

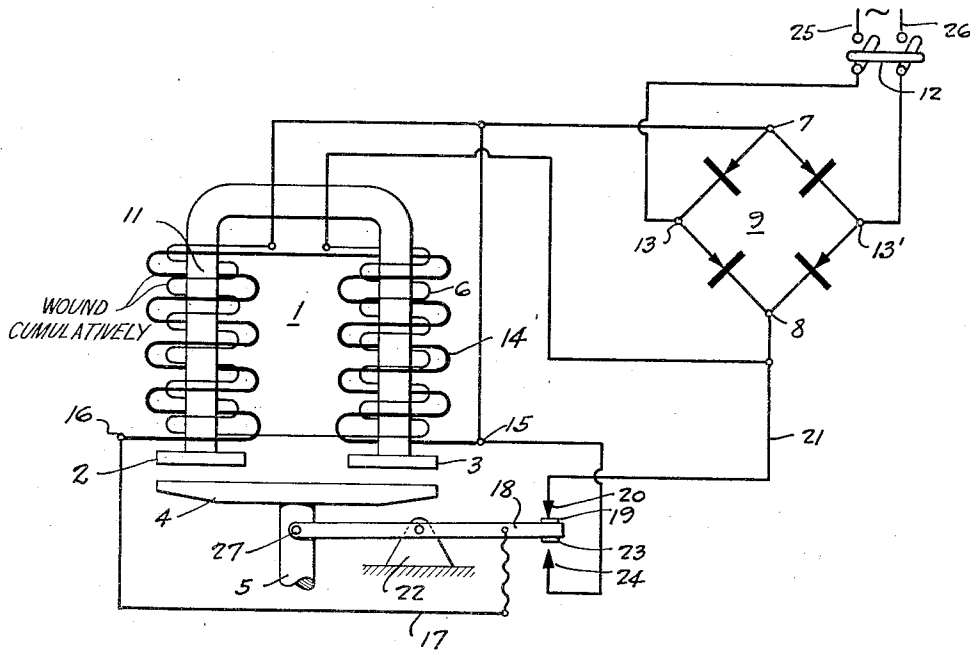
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ELECTROMAGNETIC OPERATOR

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ELECTROMAGNETIC OPERATOR

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This invention relates to an electromagnet, and especially to one that is utilized for applying a magnetic force to move an operator. Such an operator, for example, may be used to control a valve. Electromagnets for such purposes are now in common use. These electromagnets usually employ a movable plunger or armature that serves to apply the force to an operator.

It is necessary to provide an electromagnet having sufficient power to move the plunger or armature rapidly to the energized position; yet such power is unnecessary merely to hold the operator in that position. Once energized, the power of the electromagnet may be materially reduced without danger of movement of the plunger or armature to de-energized position. All this is well understood; it is referred to herein because one aspect of the invention relates to the control of the power of the electromagnet.

In such magnets, it has been common, in the past, to provide a condenser in parallel with the coil of the electromagnet. When the circuit is interrupted, the inductive kick of the coil is absorbed by the condenser, and sparking at the contacts is materially reduced.

It is an object of this invention to make it possible to obtain the advantages of such a condenser and to reduce the sparking by the aid of inexpensive devices; and, more particularly, by utilizing a coil that can operate as a short-circuited secondary for the main electromagnet coil when the electromagnet is de-energized. Since the secondary coil is not short-circuited during the period when the armature or plunger is moving to attracted position, it is ensured that the initial rush of current to the electromagnet will not induce a destructively heavy current in the secondary coil.

It is another object of this invention to make it possible to use a coil to perform the dual function of supplementing the power of the electromagnet during the major portion of the stroke, and of providing the short-circuited coil thereafter.

It is advantageous to be able to operate an electromagnet from available sources of electrical energy, such as commercial alternating current mains; yet the structure of alternating current electromagnets presents some complications. Accordingly, it has been proposed to rectify the alternating current and to operate a direct current electromagnet on the rectified current. A simple form of rectifier, such as dry disc type, produces pulsating current, and there is some likelihood of producing chatter when the armature or plunger is in attracted position.

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It is another object of this invention to provide an electromagnet capable of operating on a pulsating current, and that is relatively free of chatter. This object is accomplished by the short-circuited coil, which has the effect of steadying the flux through the core.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawings accompanying and forming part of the present specification. The form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawing, the single figure is a wiring diagram of a circuit, including an operator that embodies the invention.

In the present instance, there is shown an electromagnet 1 having a core 11. The core is diagrammatically illustrated as one having a pair of arms, provided with the pole pieces 2 and 3. These pole pieces co-operate with a movable armature 4. The armature 4 may be provided with a stem or operating member 5 connected, for example, to a load to be operated. The member 5, for example, may be the stem of a valve to be operated by the electromagnet 1.

In order to attract the armature 4 and to move it into contact with the pole pieces 2 and 3, energizing coils are provided on the core 11. The core 11 thus carries a coil 6, arranged in the present instance to be operated by a source of alternating current to which mains 25 and 26 may be connected. However, the electromagnet 1 is arranged for operating on direct current; and, for that reason, a rectifier 9 is included between mains 25 and 26 and the coil 6. This rectifier 9 may be of a conventional dry disc variety, having stacks of discs forming a closed bridge circuit.

The coil 6 may be connected directly to the diagonal points 7 and 8 of the rectifier bridge; and the mains 25 and 26 may be connected through a switch 12 to the other diagonal points 13 and 13'. The magnetomotive force produced by the coil 6 is temporarily augmented or supplemented in order to assist in pulling the armature 4 to the pole pieces 2 and 3. However, as soon as the armature 4 moves away from its unattracted position, the supplemental magnetomotive force is discontinued.

In order to obtain this result, use is made of

a supplemental coil 14, placed on core 11 in assisting relation to the coil 6. With the switch 12 closed and the armature 4 not yet started from its unattracted position, the circuit for coil 14 is completed through the following path: From diagonal point 7 of the rectifier 9, to the right hand terminal 15 of the coil 14, through the coil 14, left hand terminal 16, connection 17, contact arm 18, contact 19 carried by the arm 18, stationary contact point 20, and a connection 21, to the opposite diagonal point 8. The arm 18 is shown as angularly moved in response to the movement of the armature 4, and, for this purpose, may have its left hand end pivoted at 27 to the stem 5. Thus, when the armature 4 is in the unattracted position, the arm 18, appropriately pivotally supported on standard 22, is in a position such as to maintain contact between contact points 19 and 20. As soon as the armature 4 is attracted and moves away from its unattracted position, contacts 19 and 20 separate, and coil 14 is no longer effective to assist or supplement the coil 6.

Accordingly, by this means, a high inrush of electric energy is provided, to ensure that the armature 4 will be attracted with a force strong enough to pull it into contact with the poles 2 and 3. When the armature 4 arrives at, or near, the fully attracted position, the magnetomotive force required merely to hold it in that position can be reduced; and this is accomplished by the de-energization of coil 14.

Opening the switch 12 after the electromagnet 1 has been energized would result in harmful arcing and sparking at the switch contacts. Breaking of a circuit in which there is a heavy inductance, such as the coil 6, is attended with these difficulties, since the induction of the circuit tends to maintain an arc across the contacts of the switch while opening the circuit. This inductive kick has been often minimized by the provision of a condenser paralleling the inductance.

By the present arrangement the need of such a condenser is obviated. Instead, the arrangement is such that the coil 14, after its temporary energization, is short-circuited to absorb the inductive kick. Short-circuiting of the coil 14 can be accomplished by the aid of a contact point 23 carried on the lower part of the arm 18, and a co-operating stationary contact point 24. Thus, when the armature 4 approaches its attracted position, contact points 23 and 24 engage and the coil 14 is short-circuited through these two contacts. The complete short-circuit includes the right hand terminal 15 of coil 14, contacts 24 and 23, arm 18, connection 17, and left hand terminal 16.

This short-circuit persists until the armature 4 begins to drop away from the pole pieces 2 and 3 upon de-energization of the coil 14. Accordingly, when switch 12 is opened, a substantial part of the inductive kick is absorbed in the coil 14.

Since the coil 14 is shorted while the electromagnet 1 is energized, it serves, as heretofore stated, to reduce the fluctuations of the magnetism in core 11. Coil 14 thus serves three functions: first, temporarily to augment the power of the electromagnet; then to provide a circuit that reduces the self-inductance of the holding coil 6; and, lastly, to smooth out the variations in magnetism in the core 11.

The inventor claims:

1. In an electromagnet, a magnetic member

adapted to be influenced by a magnetomotive force to move from an unattracted position to an attracted position, a coil adapted to be connected to a source of electrical energy, another coil also adapted to be connected to said source, and magnetically coupled in cumulative relation to said first coil and connected to said source in parallel with the first coil, and means operated in response to substantial movement of said member from its unattracted position for successively disconnecting said other coil for parallel arrangement and short-circuiting the said other coil.

2. In an electromagnet, a magnetic member adapted to be influenced by a magnetomotive force to move from an unattracted position to an attracted position, a coil adapted to be connected to a source of electrical energy, another coil also adapted to be connected to said source, and magnetically coupled in cumulative relation to said first coil and connected to said source in parallel with the first coil, and means operated in response to substantial movement of said member from its unattracted position for short-circuiting the said other coil, said short-circuiting means being arranged to open the circuit of the said other coil when the member moves away from its attracted position.

3. In an electromagnet, a magnetic member adapted to be influenced by a magnetomotive force to move from an unattracted position to an attracted position, a pair of coils in cumulative relation and adapted to be connected to a source of pulsating electrical energy to cause said member to be attracted, and means operated in response to movement of said member from its unattracted position for disconnecting one only of the coils from the source and for thereafter short-circuiting said one coil.

4. In an electromagnet, a magnetic member adapted to be influenced by a magnetomotive force to move from an unattracted position to an attracted position, a pair of coils in cumulative relation and adapted to be connected to a source of pulsating electrical energy to cause said member to be attracted, and means operated in response to movement of said member from its unattracted position for disconnecting one only of the coils from the source and for thereafter short-circuiting said one coil, said means being arranged to open the short-circuit of said one of the coils when the member moves away from its attracted position.

5. In an electromagnet, a magnetic core, a pair of coils disposed on the core in cumulative relation, a magnetic member co-operating with the core and arranged to be moved from an unattracted to an attracted position, a source of pulsating current for energizing said coils, and a circuit controller operated by movement of said member in response to energization of the coils for de-energizing one only of the coils when said member moves away from its unattracted position, as well as for thereafter short-circuiting said one of the coils.

6. In combination, a full wave rectifier having an input adapted to be connected to a source of alternating current, a first coil adapted to be connected to the output side of the rectifier, a magnetic member movable to an attracted position when said coil is energized, a second coil wound cumulatively with said first coil, and adapted to be connected to said rectifier, and means operated in response to movement of said member toward its attracted position for disconnecting said second coil from the rectifier and

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for thereafter short-circuiting said second coil.

7. In combination, a full wave rectifier, means for optionally connecting the input of said rectifier to a source of alternating current, an electromagnet including a first coil connected to the output of said rectifier, and a second coil wound in assisting relation to the first coil, a magnetic member adapted to be moved from an unattracted position to an attracted position and to be retained in said attracted position upon energization of said magnet, and means operated in response to movement of said member for connecting said second coil to the output of said rectifier when the member is in its unattracted position and for short-circuiting the second coil when the member is in its attracted position.

8. In combination, an electromagnet having a first coil and a second coil wound in assisting relation, a magnetic member adapted to be influenced by said magnet to move from an unattracted position to an attracted position, switch means for connecting said second coil to a source of electrical energy and means operating in re-

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sponse to movement of said member for short-circuiting said second coil when said member is in its attracted position.

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