

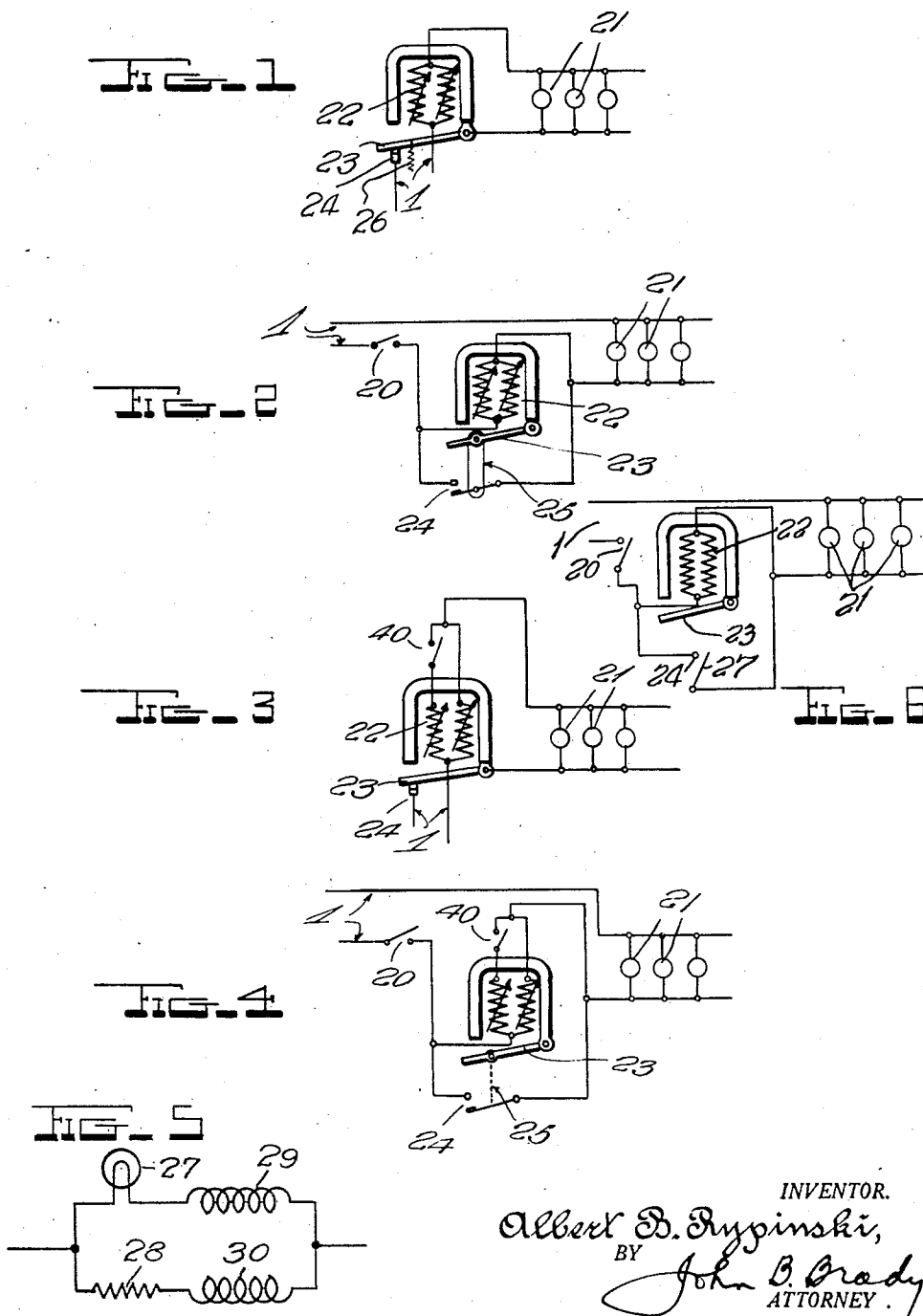
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A. B. RYPINSKI

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CIRCUIT CONTROL AND CURRENT CONTROL SYSTEM

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CIRCUIT CONTROL AND CURRENT CONTROL
SYSTEM

Albert B. Rypinski, Laurelton, Long Island, N. Y.

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9 Claims. (Cl. 177-346)

This application is a continuation in part of application No. 416,877, for Slow magnetic regulating device, filed December 27, 1929, now Patent No. 2,082,121, dated June 1, 1937.

5 My invention relates to electromagnetic devices of the class set forth in my Patent 2,082,121, dated June 1, 1937, as applied to circuit making and breaking systems, flashers, sign flashers, systems for switching and dimming lamps and circuit control systems.

This application is one of a series of related copending applications as follows:

10 Serial Number 699,619, filed November 24, 1933, for Distribution system. Patent No. 2,082,122, dated June 1, 1937.

15 Serial Number 671,767, filed May 18, 1933, for Slow electromagnetic devices having the same or similar temperature coefficients of resistance materials in differential windings. Patent No. 2,093,369, dated September 14, 1937.

20 Serial Number 703,313, filed December 20, 1933, for High temperature slow electromagnetic device. Patent No. 2,068,712, dated January 26, 1937.

25 Serial Number 705,466, filed January 5, 1934, for Slow electromagnetic devices having the same or different temperature coefficient of resistance materials in assisting windings.

30 One of the objects of my invention is to produce a direct current sign flasher device wherein the periodical opening and closing of the circuit is controlled by a slow electromagnet, the duration of the residual magnetism timing the cooling of the windings and the heating of the windings timing the opening of the circuit.

35 Another object of my invention is to produce a sign flasher device wherein the periodical opening and closing of the circuit is controlled by a slow electromagnet whose cooling time is substantially faster than its heating time.

40 A still further object of my invention is to construct a lamp dimming device wherein a slow electromagnet in series with the lamps is shunted by a contactor closed by the electromagnet when heated and opened when the electromagnet cools, providing alternate dimming and brightening of the lamps.

45 Another object of my invention is to construct a control system for altering the current supplied to a load over a time cycle wherein an electromagnet whose impedance changes with temperature is alternately connected in series with the load and shunted by a contactor controlled by the armature of the electromagnet, producing one change in the current in the circuit when

the contactor opens, and a subsequent gradual change as the impedance of the electromagnet changes with heating.

5 A further object of my invention is to construct a slow electromagnet for operation in series with a supply source and a load, said electromagnet performing the double function of moving a core or keeper to open or close contacts for the entire circuits or parts thereof and altering the resistance, impedance or power factor of the circuit in which it is connected, both effects occurring over a predetermined time period.

10 A still further object of my invention is to construct a slow electromagnet for operation in series with a direct current supply source and a load, the electromagnet functioning to do any of the mechanical operations disclosed herein and to alter the resistance of the circuit in which it is connected over a time period, the two effects occurring in time sequence with each other.

15 Other and further objects of my invention reside in the circuits and structures of my invention as more fully described in the following specification by reference to the accompanying drawing, in which:

20 Fig. 1 is a schematic diagram of the circuit control and current control system employing the electromagnetic device of my invention; Fig. 2 shows a modification of the system shown in Fig. 1; Fig. 3 shows another modification of the circuit of Fig. 1; Fig. 4 illustrates a still further modified form of the circuit of my invention; Fig. 5 shows the circuit connections of a device of my invention with series resistors in the paralleled paths; and Fig. 6 shows a further modification of the system illustrated in Fig. 1.

25 The general explanation of the operation of slow electromagnets, reactors and transformers is fully covered in Patent 2,082,121, dated June 1, 1937, based on application Serial No. 416,877, filed December 27, 1929, of which this application is a continuation in part.

30 The windings of the slow electromagnetic devices employed herein comprise a pair of inductively coupled windings, connected in parallel, and formed of, or having in series with one or both of the windings elements formed of materials having different temperature coefficients of resistance. A pair of paralleled, inductively coupled windings connected in series with a supply source and a load will tend to neutralize or assist each other magnetically. If the supply is direct current, the division of current in the paralleled paths will be inversely proportional to the resistances thereof. With alternating current sup-

plied, the currents will split in the paralleled paths in the inverse ratio of the turns of the two inductively coupled windings biased, however, by the resistances of the paths. These resistances may be of positive, negative or zero temperature coefficient of resistance material.

If the resistances are very low the currents will be almost in the inverse turn ratio, held so by the transformer action between the inductively coupled windings. The magnetism will be low since only a slight flux is required to maintain the current split in inverse turn ratio with low resistances in the two paths.

If now, by the use of high positive temperature coefficient of resistance material, the resistance of one path is caused to increase out of proportion to the increases, if any, in the other path, the current in the first path will drop and that in the second path will rise. But this upsets the inverse turn ratio between these currents, and, as will be understood by those skilled in the art, the transformer action between windings resists the tendency of these currents to leave the inverse turn ratio. The difference in magnetomotive force between the windings increases, the net magnetism produced increases, and the impedance of the device as a whole increases.

The effects just outlined increase in intensity as the resistance of one path rises more in proportion than the other until at the extreme condition, one winding has infinite resistance, that is, is open-circuited, and the second winding produces a maximum of magnetism and impedance.

The resistance which changes with temperature and alters the current split in the windings may be in one or both of the windings, or it may be embodied in one or more series resistors in the paralleled paths.

The change in magnetism and impedance of an alternating current electromagnetic device as just described is greatly assisted if a relatively small change in magnetism resulting from a disproportionate resistance change in the paralleled paths is caused to move a core into or out of magnetic coaction with the windings. It requires only a relatively slight change in magnetism to move a properly movable core, but the movement of the core alters the magnetism very largely. Thus, a relatively small change in impedance and magnetism may be utilized to initiate a much larger change.

In my Patent 2,082,121, dated June 1, 1937, and the various patents and applications related thereto, as listed herein, these effects are utilized in many ways and with various structures. This application is particularly directed to structure and use wherein the magnetism and impedance changes are utilized to move cores and do mechanical work, at the same time introducing the electrical effects of variable circuit resistance, impedance, and power factor, and in addition, the mechanical movement of the core is utilized to switch the main line current or some part thereof. All of these effects occur in predetermined time sequence.

It is not essential that the switching be automatically performed. Equally novel results can be attained with manual switching performed in the proper sequence to the automatic operation of the electromagnetic device.

In Patent No. 2,082,121, of which this is a continuation in part, many types of resistor elements are included, among which is a tungsten and a carbon lamp in Fig. 4 of that patent. In Patent

No. 2,068,712, referred to above as related to this application, many constructions are shown with the high temperature elements constructed to be comparable to tungsten lamps in their time of operation.

The heating and cooling times of tungsten filaments are controlled largely by the rate of energy input and the energy radiation respectively. In coils as shown in this application and the related cases, the energy input is under the control of the coil designer. The radiation is a function of the filament temperature, varying as the fourth power of the absolute temperature. This means that at 2000° C. the radiation rate is many hundreds of times the radiation rate at 20° C., and radiation is exceedingly rapid from 2000° to 1000° C. and less. It is therefore possible for a designer to produce a coil of the design to be explained in detail herein in which the cooling rate of the resistor is faster than its heating rate.

Again, there are factors which tend to slow down the mechanical action of the moving parts of the coils described herein as these parts are released for return to open position. Residual magnetism is always present after current is cut off where the supply is direct current, and almost always present where the supply is alternating current; one of my paralleled windings tends to discharge its current of self-induction through the other when line current goes off, prolonging the magnetism; the inertia of the moving parts prevents instantaneous movement; and finally, the force of gravity will not result in instantaneous movement of a core to open position.

In view of the fact that cooling of the filament resistor may be almost instantaneous at the higher temperatures, whereas movement of the core to open position is not instantaneous, it will be seen that a coil of applicant's design may have one time element in producing magnetism and lifting an armature or core, and a shorter time element in cooling preparatory to recycling.

While the cores in the various drawings herein are shown as armatures, it is to be understood that they are merely schematic. I may employ any well known arrangement of armature or core. Those most effective in changing magnetism are the ones which move completely in or out of the windings such as those shown in Figs. 1, 2, 3 and 4 of Patent No. 2,082,121.

The detail of operation of the systems disclosed herein will be understood by reference to the diagrams.

Fig. 1 is a schematic diagram of a circuit control system employing the electromagnetic device of my invention. A supply line 1 feeds lamps 21 through a combined slow electromagnet and reactor 22. The keeper 23 actuates a contact 24 which cuts off the current to the lamps and coil when opened. When the coil is cold or partly heated, keeper 23 is not attracted. After the current has been flowing long enough the pull of the coil increases, lifts 23 against the action of spring 26 and breaks contact at 24. The lamps go out and coil 22 cools. If the rate of cooling of the coil is very rapid as compared with its heating rate, the momentary cooling may equal an appreciable time of heating. Otherwise, particularly on direct current, the residual magnetism in keeper 23 may be utilized to hold it up against the action of spring 26 for a time after the current is off, giving the windings a longer time to cool.

The armature 23 and contacts 24 may be taken as representative of the tripping arrangement

and contacts of any well known circuit breaker mechanism including those in which the contacts remain open until reclosed manually or by other means.

Fig. 2 illustrates a modification of the control system of Fig. 1 for dimming lamps automatically and periodically, utilizing the varying resistance or impedance of the windings to alter the current as well as the movement of the keeper to open and close contacts for the same purpose. The lamps to be dimmed shown at 21 are connected in series with the paralleled windings shown at 22 across line 1. A keeper or armature 23 when lifted closes the contacts at 24 by means of arm 25 shunting a large percentage of the current out of windings 22. When current is initially applied at 1 the lamps are lighted with full voltage except for the drop through 22 which is relatively low due to the windings being unheated. As the current continues to flow the windings heat and the current split in the two windings begins to change due to the disproportionate change in resistance of the windings. Assume first that the supply 1 is direct current. The changing resistance of windings 22 will alter the current flow to the lamps, dimming their brilliancy. Meanwhile the magnetism set up by the coil as a whole is increasing until a point is reached at which the armature 23 is lifted. With alternating current supplied at 1 the effect will be the same except that the voltage supplied to the lamps 21 will alter to a greater extent since the impedance voltage drop through 22 will be greater than the resistance voltage drop in the direct current circuit. In either case, after the armature lifts, the windings are shunted, increasing the voltage across the lamps 21 and decreasing the current in coil 22, which now cools and loses magnetism. When the magnetism has fallen sufficiently the armature 23 drops, opening contacts 24 and sending the main current through windings 22 again. The windings however have cooled partially or completely and there is insufficient magnetism to lift armature 23 until they heat again. A period of time elapses, therefore, during which the brilliancy of the lamps is altered again as before, and the entire cycle repeats.

Fig. 6 is similar to Fig. 2 except that link 25 is omitted and the switch 27 is manually operated. In Fig. 6 if the contacts are normally closed, when opened the windings 22 function to choke the current to a low value at which the circuit may be disconnected at switch 20 with a minimum of arcing. Whether the connection 25 is present, in Fig. 2, or not present, as in Fig. 6, the armature contributes to the change in impedance of the windings by varying the permeability of the flux path, and therefore the inductance, as it moves to decrease or increase the air gap in the magnetic circuit. This latter effect is inherent in any movable core electromagnet.

Referring again to Fig. 1, if the windings 22 are made to alter considerably in resistance or impedance when heated, it is plain that the voltage supplied to the lamps will be altered in proportion and their brilliancy affected. In that arrangement Fig. 1 will be a device which is both a sign flasher and lamp dimmer.

It will be understood that the lamps 21 in Figs. 1 and 2 may be replaced by any proper electrical load and the slow electromagnetic devices will function as just described to control the current flow to the load.

Fig. 5 is substantially the same as Fig. 5 in my Patent 2,082,121 and shows resistors 27 and 28

in series with windings 29 and 30 within the parallel connection. It is to be understood that while the various Figures 1 to 4 inclusive show the variable resistors as built into the windings themselves, series resistors may be employed, connected as indicated in Fig. 5 for each of the combinations shown in these Figures 1 to 4 inclusive.

Any slow electromagnetic device of the types described in my copending application Serial No. 416,877, filed December 27, 1929, now Patent 2,082,121, dated June 1, 1937, for Slow magnetic regulating device, if placed in series with a load as described herein for circuit makers and breakers, sign flashers, lamp dimmers, and circuit control devices, will perform the double function of actuating an armature or keeper and varying the resistance, impedance or power factor of the circuit in which it is connected. Both of these effects are variable, that is, they increase or decrease in intensity over a time period. Many modifications of the two function device are possible within the scope of this disclosure. In addition to the uses described, the armature movement may be utilized to do mechanical work, to open or close auxiliary circuits; the varying resistance or impedance of the series windings may be utilized to perform any of the functions claimed for reactors or transformers in my copending application Serial No. 416,877, filed December 27, 1929, now Patent 2,082,121, dated June 1, 1937. Electromagnets for connection in series with a load and which operate to do mechanical work or to control circuits are in common use. My electromagnet may be designed to have a low resistance and substantially zero inductive reactance over a range of current values, but when these are exceeded, after a time period for the windings to heat, the resistance and inductive reactance may increase to a relatively large extent, altering the current to the load and attracting the armature. The design may be such as to make the inductive reactance and magnetic pull large when the windings are unheated, if so desired, and both can be made to decrease as heating proceeds.

The electromagnet of my invention finds numerous other applications, among which are relays to open and close circuits only after a predetermined time has elapsed after the current is increased in the circuit; electric circuit makers and breakers, and traffic lights. In any of the slow electromagnetic devices illustrated herein the open circuiting or disconnecting of one of the two opposed windings at any point in their operation will convert the device to an instantaneous type electromagnet, as shown in Figs. 3 and 4. I have shown in Figs. 3 and 4 the switch 40 disposed in circuit with one of the opposed windings 22 for open circuiting or disconnecting one of the windings at any time in the course of the operation of the device for converting the device to an instantaneous type of electromagnet. Or I may convert an instantaneous type coil to a slow type by connecting a second winding in parallel with the first and coupled in opposition thereto. This may be accomplished by manual or automatic switching means.

While I have described my invention in certain preferred embodiments, I desire it to be understood that modifications may be made and no limitations are intended other than may be imposed by the scope of the appended claims.

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

1. In a control system, an electromagnetic de-

vice comprising a pair of windings magnetically coupled in opposition and connected in parallel one with respect to the other, a movable core controllable by the resultant magnetism of said windings, a contactor having a normal position but actuated by said movable core to a second position, a power source and a load in series with said contactor in normal position and said windings, the impedance of said windings varying disproportionately and substantially with temperature for varying the resultant magnetism thereof, said change in impedance of said windings constituting means for altering the current supplied to said load, said changes in magnetism constituting means to move said movable core and to operate said contactor.

2. In a control system, a power supply, a load, a contactor having a normal position and movable to a second position, and an electromagnetic device connected in series, said device comprising two parallel connected inductively coupled windings on a core of magnetic material and formed of materials having different temperature coefficients of resistance, said different coefficient materials constituting means for producing changes in magnetism in said core with changes in temperature in the windings, a movable armature in magnetic relation to said core and controlling said contactor, said changes in magnetism constituting means for controlling the movement of said armature and operating said contactor for moving said contactor from normal position to the second position as well as substantially altering the impedance of said windings and the total impedance of said system.

3. In a control system, an alternating current supply, a load and an electromagnetic device connected in series, said device comprising two parallel connected magnetically coupled windings formed of materials having different temperature coefficients of resistance, a shunt circuit across said windings including a contactor, said contactor opening said circuit in one position and closing it in another position, a movable armature in magnetic relation to said electromagnetic device and altering the position of said contactor, said different coefficient materials constituting means for producing substantial changes in magnetism for controlling the movement of said armature and operating said contactor as well as substantially altering the impedance of said windings and the total impedance of said system.

4. In a control system, a power supply, a load switching means and an electromagnetic device connected in series, said electromagnetic device comprising two parallel connected inductively coupled windings formed of materials having different temperature coefficients of resistance, wound on a core of magnetic material, said core having a movable portion, the different coefficient materials constituting means to vary the current split in said windings with temperature changes therein, to alter the magnetism of said device, to move said movable core portion and further alter the magnetism of said device, said changes in magnetism constituting means to alter the impedance of said control system, a contactor carried by said movable core and connectible in parallel with said electromagnetic device through one of the windings of said two parallel connected inductively coupled windings and operating to open the circuit through said last mentioned winding when the movable portion of the core is displaced and magnetically controlled wholly by the other of said parallel connected windings, said

contactor constituting additional means to alter the current in said choking device and said load circuit in alternate time sequence to said impedance change in said windings.

5. A control system as in claim 4 except that the movement of said movable core portion controls the opening and closing of said second switch, said windings constituted to decrease in resistance to a substantial extent after said second switch has closed said parallel circuit and before said movable core has operated to open said second switch.

6. A control system including a supply source and a load including lamps, an electromagnetic choking device in series with said load, at least one contactor connected to control current flow in said system, said device comprising a pair of inductively coupled windings connected in parallel one with respect to the other, and constituted by materials having different temperature coefficients of resistance, a core of magnetic material having a movable portion in magnetic relation to said windings, means tending to normally move said core to a position removed from said windings but within the magnetic influence thereof, the movement of said core controlling said contactor, the choking action of said windings over a time period constituting means to alter the current flowing to said load, said core controlled contactor constituting means to control at least a portion of the current flow in said circuit when the magnetism produced by said windings reaches a predetermined value.

7. A control system including a supply source and a load including lamps, an electromagnetic choking device in series with said load, at least one contactor connected to control current flow in said system, said device comprising a pair of inductively coupled windings connected in parallel one with respect to the other, and constituted by materials in said parallel paths having different temperature coefficients of resistance, a core of magnetic material having a movable portion in magnetic relation to said windings, said movable portion being displaceable to either an immediate position or a remote position with respect to said windings, means normally tending to displace said movable portion remote with respect to said windings, the choking action of said windings over a time period constituting means to alter the current flowing to said load, said core controlled contactor constituting means to control at least a portion of the current flow in said circuit when the magnetism produced by said windings reaches a predetermined value.

8. A circuit control system including a supply source, a switching device, a load, and an electromagnetic choking device in series, a second switching device shunting said choking device, said choking device comprising a pair of inductively coupled windings connected in parallel one with respect to the other and constituted by materials having different temperature coefficients of resistance, said materials constituting means to substantially alter the magnetism and impedance of said device over a time period, said shunting switch constituting additional means to alter the current in said choking device and said load circuit in alternate time sequence to said impedance change in said windings.

9. A control system including a supply source and a load, an electromagnetic choking and switching device in series with said load, at least one switching means connected to control current flow in said electromagnetic device, said device

comprising a pair of inductively coupled windings connected in parallel one with respect to the other, and constituted by materials having different temperature coefficients of resistance, a core of magnetic material having a movable portion in magnetic relation to said windings, the variable choking action of said windings over a time period

constituting means to alter the current flowing to said load, said switching means constituting additional means to control at least a portion of the current flow in said circuit, said effects occurring in alternate time sequence.

ALBERT B. RYPINSKI.