July 5, 1932. P. S. TICE 1,866,137

ELECTROMAGNETIC FUEL PUMP

Original Filed Feb. 13, 1928

Fig. 1.

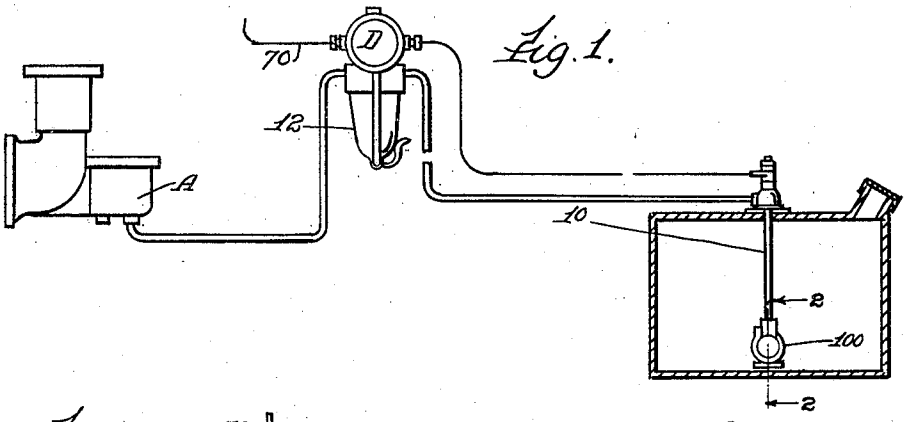


Fig. 2.

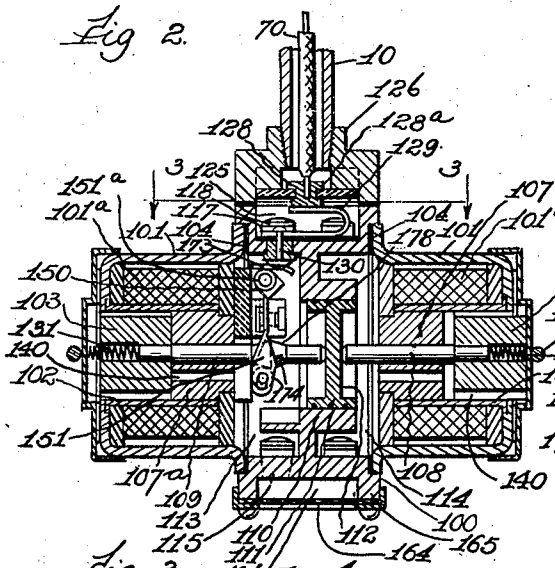


Fig. 4.

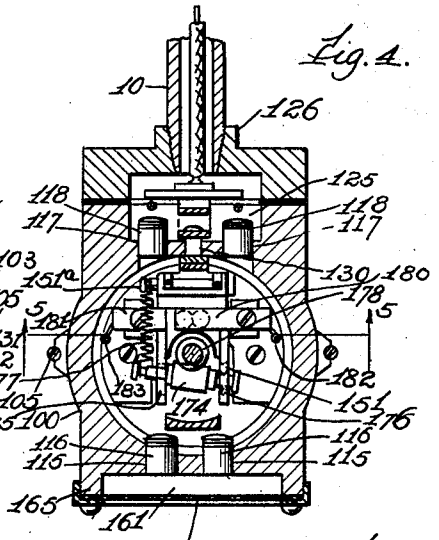


Fig. 3

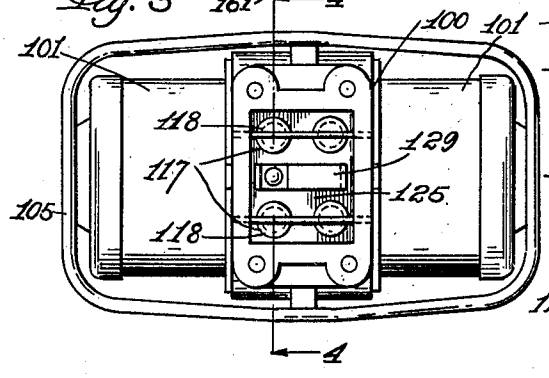


Fig. 6.

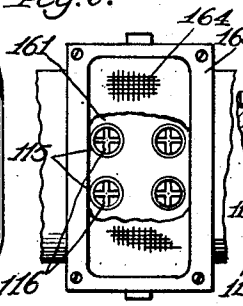
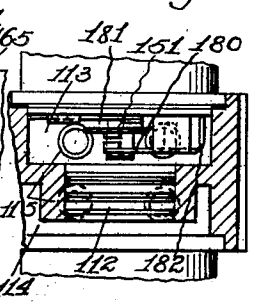


Fig. 5.



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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC FUEL PUMP

Original application filed February 13, 1928, Serial No. 253,974. Divided and this application filed August 1, 1931. Serial No. 554,514.

This application is a division of my application Serial No. 253,974, filed February 13, 1928, and still pending.

The purpose of the construction embodied in this divisional application is to provide an electromagnetic pump particularly adapted for supplying fuel to an internal combustion engine from a main fuel supply tank at a distance from the engine and at a lower level than the engine carbureter, but not limited to that specific use. The invention consists in the elements and features of construction shown and described as indicated in the claims.

In the drawing:

Figure 1 is a diagrammatic view for showing the relative position of the pump and the engine carbureter.

Figure 2 is a section at the line 2—2 on Figure 1 upon a greatly enlarged scale.

Figure 3 is a section at the line 3—3 on Figure 2.

Figure 4 is a section at the line 4—4 on Figure 3.

Figure 5 is a section at the line 5—5 on Figure 3.

Figure 6 is a detail plan view of a part of the construction looking in the direction of the arrow 6 on Figure 2, showing a screen element partly broken away.

The construction shown in the drawing comprising a central member, 100, and lateral or end members, 101 and 101, in the form of caps which are adapted to be applied to the opposite sides of the central member with packing gaskets, 104, 104, interposed, the three members being held rigidly together and the joints rendered liquid-tight by an encompassing binder, 105. In this casing there is mounted the pumping mechanism comprising two solenoids whose windings are indicated at 101^a, 101^a, of which the core members, 103, 103 are fixed in the outer ends of the respective solenoid tubes, 102, 102, the armature, 107, of the right hand solenoid being mounted rigidly upon a central stem, 108, one end of which obtains slide bearing in the right hand core member, 103. The left hand solenoid has the armature, 107^a, similarly mounted rigidly upon a stem, 109, which obtains slide bearing at the outer end in the left-hand core member, 103. The central casing member, 100, has an annular boss, 110, which affords the slide seat for the piston member, 111, fitted within said annular boss and together with said annular boss, and the transaxial web, 112, of the piston, 111, constituting a complete partition in the cavity of said central casing member, 100, dividing it into chambers, 113 and 114.

The chamber, 113, has at the lower side two ports, 115, 115, for inlet of fuel from the main tank in which the entire structure is submerged, said ports being controlled by the inwardly opening check valves, 116, 116; and said chamber has at the upper side outlet ports, 117, 117, for communication with a chamber, 125, in the upper part of the casing above the chambers, 113, and 114, said ports being controlled by check valves, 118, 118, opening for outflow, said cavity, 125, having connection at the upper side indicated by the nipple, 126, for attaching the pipe, 10, leading to an elevated reserve chamber, 12, from which the fuel is delivered by gravity to the float chamber, *a*, of the carbureter indicated at A in Figure 1.

The pumping device is energized by connection with the ignition circuit through the ignition switch, not shown, from which the conductor, 70, leads through a governing switch indicated at D (Fig. 1) and into and through the pipe, 10, into the chamber, 125, and therein to a binding post, 128, insulatedly mounted, as seen at 128^a, which is electrically connected by a C-shaped spring, 129, with the binding post, 130, at the inner end of which a switch-operating bracket, 173, is secured, being mounted upon an insulating disc, 150. At the normal position of rest with the circuit connection with the ignition switch interrupted, so that the solenoid windings are not energized, the piston, 111, occupies the position seen in Figure 2.

The stems, 108 and 109, are held in contact with the piston web by springs, 131, 131, housed in the axial bores of the cores, 103, 103, at the opposite ends of the pistons, respectively, and the armatures, 107, 107, carried by the stems, 108, 109, respectively stand

each spaced inwardly from the proximate ends of the cores respectively with which the armatures cooperate.

When the governing switch D, is closed, one or the other of the solenoids being energized according to the position at that instant of the alternating switch, 151, hereinafter more particularly described, the corresponding armature is attracted to the core, causing the piston to be drawn to one limit of its stroke, which, assuming that to be to the right-hand side of the partition,—causes fuel to be drawn in to the chamber, 114, at the left-hand side and driven out from the chamber, 113, at the right-hand side of the partition. This action operating to reverse the alternating switch, 151, in the manner hereinafter described, causes the left-hand end solenoid to be energized and the right-hand solenoid to be de-energized, resulting in the stroke of the piston in the opposite direction, drawing in the fuel to the right-hand chamber and expelling it from the left-hand chamber; the operation being thus self-repeating and maintaining pumping action as of a double-acting pump so long as the governing switch is closed.

For this action it will be understood that the fixed core members, 107 and 107ª are apertured as seen at 140 for free communication of the spaces between the armatures 103 and the fixed core members with the spaces in which the piston reciprocates for its pumping action.

The purpose served by the springs, 131, 131, reacting on the armatures for returning them to the mid-position after each stroke caused by the energizing of either cooperating core member, is that thereby the armature is positioned distant from the core whose winding is energized upon the operation of the alternating switch upon the last preceding stroke, only half as far as it would otherwise be, and the force of magnetic attraction varying inversely as the square of the distance of the armature from the attracting pole, this force for starting the armature and the pump piston is four times as great as it would have been if the armature were left at the position to which it was drawn by the attraction of the last energized core; and the length of the spring being very short relatively to the length of the coil spring which is compressed in the stroke, the resistance of the spring which has to be overcome by the magnetic attraction whose energy is thus stored in the compressed spring, is not materially greater at the end than at the beginning of the spring-compressing stroke; and the two springs practically offset each other throughout the very short stroke, each returning the armature and piston to mid-position, and the net result is that the amount of electric energy necessary to operate the device for pumping at a given rate is reduced substantially to one-fourth what would be required if the springs were omitted.

It may be understood that the entire pump structure as seen in Figure 2 being submerged in the main tank, derives fuel supply through a filter screen, 164, mounted on an annular bottom flange, 165, of the casing, 100, and enclosing an entrance chamber, 161, from which the fuel is drawn alternately into the cavities, 113, 114, by the alternating strokes of the piston, 111, past the check valves, 168 and 169.

The alternating switch by whose action the current is shifted to alternately energize the solenoid windings, 103, 103, is of the snap switch type having its movable switch member consisting of a lever, 151, pivoted at its upper end, as seen at 151ª, to a bracket, 173, which is mounted on an insulating disk, 150, secured to the right hand head, 101ª, of the left hand solenoid spool, 101.

The snap-over switch lever, 151, is forked at its lower end for carrying at the other end a roller, 174, one end of which obtains journal bearing in an elongated slot, 175, in one of the fork arms, 176, of the lever, its journal bearing at the other end in the other fork arm being loose to permit the first mentioned end to play in the slot without cramping the bearing at the opposite end; and a stretched spring, 177, connects the first mentioned end of the roller with the pivot of the lever, 151, at the upper end of the bracket, 150, as mentioned.

The stem, 109, carries a conoidal cam collar, 178, formed tapering from a maximum diameter midway of its length narrowing toward both ends. This cam collar is mounted on the stem, 109, at such position that midway in the stroke of the piston, 142, said cam collar stands with the plane of its maximum diameter containing the axis of the pivot of the snap switch lever, 151, and the length of said lever from its pivot at the upper end to the mounting of the roller, 174, at the lower end is such that the spring, 177, operates to hold the roller, 174, stretched upwardly against the conoidal cam roller.

Upon considering this construction it will be understood that when the stem, 109, carrying the double-conoidal cam roller is thrust by the armature piston from one extreme position to the other in passing the midway postion it will force the roller, 174, against the resistance of the stretched spring outward from the axis of the cone, and upon the reaction of the spring pulling it back again against the slope of the cone, the lever, 151, will be swung in the opposite direction from that of the thrust of the stem. On the insulating disk, 150, there are mounted so as to project at opposite sides of the lever, 151, spring contacts, 180 and 181, which are connected respectively by circuit wires, 182 and 183, with the outer coils of the solenoid wind-

ings, 103, 103, respectively, and said windings have their innermost coils grounded by their connection to the core.

It may be understood from the above description that the thrust of the piston, 111, due to the energizing, for example, of the solenoid winding of the left hand solenoid and magnetizing of the left hand core member, 103, will cause the operation of the snap switch to shift the current to the other solenoid winding, energizing the opposite core member which will thereupon retract the right hand armature, 107, again reversing the connection; thus the reciprocation of the piston will continue, continuing the pumping action until by any means or from any cause resistance of the fuel to the pumping action exceeds the pumping capacity of the device, or the energizing circuit is interrupted otherwise than in the alternating manner above described which causes the reciprocation.

I claim:

1. An electric pumping apparatus having a pair of solenoids each comprising a core tube and a fixed magnetizable core member occupying one end portion of the central cavity of the tube and an armature member reciprocable longitudinally of the tube in the opposite end portion thereof, said solenoids being mounted in axial alignment spaced apart from each other with the fixed core members in their proximate end portions, and the reciprocable armature members in their remote end portions; pumping chambers formed with a piston cylinder interposed between the two core tubes, and a piston reciprocably mounted in the cylinder, the reciprocable armature members in the respective core tubes having each a rigid stem extending out guidingly through the fixed core member of the tube for operative engagement with the piston; an electric circuit having two branches-in-parallel containing respectively the two solenoid windings; a switch device in said circuit having its movable member shiftable to alternate the circuit connections between the two branches-in-parallel, and thereby between the two solenoid windings, for magnetically energizing alternately the fixed core members and attracting the armature members alternately in opposite directions; one of the armature stems being operatively associated mechanically with the switch member for shifting the latter to shift the current course from one to the other of said branches-in-parallel.

2. The construction defined in claim 1 having a casing enclosing both solenoids and comprising a partition between them partitioning the pumping chambers from each other, the piston cylinder being formed in said partition and open at its opposite ends respectively in the pumping chambers, each pumping chamber having an inflow and an outflow check valve, and the casing having connection beyond the outflow valves for delivery of the liquid pumped.

3. The construction defined in claim 1 having a casing enclosing both solenoids and comprising a partition between them partitioning the pumping chambers from each other, the piston cylinder being formed in said partition and open at opposite ends respectively in the pumping chambers, each pumping chamber having an inflow and an outflow check valve, and the casing containing a third chamber into which both the outflow valves lead and having a connection from said third chamber for delivery of the liquid pumped.

4. In the construction defined in claim 1, springs reacting on the armature members respectively in the direction of the attraction of the fixed core members for increasing the thrust of the armature stems on the piston.

5. The construction defined in claim 1 having a casing enclosing the parts enumerated in said claim 1, said casing comprising an intermediate casing member containing the pumping chambers, and two cup-shaped casing members encompassing the solenoids respectively, and formed and furnished with means for seating liquid-tight on the intermediate casing member at opposite sides of the latter, and an endless binder member encompassing the three casing members dimensioned for clamping them in liquid-tight junction.

6. The construction defined in claim 1 having a casing enclosing the parts enumerated in said claim 1 containing the pumping chambers and having inflow and outflow check valves leading respectively into and out of said pumping chambers respectively, both inflow valve ports being at the same side of the casing and situated proximately with respect to each other, the casing having an exteriorly protruding hollow boss encompassing both said ports, and a reticulated screen mounted on said boss enclosing a chamber of entrance to the ports.

7. The construction defined in claim 1, the fixed core members being apertured from end to end for communication of the pumping chambers respectively with the spaces in which the armature members respectively reciprocate.

In testimony whereof I hereunto set my hand at Chicago, Illinois, this 13th day of July, 1931.

PERCIVAL S. TICE.