June 21, 1938. J. B. FISHER 2,121,657

ELECTROMAGNETIC CONTROL MEANS

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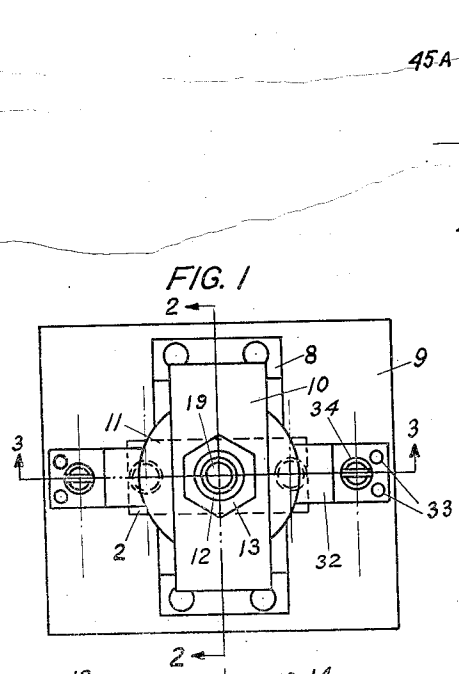


FIG. 1

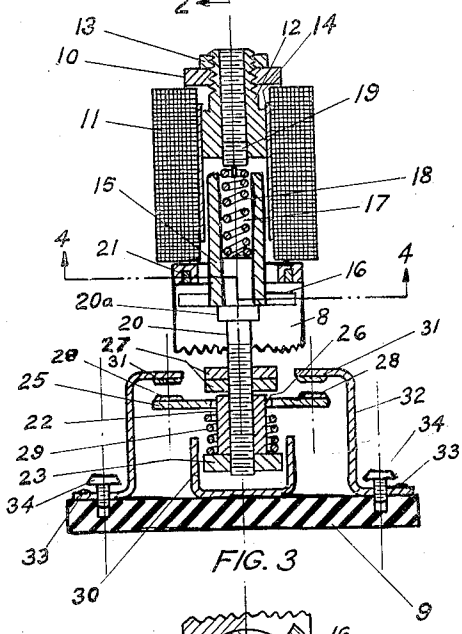


FIG. 3

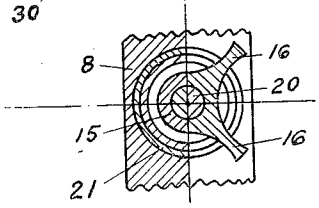


FIG. 4

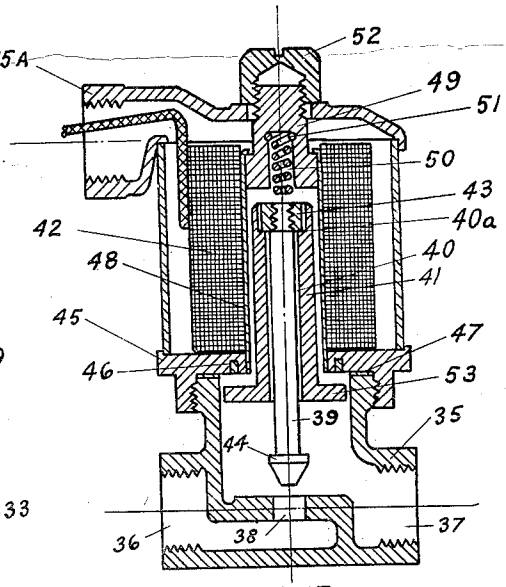


FIG. 5

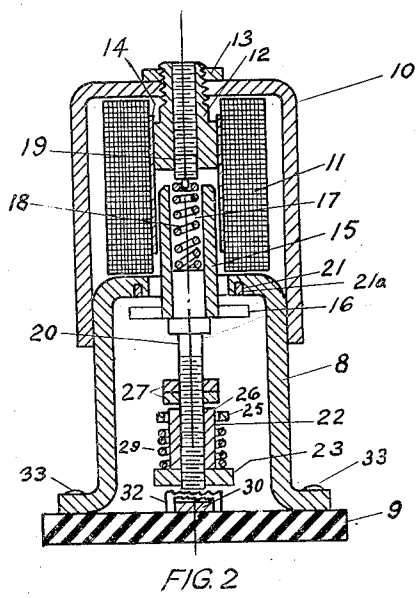


FIG. 2

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ELECTROMAGNETIC CONTROL MEANS

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1 Claim. (Cl. 175—338)

This invention relates to electromagnets and has particular reference to electromagnets for actuating relays, switches, valves and the like.

One of the objects of the invention is the provision of an electromagnet, which will utilize the magnetic force at the center of the coil. This central force is several times greater than the force available at the ends of the coil, which last named force is the one commonly utilized in general practice.

Another advantage of the invention, when applied to actuate an electrical switch, resides in the greater speed with which the contacts close, thereby decreasing objectionable arcing between the contact points. Trouble free service requires that arcing be kept at a minimum, to prevent the contacts from becoming welded together, and to avoid the necessity of repairs. Furthermore, with the improved solenoid and its greater inherent available force, it is possible to employ double contacts, thereby dividing the arcing effect and decreasing the trouble and expense derived therefrom.

A further advantage of the invention is the provision of means whereby objectionable hum and rattle are eliminated. The general characteristics of alternating current solenoid switches are such that noises are constantly present. By utilizing a copper shading coil and a plunger flange, the present invention obviates this disadvantage.

Another advantage of the invention is the provision of a movable core solenoid adapted to be energized by a small amount of electrical power and to operate a large capacity electrical switch.

An advantageous feature of the invention resides in its application to the starting of alternating current motors. Due to its speed of action and its large capacity it is particularly well adapted to handle heavy starting motor currents.

Another advantage of the invention is the rapidity with which heat is dissipated from the coil, thereby increasing the power capacity of the solenoid.

The above, as well as numerous other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawing, wherein:

Fig. 1 is a plan view of my improved movable core solenoid, as applied to actuate an electrical switch.

Fig. 2 is a sectional view taken substantially on the plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken substantially on the plane indicated by the line 3—3 of Fig. 1.

Fig. 4 is a sectional view taken substantially on the plane indicated by the line 4—4 of Fig. 3.

Fig. 5 is a vertical sectional view of my improved movable core solenoid, as applied to control a fluid-pressure valve.

Referring now more particularly to the drawing, it will be seen that in the embodiment herein disclosed, my invention, as adapted to control an electrical switch, is fully and clearly illustrated in Figures 1–4, inclusive. The reference character 8 indicates a supporting member which is preferably made of magnetic steel and which is rigidly mounted upon a base 9 of electrical insulating material such as bakelite. Secured to the member 8, by spot welding or other suitable means, is a U shaped magnetic steel yoke 10. A solenoid coil 11 is positioned between the yoke 10 and the supporting member 8 and is secured in position as hereinafter described.

Into the top of the yoke 10 is screw-fitted a plug 12, which is held thereon by means of the lock nut 13. A non-magnetic guide tube 14 is press-fitted around the outer periphery of the plug 12 and into the inner periphery of the coil 11 and serves to support the coil and perform the other functions hereinafter assigned to it. Arranged to reciprocate within the aforementioned guide tube 14 is the magnetic steel plunger 15. The plunger 15 is preferably cylindrical and is formed with a fluted flange 16 extending laterally from its lower extremity. It is also provided with a longitudinal passageway 17 into which is placed a coil spring 18 of non-magnetic material such as bronze. The upper end of the spring 18 is held in position by a set screw 19, which is threadedly secured in a longitudinal passageway, extending through the plug 12. The set screw 19 also functions to permit adjustment of the tension in the spring 18. The lower end of the spring 18 is held in place by the bolt 20, the latter being press-fitted into the lower portion of the passageway 17 in the plunger 15, to the depth of the shoulder 20*a*, which is formed on said bolt.

The flange 16 of the plunger 15 is arranged to contact the ring-shaped copper shading coil 21, which is press-fitted into an annular groove 21*a* provided in the supporting member 8. The functioning of the shading coil 21 will be more completely described in detail later in this specification, it being sufficient at present to say that it holds the flange 16 against it when the coil 11 is energized.

Positioned near the lower end of the bolt 20 is a hexagonal-shaped brass guide member 22 which

is secured in place by the brass hexagonal nut 23. A brass strip 25 is arranged to slide on the guide member 22, the former being provided with a hexagonal hole 26, slightly larger than the guide 22. To prevent the strip 25 from being disengaged from the top of the guide member 22, I provide two lock nuts 27, which are tightened together on the bolt 20 just above the guide.

The strip 25 holds two phosphorous-bronze contacts 28 at its outer extremities and the strip is normally urged upwardly by means of the spring 29, the latter being positioned between the hexagonal nut 23 and the strip 25. 30 is a brass guide fastened to the base 9 and functions to hold the bolt 20 in alignment by means of the nut 23 which slides in said guide 30. In addition, the guide 30 acts as a stop member for the bolt 20 on its downward movement.

Positioned in vertical alignment with the contacts 28 are the contact points 31 which are mounted on the brass terminals 32, the latter being secured to the insulating base 9 by means of the fastenings 33. Screws 34 are provided on each terminal to enable wires to be fastened thereto.

The operation of the device is simple. When an electric current is passed through the coil 11, said coil becomes energized and exerts an upward force upon the magnetic steel plunger 15. Upward movement of the plunger within its guide tube 14 then takes place, and is continued until the flange 16 on the lower end of the plunger rests against the underneath side of the supporting member 8. In this position the contact points 28 are held firmly against the upper contact points 31 and an electrical circuit is established between the terminal screws 34 through the medium of the intermediate brass terminals 32 and the brass strip 25. The completion of this secondary circuit operates any device connected thereto, such as an electric motor.

In the above operable position the spring 18 is compressed, as likewise is the spring 29. Interruption of the current in the coil 11 releases the plunger which is then forced downwardly by means of the energy stored in the compressed coil spring 18. This action causes the nuts 27 to push downwardly upon the brass strip 25, thus breaking the connection between the contact points 28 and 31 and thereby breaking the secondary circuit.

As hereinbefore mentioned, the shading coil 21 performs a valuable function in the operation of my device. Without such an arrangement considerable rattle or hum would be present during the operation of the solenoid switch. This would be due to the well known characteristics of solenoids used with alternating current. Alternating current is constantly changing in intensity and also completely reverses its direction twice during each cycle, which commonly occurs at the rate of sixty per second. Consequently, the force exerted upon the plunger 15 by the coil 11 is similarly changing in fixed relation to the actuating current in said coil. At the instant when this force becomes zero, or in other words, when the magnetic flux produced by the current is zero, the plunger 15 is momentarily released and tends to move downwardly under the action of the spring 18. Immediately after the above mentioned occurrence, however, the flux from the coil again increases, forcing the plunger upwardly. The rapid repetition of this cycle frequently causes objectionable noises.

The present invention obviates this disadvantage by means of a shading or holding coil 21 arranged to cooperate with the flange 16 on the plunger 15. The shading coil comprises a copper ring imbedded in the supporting member 8, being flush with the surface thereof. The alternating flux produced by the coil 11 induces a current in the shading coil 21 which in turn creates a secondary flux. This secondary flux lags behind the primary flux by a definite time interval, such that the combined effect of both fluxes exerts a continuous force upon the plunger 15. At no instant is the force zero and therefore the plunger is held upwardly with the flange 16 thereof firmly pressed against the holding coil 21, thereby making vibration impossible.

My device provides exceptionally good heat dissipation. The location of the shading coil 21 in the supporting member 8 permits the intense heat created at this spot to be rapidly conducted to the outside and there radiated to the air.

From the foregoing discussion it will be seen that my device provides a continuous magnetic path for the flux with a minimum of air gaps, thus producing an efficient and powerful instrument. The combination of the above mentioned magnetic path, the movable core within the solenoid, and the cooperating shading coil and plunger flange create a new and novel arrangement with manifold advantages.

In Fig. 5 I have illustrated an embodiment of my invention, arranged to operate a needle valve in a fluid system. The numeral 35 refers to the body of the valve which is formed with the threaded outlet 36 and a similar inlet 37, and with an orifice 38 positioned therebetween. The body is preferably made of brass and the needle 39, which is arranged to engage the orifice 38, is constructed of a non-magnetic, non-corrosive material. The needle 39 is adapted to slide within a passageway 40 formed longitudinally in the plunger, or movable core 41, of the solenoid 42. A nut 43 is threadedly secured to the top of the needle 39 and serves as a stop which engages a shoulder 40a formed by counter-boring the upper end of the plunger 41. The lower extremity 44 of the needle is formed slightly larger than the passageway 40 in the plunger to enable the lower portion of the plunger to engage it when said plunger is at rest.

The solenoid 42 is mounted upon a body member 45 having a copper shading coil 46 press-fitted into its underneath surface. The function of this shading coil is substantially the same as that previously described. The aforementioned body member 45 is screw fitted onto the valve body 35 and a tight connection is insured by means of the intermediate gasket 47.

48 is a guide tube which is centrally positioned in the solenoid and which is sealed at its lower end to the body member 45. Into the upper end of the guide tube 48 is securely sealed a magnetic steel plug 49 which is provided with a cylindrical recess 50 arranged to hold a coil spring 51 which is made of a non-magnetic material. The upper end of the plug is threaded to receive the nut 52 which secures it to the body member 45a.

It will be understood that the entire system is thoroughly sealed to prevent leakage.

When the valve is closed, the needle 39 is seated in the orifice 38 and the plunger 41 rests on the needle base 44. Upon energization of the solenoid the plunger 41 is forced upwardly, sliding over the stem of the needle 39 until the shoulder 40a strikes the nut 43 on the top of the needle stem.

This initial travel of the plunger gives it sufficient inertia to raise the needle 39 off the orifice 38. The plunger continues its upward motion until its flange 53 rests against the shading coil 46. The spring 51 is now compressed and, when the solenoid is de-energized, overcomes the residual magnetism present and permits the plunger and the needle to drop of their own weight. As the plunger 41 falls, the bottom of the flange engages the head 44 of the needle holding the needle in place. Thus it will be seen that my improved solenoid is applicable to valves as well as switches or relays.

Although I have herein disclosed certain embodiments of the invention, it will be understood that various modifications may be employed, without violating the spirit of the invention, all of which are intended to be within the scope of the appended claim.

Having described my invention, what I claim and desire to secure by Letters Patent is:

In a device of the character described, the combination of a primary exciting coil, a non-magnetic guide member within said coil, a magnetic plug in said guide member, a magnetic frame secured to said plug, a magnetic plunger slidably mounted in said guide member, said plunger having integral transverse members at one end, an inverted U shaped magnetic yoke for supporting said frame, said yoke having an opening therein through which passes said plunger, an annular groove around said opening, and a copper ring in said groove arranged to be contacted by said transverse members on said plunger.

JAMES B. FISHER.