Dec. 1, 1942. E. M. CLAYTOR 2,303,723

TIME RELAY SYSTEM

Filed Jan. 27, 1939 2 Sheets-Sheet 1

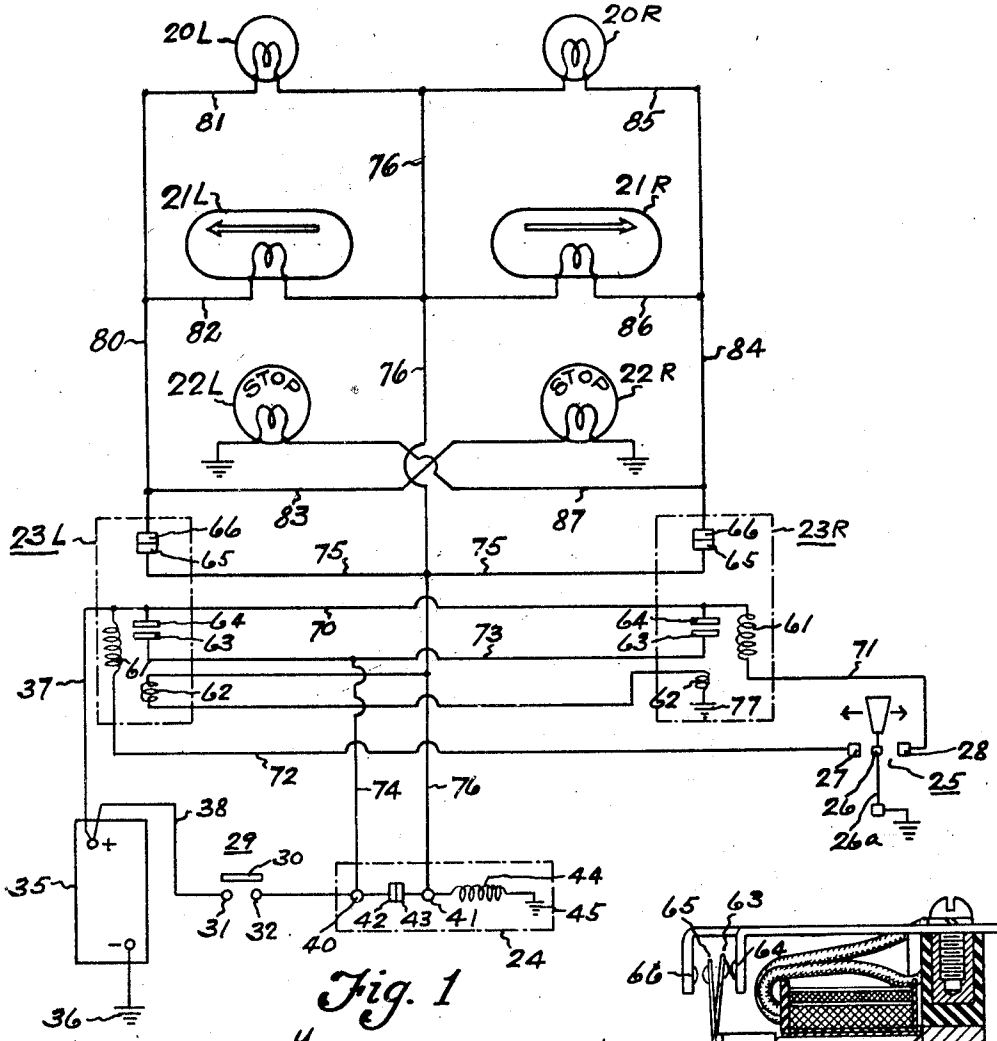


Fig. 1

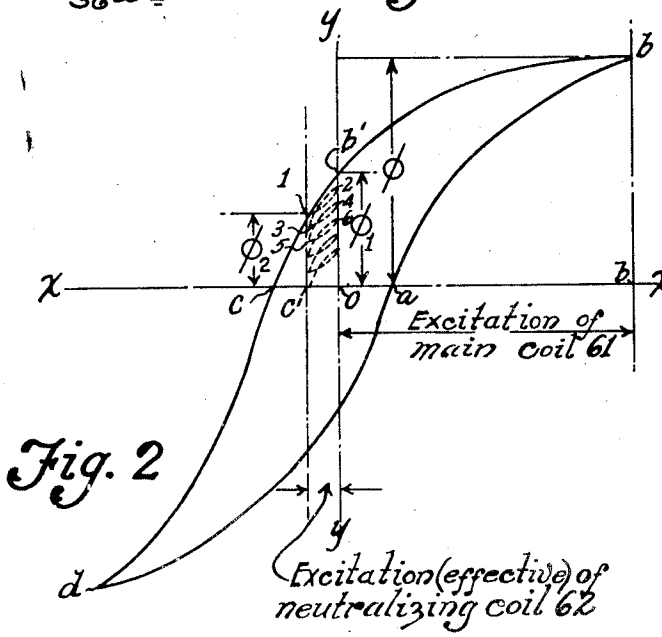


Fig. 2

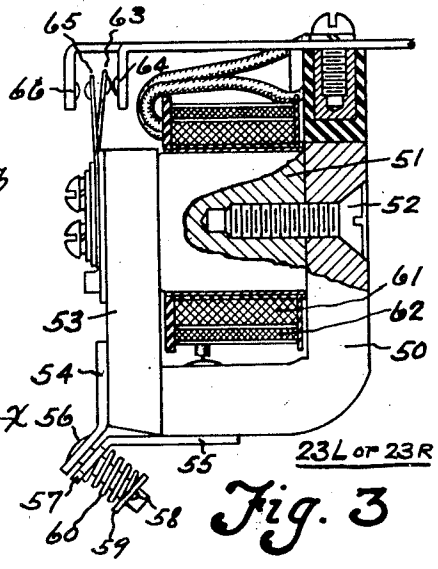


Fig. 3

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TIME RELAY SYSTEM

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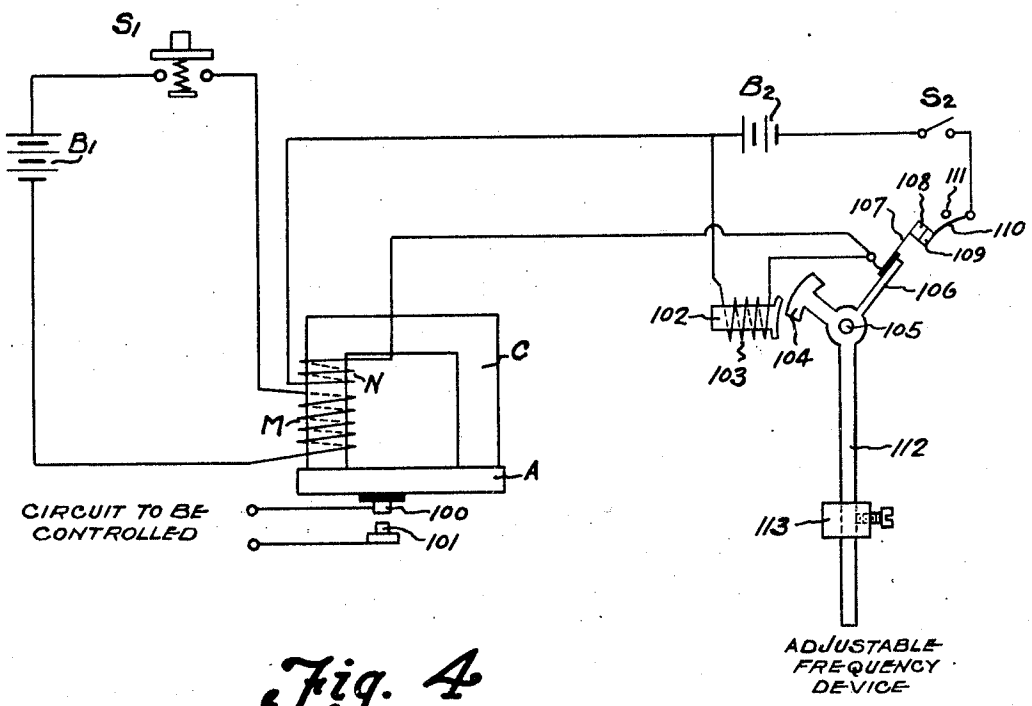


Fig. 4

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UNITED STATES PATENT OFFICE

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TIME RELAY SYSTEM

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2 Claims. (Cl. 175—373)

This invention relates to time relays in which a main exciting coil is employed to produce flux causing attraction of the armature toward the core or stationary element of the magnetic circuit, and in which a neutralizing coil producing reverse flux is employed to counteract residual magnetism in the magnetic circuit so that the armature will move away from the core and thereby control some other circuit.

Heretofore it has been the practice to excite the neutralizing coil continuously to reduce the residual magnetism to zero. The time which elapses between the opening of the circuit to the main coil and the separation of the armature from the core depends on the mass and character of the iron of the core and armature. The greater the mass, the greater will be the lapse of time required for the decay of flux.

The chief aim and object of the present invention is to provide a time relay in which the required time delay can be obtained by the use of a relatively small mass of iron and in response to a predetermined number of intermittent excitations of the neutralizing coil. In this way the bulk and cost of the relay is materially reduced, and greater variations in the magnetic properties of the iron of the core and armature are permissible.

Instead of using a large mass of iron, I can obtain the desired time lag by the use of a relatively small mass of soft iron having relatively low residual magnetism. Instead of using a continuously excited neutralizing coil of relatively great m. m. f., I obtain the lag in reduction of residual flux to zero, by using an intermittently excited neutralizing coil of relatively small magnetomotive force by means of which the residual flux is reduced in stages, the number of which will be dependent upon the magnetomotive force of the coil and the lapse of time between successive excitations.

One of the ways in which my novel time relay may be used is in a turn signalling system for an automobile. In an automobile turn signalling system a blinker relay has frequently been used to cause the direction indicating lights to burn intermittently to give a flashing signal. When my time relay is used in such a system, it operates in conjunction with the blinker to determine the length of time the blinker operates, and the blinker is so connected with the neutralizing coil of the time relay that the time relay opens the circuit of the signal after a predetermined number of flashes of the signal lamp.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a wiring diagram of an automobile stop and directional signal system including two time relays embodying the present invention.

Fig. 2 is a diagram illustrating the operation of the time relay.

Fig. 3 is a side view of the time relay partly in section.

Fig. 4 is a wiring diagram showing a modified form of the invention.

Referring to Fig. 1, 20L designates a signal light on the left front fender of an automobile. 21L designates a direction signal located on the left side of the rear of the automobile. 22L designates a stop signal lamp also located on the left of the rear of the automobile. The signal lamps 20R, 21R and 22R designate, respectively, the signal lamps which are located on the right hand side of the automobile and correspond respectively with 20L, 21L and 22L. 23L designates in its entirety the time relay for controlling the signal lamps on the left side of the car; and 23R designates the time relay for controlling the lamps on the right side of the car. 24 designates the blinker unit. 25 designates the signal control switch comprising a movable, resilient grounded contact member 26 engageable either with stationary contact 27 to effect operation of signals indicating a turn to the left, or with a contact 28 to effect operation of signals indicating a turn to the right. 29 designates a stoplight switch comprising a movable member 30 engageable with contacts 31 and 32. Switch 29 may be operated directly by the brake pedal or it may be a pressure fluid operated switch where a hydraulic brake system is used.

The blinker unit 24 which may be of any conventional form comprises terminals 40 and 41 with which normally engaged contacts 42 and 43 are respectively connected. These contacts are intermittently opened by the energization of a magnet coil 44 which is grounded at 45.

Storage battery 35 is grounded at 36 and is connected by wire 37 with the time relays 23L and 23R and by wire 38 with the stop light switch 29. Each of the timer relays 23L or 23R includes a relatively soft iron magnetic circuit comprising an L-shaped member 50, a core 51 attached to member 50 by a screw 52, and an armature 53 hingedly connected with the L-member 50 by means comprising non-magnetiz-

able hinge plates 54 and 55 attached respectively to armature 53 and member 50. Plate 54 carries a stud 56 which passes loosely through a hole 57 in the plate 55. Stud 56 carries a cross pin 58 and a washer 59. A spring 60 surrounds stud 56 and is located between the washer 59 and the plate 55. Spring 60 is compressed so that it tends to urge the adjacent ends of the hinge plates 54 and 55 closer together thereby tending to separate the armature 53 from the core 51. The core 51 is surrounded by a main relay energizing coil 61 and a neutralizing coil 62. The armature 53 insulatingly supports movable contacts 63 and 65 engageable respectively with stationary contacts 64 and 66. As shown in Fig. 1, relay contacts 65 and 66 are normally closed and contacts 63 and 64 are normally open. In the normal position of the relay, its armature 53 is separated from the core 51. In the operating position of the relay the armature 53 is against the core 51 as shown in Fig. 3; and contacts 63 and 64 are engaged while contacts 65 and 66 are separated.

Contacts 64 of time relays 23L and 23R are connected by wire 70. Wire 71 connects coil 61 of relay 23R with contact 28 of signal control switch 25. Wire 72 connects the magnet coil 61 of relay 23L with contact 27 of signal control switch 25. Wire 73 connects the contacts 63 of the time relays 23L and 23R. Wire 73 is connected by wire 74 with blinker terminal 40. Movable contacts 65 of relays 23L and 23R are connected by wire 75. Wire 75 is connected by wire 76 with blinker terminal 41. Wire 76 is connected with the two neutralizing coils 62 of relays 23L and 23R which are connected in series between wire 76 and ground 77. Contact 66 of relay 23L is connected with wire 80 from which wires 81, 82 and 83 branch off to lamps 20L, 21L and 22R respectively. Contact 66 of relay 23R is connected with wire 84 from which branch off wires 85, 86 and 87 leading to lamps 20R, 21R and 22L respectively. Lamps 22R, and 22L are grounded. Lamps 20L, 20R, 21L and 21R are connected with wire 76 to which wire 75 is connected.

To indicate a left turn, the switch 25 is operated to close contacts 26 and 27 thereby connecting magnet coil 61 of relay 23L with the battery through the following circuit: battery 35, wire 37, coil 61, wire 72, contacts 27 and 26, blade 26a and ground return to battery. The energization of magnet coil 61 causes contacts 63 and 64 of time relay 23L to be closed and the contacts 65 and 66 thereof to be separated as shown in Fig. 3. When this occurs, current will flow from the battery through the blinker to the left turn signal lamps 20L and 21L through the following circuit: battery 35, wire 37, contacts 64 and 63 of relay 23L, wire 74, blinker contacts 42, 43, wire 76, lamps 20L and 21L, wire 80, wire 83, stop lamp 22R and ground return to battery. Current will also flow to stop lamp 22L from wire 76, through wire 75 contacts 65, 66 of time relay 23R, wire 87, stop lamp 22L and ground. Thus, when a turn signal lamp is connected, both stop lamps will also be connected, but the stop signal lamp on the same side of the vehicle as the selected turn signal lamp will burn the brighter, because it is energized in parallel with the turn signal lamp, while the dimmer stop signal lamp is in series with the selected turn signal lamp. Lamps 20L and 21L will be illuminated to indicate the left turn at front and rear of the car and the stop lamps will act to call attention to the change about to be made. The blinker 24 will operate intermittently to separate contacts 42 and 43 through the operation of the magnet coil 44 to separate the contacts against the force of a contact closing spring not shown. Therefore, lamps 20L and 21L and both stop lamps are giving an intermittent flashing signal. This flashing signal is produced an instant following the closing of contacts 26 and 27 of switch 25 and will continue for a short period after these contacts have separated. Hence, it is not necessary for the operator to hold the switch blade 26a in contact closing position.

As stated before, the closing of contacts 26 and 27 causes magnet coil 61 of relay 23L to be energized. When this occurs, the armature 53 shown in Fig. 3 is caused to contact with the stationary magnetizable parts 50 and 51. Due to residual magnetism in the relay iron, the armature 53 does not immediately separate from the parts 50 and 51 when contact 26 is separated from contact 27. There is a certain lag due to hysteresis producing a relatively slow decay in flux. This decay in flux is retarded to a predetermined extent by the operation of neutralizing coil 62 which is energized intermittently by the blinker 24. The blinker 24 may be constructed and adjusted to cause a signal flash once every .5 to 1.5 seconds. The time relay may be constructed and adjusted to require a predetermined number of flashes to take place before the time relay separates contacts 63 and 64 and recloses contacts 65 and 66 as will be explained hereinafter. The time relay may be adjusted to require from 5 to 10 excitations of neutralizing coil 62 through the operation of the blinker 24 before the relay opens. If for example, the blinker 24 gives a flash every 1.5 seconds, and the time relay is constructed and adjusted to require 10 excitations of the neutralizing coil 22 before the relay opens, then the flashing will continue for approximately 15 seconds after a contact 26 of switch 25 is separated from contact 27. If blinker 24 is set for causing a flash every .5 second and the relay is constructed and adjusted to require 5 excitations of neutralizing coil 62 before the time relay opens, then the flashing will continue for 2.5 seconds after contacts 26 and 27 of switch 25 are separated. The period of 15 seconds may be longer than necessary for an automobile signal. However, these figures are given to show that the duration control by the time relay may be varied to suit the requirements of the equipment in which the time relay is used.

To indicate a right turn, switch 25 is operated to close contacts 26 and 28 thereby energizing magnet coil 61 of the time relay 23R to effect the closing of contacts 63 and 64 and the opening of contacts 65 and 66 thereof, while the contacts of relay 23L remain in the condition shown in Fig. 1. When this occurs, the right hand signal lamps will receive current from the battery through the following circuit: battery 35, wire 37, wire 70, contacts 64 and 63 of time relay 23R, wire 73, wire 74, blinker contacts 42 and 43, wire 76, lamps 20R and 21R, wire 84, wire 87, stop lamp 22L and ground return to battery. The right hand time relay 23R operates in conjunction with blinker 24 in the manner described with respect to left hand time relay 23L.

For the signal switch 25 having a blade 26a movable into two positions from a central position, one may use two push button switches connected in alternate circuits, one of which is used

to indicate a left turn and the other a right turn. These switches may be conventionally mounted on or adjacent a steering wheel of an automobile.

Obviously, when the left signal lamps **20**L and **21**L are burning, the right signal lamps **20**R and **21**R do not burn, because both terminals of each are subjected to the same potential as the wire **76**, by means of the closed contacts **65**, **66** and wire **75** of the relay **23**R. For the same reason the lamps **20**L and **21**L do not burn when the signal lamp **20**R and **21**R are operating.

When the brake is applied, the brake switch **29** is closed to cause both stop lamps **22**R and **22**L to be connected to the battery through the flasher **24**.

I will now describe in more detail the operation of the time relays **23**R and **23**L. In Fig. 2 distance horizontally from the right of line *y*—*y* represents positive excitation and distance horizontally from the left of line *y*—*y* represents opposite or negative excitation. Distance vertically above the line *x*—*x* represents flux in a positive sense and distance vertically below the line *x*—*x* represents flux in the opposite or negative sense. Point O is the intersection of lines *x*—*x* and *y*—*y*. The curve *a*—*b*—*c*—*d*—*a* is the hysteresis loop of the time relay. Part *a*—*b* is the build-up of flux corresponding to excitation of the main coil **61** when the excitation is measured by the line *o*—*b*. The flux is represented by ϕ. Assuming that at point *b* the magnet coil **61** is disconnected from the current source, the flux will die down slowly as indicated by line *b*—*b'* due to the effect of circulating eddy currents whose effect in turn opposes the decay of flux. Due to residual magnetism, there will be flux ϕ, although the excitation of coil **61** is zero. In order that the residual flux may be reduced to zero, it has been the practice to use a neutralizing coil which is continuously energized to the extent represented by line O—C. When a continuously energized neutralizing coil is used, it is necessary to provide the relay with a large mass of iron of prescribed magnetic properties, otherwise the magnetism would be reduced to zero in too short a time. I have discovered that I can effect the same time delay through the use of an electromagnet having much less iron in its circuit, if I use a relatively weak neutralizing coil in contrast to a relatively strong energizing coil as used heretofore, and if I intermittently energize the neutralizing coil instead of continuously as heretofore. Therefore, instead of employing a neutralizing coil requiring excitation O—C, I use a smaller one requiring excitation O—C' which does not reduce the residual flux from ϕ_1 to zero, but from ϕ_1 to ϕ_2. Then I disconnect the neutralizing coil **62** from the current source when the flux is at point **1** on the line *b*—*c*. The dying away of the negative excitation of coil **62** causes the flux to return along the line **1**—**2**. The next excitation of coil **62** causes the flux to die away along the line **2**—**3** which is below the line *b*—**1**. Then the second disconnection of the coil **62** from the current source results in a return of residual flux to the point **4** on the line *y*—*y*. Then reenergization of coil **62** causes residual magnetism to follow the line **4**—**5** and deenergization of coil **62** causes the residual magnetism to return along the line **5**—**6**. This process of demagnetizing continues until the residual magnetism is reduced to zero. Instead of the magnetism falling to zero at point C which would require the continuous excitation of neutralizing coil requiring C—O ampere turns which would produce demagnetism in a relatively short time, I am able to delay demagnetization through the intermittent excitation of the neutralizing coil **62** requiring a relatively small number of ampere turns as represented by line C'O. This effect is due to the fact that the residual magnetism is alternately opposed and then allowed to build up again as represented by the series of small hysteresis loops such as *b'*—**1**—**2**, **2**—**3**—**4**, **4**—**5**—**6**, etc. In other words, I provide cycles of magnetomotive force in opposition to residual flux which destroy the flux in steps, each step being represented by a miniature hysteresis loop which reduces the original residual flux lower and lower until it has finally become zero. The diagram shows that six energizations of coil **62** will effect reduction of the flux to zero. Obviously, the number of intermittent excitations of coil **62** as represented by the small hysteresis loops, required to reduce the residual flux to zero can be made to vary according to the construction of the relay. Thus the time relay embodying my principle can be constructed to suit any sort of equipment in which it is possible to use a relay which can be made to control a circuit in response to a predetermined sequence of excitations of the neutralizing coil of the relay. For use with an automobile signalling system a relay which requires five to ten intermittent excitations of the neutralizing coil is satisfactory.

I have found that instead of using a relatively large mass of iron to provide the required time delay, I am able to obtain satisfactory results with a relatively small mass of iron. I find that it is unnecessary to be so careful about the grade of iron used as to its residual magnetism since I do not neutralize residual magnetism in one step, but in a series of small steps.

When using the relay in a circuit subjected to variable voltage, such as in an automobile electrical circuit in which the voltage may vary from 6 to 8.4 volts, it may be that the time of delay of the relay is too short when the voltage is increased. To obtain a longer time where the voltage is not constant, I may employ a short circuiting band of copper or other good conducting material around the core. This tends to stabilize the demagnetizing flux by giving a lower percentage change in demagnetizing flux than the percentage of change in voltage.

To summarize briefly, the principle of my invention is the reduction of residual flux to zero in a predetermined series of small steps as the result of intermittent excitation of a neutralizing coil of relatively low magnitude or ampere turns. The functions of the relay depend in part on the rate of decay of flux, the magnitude of the hysteresis loops, the frequency of the intermittent current impulses through the neutralizing coil and the duration of said current impulses. By using an intermittently operated neutralizing coil I am able to obtain a time delay as great as that heretofore obtained by use of a much larger relay having a relatively massive magnetic circuit and coils of much greater structural dimensions. Furthermore, I am able to control the duration of delay because it is responsive to a predetermined sequence of excitation of the neutralizing coil.

Fig. 4 is a wiring diagram of a circuit in which an adjustable frequency device is employed for controlling the neutralizing coil of the time relay so that the armature of the time relay will drop out a predetermined time after a controlling switch has been closed. The circuit to be con-

trolled includes a switch comprising contacts 100 and 101. Contact 100 is carried by the armature A of the time delay relay, the core of which is indicated by letter C. One leg of the core is surrounded by the main exciting coil M and by the neutralizing coil N. Coil M is in circuit with a switch S_1 and a battery B_1.

The adjustable frequency device which controls the energization of the demagnetizing or neutralizing coil N comprises a magnet core 102 surrounded by an energizing winding 103. When this magnet is energized, an armature 104 is attracted from the position shown in Fig. 4 downwardly. Armature 104 is pivotally supported at 105 and is connected with a lever arm 106 which insulatingly supports a contact arm 107 carrying a contact 108, normally engaging a contact 109 attached to a resilient contact support 110, the movement of which is obstructed by a stop pin 111. The armature is connected also with a pendulum rod 112 along which slides an adjustable pendulum bob 113. The position of the bob 113 on the rod 112 determines the frequency of oscillation of the pendulum, armature 104 and contact supporting member 106. The neutralizing winding N and the magnet energizing coil 103 are connected together in parallel and each of these windings is connected in series with a battery B_2, a switch S_2 and the contacts 108 and 109 of the adjustable frequency device.

It is assumed that the circuit to be controlled is to be controlled by the closing of contacts 100 and 101. Therefore, initially the contact 100 is separated from contact 101 by upward movement of the armature A into contact with the core C of the time relay. This upward movement is effected by the closing of switch S_1 which causes current to flow from the current source B_1 to the main exciting coil M. Swith S_1 is only momentarily closed to cause armature A to engage the core C. Thereafter switch S_1 is opened. Residual magnetism in the core C maintains the armature A in the attracted position. The adjustable frequency device is set so that the contacts 101 and 100 of the circuit to be controlled will be engaged a predetermined time after the closing of the switch S_2. The closing of the switch S_2 causes current to flow through the demagnetizing winding N and also through the magnet coil 103 of the adjusting frequency device. The energization of coil 103 causes counterclockwise movement of the armature 104 thereby causing contact 108 to be separated from contact 109, thereby effecting oscillation of the rod 112 and bob 113. The oscillatory movement of the rod 112 effects the intermittent closing of contacts 108 and 109 thereby effecting the intermittent energization of the neutralizing coil N. After a predetermined number of intermittent excitations of the neutralizing coil N have taken place, the residual magnetism in the core C of the time delay relay will be completely neutralized and the armature A will descend by gravity carrying contact 100 into engagement with contact 101. Since the release of the relay armature A depends on a predetermined number of impulses of excitations in the coil N, the period of oscillation of the adjustable frequency device will determine the lapse of time between the closing of the switch S_2 and the dropping of the armature A.

The system shown in Fig. 4 is adapted for use in any device where it is desired to effect the operation of some electrically controlled device a predetermined time after the closing of a control switch. For example, it may be desirable to effect the detonation of an explosive charge a predetermined time after the closing of an electric circuit. In such case the contacts 100 and 101 would be in the circuit of the electrical means for detonating an explosive charge. The contact 100 would be held separated from the contact 101 by momentarily exciting the relay magnet winding M by momentarily closing the switch S_1. If the neutralizing winding N is effective after six intermittent excitations thereof to neutralize the residual magnetism in core C, and if the frequency device has been adjusted to a frequency of 60 cycles per minute or 1 per second then it follows that, after six seconds have elapsed from the closing of the switch S_2, the armature A will drop and carry the contact 100 into engagement with the contact 101 whereupon an explosion will take place.

Another example of use of the system shown in Fig. 4 would be in connection with signalling where it is desirable to effect the operation of signals a fixed time interval after the closing of an electric circuit.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

1. A time relay system comprising a current source, a load to be connected with the source, means for connecting the load with the source and including a relay characterized by relatively high residual magnetism and having a pair of normally open contacts which when closed make an electrical connection between the source and load, an energizing coil on the relay for closing said contacts, a demagnetizing coil on the relay for removing the residual magnetism, means for momentarily connecting the relay energizing coil with the source, and means for connecting the demagnetizing coil with the source and including means set into operation in response to closing of said relay contacts for intermittently making and breaking connection between the source and demagnetizing coil of the relay, so that the residual magnetism of the relay is reduced by a plurality of successive impulses.

2. A time relay system comprising a current source, a load to be connected with the source, means for connecting the load with the source and including a relay characterized by relatively high residual magnetism and having a pair of normally open contacts which when closed make an electrical connection between the source and load, an energizing coil on the relay for closing said contacts, a demagnetizing coil on the relay for removing the residual magnetism, means for momentarily connecting the relay energizing coil with the source, and means for connecting the demagnetizing coil with the source and including means set into operation in response to the closing of said relay contacts for intermittently making and breaking connection between the source and the demagnetizing coil of the relay and between the source and the load, so that the residual magnetism of the relay is reduced by a series of impulses coincident with intermittent energization of the load.

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