Oct. 8, 1929. C. H. RIPPL 1,730,688

MAGNETIC SWITCH

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Fig. 1.

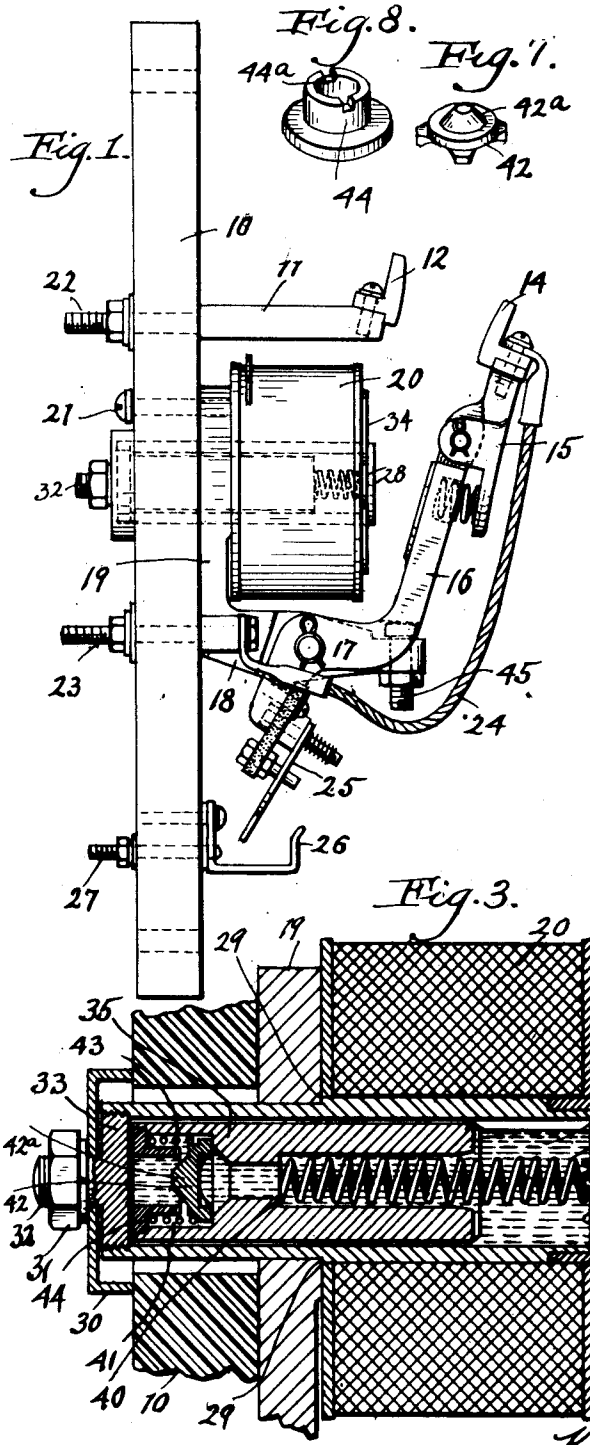


Fig. 8.

Fig. 7.

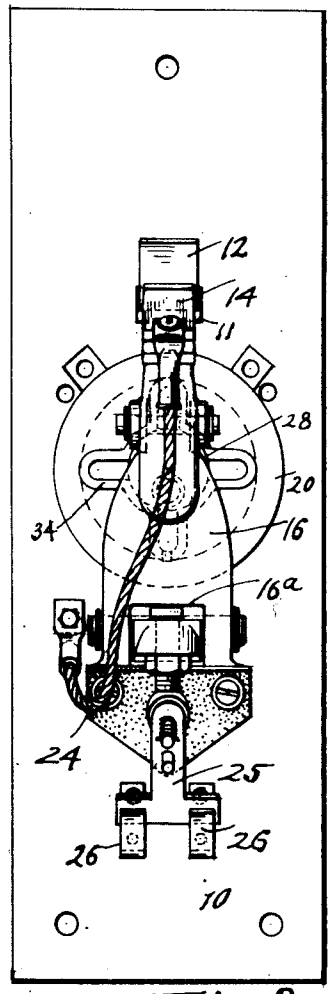


Fig. 2.

Fig. 3.

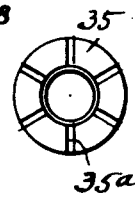


Fig. 6.

Inventor:
Charles H. Rippl
Howson Hudson & Kent
attys.

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Fig. 4.

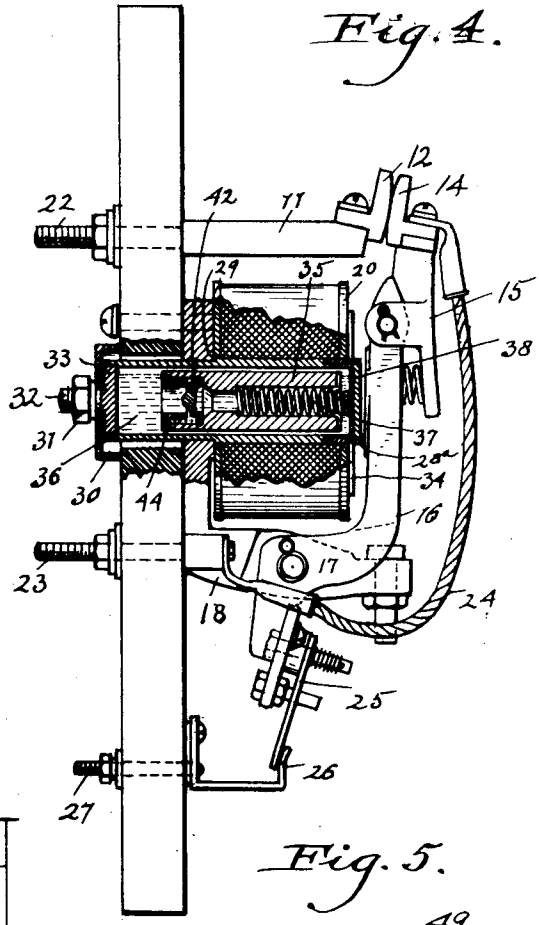
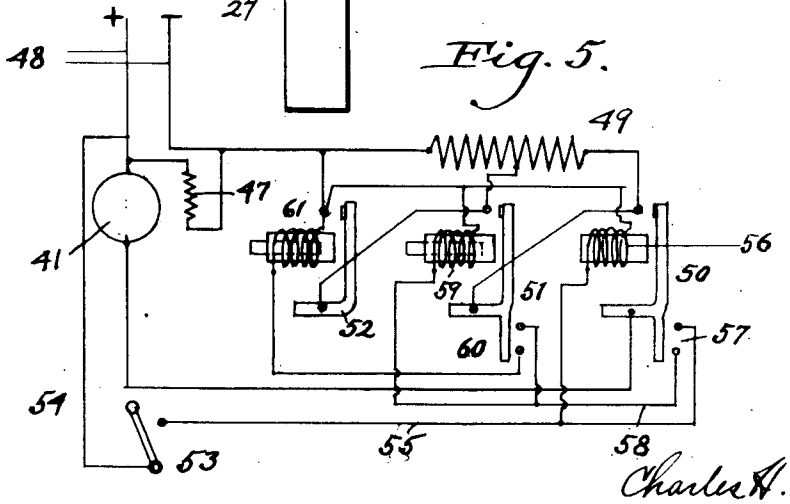


Fig. 5.



Inventor

Charles H. Rippl.

By Kerr Hudson & Kent.

Attorney

Patented Oct. 8, 1929 1,730,688

UNITED STATES PATENT OFFICE

CHARLES H. RIPPL, OF EAST CLEVELAND, OHIO, ASSIGNOR TO THE CLARK CONTROLLER COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO

MAGNETIC SWITCH

Application filed July 14, 1927. Serial No. 205,584.

This invention relates to a magnetic or electrically operated switch and especally to a magnetic switch where there is a time interval between the energization of the coil of the switch-operating magnet and the closure of the switch, a switch of this kind having special utility in motor starting apparatus.

The objects of the present invention are to provide a switch of this character embodying the features of simplicity of construction and cheapness of manufacture; small number of repair parts to be kept in stock; ease of adjustability of the time interval between the energization of the magnet coil and the actuation of the switch by the magnet; and, automatic compensation for voltage and temperature changes.

In carrying out my invention I provide a switch of this type wherein the switch arm is adapted to be actuated by a magnet having a movable core which is normally positioned so that when the coil is energized the flux density is insufficient to actuate the switch arm, the arrangement being such that the core has a retarded movement by the action of the magnetic flux in one direction and when it reaches a predetermined position it increases the flux density to an amount such that the magnet becomes effective to operate the switch. The switch embodies other features which include the provision of means for varying the time interval, preferably by varying the extent of the retarded movement of the core to bring it to a position such that there is a sufficient pull exerted on the switch arm to actuate the same, and means preferably in the form of a check valve which may or may not be carried by the core itself and the effect of which is to render the time interval substantially independent of changes in voltage impressed upon the coil and changes in temperature.

The invention may be further summarized as consisting in certain novel combination and arrangements of parts and details of construction which will be described in the specification and set forth in the appended claims.

In the accompanying drawings, wherein I have illustrated an embodiment of the invention which operates very effectively,

Fig. 1 is a side elevation of my improved switch;

Fig. 2 is a front view of the same;

Fig. 3 is an enlarged sectional view through the switch-operating magnet and associated parts, the core being in its normal position displaced from the front face of the magnet;

Fig. 4 is a view similar to Fig. 1 but with the switch closed and with the core at or about the position in which the switch is closed by the magnet;

Fig. 5 is a diagrammatic view illustrating one of the applications or fields of use of the switch, a so-called automatic starter being here shown;

Fig. 6 is an end view of the core; and

Figs. 7 and 8 are perspective views of the check valve and one of the seats for the valve.

Referring now to the drawings, 10 represents a panel of suitable insulating material, which may be slate, to which is attached a support 11 for the stationary contact 12 of the switch. The cooperating movable contact, which is shown at 14, is carried by a contact arm 15 pivotally connected in the usual manner to a switch arm 16. The latter is pivoted at 17 to an arm 18 of a magnet frame 19 carrying the coil 20 of the switch-operating magnet, the frame 19 being secured to the panel 10 by screws 21, or otherwise.

In this instance, the support 11 for the stationary contact 12 is shown as provided with an extension 22 constituting one of the terminals of the switch, but ordinarily the switch is provided with a blow-out coil to which one of the terminals is connected, this blow-out coil and the associated parts being unessential to an understanding of the present invention and having, therefore, been omitted. The other terminal of the switch is illustrated at 23, this terminal being connected to a shunt or pigtail 24 which, in turn, is connected to the movable contact 14. This feature is commonly employed in switches of this kind and constitutes no part of the prevent invention.

The lower part of the switch arm 16 carries a contact 25 which, when the switch is closed, is adapted to bridge a pair of cooperating

contacts 26 supported by the panel 10 and having terminals 27, the contacts 26 being bridged by the contact 25 when the switch is closed, the purpose of the same being to cause the energization of the coil of a companion switch. However, these details likewise are unessential to the invention and they may or may not be employed.

Coming now to the parts more directly involving the invention, and referring particularly to Figs. 3 and 4, it will be observed that the coil 20 surrounds and is mounted upon a hollow chamber 28 which is preferably cylindrical in shape, this chamber preferably being formed of non-magnetic material, such as brass. As the switch is ordinarily constructed and operated the panel 10 is supported in vertical position, in which event the axis of the chamber 28 is horizontal. This chamber, as illustrated, extends through the core frame 19 and through the panel 10. It may be held in position in any suitable way but in this instance the chamber has a shoulder 29 engaging the front face of the core frame and the shoulder is held up against the core frame by a clamp 30 which is tightened and held in place by a nut 31 screwed onto an extension 32 of a disk 33 which has a threaded engagement with the end of the chamber and forms the closure therefor.

When the chamber is formed of non-magnetic material, I may provide at the forward end thereof a ring of magnetic material such as indicated at 28a. While I do not regard this ring as essential to the invention, I find that under certain circumstances it is advantageous to use the same, particularly when the switch arm 16 is set (in the manner hereinafter explained) so as to cause a comparatively short time interval to elapse between the energization of the coil and the closure thereof. Under these conditions, the addition of the ring insures a tight closing of the switch or the so-called sealing of the contacts.

The coil 20 is mounted on that part of the chamber which projects forwardly from the magnet frame 19, and though the coil may be positioned on the chamber in any suitable way, it is here shown held in place by the equivalent of a spring washer 34, which is adapted to be snapped into a slot near the front end of the chamber.

Located in and movable in an endwise direction through the chamber 28 is a core 35 of magnetic material, such as steel or iron, and also contained in the chamber is a fluid, indicated at 36, which gives a retarded movement to the core when the coil is energized. Various fluids may be employed for this purpose but a liquid, such as thin oil, is preferred, and the chamber is substantially filled with the fluid and after the same is supplied, the chamber is tightly sealed so as to prevent leakage and also the entrance of any foreign matter. This sealing is done not only by screwing in the closure disk 33 but the joint is preferably soldered or otherwise hermetically sealed.

Normally, i. e. when the coil 20 is deenergized the core is held displaced from the front end of the chamber and, in fact, is normally at the rear end of the chamber as shown in Fig. 3 the relative lengths of the chamber and the core being such that the core may travel a predetermined distance to or toward the front end of the chamber or until a sufficient magnet pull is exerted on the switch arm to cause the closure of the switch.

The core is held in its normal displaced position preferably by a coil spring 37, the front end of which, in this instance, engages a disk 38 which is pressed against the forward end of the chamber, the forward end of the spring fitting around a centering lug 39 formed on the disk. The centering lug (if one is needed) may be formed directly on the end of the chamber, in which event the disk may be omitted. The core is hollow as it is preferably provided with a centrally disposed passageway of irregular shape extending from end to end therethrough and the spring extends into this passageway from the forward end until it engages a shoulder 40 which, in this instance, is located somewhere rearwardly of the center of the core. With this construction the spring 37 normally holds the core in the position shown in Fig. 3 but it permits the core to be drawn by the pull of the magnet to or toward the forward end of the chamber, the spring then being, of course, compressed.

As the core is moved inwardly by the action of the energized magnet coil, the fluid passes from in front of the core to the rear thereof, the major portion passing through the core itself. It is obvious that the rate of transference of the fluid will determine the rate of movement of the core with a given magnetic pull and this rate of movement is preferably determined by a check valve which, for a purpose to be explained, is preferably incorporated in the core itself.

It will be observed that the passageway through the core is somewhat restricted for a short distance rearwardly of the shoulder 40 and that it then flares outwardly and merges into a cylindrical enlargement 41 constituting a valve chamber. In this chamber is a movable valve member 42 somewhat disk-shaped which is normally held by a light spring 43 against the seat formed at the forward end of the chamber, as illustrated in Fig. 3. However, the shape of the valve is such (see Fig. 6) as not to entirely close the passageway through the core when the valve is seated, as just stated, this being of importance to permit a quick return of the core to normal position when the coil is deenergized.

Fitted into the end of the core is a second seat member 44 in the form of a bushing with an inwardly or forwardly projecting annular flange, the forward end of which may be

engaged by the valve under certain conditions. The valve 42 is provided with a conical protuberance 42ª which extends, more or less, into the passageway within the flange of the seat member 44, and as the valve is unseated and moves toward the bushing 44 the conical portion enters a greater distance into the flange of the member 44 and thus restricts the passage of fluid past the valve and through the bushing to an extent depending upon the amount of the unseating. Even when the valve engages the forward end of the flange of the bushing it does not entirely shut off the flow of fluid as the forward end of the flange is provided with notches 44ª, as indicated in Fig. 7. Likewise, the forward end of the core is preferably provided with radial notches or grooves 35ª, (see Fig. 6) so that the passageway through the core will not be closed if the core is seated against the disk 38 or against the forward end of the chamber 28.

The operation is as follows:

When the switch is open the core is held displaced from the front end of the chamber by the spring 37, as previously explained, but when the coil 20 is energized the flux pulls the core forwardly against the action of spring 37. The movement of the core toward the forward end of the chamber causes the fluid to flow through the central passageway of the core creating a head or pressure on the valve which unseats the valve so that the fluid may flow through the core to the rear thereof. By the provision of the check valve 42 the movement is substantially uniform due to the fact that the valve regulates the flow of fluid through the core and an acceleration of the movement creates a greater pressure on the valve causing a greater movement of the same toward the rear seat member 44 and so restricts the flow. The result is that the core moves forwardly, substantially, uniformly and slowly enough to give the desired time interval between the energization of the coil and the switch closure. When the coil is initially energized the core is sufficiently displaced from the switch arm 16 that the density of the flux passing between the switch arm and the core is not sufficient to cause the immediate closure of the switch, but as the core moves forwardly the magnetic pull on the switch arm is gradually increased, and when the core reaches a given position in its forward travel, the magnetic pull on the switch arm becomes strong enough to close the switch.

As soon as the coil 20 is deenergized, the switch opens, the arm 16 falling back to normal position by gravity, and at the same time core 35 is moved by spring 37 to its normal displaced position against the outer end of the chamber. The return movement of the core takes place quickly, as is desirable, in order that the switch will be in condition for immediate operation. The quick return of the core to normal position is permitted by the special shape of the valve 42 which allows a substantially free flow of fluid past the valve when the latter is seated against the inner end of the chamber, as shown in Fig. 3.

The time interval between the energization of the coil and the closure of the switch depends, in this instance, upon the normal position of the switch arm with reference to the front of the magnet when the switch is open. Accordingly, I provide means for adjusting the position of the switch arm when the switch is open, and in the embodiment illustrated this is in the form of a screw 45 which extends upwardly through the forward end of the arm 18 of the magnet frame 19 so that a shoulder or abutment 16ª formed on the switch arm above the screw may engage the head or upper end of the screw, which serves as a stop to limit the opening movement of the switch arm. By moving the screw up or down the switch arm will come to rest (when the switch is open) at a less or greater distance, as the case may be, from the front of the magnet. Thus by this simple expedient the time interval or delay between the energization of the coil 20 and the closure of the switch may be varied without in any way adjusting or changing the core or any other part of the switch.

A change in the voltage impressed on coil 20 and a change in the viscosity of the fluid by temperature changes, whether or not the latter is caused by the heating of the coil, will have practically no effect on the rate of movement of the core for, as previously explained, an increase in the rate of movement, under either condition mentioned, is prevented by increased restriction of the flow of fluid through the core.

In addition to the advantages above mentioned, the features of simplicity of the construction should be noted as well as the freedom of complicated parts to effect the time interval or to adjust the same.

As previously stated, my improved switch has special utility in motor starting apparatus and in Fig. 5 I have illustrated conventionally a motor and an automatic starter showing how switches of the type herein illustrated may be employed advantageously therein. In this figure the motor armature is shown at 46 and the field at 47, current being adapted to be supplied to the motor from the supply mains or conductors illustrated at 48. The starter includes a sectional resistance 49 and three magnetic switches 50, 51 and 52, the switches being rendered effective through the manipulation of a suitable hand-operated switch 53. When this switch 53 is closed, a circuit is completed by way of conductors 54 and 55 through the coil 56 of switch 50. This switch preferably has a fixed core, that is to

say is not of the time interval type, so that it will be closed immediately upon the energization of the coil. When this switch closes it completes the motor circuit with the resistance 49 in series with the armature and it also closes the auxiliary switch 57 which, by way of conductors 55 and 58, closes the circuit through the coil 59 of the switch 51. This switch and a companion switch 53 are like that constituting the subject matter of the present invention and, accordingly, both these last mentioned switches will be closed a predetermined time after their coils are energized. When switch 51 closes a predetermined time after the motor starts, it cuts out a section of resistance 49 and, at the same time, through auxiliary switch 60, closes the circuit through the coil 61 of switch 52. A predetermined time after this coil is energized switch 52 is closed, cutting out the remainder of the resistance 49 so as to allow the motor to reach its full speed.

It will be understood, of course, that my improved switch may be employed with other forms of starting apparatus than illustrated in Fig. 5, and may be used also for other purposes than in motor starters.

While I have shown the preferred embodiment of my invention, I do not desire to be confined to the precise details illustrated, but aim in my claims to cover all modifications which do not involve a departure from the scope and spirit of my invention.

Having thus described my invention, I claim:

1. In a magnetic switch, a pair of cooperating contacts, a movable switch member by which the contacts are brought into and out of engagement, a magnet arranged adjacent the switch member and adapted when energized to actuate the switch, said magnet comprising a coil, a core, a closed chamber containing a fluid in which the core has a retarded movement under the action of the magnetic field to increase the pull of the magnet on the movable switch member, and means for variably retarding the passage of fluid from one end of the chamber to the other whereby the movement of the core in the chamber under the action of the magnetic field is at a substantially constant rate.

2. In a magnetic switch, a pair of cooperating contacts, a movable switch member by which the contacts are brought into and out of engagement, a magnet arranged adjacent the switch member and adapted when energized to actuate the switch, said magnet comprising a coil, a core, a closed chamber containing a fluid in which the core has a retarded movement under the action of the magnetic field to increase the pull of the magnet on the movable switch member, and means comprising a valve for causing the rate of movement of the core in the chamber to be substantially independent of variations of voltage impressed on the coil.

3. In a magnetic switch, a pair of cooperating contacts, a movable switch member by which the contacts are brought into and out of engagement, a magnet arranged adjacent the switch member and adapted when energized to actuate the switch, said magnet comprising a coil, a core, a closed chamber containing a fluid in which the core has a retarded movement under the action of the magnetic field to increase the pull of the magnet on the movable switch member, and means comprising a check valve carried by the core for causing the rate of movement of the core to be substantially independent of variations of voltage impressed on the coil.

4. In a magnetic switch, a pair of cooperating contacts, a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, and means for increasingly retarding the passage of fluid from one end of the chamber to the other as the rate of forward movement of the core increases whereby the forward movement of the core is at a substantially constant rate irrespective of changes in the voltage impressed on the coil.

5. In a magnetic switch, a pair of cooperating contacts, a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, a check valve for regulating the rate of movement of the core, and means yieldably resisting the movement of the valve by the pressure created thereon during the forward movement of the core.

6. In a magnetic switch, a pair of cooperating contacts, a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, a check valve carried by the core and a spring for yieldably opposing the movement of the valve under the pressure of the fluid during the forward movement of the core.

7. In a magnetic switch, a pair of cooperating contacts, a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, the core having a passageway therethrough, a check valve controlling the flow of fluid through the passageway and nor-

mally held in a position to permit the quick return of the core and adapted to be moved from said position by fluid pressure thereon during the retarded forward movement of the core, and a spring acting on the valve to yieldably oppose the last mentioned movement of the valve.

8. In a magnetic switch, a pair of cooperating contacts a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, the core having a fluid passageway therethrough, a check valve carried by the core and controlling the flow of fluid through the passageway, the valve having two seats or stops, one of which it engages on the return movement of the core and said valve having means for increasingly restricting the flow of fluid through the passageway of the core as the valve approaches the other seat or stop.

9. In a magnetic switch, a pair of cooperating contacts, a movable switch member, a magnet adapted to actuate said switch member and comprising a coil, a core, a chamber containing a fluid in which the core has a retarded forward movement under the action of the magnetic field and a relatively free return movement, said core having a passageway therethrough, a valve carried by the core and movable between two seats or stops, a spring for normally holding the valve against one seat or stop during the return movement of the core and yieldingly opposing the movement of the valve toward the other seat or stop during the forward movement of the core, said valve having means for increasingly restricting the flow of fluid through the core as the valve approaches the second mentioned seat or stop.

In testimony whereof, I hereunto affix my signature.

CHARLES H. RIPPL.