Nov. 7, 1950 W. C. JACKSON ET AL 2,528,520

SOLENOID OPERATED SWITCH

Filed May 17, 1947

Fig. 1.

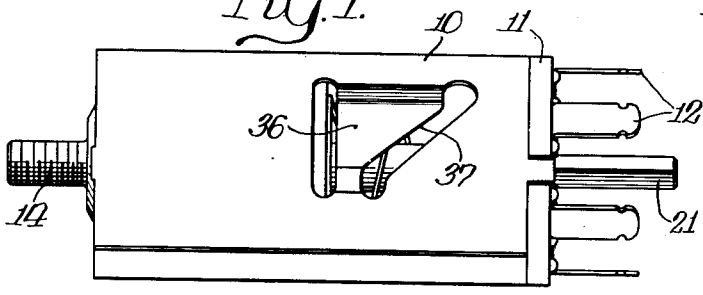


Fig. 2.

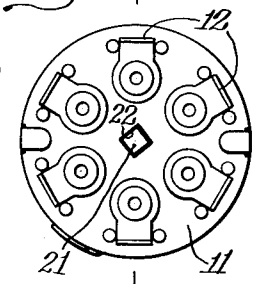


Fig. 3.

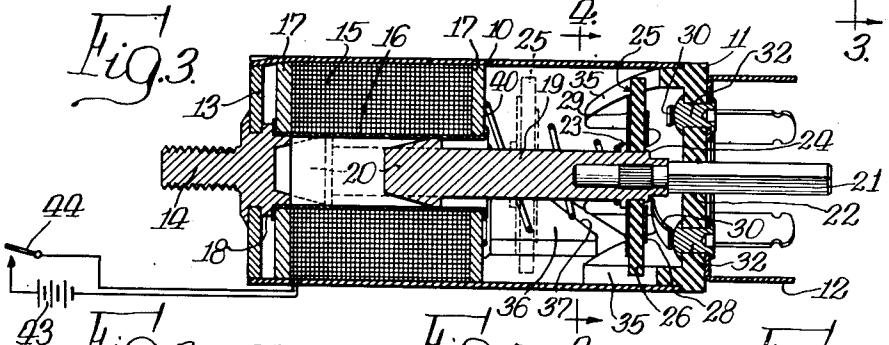


Fig. 4.

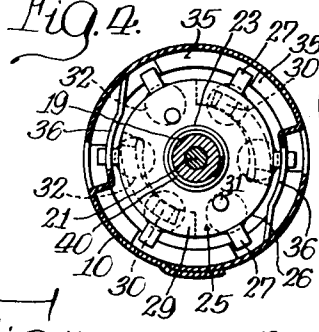


Fig. 5.

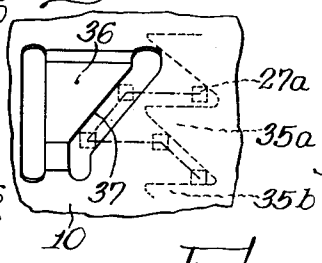


Fig. 6.

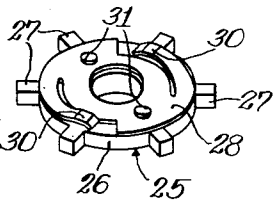


Fig. 7.

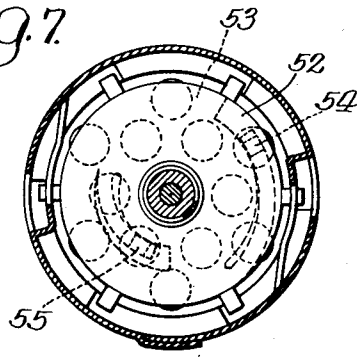
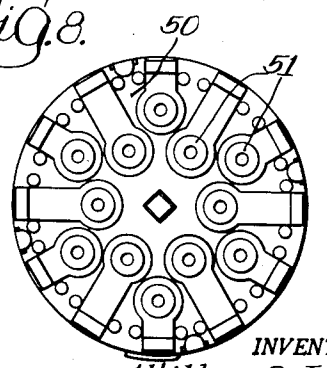


Fig. 8.



INVENTORS.
Wilbur C. Jackson,
BY Louis T. Clemens,
Isaman L. Mueller
Atty.

Patented Nov. 7, 1950 2,528,520

UNITED STATES PATENT OFFICE

2,528,520

SOLENOID OPERATED SWITCH

Wilbur C. Jackson, Oak Park, and Louis T. Clemens, Chicago, Ill., assignors to Motorola, Inc., a corporation of Illinois

Application May 17, 1947, Serial No. 748,730

5 Claims. (Cl. 200—87)

1

This invention relates generally to switches and more particularly to remotely controlled solenoid operated step-by-step switches.

In the prior art the use of remotely operated switches in various types of control systems are well known. Very small remotely controlled switches of this type have generally been unsatisfactory for one or more of the following reasons; a comparatively large amount of power is required for operating the switch, the switch tends to be noisy in operation, the movable contact may become jammed and not make good connection upon operation, and vibration of the switch causes the movable contact to creep off the fixed contacts. Further, in various types of control circuits a remotely controlled switch is required which can be used to selectively provide a plurality of different contact closing positions. Switches of this type have been generally complicated and expensive and have been objectionably large for use in many applications.

It is, therefore, an object of this invention to provide a small remotely controlled switch which is dependable in operation.

It is a further object of this invention to provide an improved electrically operated switch arranged for step-by-step movement to provide a plurality of different connecting positions.

A feature of this invention is the provision of a switch having a solenoid operated plunger carrying a contact member which is rotated in response to reciprocal movement of the plunger to change the position of the contact member.

A further feature of this invention is the provision of a reciprocally and rotatably movable contact member having radially extending projections and a terminal support member including teeth which engage the projections to cause rotation of the contact member in response to reciprocation thereof and which prevent rotation of said contact member when the contact member is at rest.

A still further feature of this invention is the provision of a solenoid operated switch including a contact member movable in one direction by the solenoid and in the opposite direction by a spring, the spring being further adapted to hold the movable contact in firm engagement with fixed contacts and to make electrical contact thereto.

Further objects, features and advantages will be apparent from a consideration of the following description taken in connection with the accompanying drawings in which:

Fig. 1 is an elevation view of the switch in accordance with the invention;

2

Fig. 2 is an end view showing the exposed end of the terminal member;

Fig. 3 is a cross-sectional view along the lines 3—3 of Fig. 2;

Fig. 4 is a cross-sectional view along the lines 4—4 of Fig. 3;

Fig. 5 is a diagrammatic view illustrating the movement of the contact member of the switch;

Fig. 6 is a perspective view of the contact member;

Fig. 7 illustrates a modified switch in accordance with the invention; and

Fig. 8 shows the terminal member of the modified switch.

In practicing our invention we provide a solenoid operated switch including a tubular housing having a coil at one end thereof and a magnetic core adapted to be drawn within the coil when the coil is energized. The magnetic core is a part of a reciprocating plunger structure which includes a contact member rotatably supported thereon. The contact member is of generally annular configuration having radial projections on the periphery thereof. A terminal member is provided in the end of the housing opposite to the coil and includes a plurality of projecting teeth adapted to engage the projections on the contact member. The terminal member also includes a plurality of fixed contacts and the contact member includes a conducting portion which is adapted to engage the fixed contacts. A spring is provided to normally hold the plunger in a position in which the core is substantially withdrawn from the coil and the conducting portion is in engagement with the fixed contacts. The switch housing includes inwardly extending portions having slanting edges which engage the projections of the contact member when the plunger is moved by movement of the core into the solenoid to rotate the contact member. When the solenoid is deenergized the spring moves the plunger to the normal position and the teeth of the terminal support member engage the projections on the contact member to further rotate the contact. Therefore, it is seen that reciprocal movement of the plunger causes rotation of the contact member which results in the engagement of different fixed contacts by the conducting member.

Referring now to the drawings, in Figs. 1 to 6, inclusive, there is illustrated a switch including a housing 10 and a terminal support member 11 having a plurality of terminals 12 thereon. The terminal support member 11 forms a closure for one end of the tubular housing 10, the other end of which is closed by an annular member 13 hav-

ing a mounting stud 14 secured therein. The solenoid driving unit comprises a coil 15 wound on a coil form including a tubular spool 16 and annular end members 17 which are supported within the housing 10. The mounting stud 14 includes a shoulder 18 against which one end of the spool 16 rests to position the coil within the housing. A reciprocal plunger unit is provided including an iron core 19 having an end 20 of such configuration to provide a sliding fit within the spool 16. The end 20 supports one end of the plunger, the other end being supported by a pin 21 which is secured to the core and is slidably positioned in an opening 22 in the terminal support member 11. The pin 21 and the opening 22 are of the same irregular configuration so that the pin cannot rotate in the opening, a square pin and opening being illustrated in the drawings.

The movable plunger further includes a contact member 25 which is rotatably supported on the iron core 19. An annular rim 23 and a spun-over edge 24 on the core 19 engage the sides of the contact member 25 to cause the member to move longitudinally with the core but permitting rotation of the member with respect thereto. The detailed construction of the contact member 25 is apparent from Figs. 3, 4 and 6 in which the contact member is illustrated as including an annular disc 26 having projections 27 radially spaced about the periphery thereof. Conducting members 28 and 29 are provided on either side of the insulating member, the conducting member 28 including bent up contact engaging portions 30 on opposite sides thereof. The conducting members are secured to the insulating member 26 by a pair of rivets 31 which secure the contact member together as an assembly and also electrically connect the two conducting members. As shown in Fig. 3, the contact engaging portions 30 engage contacts 32 in the terminal support member 11, the contacts 32 being secured to the terminals 12 in any suitable manner.

As is apparent from Figs. 3 and 5, the terminal support member 11 includes a plurality of projecting teeth 35 which extend along the inner wall of the housing 10. The number of teeth 35 on the terminal member is equal to the number of projections 27 on the contact member, the projections being arranged to engage the teeth 35 when the contact member is moved to rotate the contact member as will be explained. The housing 10 includes inwardly extending offset portions 36 having slanting edges 37 which are positioned in the path of the contact member 25 and engage the projections 27 thereof to cause rotation of the contact member 25.

A spring 40 is provided for holding the plunger in the position in which the contact engaging portions 30 engage the fixed contacts 32. The ends of the spring are positioned against one of the coil forms 17 and the annular rim 23 of the core 19 as clearly shown in Fig. 3. The spring holds the projections 27 of the movable contact member 25 in the V-shaped grooves between the teeth 35 so that the contact member 25 cannot be rotated. The spring also functions to return the plunger after it has been moved by the solenoid as will be explained.

Considering now the operation of the switch of Figs. 1 to 6, it is pointed out that the movable contact member 25 includes six projections 27 on the periphery thereof, and the terminal support member 11 likewise includes six teeth

35 and six fixed contacts 32. Movement of the plunger is caused by energization of the coil 15 which draws the core 19 therein as shown by the dotted lines in Fig. 3. A circuit including a source of energy 43 and a remote switch 44 is illustrated for energizing the coil 15. This, of course, causes the contact member 25 to be drawn toward the coil to the position shown in dotted lines. As previously stated, the offset portions 36 of the housing are in the path of the projections 27 on the contact member and as the contact member 25 is drawn toward the coil 15, the projections 27 will engage the slanting edges 37 of the offset portions causing rotation of the contact member. This operation is clearly shown in Fig. 5 wherein the motion of one projection 27 designated as 27*a* is shown by dot-dash lines. Movement of the projection 27*a* to the left will cause the projection to engage the slanting edge 37 and follow this edge until movement of the projection to the left is stopped. When the coil 15 is deenergized and the spring 40 moves the plunger to the right, the projection 27*a* will engage the tooth 35 indicated as 35*a* and follow the slanting edge of the tooth to the V-shaped groove between the tooth 35*a* and the next tooth marked 35*b*. Therefore, it is seen that the reciprocal movement of the contact member causes each projection 27 to be rotated from a position between a pair of teeth to the next succeeding position and so on.

In a switch having six projections and six teeth as illustrated, each movement causes rotation of the contact member through 1/6 of a complete revolution or through 60 degrees. It is apparent from Figs. 4 and 6 that this will cause the conducting member 28 to be moved from a position in which it bridges a pair of oppositely positioned fixed contacts 32 to a position in which it bridges the next pair of oppositely positioned contacts. Therefore, successive step-by-step operation of the switch provides three different contact closing positions provided by each of the three pairs of oppositely positioned fixed contacts in the terminal support member 11. It is obvious, however, that instead of providing six contacts (three pairs) and six projections 27 on the contact member and six projecting teeth 35, any other number can be used depending upon the particular requirements.

The switch may be used in various manners as will now be explained. In the structure shown, the conducting member 28 in addition to bridging a pair of contacts 32 connects the contacts to the housing 10. This connection is made from the conducting member 28 through rivets 31 to the conducting plate 29. The conducting plate 29 firmly engages the annular rim 23 on the core and the circuit continues through this rim to spring 40 which engages the coil end plate 17. As the end plate 17 is made of ferrous metal, it is conducting and the circuit is completed therethrough to the housing 10. Therefore, by grounding the mounting stud 14 or connecting it to any circuit, the contacts 32 engaged by member 28 are connected to this circuit. If it is desired to use the switch only to bridge contacts and not connect them to another circuit, the conducting plate 29 may be eliminated and the bridged contacts will then be insulated from the housing and operating structure of the switch.

Figs. 7 and 8 illustrate a modified terminal member and contact member which have utility in other circuits. The terminal member 50 has contacts 51 thereon arranged in two concentric

rows, and the movable contact member 52 includes a conducting member 53 in which the contact engaging portions 54 and 55 are positioned so that the portion 54 will selectively engage the outer row of contacts and the portion 55 will engage the inner row. It is obvious, therefore, that in any position of the contact member 52 one of the contacts in the outer row will be connected to a contact in the inner row. By providing six contacts in each row, a total of six different circuit bridging positions is obtained instead of three positions as in the modification previously described. As explained with respect to the structures of Figs. 1 to 6, the fixed contacts instead of merely being bridged together can be grounded or connected to any other circuit by making connections through the plunger return spring to the housing and the mounting stud.

Switches constructed in accordance with the invention have been found to be very dependable in operation and to be generally very satisfactory in use. The original rotational movement of the contact member 25 by the offset portions 36 on the housing is smoothly accomplished without jamming of the contact due principally to the fact that two offset portions are provided. This causes rotational movement of two oppositely positioned projections as is clearly shown in Fig. 4 providing a balanced torque which tends to eliminate jamming of the contact member when it is moved by the effect of the coil 15 on the core 19. When the contact member 25 moves in the direction toward the fixed contacts under the force of spring 40, a very smooth turning movement is provided which prevents jamming of the contact member and results in a firm connection between the contact engaging portions 30 and the fixed contacts 32. This movement of the plunger by the spring 40 results in each of the projections 27 resting on the slanting surface of one of the teeth 35 eliminating any tendency for the contact member 35 to tilt or jam. The projections follow the slanting surfaces of the teeth to the grooves between the teeth where they rest until the switch is again operated.

The operation of the switch in accordance with the invention is accomplished with the use of a relatively small amount of electrical energy due to the efficient magnetic circuit provided. Referring to Fig. 3, this circuit extends through the right end member 17, housing 10, left end member 17 and the movable core 20. The end plate 13 may also be of magnetic material further reducing the reluctance of the magnetic circuit. The switch has been found to be very dependable, movement of the plunger being fast and relatively quiet. The structure disclosed is simple and can be very inexpensively manufactured. Each of the components can be either punched or molded and as the configuration of the components is not unduly critical, high speed production line methods can be used in manufacture. The switch is adaptable to construction as a very small unit and is rugged and not subject to defective operation due to vibration thereby making it particularly applicable for use in vehicular installations or in other conditions where vibration is present.

Although we have disclosed certain embodiments of our invention, it is apparent that various modifications and changes can be made therein without departing from the intended scope of the invention as defined by the appended claims.

We claim:

1. A solenoid operated switch comprising a tubular housing, a coil positioned within said housing at one end thereof, a movable plunger including a magnetic core adapted to be drawn into said coil, a contact member rotatably mounted on said plunger and having a plurality of radial projections thereon, said housing having an offset portion with an inwardly extending slanting edge adapted to engage said projections when said core is drawn into said coil to rotate said contact member, a spring tending to hold said plunger away from said coil, and a terminal support member at the end of said housing opposite to said coil and including a plurality of contacts and a plurality of teeth positioned to engage said projections to cause further rotation of said contact member when said plunger is moved away from said coil by said spring.

2. A step-by-step switch comprising a housing, a plunger mounted for reciprocal movement within said housing, a contact member rotatably mounted on said plunger and having a plurality of radial projections thereon, said housing having offset portions including inwardly extending slanting edges adapted to engage said projections when said plunger is moved in one direction to rotate said contact member, a spring tending to move said plunger in the opposite direction, and a terminal support member at one end of said housing including a plurality of teeth thereon adapted to engage said projections to cause further rotation of said contact member when said plunger is moved in said opposite direction by said spring.

3. A step-by-step switch comprising a housing, a plunger mounted for reciprocal movement within said housing, a contact member rotatably mounted on said plunger and having a plurality of radial projections thereon and a conducting member secured thereto, said housing having offset portions including inwardly extending slanting edges, a terminal support member at one end of said housing including a number of teeth equal to the number of said projections and a plurality of fixed contacts adapted to be selectively engaged by said conducting member, a spring for holding said plunger in a position in which said conducting member engages certain of said fixed contacts, and means for moving said plunger away from said one position, said means being arranged to move said conducting member away from said fixed contacts and cause said projections to engage said slanting edges to rotate said contact members, movement of said plunger to said one position by said spring upon release of said means being effective to cause said projections to engage said teeth to further rotate said contact member so that said conducting member engages different fixed contacts, said spring being effective to hold said conducting member firmly against said fixed contacts and to make electrical contact between said conducting member and said housing.

4. A step-by-step switch comprising a housing, a plunger mounted for reciprocal movement within said housing and including a rotatable contact member having a plurality of radial projections thereon and a conducting member secured thereto, said housing having a pair of offset portions on opposite sides thereof including inwardly extending slanting edges, a terminal support member at one end of said housing including a number of teeth equal to the number of said projections and a plurality of fixed contacts adapted to be selectively engaged by said conducting member, said teeth being symmetrically positioned and having slanting edges, a spring for holding said plunger in a position in which

said conducting member engages certain of said fixed contacts, and means for moving said plunger away from said one position, said means being arranged to move said conducting member away from said fixed contacts and cause a pair of oppositely positioned projections to engage said slanting edges to rotate said contact members, movement of said plunger to said one position by said spring upon release of said means being effective to cause said projections to individually engage the slanting edges of said teeth to further rotate said contact member so that said conducting member engages different fixed contacts.

5. A solenoid operated switch comprising a tubular housing, a coil within said housing and positioned at one end thereof, a movable plunger including a magnetic core adapted to be positioned within said coil and a contact member rotatably mounted on said core, a spring tending to hold said plunger away from said coil, an insulating terminal member at the opposite end of said housing including a number of radially spaced teeth and an equal number of radially spaced contacts thereon, said movable contact member including a conducting member adapted to bridge a pair of said contacts and an insulating disc having radial projections thereon equal in number to said spaced teeth, said housing having a pair of offset portions on either side thereof including inwardly extending slanting edges, said projections being adapted to engage said slanting edges of said offset portions when said core is drawn into said coil to rotate said contact member in a given direction, said projections being adapted to engage said teeth when said plunger is moved away from said coil by said spring to further rotate said contact member in said given direction so that said conducting member is moved from a position bridging one pair of contacts to a position bridging a different pair of contacts, said spring tending to hold said conducting member against said contacts.

WILBUR C. JACKSON.
LOUIS T. CLEMENS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
701,627	Schreier et al.	June 3, 1902
820,119	Kitt	May 8, 1906
1,285,072	Douglas	Nov. 19, 1918
1,315,204	Bramming	Sept. 9, 1919
1,934,320	Nowosielski	Nov. 7, 1933

FOREIGN PATENTS

Number	Country	Date
8,025	Great Britain	1909
180,172	Switzerland	Dec. 16, 1935