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ELECTRICALLY OPERATED FUEL PUMP

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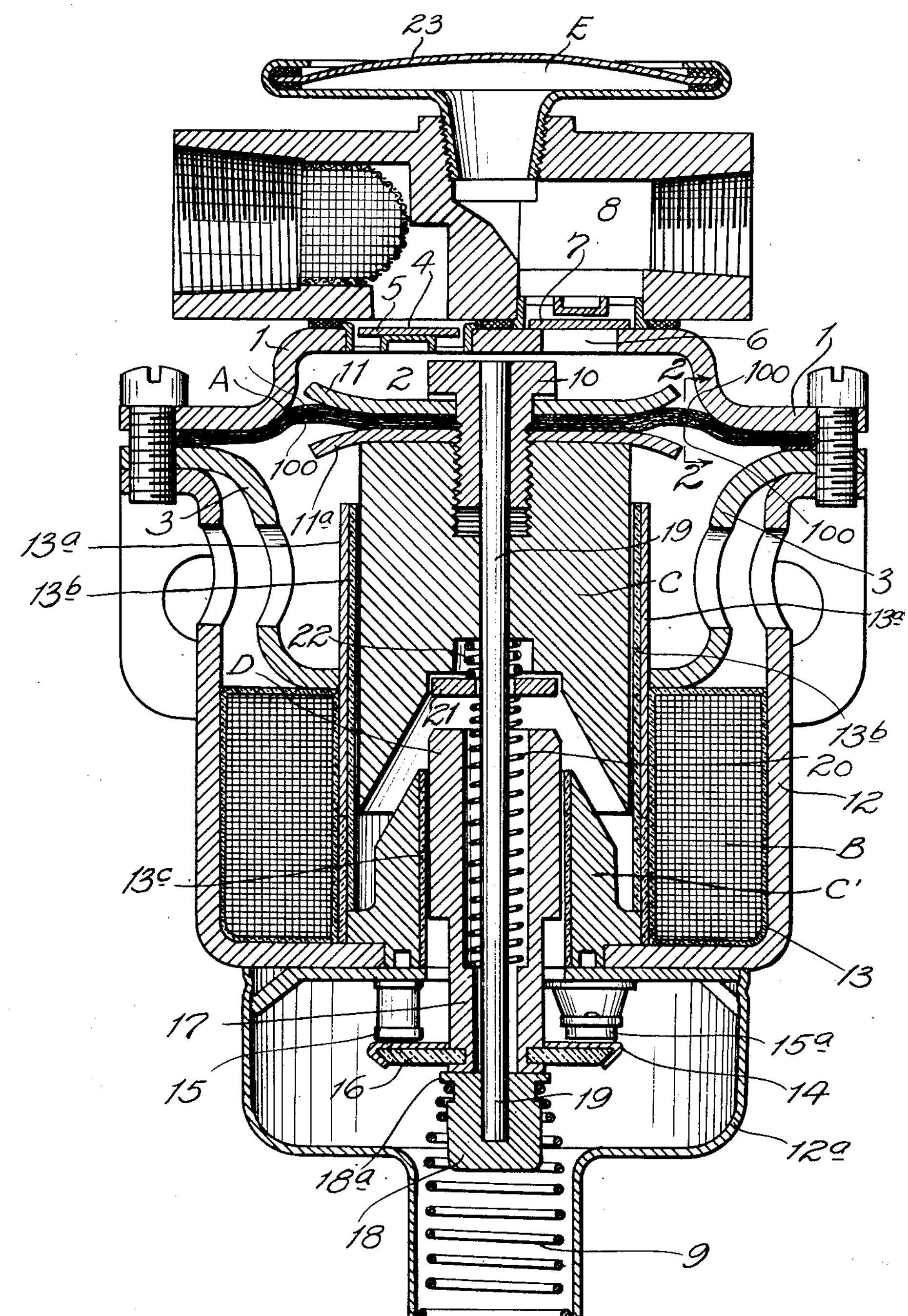

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ELECTRICALLY-OPERATED FUEL PUMP.

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This invention relates to electrically-operated fuel pumps, such as are used for pumping liquid fuel from a lower to a higher level, and particularly, fuel pumps of the type in which the pumping element consists of a diaphragm actuated by an electrically-operated mechanism which is controlled by an automatic, intermittent switch.

One object of my present invention is to provide an electrically-operated pump of the general type referred to, in which the means that is used to close the contacts of the intermittent switch is of such design and construction that if the co-operating parts of said means are disassembled, they can be reassembled easily without the necessity of accurately adjusting any of said parts to insure proper operation of the switch when the pump is thereafter put into service.

Other objects and desirable features of my invention will be hereinafter pointed out.

The figure of the drawing is a vertical sectional view of an electrically-operated fuel pump embodying my present invention.

Referring to the drawing which illustrate the preferred form of my invention, A designates the diaphragm of the pump. Said diaphragm is arranged in opposed relation to a rigid, cup-shaped member 1 so as to form a pumping chamber 2, and the peripheral edge portion of said diaphragm is combined with the member 1 and an opposed clamping member 3 in such a way that the diaphragm will be taut, but capable of moving towards and away from the wall 1 of the pumping chamber so as to draw liquid fuel into said pumping chamber from a source of supply, and thereafter force said fuel out of said pumping chamber to an internal combustion engine or to a carburetor associated with such an engine. The pumping chamber 2 is provided with an inlet 4 that is governed by an automatic inlet valve 5 which opens and permits liquid fuel to pass from a source of supply into the chamber 2 during the suction stroke or downward stroke of the diaphragm A, and said pumping chamber is provided with an outlet 6 controlled by an automatic discharge valve 7 that opens and permits fuel to escape from the chamber 2 when the diaphragm flexes in the opposite direction. In the pump herein illustrated the fuel, after escaping from the pumping chamber 2, enters a passageway 8 to which is connected a fuel supply pipe, which, in most instances, will lead to a carburetor (not shown) that is arranged at a lower level than the passageway 8. The pump can either be arranged in a position wherein the diaphragm A is disposed horizontally, as shown herein, or it can be arranged in a position wherein the diaphragm is disposed vertically.

The diaphragm A is flexed in one direction, namely, upwardly when the pump is arranged as illustrated in the Figure 1 of the drawing, by means of a spring 9 which acts on a part that is connected with said diaphragm, and said diaphragm is flexed in the opposite direction against the force of said spring by a solenoid which comprises a coil B and a core composed of a movable core piece C and a stationary core piece C′, the movable core piece C being connected with the diaphragm A in any suitable manner, as, for example, by means of a bolt or screw 10 screwed into the core piece C and arranged with its head in engagement with a clamping plate 11 that clamps the central portion of the diaphragm against a co-operating clamping plate 11^a which bears against the upper end of the core piece C. The coil B of the solenoid is arranged inside of a housing of magnetic material formed by the member 3 previously referred to and by a substantially cup-shaped member 12 that is combined with the member 3, as illustrated in the drawing. The spool on which the coil B of the solenoid is wound preferably comprises a tubular portion 13 of non-magnetic material and a tubular portion 13^a of magnetic material that is connected to the housing member 3 and which is of sufficient area to insure the flux passing freely from the flux field to the core when the solenoid circuit is closed, making it possible to operate the pump with a relatively small amount of electric current. Both members C and C′ of the core are formed of magnetic material and the stationary member C′ has a cone-shaped portion that telescopes in a tapered socket in the inner end portion of the movable member C of the core. A switch operating member D, which is also formed of magnetic material, is reciprocatingly mounted in the stationary member C′ of the core at the center of said member, said switch operating member being used for separating the contacts of the intermittent switch that controls the solenoid circuit and being of the same general character and arrangement as the hammer described in my pending application for Patent Serial No. 728,051, filed July 24, 1924. In order to properly guide the movable core member C and hold it in concentric relation with the stationary core member C′, and in order to hold the switch operating member D properly centered with relation to the stationary core member C′, I arrange a guiding device 13^b of non-absorbent material, such as bakelite, inside of the spool of the solenoid, and I arrange a guiding device 13^c of similar material inside of the stationary core member C′, the advantage of providing the solenoid with such guiding devices being that it insures free movement of the members C and D, even though the solenoid becomes submerged in water, due to the fact that bakelite is a non-absorbent substance that is capable of use as a bearing for steel or the like without lubrication.

The electric circuit that is used to energize the solenoid of the pump is provided with two switches, one a manually-operable switch (not shown) that is closed when the pump is in use, and the other an automatically-operating, intermittent switch that opens and closes the solenoid circuit intermittently so as to cause the movable core piece C to reciprocate, and thus actuate the diaphragm or pumping element A. Said intermittent switch may be of any preferred construction, but I prefer to equip the pump with a switch whose movable contact consists of a revolubly mounted member of disk or annular form, arranged so that it will move into and out of engagement with two stationary contacts, one of which is electrically connected with the coil of the solenoid and the other being grounded, as described in my pending application Serial No. 33,727, for electrically-operated fuel pump, filed May 29, 1925. Said intermittent switch is arranged inside of a removable cap piece 12^a on the end wall of the housing of the solenoid and comprises a revoluble member 14 of disk or annular form that constitutes the movable contact of the switch, and two stationary contacts 15 and 15^a arranged in spaced relation above the movable contact 14, one of said stationary contacts being electrically connected to the coil B of the solenoid and the other stationary contact being grounded. The movable contact 14 is carried by an insulator 16 that is rotatably mounted on a tubular extension 17 of the switch operating member D. Said insulator is moved downwardly or away from the stationary contacts 15 and 15^a by the movement of the member D in one direction, as hereinafter described, and said insulator is moved upwardly or towards said stationary contacts by means of a stop or abutment 18 on a rod 19 that is rigidly connected at its upper end to the bolt or screw 10, previously described, which is used to connect the core piece C with the diaphragm.

The switch operating member D causes the solenoid circuit to be opened with a quick break at the end of the suction stroke of the diaphragm A. In the form of my invention herein illustrated said member D is so constructed and arranged that when the solenoid circuit is closed the magnetic force of the solenoid is exerted on said member in a direction to hold the movable contact 14 pressed tightly against the stationary contacts 15 and 15^a while the core member C is moving downwardly to impart a suction stroke to the diaphragm. Just before the core member C reaches the end of its downward stroke the magnetic force which previously had been exerted on the member D in a direction to hold the contacts closed is removed, and thereafter a spring acts to impart a quick stroke to said member D and cause the movable contact 14 to be separated from the stationary contacts with a quick break. As shown in the Figure 1, the switch operating member D is provided with a center socket that houses a spring 20 which surrounds the rod 19, previously referred to. A washer 21 is mounted on said rod between one end of the spring 20 and a spring 22 that is stronger than the spring 20, and which is seated in a recess in the core member C, the spring 20 being confined between the washer 21 and the inner end of the socket in the switch operating member D that receives said spring.

When the manually-operable switch in the solenoid circuit is open, the movable member C of the core is held spaced away from the stationary core member C′ by the expansive force of the spring 9 which is exerted on the stop 18 on the rod 19, which, as previously stated, is rigidly connected with the core member C, said spring 9 being confined between a flange 18^a on the stop 18 and the end wall 12^b of a spring housing on the cap 12^a. At such times, namely, when the manually-operable switch is open, the expansive force of the spring 9 is also utilized to hold the movable contact 14 of the intermittent switch in engagement with the stationary contacts 15 and 15^a, this being effected by arranging the stop 18 on the rod 19 so that it bears directly against the end of the switch operating member D. When the manually-operable switch of the solenoid circuit is moved into its closed position, the movable member C of the core moves downwardly towards the stationary core member C′ and the switch operating member D which is free to reciprocate relatively to the stationary core member C′

assumes the position shown in the Figure 1 of the drawing, due to the magnetic attraction of the solenoid. The downward movement of the core member C imparts a suction stroke to the diaphragm A and also builds up energy in the spring 20 and in the stiff spring 22 that is arranged above the washer 21, it being understood that the member D is held at rest during the downward stroke of the core member C by the magnetic attraction of the solenoid and that this magnetic attraction is exerted on the member D in a direction to hold the movable contact of the intermittent switch pressed tightly against the stationary contacts. At the time the core member C starts to move downwardly the space between the tapered surface on the core member C and the inclined surface on the inner end of the switch operating member D is less than the space between the tapered surface on the core member C and the tapered surface on the core member C′. The downward movement of the core member C reduces the width of said spaces, and when the core member C reaches such a position that the washer 21 bears against the inner end of the switch operating member D, part of the flux path becomes short-circuited across the air gap or space between the tapered surface of the core member C and the inclined surface on the inner end of the member D, due, of course, to the fact that said space or air gap is of less width than the space or air gap between the tapered surfaces on the core members C and C′. Consequently, the switch operating member D starts to move with the core members C, thereby causing the pulling force of the solenoid to be reduced automatically to such an extent that the solenoid exerts practically the same pull on the diaphragm at the end of the suction stroke as it exerted on the diaphragm at the beginning of the suction stroke. In other words, by forming the switch operating member in such a manner that the inner end of same is separated from the tapered surface of the core member C by an air gap of less width than the air gap between the tapered surfaces of the core members C and C′, I prevent the pull of the solenoid on the diaphragm from building up progressively as the core member C moves downwardly. This is highly desirable, as it prevents the diaphragm from being operated at such a high speed that sufficient time is not provided to insure a full charge of fuel entering the pumping chamber 2 before the diaphragm starts to move upwardly under the influence of the spring 9. At the time the switch operating member D starts to move with the core member C the spring 22 and the spring 20 are exerting a longitudinal thrust on the member D that is only slightly less than the force which holds said member D in the position shown in the Figure 1 of the drawing. Further downward movement of the core member C causes the movable contact 14 to start to move away from the stationary contacts 15 and 15ª, thereby reducing the magnetic attraction of the solenoid and permitting the spring 22 to break the switch operating member D loose from the core member C. As soon as said member D has broken away from the core member C the spring 20 imparts a quick stroke to the member D in a direction to separate the contact 14 from the contacts 15 and 15ª with a quick break, the momentum of the member D being taken up or absorbed by the stop 18 on the rod 19 which is backed up by the spring 9, as hereinafter described. Immediately after the circuit has been opened the spring 9, which is then under maximum compression, comes into action and moves the core piece C upwardly, and during this upward stroke of the core piece C the stop 18 on the rod 19 engages the switch operating member D and moves it in a direction to cause the contact 14 to move into engagement with the contacts 15 and 15ª, and thus close the solenoid circuit, whereupon the operations above described are repeated.

As previously stated, one object of my present invention is to overcome the necessity of requiring accurate adjustment of any of the parts of the means that is used to operate the intermittent switch in the event said means is taken apart and thereafter reassembled. I accomplish this desirable result by mounting the stop 18 on the rod 19 in such a manner that if said stop is removed, it can be easily replaced without requiring any adjustment of said stop relatively to said rod. As shown in the Figure 1 of the drawing the stop 18, instead of being secured to the rod 19 by co-operating screw threads on said parts, is merely provided with an unthreaded socket into which the end of the rod 19 projects with the end of the rod butting against the bottom of said socket. The spring 9 that acts on the flange 18ª of the stop 18 exerts pressure on the stop 18 in a direction to hold said stop pressed tightly against the end of the rod 19. Accordingly, if it becomes necessary to clean or inspect the contacts of the intermittent switch, this can be done easily, simply by removing the detachable cap 12ª that incloses the switch, then withdrawing the stop 18 from the end of the rod 19, whereupon the switch operating member D and the movable contact 14 thereon can be removed and inspected or cleaned. To reassemble said parts it is only necessary to slip the stop 18 over the end of the rod 19 and then replace the cap 12ª, the spring 9 being preferably combined with the stop 18 in such a manner that it is removed as a single unit with said stop.

If desired, a reservoir E can be arranged in communication with the discharge passageway 8 into which fuel is discharged from the pumping chamber 2 at each discharge stroke of the pumping element A, so as to insure practically a constant supply of fuel to the carburetor or other device with which the pump is used. Said reservoir E can be of any preferred size or capacity and it can either be provided with immovable walls, as described in my pending application Serial No. 12,057, filed February 27, 1925, or one wall or one portion of said reservoir can be formed by a flexible member or movable member 23, thus producing a reservoir from which the fuel will escape freely by gravity at each suction stroke of the diaphragm A, as described in my pending application for Patent Serial No. 315,259, filed October 26, 1928.

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

1. In a liquid fuel pump, a solenoid for actuating the pumping element, an intermittent switch for governing the solenoid circuit, and a means for moving the contacts of said switch into engagement with each other consisting of a rod connected to the movable core of the solenoid, a removable device on said rod capable of being arranged in only one position thereon, and a spring for holding said device in operative position on said rod.

2. In a liquid fuel pump, a solenoid for moving the pumping element in one direction, a switch for governing the solenoid circuit, a rod connected to the core of said solenoid, a removable device on said rod for holding the contacts of said switch closed, and a spring for holding said device in operative position on said rod and for restoring the pumping element after it has been actuated by the solenoid.

3. In a liquid fuel pump, a solenoid provided with a movable core piece, a switch for controlling the solenoid circuit, an operating member for said switch arranged so that the magnetic attraction of the solenoid holds the contacts of said switch closed during the stroke of said core piece in one direction, means for imparting a quick stroke to said switch operating member to open said contacts with a quick break at the end of the said stroke of the core piece, and a spring arranged outside of the magnetic path for imparting a stroke to said core piece in the opposite direction and for closing the contacts of said switch.

4. In a fuel pump, a solenoid provided with a movable core piece, a switch for controlling the solenoid circuit, a switch operating member arranged in the magnetic path of the solenoid and having the movable contact of said switch mounted thereon, said switch operating member being so disposed with relation to said movable core piece that it moves with same during a portion of the stroke of said core piece in one direction, resilient means for breaking said member away from the core piece and for moving said member in a direction to separate the contacts of said switch with a quick break, a rod connected to said movable core piece, a removable stop on the end of said rod that is adapted to engage said switch operating member and move it in a reverse direction so as to close said contacts, and a spring combined with said stop and rod for restoring said movable core piece, at the time the solenoid circuit is interrupted.

5. In a fuel pump, a solenoid for actuating the pumping element, and a guide for the movable core of the solenoid composed of a non-metallic, non-absorbent, non-magnetic material that has great wear-resisting properties, and extending throughout the entire area of the rubbing surface of the movable core.

6. In a fuel pump, a solenoid for actuating the pumping element provided with a movable core piece, a switch for controlling the solenoid circuit, an operating member for said switch reciprocatingly mounted in the stationary member of the core, and guides for the movable member of the core and for said switch operating member constructed of non-absorbent, non-magnetic material.

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