July 3, 1923.

1,460,390

W. J. O'LEARY

SOLENOID

Filed May 21, 1920

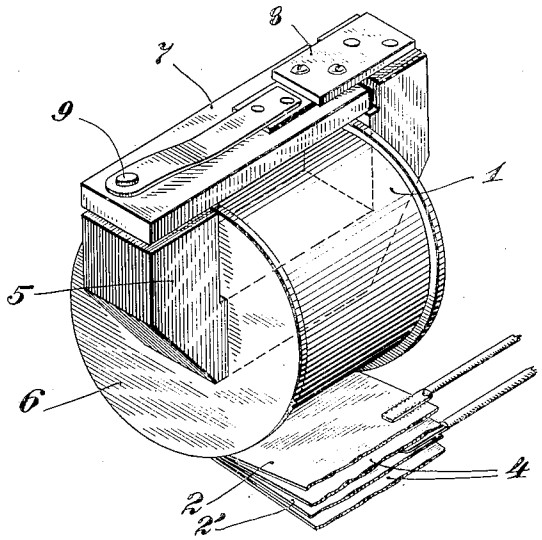

Fig. 1.

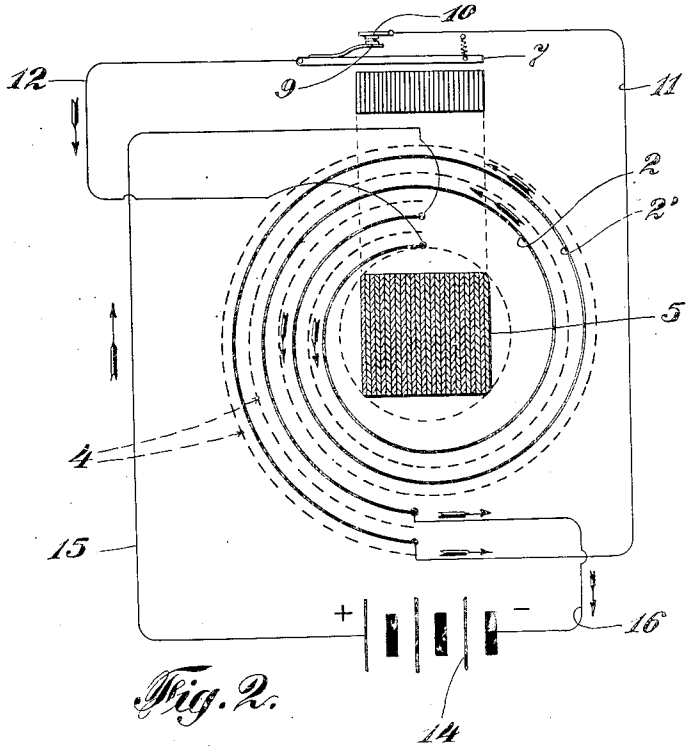

Fig. 2.

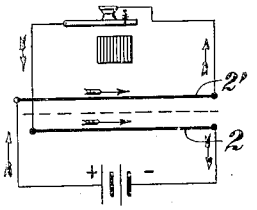

Fig. 3.

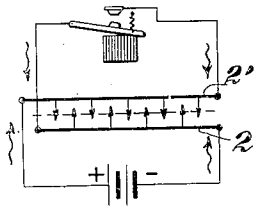

Fig. 4.

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Patented July 3, 1923. 1,460,390

UNITED STATES PATENT OFFICE.

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SOLENOID.

Application filed May 21, 1920. Serial No. 383,123.

To all whom it may concern:

Be it known that I, WILLIAM J. O'LEARY, a subject of the King of England, residing at Montreal, Province of Quebec, Dominion of Canada, have invented new and useful Improvements in Solenoids, of which the following is a specification.

This invention relates broadly to electrical apparatus and specifically to the construction of a solenoid, which is particularly adapted for use in a current interrupting device.

As is well known in the art, in the operation of current interrupting devices such as induction coils, buzzers, relays, and the like, wherein the electrical circuit is closed and opened intermittently by contact points which are brought together and separated, as by a vibrating armature, a spark occurs at the contacts at the instant of opening the circuit, and operates to destroy them with greater or less rapidity, affecting the accuracy of operation of the device and ultimately rendering it inoperative. This sparking is commonly estimated as due to the self-induction of the solenoid coil, which has the effect of tending to maintain or sustain a current in the coil even after the contacts have been separated. In devices of this type, when a core is employed in conjunction with the energizing coil, said core likewise contributes to the effect by virtue of its own inductance, which tends to maintain a magnetic flux after the opening of the energizing circuit and which magnetic flux tends to induce an E. M. F. in the coil.

The purpose of the present invention is the provision of an improved construction for a solenoid device particularly adapted to use in a current interrupting apparatus of the rheotome sort, by virtue of which construction the tendency to spark at the contacts is eliminated or effectively inhibited without the employment of ancillary apparatus, such as a condenser, quenching device, or the like.

A further object of the invention is the provision of a current interrupting device of the rheotome sort in which the making and breaking of the circuit is complete and abrupt, and the operation of the device regular and uniform.

Other and further objects of the invention will be obvious upon an understanding of the illustrative disclosure herein, or will become apparent to one skilled in the art upon employment of a suitable embodiment thereof.

The illustrative disclosure herein, as will be obvious from the accompanying drawings, is made with the aid of illustrations which are entirely diagrammatic in nature, and, therefore, it is to be understood that such disclosure is not intended for the purpose of limiting the invention to any particular proportions or details of construction not specifically claimed as essential component features of the invention.

In the said drawings Figure 1 represents a perspective view of one form of apparatus in which the invention may be embodied, the structure being shown as partly disassembled for the purpose of illustrating parts normally concealed.

Figure 2 is a diagrammatic illustration designed to show certain relationships of some of the parts of an apparatus embodying the invention, the same being in the nature of a section through the core and solenoid windings.

Figures 3 and 4 are conventional illustrative diagrams for illustrating certain phases in the operation of the device.

Described generally, the invention resides in a solenoid construction which is characterized by the provision of an energizing coil formed of associated conductors arranged in effective relationship as the plates of a condenser and separated by a suitable dielectric material; the said conductors being convoluted or wound together about an axis, and being connected in series through a source of current supply and a make and break device, which latter is arranged to open the circuit between the conductors. The make and break device may be of any convenient sort, but the invention is designed particularly to add to the effectiveness of a current interrupting device of the sort wherein the cooperation of the contacts is controlled by a vibrating armature which is energized and operated magnetically by the solenoid, ordinarily through the instrumentality of a magnetizable core arranged to be inductively energized from the conductor coil.

The nature of the invention will be specifically understood by reference to the accompanying drawings in which the reference numeral 1, as shown in Figure 1,

designates generally the solenoid coil, which is formed of conductors 2 and 2′. preferably in the form of strips or ribbons of suitable conductive material, and of substantially equal dimensions, separated by sheets of suitable dielectric material 4, and wound together in convoluted form so that the conductors 2 and 2′ are disposed in the relationship of the metallics of a condenser. The relationship of the coiled conductors is illustrated diagrammatically in Figure 2, it being understood that the dimensions of the conductors may be varied to suit the particular application of the invention, and that the size and number of the convolutions is adapted to similar variation. In the arrangement illustrated, the conductors are associated with a core member 5, being convoluted about it so that it occupies a relationship corresponding to the customary electromagnetic core. In the embodiment shown in Figure 1 the margins of the convoluted conductors and strips of dielectric material are covered and protected by disks 6, and the core is shown provided with angular pole members, on one of which an armature 7 is mounted by means of a spring 8. The armature is shown as carrying a contact point 9 which, as is obvious to one skilled in the art, is adapted for cooperation with an associated contact member, diagrammatically illustrated in Figures 2, 3, and 4, at 10. Said contacts are arranged for cooperation to close a connecting circuit between the conductors 2 and 2′, said circuit being illustrated as comprising the wires 11 and 12, connected respectively to the respective conductors so that they are associated in series. As thus arranged, the conductors are connected in series between the poles of a source of current supply, diagrammatically illustrated at 14, said connections being illustrated as the wires 15 and 16. The disposal of the connections is such that when the circuit is closed through the make and break device 9—10, the direction of the impressed E. M. F. and resulting current will be the same in both conductors 2 and 2′ about the axis of the coil. In the relationship illustrated in Figure 2, this will be a counterclockwise direction, as shown by the feathered arrows.

It will be readily understood that, at this phase of the operation of the device, the solenoid is energized and induces a magnetic condition in the core 5. Upon the flux in the core or the magnetic influence of the coil overcoming the resistance of the spring 8, the armature 7 will be drawn down so that the contacts 9 and 10 will be separated. Immediately this occurs, the circuit between the conductors 2 and 2′ thereby being opened, the capacity effectiveness of said conductors will assume immediate predominance, with the result that the coil will function as a condenser, charging from the conditions obtaining in the source 14, core 5, and the other connections. The action of the coil at the instant of break causes a quick contraction of the core flux and thereby inhibits its becoming effective to contribute to the maintenance of an E. M. F. in the coil in the direction of the original current. This immediate condenser influence, furthermore, abruptly overcomes the self-induction of the coil at the instant of break, and eliminates that influence as a factor tending to sustain a current across the contacts. The phases of operation are diagrammatically illustrated in Figures 3 and 4. In said diagrams the conductors 2 and 2′ are shown as laid flat, with the feathered arrows in Figure 3 showing the direction of the E. M. F. and resulting current when the circuit is closed. Figure 4, which is intended to illustrate the condition at the instant of break, illustrates in the small straight arrows the condenser tendency or effectiveness of the conductors, and by the wavy arrows the tendency or direction of residual surges in the conductors and connections produced by the condenser action. In this it will be seen that the tendency of such residual energy as may exist in the circuit after the break, is away from the contact points, thus eliminating the cause of sparking.

I conceive that the effectiveness of the device in this particular is contributed also by the arrangement and relationship of the conductors. It will be observed that their disposal is such that the static field, or lines of force or stress controlled by the condenser influence, are substantially at right-angles to the lines of force of the core flux and the magnetic field of the coils, in their common zone of influence. This probably has the effect of increasing the electrical density, the electrical elasticity, or both, of the medium in the common zone of the condenser and magnetic fields.

At any rate, the effectiveness of the arrangement is as above described, and in addition to eliminating the necessity for the employment of auxiliary apparatus for reducing the spark, secures a much better effect than could be had by the employment of any such arrangement now known in the art, due no doubt, to the reason that the spark producing causes are either entirely inhibited, or are effectively counteracted at their inception and source. It is obvious, moreover, that the arrangement greatly simplifies construction and reduces cost.

It is to be observed that the construction may be employed in a variety of modifications and in any of the great number of uses wherein it may be desired to employ a solenoid or a current interrupting device.

Having thus described my invention, what I claim is:

1. A solenoid comprising a pair of conductors separated in parallel relationship by a dielectric and coiled together in superimposed convolutions about an axis, means for supplying a current to said conductors, means electrically connecting said conductors in series whereby the flow of a normal energizing current is in the same direction in both about the axis of the coil, and means for interrupting the electrical connection between said conductors.

2. A solenoid comprising a pair of conductors separated in parallel relationship by a dielectric and coiled together in superimposed convolutions about an axis, means for supplying a current to said conductors, means electrically connecting said conductors in series whereby the flow of a normal energizing current is in the same direction in both about the axis of the coil, and means under control of the magnetic field of the coil for interrupting the electrical connection between said conductors.

3. A solenoid comprising a pair of conductors arranged for connection in series between the poles of a source of current supply, said conductors being associated in condenser relationship and coiled together about a core in such disposal that the lines of force of their static field are substantially perpendicular to the lines of force of the magnetic field of the device, the arrangement of the connections between the conductors being such that the direction of current flow about the axis is the same in both, and means for opening and closing the conductive connection between said conductors.

4. A solenoid comprising a pair of conductors arranged for connection in series between the poles of a source of current supply, said conductors being associated in condenser relationship and coiled together about a common axis, the arrangement of the connections between the conductors being such that the direction of current flow in both is in the same direction about said axis, and means for opening and closing the conductive connection between said conductors.

5. A solenoid comprising a pair of conductors separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

6. A solenoid comprising a pair of conductors separated by a dielectric and coiled together about a magnetizable core in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

7. A solenoid comprising a pair of conductors in the form of strips or ribbons separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

8. A solenoid comprising a pair of conductors of substantially equivalent extent separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

9. A solenoid comprising a pair of conductors in the form of strips or ribbons of substantially equivalent extent separated by a dielectric and coiled together about a magnetizable core in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

10. A solenoid comprising a pair of conductors in the form of strips or ribbons separated by a dielectric and coiled together about a magnetizable core in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

11. A solenoid comprising a pair of conductors of substantially equivalent extent separated by a dielectric and coiled together about a magnetizable core in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direc-

tion about the axis of the coil, and means for interrupting the flow of current from one to the other of said conductors.

12. A solenoid comprising a pair of conductors separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means operable by influence of the magnetic field of the coil for interrupting the flow of current from one to the other of said conductors.

13. A solenoid comprising a pair of conductors separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, a magnetizable core associated with the coil, and means operable by influence of the magnetic field of the core for interrupting the flow of current from one to the other of said conductors.

14. A solenoid comprising a pair of conductors in the form of strips or ribbons separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means operable by influence of the magnetic field of the coil for interrupting the flow of current from one to the other of said conductors.

15. A solenoid comprising a pair of conductors of substantially equivalent extent separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means operable by influence of the magnetic field of the coil for interrupting the flow of current from one to the other of said conductors.

16. A solenoid comprising a pair of conductors in the form of strips or ribbons of substantially equivalent extent separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, and means operable by influence of the magnetic field of the core for interrupting the flow of current from one to the other of said conductors.

17. A solenoid comprising a pair of conductors in the form of strips or ribbons separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, a magnetizable core associated with the coil, and means operable by influence of the magnetic field of the core for interrupting the flow of current from one to the other of said conductors.

18. A solenoid comprising a pair of conductors of substantially equivalent extent separated by a dielectric and coiled together about an axis in such relationship as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the coil, a magnetizable core associated with the coil, and means operable by influence of the magnetic field of the core for interrupting the flow of current from one to the other of said conductors.

19. A solenoid comprising a pair of conductors in the form of bands separated by a dielectric and coiled together about a magnetizable core in substantially parallel superposed relationship so as to function effectively as a condenser, means for supplying a current to said conductors, connections associated with said conductors whereby the flow of a normal energizing current is in the same direction about the axis of the core, and means operable by influence of the magnetic field of the coil for interrupting the flow of current in said conductors intermittently and at a point between said conductors.

WILLIAM J. O'LEARY.