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CONTROL SYSTEM

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Fig. 1.

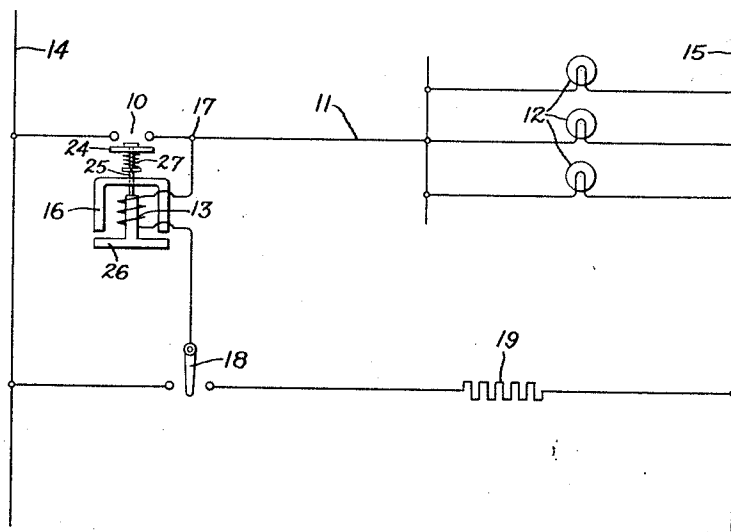
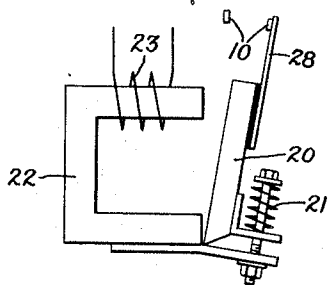


Fig. 2.



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UNITED STATES PATENT OFFICE

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CONTROL SYSTEM

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10 Claims. (Cl. 175—375)

My invention relates to control systems, more particularly to systems for operating electromagnetic switches and has for its object a simple and reliable system of this character.

In carrying out my invention, I provide a magnetic iron core for the operating coil of the main load switch which core is made of a material having relatively high magnetic flux retentivity whereby it retains a relatively great amount of residual magnetism after the energizing coil is deenergized, this residual magnetic effect being great enough to hold the switch closed.

For the control of the energizing winding of the main switch, I provide a two-way single pole control switch which, when thrown in one direction, connects the coil for energization in parallel with the main switch and in series with the load whereby the coil is short circuited when the main switch is closed, and the main switch is held closed by the residual magnetism of the core. To open the main switch, the control switch is thrown to its other position whereby the coil is connected for energization through the main switch and in parallel with the load and is deenergized when the switch opens.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a diagrammatic representation of a control system embodying my invention; while Fig. 2 is an elevation view of a preferred form of switch.

I have shown my invention in one form as applied to the opening and closing of a main switch 10 to control a load circuit 11 energizing, as shown, a plurality of electric lamps 12. The switch 10 is normally biased to its open circuit position as by a spring or, as shown in Fig. 1, by gravity. It is moved to its closed position by means of a suitable coil 13. When closed, the switch 10 connects the lamps 12 across suitable supply mains 14 and 15 which may be energized either with alternating or direct current.

The coil 13 is provided with a magnet iron core 16 having sufficient magnetic retentivity to hold its armature in its attracted position and thereby hold the switch 10 closed for an indefinite period of time after the coil 13 has been deenergized. For example, the core may be made of a material containing three (3) per cent or more of chromium by weight, the remainder being iron.

For the purpose of energizing it, one side of the coil 13 is connected to the point 17 which is between the switch 10 and the load, shown as electric lamps 12. The other end of the coil is connected to a two-way single pole control switch

18. When this switch is thrown toward the left hand, as seen in the drawing, it connects the coil 13 across or in parallel with the open switch 10 so that the coil 13 is thereby connected across the mains 14 and 15 in series with the load 12. The coil 13 thereupon closes the switch 10 and the switch in closing short circuits the coil 13, the switch being held closed by the residual magnetism in the core of the coil 13.

For the purpose of opening the main switch 10, the switch arm 18 is thrown to its right-hand position which connects the coil 13 in series with a suitable resistance 19 in parallel with the lamps 12 and in series with the switch 10 whereby the coil 13 is energized sufficiently to neutralize the residual magnetism in the core 16 and permit the switch 10 to open. When the switch 10 opens, the coil 13 is deenergized for the reason that it is connected in series with the switch 10.

In the preferred form of electromagnetic switch 10 shown in Fig. 2, the pivotally mounted armature 20 is biased to the open circuit position shown, by means of a helical spring 21. The armature 20 and the stationary core member 22 are made of a suitable material, mainly iron, which retains a sufficient amount of residual magnetism to hold the armature in its attracted position after the coil 23 has been energized to pick up the armature 20 and then deenergized. This is a desirable means of holding the switch closed for an indefinite period against the force applied by the spring 21. It requires no additional energy and has no resultant noise.

Because of the fact that the armature 20 is released by neutralizing the residual magnetism in the magnetic structure of which it forms a part, instead of having a low value of residual magnetism insufficient to retain the armature when the circuit of the coil is opened, no air gap is provided between the armature and the core member 22. Moreover, the absence of the air gap gives the residual magnetism an advantage in holding the armature in its attracted position.

In order to provide for wear of the engaging contact surfaces of the switch 10, the movable contact of the switch which is operated by the armature is resiliently secured to the armature so that the switch 10 is closed before the armature has reached its final sealed in or attracted position. By reason of the short circuiting of the coil 13 or 23 by the closure of the switch, however, the coil maintains the magnetic flux in the core structure to a high value for a substantial period of time by reason of the self-

inductance of the coil. This maintenance of the flux by the short circuited coil is sufficient in time to provide for the armature to be pulled to its final attracted position. The magnetic flux thereupon decreases to its residual value.

For example, in the arrangement of Fig. 1, the movable contact 24, shown as a bridging contact, is slidably mounted on the rod 25 connected to the movable armature 26. The contact is resiliently pressed against a stop on the end of the rod 25 by means of a helical spring 27 surrounding the rod. Thus, after the movable contact engages the stationary contacts and the switch is closed, the spring 27 is compressed by continued movement of the armature 26 to its attracted position. In the arrangement of Fig. 2, the contact arm 28 carrying the movable contact can be flexible to provide a similar effect.

It will be understood that the control switch 18 may be operated in any suitable manner. For example, it may be operated as a limit switch or it may be operated in response to variable quantities such as light, temperature, pressure, liquid level, etc. Also the load 12, indicated as electric lamps, may be any suitable load such as an electric motor. The switch 18, of course, may also be operated manually, as shown in Fig. 1, for example, in the turning on and off of street lamps, indicated by the lamps 12.

It will be observed that when the control switch 18 is closed, it is immediately thereafter either short circuited by the switch 10 or its circuit is opened by the switch 10 so that the switch 18 is thereafter opened with no voltage across its contacts.

In view of the fact that the coil 13 is energized only momentarily, it can be of inexpensive construction and be wound with a relatively small copper conductor which would be overheated if continuously energized from the supply circuit.

When operating with alternating current on the supply mains 14 and 15, if the switch 10 should close at about the zero point on the current wave, the residual magnetism may not be strong enough to hold the switch closed. In such case, the switch 10 opens and its coil 13 is immediately reenergized whereupon the switch closes again. Obviously the switch cannot be noisy when operating on A. C. except for the momentary periods when the coil is connected to the supply mains.

When the supply mains 14 and 15 are supplied with direct current, it will be observed that the control switch 18 when thrown to its right-hand position reversely energizes the coil 13 and consequently the residual magnetism is neutralized. The resistance 19 allows the correct amount of current to demagnetize the core, i. e. reduce its residual magnetism to a low value insufficient to hold the armature in its attracted position.

When the supply mains are energized with alternating current, I have found that energization of the coil 13 at a low value through an impedance, as shown the resistance 19, very effectively reduces after a few cycles of the current the residual magnetism in the core to a low value insufficient to hold the armature in its attracted position against its bias to its unattracted position. The armature then moves to its unattracted position opening the switch 10. In fact, the switch 10 opens practically instantaneously after the closing of the control switch 18 to demagnetize the coil.

It will be understood that when alternating current is used to demagnetize the core, the de-

magnetizing current must be smaller than the current required to pick up the armature or to hold the armature in its attracted position. In other words, the alternating current must be so weak that the out-of-phase flux produced by the shading coil on the core is too small to hold the armature in its attracted position. One half of each current wave of the demagnetizing current produces a flux in the core in opposition to the residual magnetism in the core while the other half of the wave tends to remagnetize the core. However, the residual magnetism is reduced each cycle more than it is built up because of the fact that more energy is required to magnetize a core than to demagnetize it. As a result, the core is demagnetized by successive cycles of the demagnetizing current.

Preferably the resistance 19 is one having a positive temperature coefficient of resistance when A. C. power is used and is selected so that it heats after a few cycles of current to a temperature at which its resistance is 8 or 10 times its cold resistance value. A suitable tungsten lamp is a very satisfactory resistance of this type. This increasing resistance by reducing the current approaches the effect obtained by gradually reducing the voltage on the coil. This effectively reduces the residual magnetism in the core to a low value insufficient to hold the armature in its attracted position.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto, since many modifications may be made and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In combination, a switch biased to its open circuit position, a coil for operating said switch to its closed circuit position, a magnet iron core structure for said coil having sufficient residual magnetism after said coil is deenergized to hold said switch closed, and a control switch movable to connect said coil across said switch for energization of said coil to close said switch whereby said coil is short circuited by said switch.

2. In combination, a switch biased to its open circuit position, a coil for operating said switch to its closed circuit position, a magnet iron core structure for said coil having sufficient residual magnetism after said coil is deenergized to hold said switch closed, and a control switch movable to one of two positions to connect said coil across said switch for energization of said coil to close said switch whereupon said coil is short circuited by said switch, said control switch being movable to its other position to connect said coil in series with said switch for demagnetization of said core and opening of said switch.

3. In combination, a switch biased to its open circuit position, a coil for operating said switch to its closed circuit position, a magnet iron core structure for said coil having sufficient residual magnetism after said coil is deenergized to hold said switch closed, an impedance, and a control switch movable to one of two positions to connect said coil across said switch for energization of said coil to close said switch whereupon said coil is short circuited by said switch, said control switch being movable to its other position to connect said coil in series with said switch and said impedance for demagnetization of said core and opening of said switch.

4. The combination with an electric translating device, of a switch biased to its open position in circuit with said device, a coil for operating said switch to its closed circuit position, connections for energizing said coil in series with said translating device in parallel with said switch to close said switch whereby said translating device is energized and said coil is short circuited, a magnet iron core structure for said coil having sufficient residual magnetism after said coil is deenergized to hold said switch closed, and connections for energizing said coil in parallel with said translating device to demagnetize said core whereupon said switch opens in accordance with its bias and opens the circuits of said translating device and said coil.

5. The combination with an electric translating device, of a switch biased to its open position in circuit with said device, a coil for operating said switch to its closed circuit position, connections for energizing said coil in series with said translating device and in parallel with said switch to close said switch whereby said translating device is energized and said coil is short circuited, a magnet iron core structure for said coil having sufficient residual magnetism after said coil is deenergized to hold said switch closed, an impedance, and connections for energizing said coil in parallel with said translating device through said impedance to demagnetize said core whereupon said switch opens in accordance with its bias and opens the circuits of said translating device and said coil.

6. The combination with a switch, of a magnet core structure, a movable armature for said core structure, a spring connection between said armature and said switch providing for closure of said switch before said armature has reached its attracted position after which said spring yields to provide for movement of said armature to its attracted position, means biasing said armature to its unattracted position thereby to bias said switch to its open position, a coil on said core structure for operating said armature to move said switch to its closed circuit position, electrical connections for energizing said coil in parallel with said switch to close said switch whereby said coil is short circuited by said switch, said short circuited coil maintaining a high value of flux in said core structure for completion of the movement of said armature to its attracted position and said core structure having sufficient residual magnetism thereafter to hold said armature in its attracted position.

7. The combination with a switch, of a magnet core structure, a movable armature for said core structure, a spring connection between said armature and said switch providing for closure of said switch before said armature has reached its attracted position after which said spring yields to provide for movement of said armature to its attracted position, means biasing said armature to its unattracted position thereby to bias said switch to its open position, a coil on said core structure for operating said armature to move said switch to its closed circuit position, electrical connections for energizing said coil in parallel with said switch to close said switch whereby said coil is short circuited by said switch, said short circuited coil maintaining a high value

of flux in said core structure for completion of the movement of said armature to its attracted position and said core structure having sufficient residual magnetism thereafter to hold said armature in its attracted position, an impedance, and connections energizing said coil through said impedance to demagnetize said core whereupon said armature moves to its unattracted position in accordance with its bias and opens said switch.

8. The combination with an electric translating device of a switch connected in circuit with said device, a magnet core structure, a movable armature for said core structure, a spring connection between said armature and said switch providing for closure of said switch before said armature has reached its attracted position after which said spring is compressed to provide for movement of said armature to its attracted position, means biasing said armature to its unattracted position thereby to bias said switch to its open position, a coil on said core structure for operating said armature to move said switch to its closed circuit position, electrical connections for energizing said coil in series with said translating device and in parallel with said switch to close said switch whereby said translating device is energized and said coil is short circuited by said switch, said short circuited coil maintaining a high value of flux in said core structure for completion of the movement of said armature to its attracted position and said core structure having sufficient residual magnetism thereafter to hold said armature in its attracted position, an impedance, and connections for energizing said coil in parallel with said translating device through said impedance to demagnetize said core whereupon said armature moves to its unattracted position in accordance with its bias and opens the circuit of said translating device and said coil.

9. The combination with an electric translating device of a switch biased to an open circuit position in circuit with said device, a coil for operating said switch to a closed circuit position, connections for energizing said coil to close said switch and energize said translating device, means responsive to the closure of said switch for deenergizing said coil, a magnetic core structure for said coil having sufficient magnetic retentivity to hold said switch closed after said coil is deenergized, and connections for energizing said coil in parallel with said translating device so as to cause said core structure to release said switch.

10. The combination with an electric translating device of a switch biased to an open circuit position in circuit with said device, a coil for operating said switch to a closed circuit position, connections for energizing said coil to close said switch and energize said translating device, means responsive to the closure of said switch for deenergizing said coil, a magnetic core structure for said coil having sufficient magnetic retentivity to hold said switch closed after said coil is deenergized, an impedance, and connections for energizing said coil in parallel with said translating device through said impedance so as to cause said core structure to release said switch whereupon said switch opens in accordance with its bias to deenergize said translating device and said coil.

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