

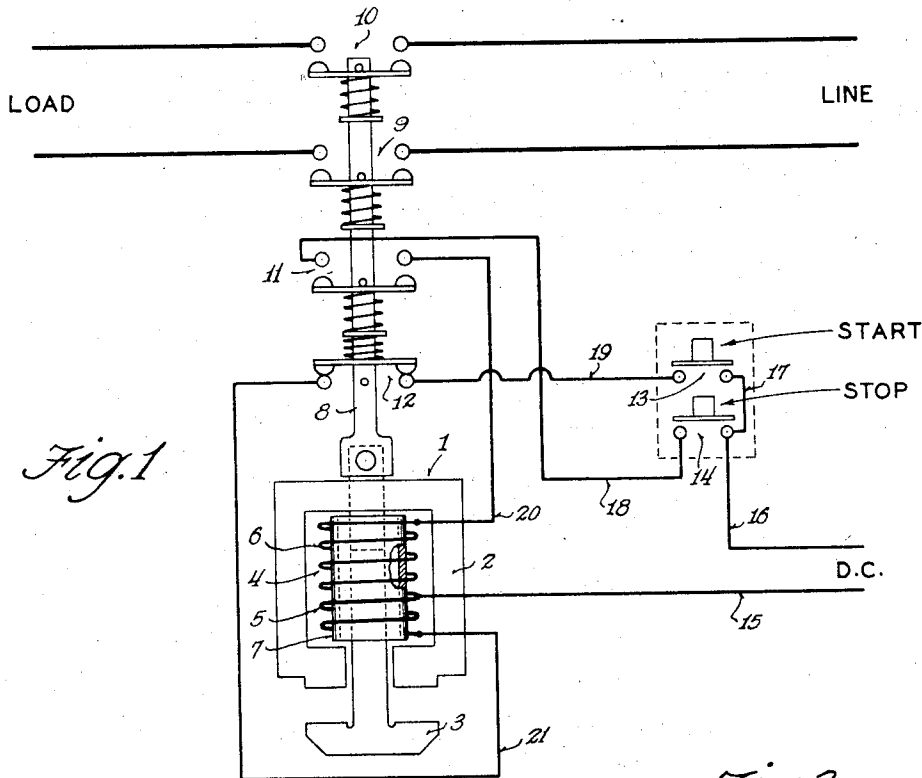
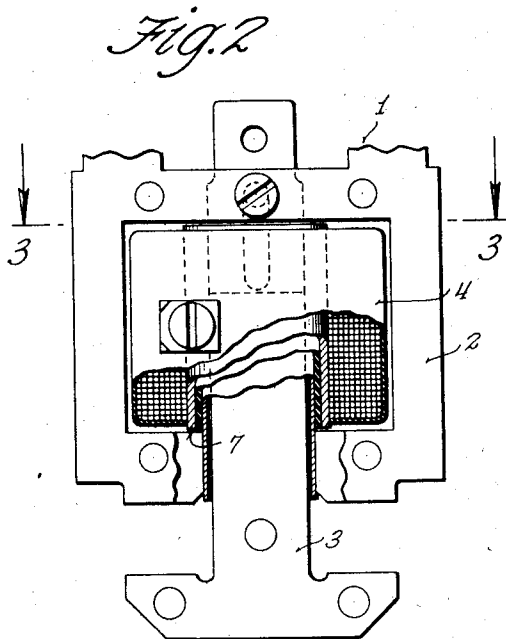
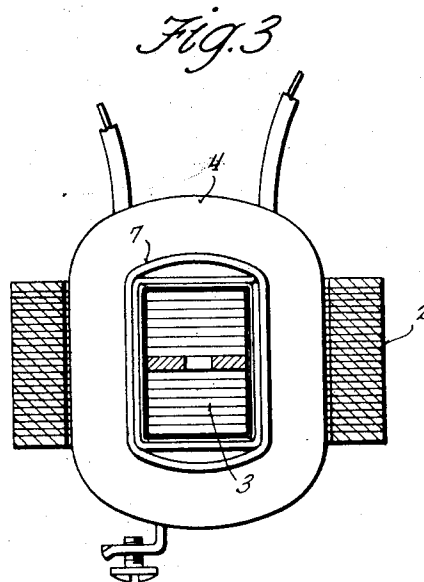
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RESIDUALLY MAINTAINED DIRECT CURRENT ELECTROMAGNET

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RESIDUALLY MAINTAINED DIRECT
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This invention relates to an electromagnet of the type that is operated to the "closed" position by energization of a direct current coil, maintained in the "closed" position against a biasing means by residual magnetism obtained from the closing direct current energization, and returned to the "open" position by a direct current demagnetizing force of sufficient intensity to reduce the residual magnetism.

This invention comprehends the use of a low resistance coil linking the main magnetic circuit of an electromagnet; a suitable control means by which the electromagnet is subjected to a momentary direct current magnetizing force to move it to "closed" position; and a control means by which the electromagnet is subjected to a direct current demagnetizing force to effect return to "open" position.

The direct current magnetizing force to operate the electromagnet to "closed" position continues until the armature is in close proximity to the fieldpiece. Upon interruption of the closing magnetizing force the flux in the magnetic circuit begins to decay. The final residual flux in the magnetic circuit, at the time the armature engages the fieldpiece, is dependent upon the decay of flux that occurs from the point of interrupting the closing magnetizing force to the point at which the armature and fieldpiece seal. The low resistance coil linking the main magnetic circuit retards the rate of decay of flux during the closing period and, as a result, an increased holding force is obtained from a given closing magnetizing force.

The direct current demagnetizing force to operate the electromagnet to "open" position continues until the armature is released and returns to the "open" position. During the period of demagnetization the flux in the magnetic circuit is subjected to a magnetizing force which will reverse the direction of the flux. The low resistance coil linking the main magnetic circuit retards the rate of reversal of flux during the period of demagnetization, thus increasing the time during which the electromagnet can satisfactorily return to the "open" position.

It is an object of this invention to cause the sealing of the armature and fieldpiece to occur with a comparatively high residual flux remaining in the magnetic circuit.

It is a further object of this invention to permit the use of a high direct current demagnetizing force to operate the electromagnet to the "open" position.

It is a further object of this invention to improve the performance of a direct current electro-

magnet of the type described by retarding the rate of change of flux in the electromagnet under conditions of energization and deenergization whereby, a greater holding force is secured in the "closed" position and more reliable operation is secured in returning the electromagnet to the "open" position.

It is a further object of this invention to increase the successful range of voltages throughout which an electromagnet of the type described can satisfactorily be actuated to the "closed" position and returned to the "open" position.

It is a further object of this invention to obtain the aforesaid objects by the use of a single device that can be incorporated in the usual electromagnet structure without undue complexity.

A further object of this invention is to alter the electromagnetic constants of the usual alternating current electromagnet structure by means of a low resistance coil linking the main magnetic circuit whereby, the usual alternating current magnet structure can successfully be used as a direct current electromagnet of the type described.

Further objects and features of this invention will be readily apparent to those skilled in the art from the following specification and the attached drawing illustrating the preferred embodiment of this invention in which:

Fig. 1 is a schematic diagram showing the elements of the electromagnet, the source of direct current power and the connections whereby the several elements of the structure are made to operate in the manner disclosed;

Fig. 2 is a partially sectioned front view of the electromagnet; and

Fig. 3 is a section taken along the lines 2—3 in Fig. 2.

The electromagnetic device 1 and control connections are shown in Fig. 1 as controlling the connection of "load" to "line." This device includes a fieldpiece 2 and an armature 3 that is relatively movable to and from a "closed" position with fieldpiece 2. A magnetizing coil 5 and demagnetizing coil 6 provide means for actuating armature 3 to the "closed" position and for effecting the return of armature 3 to the "open" position. A switch contact carrier 8 attached to armature 3 is adapted to actuate switches 9, 10, 11 and 12. A low resistance coil 7, arranged concentrically with coils 5 and 6, is for the purpose of retarding the rate of change of flux in the magnetic circuit.

This device operates as a residually held switch. Movement to the "closed" position is effected by

momentary energization of coil 5 by a source of direct current power. This connection is made through conductor 16, conductor 17, the normally open "start" switch 13 in its "closed" position, conductor 19, normally closed switch 12, conductor 21, coil 5 and conductor 15. As armature 3 approaches "closed" position, switch 12 opens, thus interrupting the direct current magnetizing force. In substantially "closed" position of the armature 3, the magnetic circuit comprising fieldpiece 2 and armature 3 is such that it retains residual magnetism. In order to increase the value of the residual magnetism remaining in the magnetic circuit, in its "closed" position, low resistance coil 7 functions to retard the decay of flux that ensues following the interruption of the magnetizing force by the opening of switch 12. Thus the decay of flux is at a slow enough rate to permit armature 3 to seal with high residual flux.

The return of armature 3 to the "open" position is effected by reducing the residual flux in the magnetic circuit to permit armature 3 to return by the biasing means. The demagnetizing coil 6 is connected to the source of direct current power through conductor 18, normally open "stop" switch 14 in its "closed" position, conductor 18, normally open switch 11 in its "closed" position, conductor 20, demagnetizing coil 6 and conductor 15. It is to be noted that the connections to the coil are such that the direction of the magnetizing force of coil 6 is opposite to that of the magnetizing force of coil 5. As armature 3 approaches the "open" position, switch 11 opens, interrupting the demagnetizing force of coil 6.

It is particularly advantageous to be able to use a relatively high demagnetizing force to effect the movement to the "open" position. However, the use of a high demagnetizing force may give rise to the development of high residual magnetism of opposite polarity occurring so quickly that the armature remains in the sealed position. It has been found that it is possible to use a high demagnetizing force, by linking the main magnetic circuit with a very low resistance coil which retards the rate of reversal of flux in the magnetic circuit to permit the armature to open before the reversed flux attains a value sufficient to maintain closure.

The construction of armature 3, fieldpiece 2 and coil 4 is shown in detail in Figs. 2 and 3. In the preferred form shown, the fieldpiece 2 comprises a number of laminations of silicon steel such as that used in the conventional alternating current magnet. The armature 3 is likewise shown as comprising a number of laminations similar in structure to that used in an alternating current magnet. The steel used in armature 3 is, however, a chromium steel alloy having high retentivity and coercive force. The magnetic circuit of the fieldpiece and armature in its "closed" position, when adequately magnetized by a source of direct current power will retain, upon interruption of the magnetizing force, sufficient residual magnetism to maintain the armature closed.

It has been found to be quite advantageous to wind coils 5 and 6 as one composite coil 4, upon and concentric with the low resistance shading coil 7. This construction is clearly shown by the partially sectioned view of Fig. 2. The low resistance coil 7 links the main magnetic circuit and is very effective in retarding the rate of change of flux in the magnet.

The use of a low resistance coil linking the main magnetic circuit is particularly advantageous

when used in connection with a magnet structure such as that ordinarily used in alternating current work. Due to the large number of alternating current applications and the relatively small number of applications for direct current, it is advisable, from the standpoint of production to modify the conventional alternating current magnet structure so that it can be used on direct current. In the conventional direct current magnet structure the iron circuit is not laminated and the usual precautions against induced circulating currents within the magnet structure are not taken. The rate of change of flux in magnets of this type is accordingly slower than in an alternating current magnet. The invention is therefore particularly applicable to devices employing an alternating current magnet structure and to direct current magnets wherein the rate of change of flux is too rapid to secure the proper operating characteristics.

The low resistance coil linking the main magnetic circuit permits greater latitude in the design of the electromagnetic device. In a particular device it has been found to be possible by the use of the low resistance coil to reduce the closing ampere turns from 2,920 to 1,730. With the addition of the low resistance coil and the reduction in closing ampere turns it was found possible to increase the maximum permissible voltage rating of the energizing coil, necessary to obtain the desired closing ampere turns, from 72 to 230 volts D. C. In other words, in the design of the closing coil to secure the required closing ampere turns of 2,920 for an electromagnet without the low resistance coil, the closing magnetizing current could not be interrupted at a voltage greater than 72 volts D. C.; with the addition of the low resistance coil the design of the closing coil to secure the necessary closing ampere turns of 1,730, the closing magnetizing current could be interrupted at 230 volts D. C. To secure proper dropout action of the electromagnetic device it was found by the use of the low resistance coil that the permissible dropout ampere turns could be increased from 245 to 500 and still have the rate of reversal of flux retarded sufficiently to permit the armature to return to "open" position before the reversed flux attained a value sufficient to maintain the armature in "closed" position.

It is desired that the protection of Letters Patent afforded hereby extend to the full extent of the inventive concept hereof as represented by the scope of the claims appended without being limited by statements which are made in connection with the setting forth of the specific instance of practice and use.

What I claim as my invention and wish to secure by Letters Patent is:

1. In combination, a switch biased to its open circuit position, a switch biased to its closed circuit position, an electromagnet coupled to actuate said two switches and having a magnet core structure which, when energized by a suitable momentary direct current magnetizing force to effect movement from "open" to "closed" position, retains sufficient residual magnetism to maintain said two switches in operated position against the biasing means, a magnetizing means for said electromagnet controlled by said second switch, a demagnetizing means for said electromagnet controlled by said first switch, and a source of direct current power; control means, including said second switch, to connect said source of direct current power to said magnetiz-

ing means to effect movement from "open" to "closed" position, the supply of direct current power to said magnetizing means being interrupted by said second switch when said electromagnet approaches substantially "closed" position, and the decay of flux following said interruption being substantially retarded by a low resistance coil linking the magnetic circuit of said electromagnet to secure increased residual magnetism to maintain said two switches in operated position against the biasing means; and a second control means, including said first switch, to connect said source of direct current power to said demagnetizing means to effect the return of said electromagnet from "closed" to "open" position with said low resistance coil retarding the rate of demagnetization of said electromagnet to permit an increased time for the electromagnet to return to the "open" position and the supply of direct current power to said demagnetizing means being interrupted by said first switch when said electromagnet returns to substantially "open" position.

2. An electromagnetic device comprising, a magnetic circuit having high retentivity and coercive force and including a fieldpiece and an armature relatively movable to and from "closed" position with said fieldpiece, means biasing the armature to "open" position, a magnetizing coil for said magnetic circuit to actuate said armature to "closed" position, a demagnetizing coil for said magnetic circuit to effect the return of said armature from "closed" to "open" position, a source of direct current power, and connections controlling the energization of said magnetizing and demagnetizing coils; direct current energization of said magnetizing coil being sufficient to actuate the armature to the "closed" position, said closing energization being interrupted when said armature approaches the "closed" position, and thereafter said magnetic circuit retaining residual magnetism; direct current energization of said demagnetizing coil when said armature is in "closed" position being sufficient to reduce said residual magnetism to permit said armature to return to "open" position; the combination with said device of a low resistance coil linking said magnetic circuit to retard the rate of change of flux when the magnetizing coil is deenergized to secure a high residual flux in the magnetic circuit and to cause a retardation in the decay of flux on the energization of the demagnetizing coil to secure an opening of the armature to its open position before the flux builds up in the opposite direction tending to maintain the armature closed.

3. An electromagnetic device comprising, a magnetic circuit having high retentivity and coercive force and including a fieldpiece and an armature relatively movable to and from "closed" position with said fieldpiece, means biasing the armature to "open" position, a magnetizing coil for said magnetic circuit to actuate said armature to "closed" position, a demagnetizing coil for said magnetic circuit to effect the return of said armature from "closed" to "open" position, a source of direct current power, and connections controlling the energization of said magnetizing and demagnetizing coils; direct current energization of said magnetizing coil being sufficient to actuate the armature to the "closed" position, said closing energization being interrupted when said armature approaches the "closed" position, and thereafter said magnetic circuit retaining residual

magnetism to maintain said armature in "closed" position, direct current energization of said demagnetizing coil when said armature is in "closed" position being sufficient to reduce said residual magnetism to permit said armature to return to "open" position; the combination with said device of a low resistance coil linking said magnetic circuit to retard the decay of flux therein upon interruption of said closing energization to permit a reduced magnetizing force to attain adequate residual magnetism to maintain the armature in "closed" position, and said low resistance coil retarding the rate of reduction of the residual magnetism in said circuit during said direct current energization of said demagnetizing coil to secure an opening of the armature to its open position before the flux builds up in the opposite direction tending to maintain the armature closed.

4. An electromagnetic device comprising a magnetic circuit having high retentivity and coercive force including a fieldpiece, an armature relatively movable to and from closed position with said fieldpiece, means biasing the armature to open position, a magnetizing coil for said magnetic circuit to actuate said armature to closed position, a demagnetizing coil for said magnetic circuit to effect the return of said armature from closed to open position, a switch in circuit with said magnetizing coil and operable by said armature, a second switch in circuit with said demagnetizing coil and operable by said armature, and a source of direct current power with connections for said magnetizing and demagnetizing coils; energization of said magnetizing coil to actuate the armature to the closed position and to move said first switch to the open position as the armature approaches its closed position, and energization of said demagnetizing coil with the armature in its closed position to reduce residual magnetism in said magnetic circuit to permit said armature to return to open position and to move said second switch to its open position; the combination with said device of a low resistance coil linking said magnetic circuit to retard the rate of change of flux when the magnetizing coil is deenergized to secure a high residual flux in the magnetic circuit and to cause a retardation in the decay of flux on the energization of the demagnetizing coil to secure an opening of the second switch before the flux builds up in the opposite direction tending to maintain the armature closed.

5. An electromagnetic device comprising a magnetic circuit having high retentivity and coercive force including a fieldpiece, an armature relatively movable to and from closed position with said fieldpiece, means biasing the armature to open position, a magnetizing coil for said magnetic circuit to actuate said armature to closed position, a demagnetizing coil for said magnetic circuit to effect the return of said armature from closed to open position, a switch in circuit with said magnetizing coil and operable by said armature, a second switch in circuit with said demagnetizing coil and operable by said armature, and a source of direct current power with connections for said magnetizing and demagnetizing coils; energization of said magnetizing coil to actuate the armature to the closed position and to move said first switch to the open position as the armature approaches its closed position, and energization of said demagnetizing coil with the armature in its closed position to reduce residual magnetism in said

magnetic circuit to permit said armature to return to open position and to move said second switch to its open position and such energization of said demagnetizing coil being of a magnitude to establish residual magnetism in the magnetic circuit to maintain the armature in its closed position; the combination with said device of a low resistance coil linking said magnetic circuit to retard the rate of change of flux when the magnetizing coil is deenergized to secure a high residual flux in the magnetic circuit and to cause a retardation in the decay of flux on the energization of the demagnetizing coil to secure an opening of the second switch before the flux builds up in the opposite direction tending to maintain the armature closed.

6. In a direct current electromagnetic device employing a laminated fieldpiece and laminated armature of the type used for alternating current and having high retentivity and high coercive force, means biasing the armature to open position, a magnetizing coil for said magnetic circuit to actuate said armature to closed position, a demagnetizing coil for said magnetic circuit to effect the return of said armature from closed to open position, a switch in cir-

5 cult with said magnetizing coil and operable by said armature, a second switch in circuit with said demagnetizing coil and operable by said armature and a source of direct current power with connections for said magnetizing and demagnetizing coils; energization of said magnetizing coil to actuate the armature to the closed position and to move said first switch to the open position as the armature approaches its closed position and energization of said demagnetizing coil with the armature in its closed position to reduce residual magnetism in said magnetic circuit to permit said armature to return to open position and to move said second switch to its open position; the combination with said device of a low resistance coil linking said magnetic circuit to retard the rate of change of flux when the magnetizing coil is deenergized to secure a high residual flux in the magnetic circuit and to cause a retardation in the decay of flux on the energization of the demagnetizing coil to secure an opening of the second switch before the flux builds up in the opposite direction tending to maintain the armature closed.

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