to perform a plurality of circuit-controlling operations. Likewise, as previously explainder, supplementary relay **60** may assume a variety of forms, so as to achieve any desired type or types of predetermined circuit-controlling operation upon energization or de-energization of the selective relay apparatus.

The arrangement shown is furthermore such that even though relatively strong currents of the wrong frequency (i. e., currents or impulses having some other periodicity than that to which the relay is intended to respond) are impressed upon the solenoid **20, 21**, the mechanical impedance, so to speak, of the armature assembly will ordinarily prevent its building up to a sufficient amplitude of oscillation for closure of contacts **43, 44**. That is, even with relatively strong current, the first deflection of the armature will be insufficient to operate the contacts, and if the current is of the wrong periodicity, its next and succeeding impulses will be out of step with the natural period of the assembly and will thus actually oppose or prevent its oscillation. Furthermore, even if a casual deflection of the armature should, although it is unlikely, effect a closure of contacts **43, 44**, such isolated closures could not effect sustained energization of the relay **60**, nor the predetermined sustained circuit-controlling operation of contacts **72, 73**.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus which I now consider to represent the most advantageous embodiments thereof, but I desire to have it understood that the apparatus disclosed is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted and some of the features of each modification may be embodied in the others without interfering with the more general results oultined, and the invention extends to such use within the scope of the appended claims.

I claim:

1. A selective relay device, comprising in combination, a torsional pendulum having associated therewith circuit-controlling means adapted to be operated upon rotative oscillation of said pendulum at its natural period and adapted for free pendulum rotation unobstructed by said means, said pendulum having torsional mounting means adapted to prevent non-rotative displacement of the pendulum, and electromagnetic means for imparting driving torque to said torsional pendulum in accordance with the periodicity of energizing current supplied to said electromagnetic means.

2. A selective relay device comprising circuit-controlling means, an electrically independent, torsionally suspended, magnetized armature having a natural period of rotative oscillation, an air-core stator coil for imparting oscillatory driving force to said armature, said armature being disposed for rotative oscillation within said coil, and means responsive to rotative oscillation of said armature at its natural period for operating said circuit-controlling means.

3. A selective relay device comprising circuit-controlling means, an electromagnetically driven torsional pendulum for effecting operation of said means upon rotative oscillation of said pendulum at its natural period, said pendulum comprising a rotatable mass, means resiliently holding said mass against rotation, and journalling means supporting the weight of said mass independently of said last-mentioned means.

4. A selective relay device comprising circuit-controlling means and an electromagnetically driven torsional pendulum for effecting operation of said means upon rotative oscillation of said pendulum at its natural period, said pendulum including a member journalled for rotation, a spring adapted to bias said member against rotation, and adapted for adjustment of its effective length to vary the natural period of the pendulum, and means adjustably securing said spring to normally maintain said member in a predetermined position of rest upon adjustment of the effective length of the spring.

5. A selective relay device comprising a contact device, a permanently magnetized armature torsionally suspended for oscillation at a predetermined natural period and in a rotative direction only, said armature having mounting means adapted to prevent non-rotative displacement of the armature, stationary electromagnetic means comprising an open-cored solenoid for imparting oscillatory driving force to said armature, said armature being adapted to oscillate into and out of the core of said solenoid, and means responsive to oscillation of said armature at its natural period for operating said contact device.

6. A selective relay device comprising a contact device, a member of ferrous metal torsionally suspended for rotative oscillation and having mounting means for preventing non-rotative displacement of said member, stationary electromagnetic driving means for said member, and means responsive to displacement of said member for operating said contact device.

7. A selective relay device comprising a set of contacts, a tuned torsional pendulum device having a natural period of rotative oscillation, electromagnetic means for imparting oscillatory driving force to said pendulum in accordance with the periodicity of energizing current supplied to said electromagnetic means, and means mechanically responsive to oscillation of said pendulum device at its natural period for effecting the same operation of the same aforesaid set of contacts dur-

ing each half cycle of oscillation of the pendulum device.

8. A selective relay device comprising stationary electromagnetic means comprising an air-core winding, circuit-controlling means, and means for operating said circuit-controlling means upon predetermined periodic energization of said electromagnetic means, said operating means including a permanent magnet yieldably supported for oscillation within said air-core winding and having a predetermined oscillatory period.

9. A selective relay device comprising contacts and an electromagnetically energizable pendulum mounted for rotative oscillation and having camming means adapted for unobstructed travel of the pendulum past said contacts, for operating the contacts upon oscillation of the pendulum at its natural period, said pendulum having mounting means adapted to prevent non-rotative displacement of the pendulum.

10. A selective relay device comprising circuit-controlling means, a plurality of coil members, an electrically independent armature member which is torsionally suspended between said coil members for rotation within each of same and which has a predetermined natural period of rotative oscillation relative to said coil members and which is magnetically responsive to energization of said coil members by a current having a periodicity corresponding to said natural period, for receiving oscillatory driving torque from said coil members, and means responsive to oscillation of said armature at its natural period for operating said circuit-controlling means.

11. A selective relay device comprising circuit-controlling means and an electromagnetically driven torsional pendulum for effecting operation of said means upon rotative oscillation of said pendulum at its natural period, said pendulum including a member journalled for rotation, a helical spring disposed coaxially with said member, means adjustably securing one end of said spring to said member for variation of the angular position of the spring relative to the member, and means adjustably securing the other end of said spring against rotation, for variation of the effective length of said spring upon rotative displacement of said other end of the spring.

12. A selective relay device adapted to perform a predetermined circuit-controlling operation upon reception of current having a predetermined periodicity, and including, in combination, a stationary air-core field winding and a mechanical oscillator having a natural period of oscillation corresponding to said predetermined periodicity, said oscillator including a permanently magnetized armature mounted to oscillate within said field winding and adapted to receive oscillatory driving impulses from the field winding, and means for effecting the predetermined circuit-controlling operation upon oscillation of said oscillator at its natural period.

13. A selective relay device comprising in combination a shaft journalled for rotation, yieldable means normally biasing said shaft against rotation, electromagnetic means which include an armature carried by said shaft and which are adapted, upon energization by current having a predetermined periodicity, to effect oscillation of said shaft about its axis, said shaft, armature and yieldable means providing an assembly adapted for free oscillation at substantially only said predetermined periodicity, and circuit-controlling contact means operated upon oscillatory deflection of said shaft.

14. A selective relay device comprising, in combination, a solenoid having an open core; torsional pendulum means adapted for free oscillation at a natural period and having a shaft adapted for oscillation about its axis, an armature mounted on said shaft for oscillation therewith into and out of the open core of the solenoid, and resilient means normally maintaining said shaft in a position of rest with the armature positioned for the exertion of electromagnetic force thereon by the solenoid to displace the armature in its path of oscillation; and contact means adapted for operation upon oscillatory displacement of said armature in response to energization of the solenoid by current having a periodicity corresponding to the aforesaid natural period.

15. A selective relay device comprising circuit-controlling means, and electromagnetic means for operating the same upon energization by current having a predetermined periodicity, said electromagnetic means including magnetically reacting stator and armature members, said armature member being torsionally suspended for rotative oscillation relative to said stator member at a natural period corresponding to the aforesaid predetermined periodicity, and flux-localizing means magnetically adjacent to and adapted for rotative oscillation with said armature, to minimize eddy current losses upon oscillation of said armature member when the electromagnetic means is energized by the aforesaid current.

16. In a selective relay device for circuit control in response to current of predetermined periodicity, in combination, a permanently magnetized armature, mechanically tuned means whereby said armature is adapted for periodic deflection at a predetermined natural period, electromagnetic means for supplying driving impulses to said armature, and flux localizing means movable with said armature and providing therefor a magnetic path of substantially less reluctance than air.

17. The combination of claim 16 wherein said flux localizing means comprise a permanently magnetized member deflectable with said armature and astatically arranged with respect to said armature.

18. In a selective relay device for circuit control in response to current of predetermined periodicity, in combination, a solenoid, a permanently magnetized armature therefor, torsionally mechanically tuned means whereby said armature is adapted for periodic deflection at a predetermined natural period, and flux-localizing means comprising a bar of ferrous metal adjacent to and deflectable with said armature and providing therefor a magnetic path of substantially less reluctance than air.

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