C. T. HENDERSON.

ELECTRIC SWITCH.

APPLICATION FILED SEPT. 14, 1914.

1,269,563.

Patented June 11, 1918.

Fig. 1

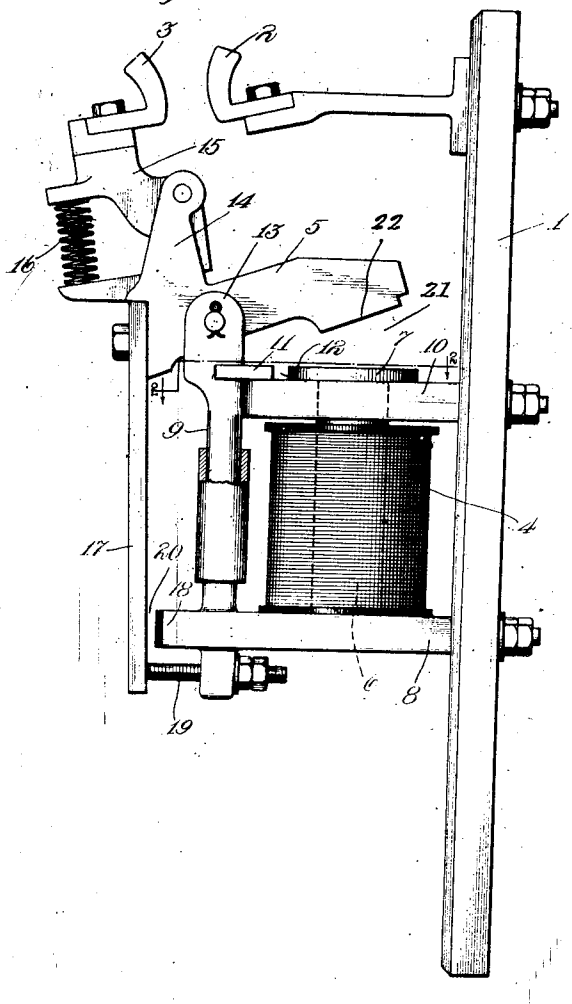


Fig. 2

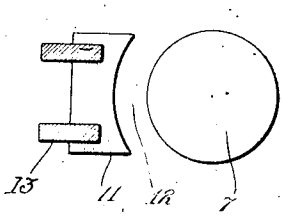
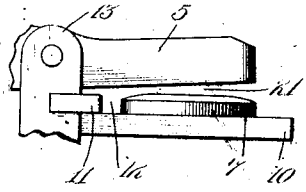


Fig. 3



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UNITED STATES PATENT OFFICE.

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ELECTRIC SWITCH.

1,269,563. Specification of Letters Patent. Patented June 11, 1918.

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To all whom it may concern:

Be it known that I, CLARK T. HENDERSON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Electric Switches, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

The invention relates to electromagnetic mechanisms, particularly electromagnetic switches.

Switches have heretofore been proposed called "series switches" which are constructed so that they remain open when the switch winding is energized above a certain value and closed when the energization decreases to a predetermined value. These switches have a single operating winding and are provided with a magnetic circuit having a portion of limited capacity. When the switch winding is highly energized the excess flux flows through a circuit in shunt to the circuit of limited capacity and acts on a means which prevents the switch from operating. When the energization decreases the flux through the shunt circuit decreases, the holding means becomes inactive and the switch is closed. The magnetic circuit of limited capacity is a necessary element in these switches and it gives rise to several limitations hereinafter pointed out.

Switches of the above mentioned type are often equipped with contacts which are closed against the pressure of a spring. It is desirable that the movement against the spring pressure be for a considerable distance in order to compensate for wear on the contacts. The force necessary to close the contacts against the spring pressure is larger than that necessary to start the movement thereof. For this and other reasons it follows that the force acting on the contacts should be at a maximum value as the contacts are moved to and held in closed position.

The restriction on the magnetic circuit in switches of the type described limits the maximum closing pull for any given size of switch. When the operating coil and the movable parts are made of proper size for a given current, the restricted portion of the magnetic circuit must be limited to a proper capacity to insure that the switch will operate when the current decreases to a predetermined value. The capacity of the circuit when so limited is such that it is substantially saturated by the actuating flux passing through it at the time the switch starts to operate. It therefore cannot accommodate an increase in lines of force and does not act as a return path for the increase in flux. The result is that as the armature moves to decrease its air gap, the additional flux which would normally tend to thread through the armature and exert an additional pull thereon does not do so for the reason that the saturated restricted magnetic circuit does not provide a return path from the armature. Since there is no substantial increase in the amount of flux passing through the armature as it decreases its air gap, the pull does not increase to the high maximum desirable during final closing movement. An increase in pull on a given size of contact obtained by increasing the size of the coil, the armature and the magnetic circuit above what would otherwise be necessary to secure operation on predetermined current is objectionable for several reasons, among which are that the switch is more expensive and an increased space for installation is necessary.

One of the objects of the present invention is to provide an electromagnetic mechanism with a means for causing an additional pull to be exerted on its armature after the armature has responded.

Another object is to provide an electromagnetic switch of the type above described with means for increasing the force acting to close the switch without increasing the force tending to initiate movement of the switch.

A further object of the invention is to provide a magnetic structure of the type above described with a means whereby all the flux saturating the restricted magnetic circuit does not exert a starting pull on the armature but does exert a closing pull thereon.

Various other objects of my invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of my invention, and in said drawings:

Figure 1 is a side elevation of a switch embodying my invention.

Fig. 2 is a sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a modification of Fig. 1, showing a pole having a rounded head coöperating with a straight armature.

The switch has a stationary contact 2, a coöperating movable contact 3, a switch frame acting as a magnetic circuit, an operating winding 4 and a pivoted armature 5 carrying the movable contact 3.

The switch frame forms part of the magnetic circuit for the coil 4. This frame has a bottom 8 and a side 9, both of magnetic material. The side 9 is of limited magnetic cross section for a purpose hereinafter described. A top 10 of brass or other non-magnetic material strengthens the frame without affecting the magnetic circuit of the switch. A projection 11 extends from the top of side member 9 toward the head 7 of a magnetic core 6 inside of coil 4. This projection coöperates magnetically with the core 7 to form a path for flux from core head 7 to side 9. In the present structure, an air gap 12 is shown between said parts. A magnetic circuit is completed in the above described structure from the core head 7 across gap 12 to projection 11, through side 9 to bottom 8 and core 6.

A second magnetic circuit for the flux from coil 4 is provided by the movable armature structure. Pivoted to a magnetic extension 13 of the frame is an armature 5 carrying an extension 17 in the form of a bar of magnetic material. This bar acts as an armature for pole piece 18. The armatures 5 and 17 form in effect a single armature structure. The movable armature structure is so balanced that the bar 17 normally rests against the brass screw 19 in the position shown. The screw 19 constitutes an adjusting means for regulating the length of the air gap 20 between bar 17 and pole piece 18. The magnetic circuit may be traced from armature 5 through bar 17, across gap 20 to pole piece 18, bottom member 8 and core 6.

When the coil 4 is energized, the flux produced thereby passes from the head 7 of core 6 across gap 12 to projection 11, member 9 and bottom 8 to core 6. Another path for the flux is across the gap 21 to armature 5 and back through members 9 and 8 to core 6.

When the coil is energized with a high current, the side member 9 becomes saturated and the excess flux follows a path from the armature 5 through the bar 17, across gap 20 to pole piece 18, bottom 8 and core 6. Two opposing pulls are exerted on the movable structure under these conditions, one at the gap 21 tending to operate the switch, and the other at gap 20 acting to hold the switch open. The pull at gap 20 on bar 17 is more effective than the pull at gap 21 on armature 5 when the current in the coil is high. As the current is reduced, the pull at gap 20 is weakened for the reason that the greater proportion of the flux is carried by member 9. When the current decreases to a predetermined value, the pull at gap 21 overcomes that at gap 20 and the switch is moved toward closed position. The gaps 12 and 21 should be properly proportioned to insure that at the time the part 9 is carrying the greater proportion of the flux, a sufficient quantity of the flux is bridging gap 21 to operate armature 5.

The movement of armature 5 toward core 7 rapidly decreases the reluctance of gap 21 until it becomes less than that of gap 12 whereupon the flux from corehead 7 which has previously been crossing gap 12, passes into armature 5 to the return circuit 9—8. Accordingly the magnetic circuit including gap 12 is short circuited by armature 5. The increase in flux through armature 5 causes an increase in pull on the same which becomes maximum as the armature seals with its core. A maximum pull is consequently obtained to positively close the switch and hold the contacts in engaged position.

The restricted magnetic circuit 9 in the present structure is enlarged in a given size of switch above what would ordinarily be an operative capacity. It easily accommodates the increase in flux through armature 5 since the change relative to it is one of substantially the same amount of flux entering it by one path instead of two. The operation of the switch on decrease in current is retained by means of the circuit including extension 11, gap 12 and corehead 7. Approximately the same starting flux passes across gap 21, the additional flux being taken care of by the extension 11 and coming into active use only during closing movement of the armature when it is most needed.

The sealing pull is further increased by providing the armature 5 with a head 22 such as shown in Fig. 1 which is of smaller area than the head 7 of core 6. When the armature is in retracted position the flux from the corehead 7 passes across the air gap 21 to the armature 5, entering said armature adjacent the head thereon, as well as through said head 22, the size of the air gap 21 being such that the effect of the armature head on the length of the gap is relatively small. As the armature approaches the corehead 7, however, the effect of the armature head increases since the air gap between the corehead and the armature head becomes smaller and the gap between the corehead and the other parts of the armature become relatively larger. The result

is that as the armature approaches the core the flux concentrates in the armature head and exerts a higher sealing pull than would be obtained if the flux were distributed over a larger area. This higher sealing pull is obtained without seriously interfering with the initial pull on the armature and is thus obtained without disturbing the operation of the switch previously described.

The same effect is secured by using a straight armature and rounding off the corehead in the manner shown in Fig. 3. The flux passes from the whole corehead surface to armature when said armature is in open position but is concentrated into the contacting surface as the armature closes. Various other shapes of armature and coreheads might be used if desired.

The type of contact carried by armature 5 may be varied to suit different conditions. As shown, it is pivoted to the armature by means of a bracket 15. A spring 16 acts to normally bias the bracket 15 forward so that the contact 3 engages contact 2 before armature 5 seals with its core. Contact 3 is thereby given sufficient movement after engagement to produce a wiping action.

The coil winding may be connected in series with the switch contacts or it may be otherwise suitably connected to an electric circuit.

It will thus be seen that I have provided a means which avoids the limitation ordinarily encountered in switches having restricted magnetic circuits. This means allows the restricted magnetic circuit to be enlarged in a given size of switch to thereby obtain increased closing pull without materially changing the predetermined current operating characteristics of the switch.

While I have shown and described a preferred embodiment of my invention, it is obvious that many changes may be made in the details of construction and arrangement of parts without departing from the spirit and scope of the appended claims.

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

1. An electromagnetic mechanism having a movable member, and operating winding therefor, a magnetic circuit of limited capacity, means controlled by excess flux from said limited capacity circuit for preventing movement of the movable member when the winding is energized above a predetermined value, and means for shunting a portion of the flux through said circuit of limited capacity away from the armature so that it will be inactive to exert a starting pull on the movable member until movement of said member has been initiated.

2. An electromagnetic mechanism having a movable member, an operating winding therefor, a magnetic circuit of limited capacity for the flux tending to move said member, means controlled by excess flux from said limited capacity circuit for preventing movement of the member when the winding is energized above a predetermined value, and means for diverting a portion of the flux through the limited capacity circuit from said movable member to cause it to be inactive to exert a starting pull on the member, said means being arranged so that it is short circuited by the movable member after the latter starts to move whereby an increased pull is exerted on said member after it starts to move.

3. An electromagnet having an energizing winding provided with a core, an armature adapted to be attracted by said core, means including a magnetic circuit of limited capacity for preventing movement of the armature when the winding is energized above a predetermined value, and a magnetic circuit from said core to said circuit of limited capacity comprising a member in shunt to said armature and extending from the circuit of limited capacity nearly to the core, said member being arranged so that it is short-circuited by the armature as the armature moves toward the core whereby an increased pull is exerted on the armature as it approaches the core.

4. An electromagnet having an operating winding provided with a core, an armature adapted to be attracted by said core, a magnetic return circuit of limited capacity from the armature to the core, a second armature connected to the first and arranged to be acted upon by excess flux from the limited capacity circuit to exert a pull in opposition to that of the first armature, and a projection on the limited capacity circuit extending nearly to the core and coöperating across an air gap with the core to provide a magnetic path in parallel to the first armature which is short-circuited by the armature as it moves toward the core whereby an additional pull is exerted thereon as the armature seals with the core.

5. An electromagnetic mechanism having a movable member, an operating winding therefor, a magnetic circuit some of the flux in which tends to move said member, and means for diverting a portion of the flux in said circuit from said movable member to cause it to be inactive to exert a starting pull on the member, said means being arranged so that it is short-circuited by the movable member after the latter starts to move whereby an increased pull is exerted on said member after it starts to move.

6. An electromagnetic mechanism having a movable member, an operating winding therefor, a magnetic circuit some of the flux in which tends to move said member, said circuit comprising the core of the winding and a member made of magnetic material

and arranged substantially parallel with said core, and means for shunting a portion of the flux from said member to the core, said means comprising a element bridging all but a small portion of the distance between said member and the core and arranged to be short-circuited by said movable member after the latter starts to move.

7. An electromagnetic mechanism having a movable member, an operating winding therefor, a magnetic circuit of limited capacity, means controlled by excess flux from said limited capacity circuit for preventing movement of the movable member when the winding is energized above a predetermined value, and means for increasing the pull on said member after movement thereof has been initiated, said limited capacity circuit being made of less limited capacity than required when said last named means is not employed.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

CLARK T. HENDERSON.

Witnesses:
L. C. SCHANTZ,
C. A. WATSON.