May 9, 1933. J. B. WHITTED 1,908,092

ELECTRIC FUEL PUMP

Filed Oct. 9, 1931 3 Sheets-Sheet 1

Fig. 1.

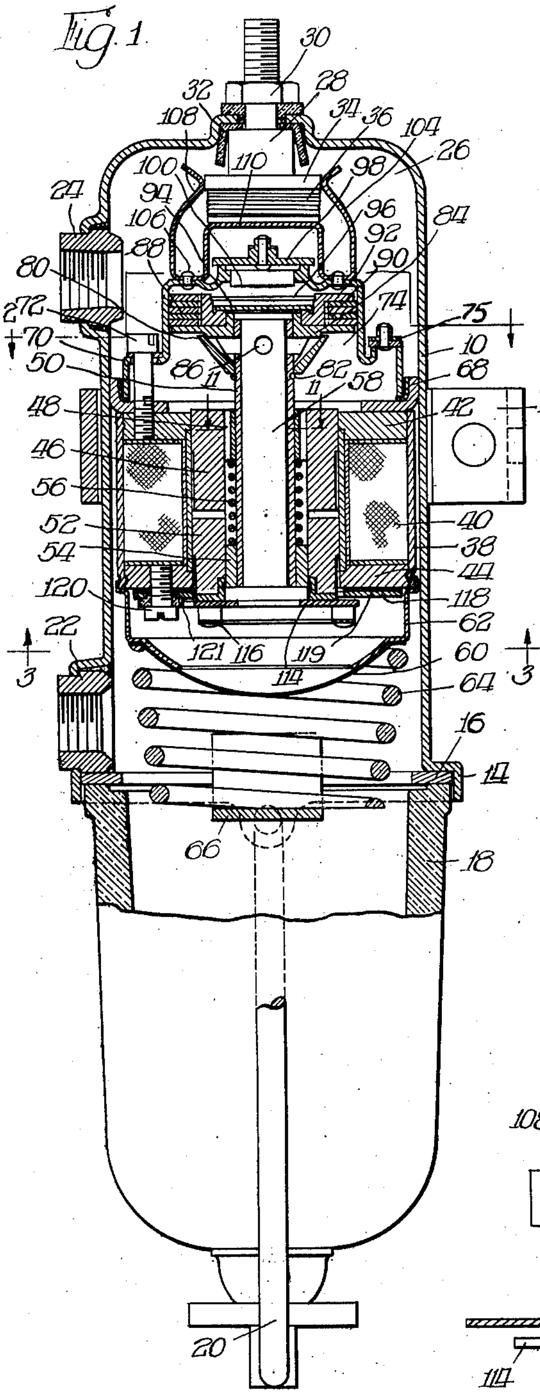


Fig. 2.

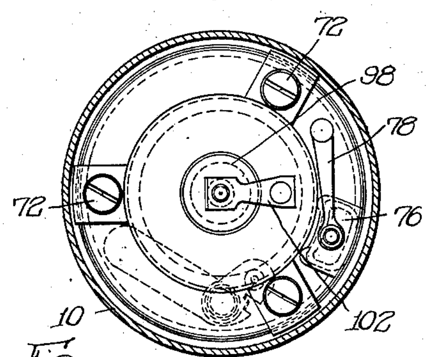


Fig. 11.

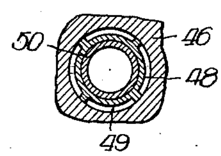


Fig. 3.

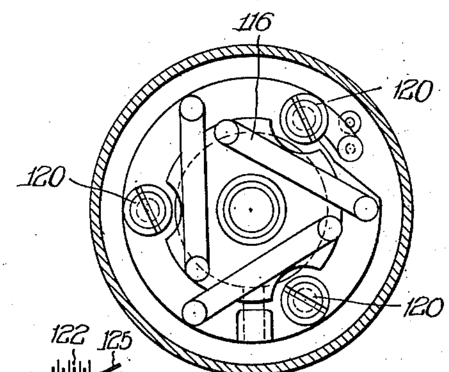
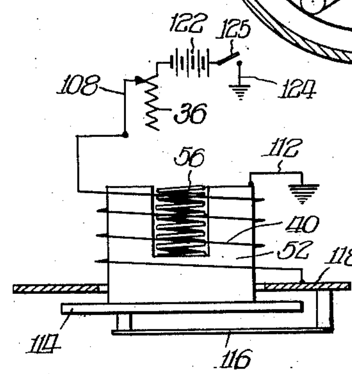


Fig. 4.



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ELECTRIC FUEL PUMP

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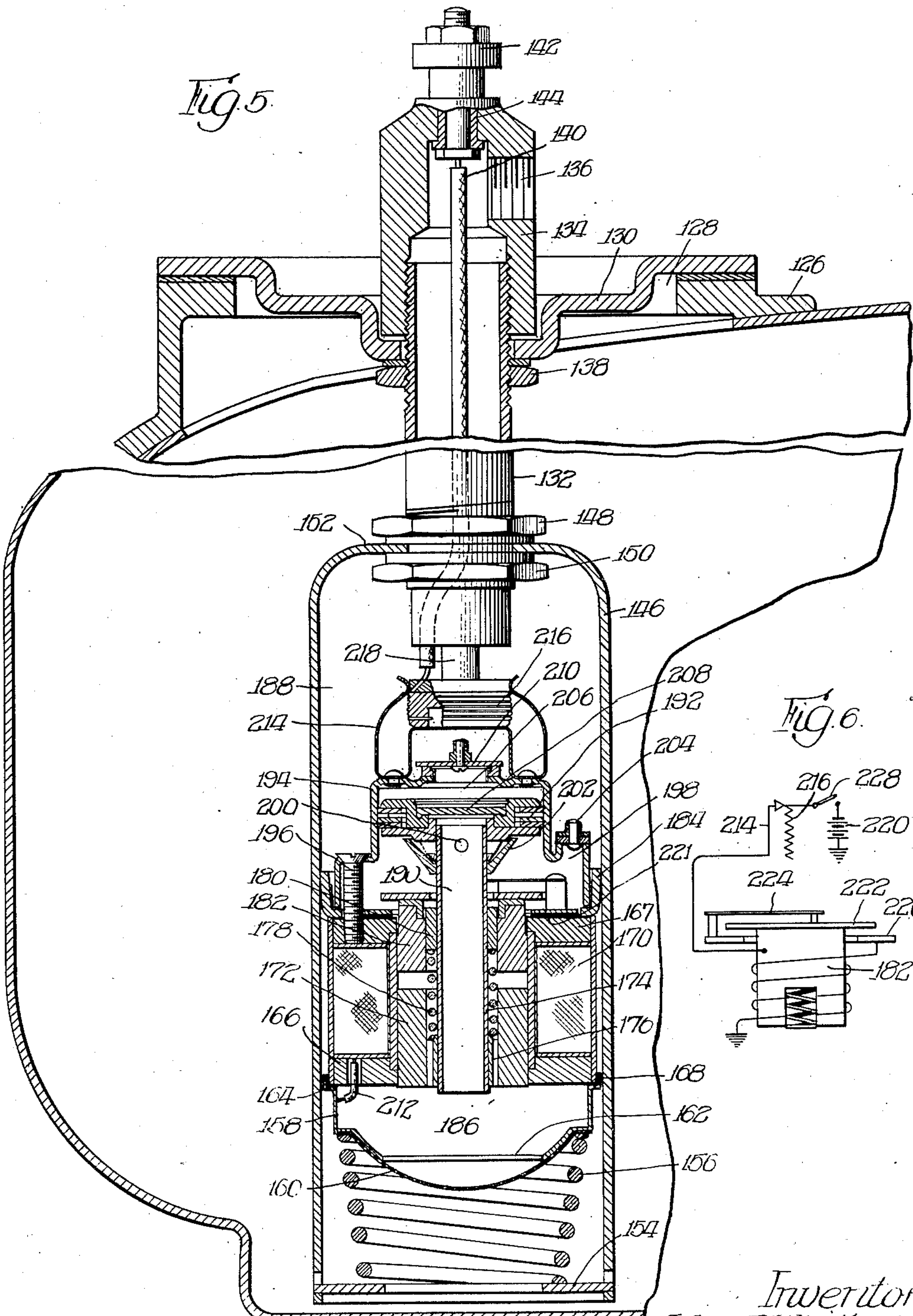

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ELECTRIC FUEL PUMP

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Fig. 8.

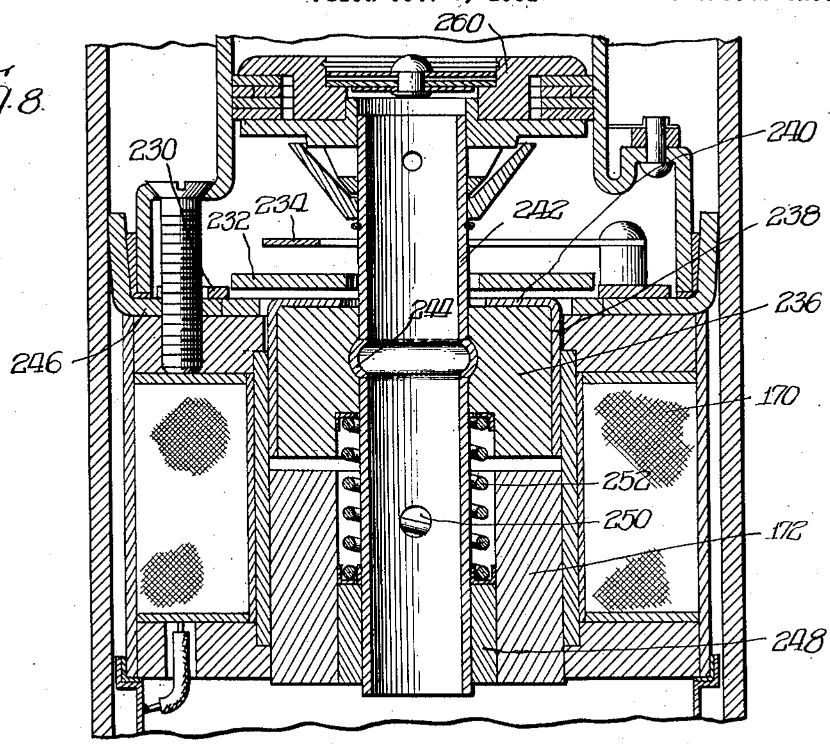

Fig. 7.

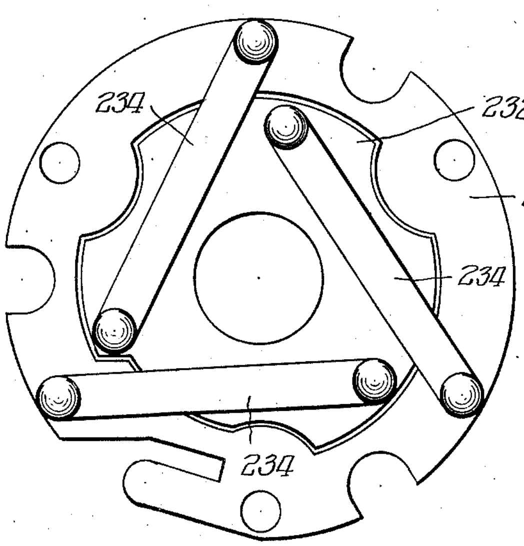

Fig. 9.

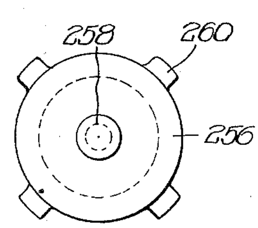

Fig. 10.

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Patented May 9, 1933 1,908,092

UNITED STATES PATENT OFFICE

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ELECTRIC FUEL PUMP

Application filed October 9, 1931. Serial No. 567,875.

This invention relates to improvements in electric fuel pump particularly adapted for use in association with a motor vehicle for delivery of fuel from the supply tank to the carbureter of the engine.

It is an object of the invention to provide a fuel pump which will be double acting to insure a uniform flow to the carbureter and in which the stroke of the pumping member is resilient in one direction and produced by electric magnetic means in the opposite direction.

It is further an object of the present invention to provide an improved fuel pump construction adapted for electrical operation which will be double-acting to provide a more uniform delivery and which will include differential delivery capacity for the pumping member in its opposite movements.

A still further object resides in the provision of a double-acting electrically actuated fuel pump for delivery of fuel to a carbureter provided with means for decreasing the delivery as the outlet pressure rises and to so arrange the pumping member with respect to a magnetic stroke in one direction and a spring-pressed stroke in the opposite direction that the magnetic stroke is operative with a decreased effective area of the pumping member than during the spring-pressed stroke thereby providing for economy of current consumption under increased outlet pressure and decreasing flow.

It is further an object of the present invention to provide a simple construction in which a pair of pumping chambers controlled by a reciprocable pumping member are associated with electro-magnetic actuating means.

An additional object of the present invention is to provide a construction in which a fuel pump unit is slidable in a casing between inlet and outlet chambers therein and is normally held by resilient means in position for maximum flow into the outlet chamber whereby the action of a pumping unit delivering fuel into the outlet chamber may produce a pressure in excess of that required by the carbureter and produce movement of the entire pumping unit thereby increasing the resistance in the electric circuit of operating unit to thereby slow the movement of the pump.

It is further an object of the present invention to provide an electro-magnetic fuel pump unit slidably supported in a casing between inlet and outlet chambers and to control the effective pumping action by the movement of the fuel pump unit with respect to the casing, such as by the control of a variable resistance control in the electrical circuits.

Further objects and advantages of the present invention will be more readily apparent from the following description taken in connection with the attached drawings, in which—

Figure 1 is a vertical section taken through the electric fuel pump;

Figure 2 is a detail section taken on the plane indicated 2—2 in Figure 1;

Figure 3 is a detail section taken on the plane indicated 3—3 in Figure 1;

Figure 4 is a diagram of the circuit connections;

Figure 5 is a vertical section taken through a fuel tank and an electric fuel pump included therein;

Figure 6 is a diagram of the circuit connections of Figure 5;

Figure 7 is a plan view of a modified construction of the circuit breaker;

Figure 8 is a vertical section taken through a fuel pump embodying the modified construction of a circuit breaker;

Figure 9 is a plan view of a modified form of inlet check valve;

Figure 10 is an elevation of the check valve shown in Figure 9, and

Figure 11 is a detail section taken on the plane indicated 11—11 in Figure 1.

In the construction disclosed in Figures 1 to 4, inclusive, the casing 10 is fixed to a stationary part of the motor vehicle by a bracket 12. At the bottom of casing 10 there is an enlarged flanged portion 14 adapted to receive a gasket 16 and the upper end of an inverted cup-shaped member 18 which forms a fuel receiving and sediment trap chamber in the usual manner. The cup-shaped member 18 may be secured by an adjustable swinging yoke generally designated 20. At the bottom of the casing 10 just above the top of the cup-shaped member 18 is secured a threaded inlet connection plug 22 while at the upper end of the casing I show a threaded outlet connection plug 24. The usual fuel intake and discharge pipe lines may be connected to the plugs 22 and 24 respectively. Thus the intake will draw fuel from a source of fuel supply such as a low positioned fuel tank and the discharge connection will deliver fuel to the float chamber of a carbureter. The chamber 26 at the upper portion of the casing 10 forms a fuel outlet pressure chamber. The upper end of the casing 10 is closed by a plug 28 which is secured by a nut 30 and insulated from the casing 10 by insulation 32. The plug 28 has a lower enlarged portion 34 carrying a resistance winding 36.

The electrical pumping unit which delivers fuel from the lower fuel receiving chamber to the upper pressure chamber 26 is slidably mounted in the casing 10 and includes a cylindrical housing 38 having a solenoid coil 40 included between an upper cap member 42 and a lower cap member 44. Extending into the upper end of the solenoid coil is a stop member 46 which is fixed with respect to the housing 38 and has secured thereto a guide bearing 48 for a reciprocable sleeve 50. The guide bearing 48 is provided with slots 49 on its exterior surface for a purpose to be later described. The sleeve 50 is fixed by a stop member 54 to a reciprocable magnet plunger 52 extending into the lower end portion of the solenoid coil. Surrounding the sleeve 50 and reacting between the stop member 54 and the bearing 48 is a compression spring 56 which normally holds the movable plunger 52 together with the sleeve 50 in its lower position in readiness for its upward stroke upon energization of the solenoid.

The sleeve 50 has a fuel flow passage 58 extending therethrough into communication with the fuel receiving chamber at the lower end of the casing 10. The entrance to the flow passage 58 however includes a filter member 60 which is secured to the pressed metal support 62 carried by the housing 38. The support 62, for the strainer or filter member 60, also acts as a retainer for a compression spring 64 which reacts upwardly against the support 62 and reacts at its lower end against a spring seat 66 fixed to the casing. A cup-shaped leather piston 68 is secured to the upper cap member 42 of the housing 38 and is held by the head member 70 fastened by screw bolts 72. The head 70 forms a pumping chamber 74 which is in communication with the outlet pressure chamber 26 by a check valve 76 normally held in closed position by a light spring arm 78, as shown in Figure 2. A cone-shaped inlet check valve 80 is shown surrounding the sleeve 50 and adapted to have a slightly vertical movement between a lower stop 82 and an upper valve seat on the disk 84. The sleeve 50 has laterally directed fuel flow passages 86 which allow the fuel to flow from the passage 58 of the sleeve 50 past the inlet check valve 80 into the expansible and reducible chamber 74 and thence outwardly past the check valve 76. The expansion and reduction of chamber 74 is obtained by piston 88 formed by a plurality of sealing rings 90 held between an upper disk member 92 and the lower disk member 84 and thus fixed to the upper end of the sleeve 50. The upper ring 92 forms a valve seat for an inlet check valve 94 which is prevented from displacement by a cross pin 96. The head 70 forms at its upper end a valve seat for an outlet check valve 98 and the space between the check valves 94 and 98 forms a second pumping chamber 100 which is also enlarged and reduced by the movement of the piston 88. The check valve 98 is normally held in closed position by a light spring arm 102, as indicated in Figure 2.

Immediately above the check valve 98 the head 70 has secured thereto a pressed metal strip 104 which is attached by rivets 106 and includes spring contact arms 108 pressing against the cylindrical portion 34 and against the resistance winding as the pumping unit is moved downwardly in a manner to be later described. The central portion of the metal strip 104 is curved upwardly as at 110 forming a stop engaging the bottom portion of the plug 28 but suitably insulated therefrom.

The chamber 100 may be termed the "primary pumping chamber" while the chamber 74 may be termed the "secondary pumping chamber". The pumping chamber 74 has a pumping capacity less than that of chamber 100 since the movable plunger 52 also forms a movable wall of chamber 74 as the fuel is free to flow through the slots 49 in bearing 48. Therefore, the effective expansion and reduction of chamber 74 is determined by the differential area between piston 88 and plunger 52. It will be understood that energization of the solenoid produces a reduction in chamber 100 thereby discharging fuel past the check valve 98 into the pressure chamber 26 while at the same time the chamber 74 is being enlarged to draw fuel thereinto past the check valve 80. This upward movement of the piston 88 causes a compression of the spring 56 which, when the solenoid is de-energized, expands and returns the piston 88 to its lowermost position thereby discharging fuel from the chamber 74 through the check valve 76 and sucking fuel into the chamber 100 through the inlet check valve 94. The pump is therefore double-acting. As soon as the pressure in outlet chamber 26 reaches an amount sufficient to over-balance the spring 64, the entire pumping unit will be moved downwardly thereby compressing the spring 64. During the normal operation of the engine, fuel is being consumed by the carbureter and the rate of utilization of the fuel determines the pumping action of the fuel pumping unit. As fuel is being consumed by the carbureter substantially as fast as it is being supplied by the pumping unit the pressure in the chamber 26 and the stored energy in the spring 64 tending to restore the pumping unit to its uppermost position are substantially balanced. As the fuel in the carbureter bowl exceeds a certain level due to slowing down of the engine, the float valve in the float chamber is closed stopping the flow of fuel thereto. Therefore the fuel pressure in the chamber 26 is increased and overcomes the resistance of the spring 64 to move the entire pumping unit downward to further compress the spring 64 causing contact spring arms 108—108 to successively cut in resistance in series with the solenoid coil winding to decrease the effective pumping action. As fuel in the carbureter bowl is consumed, the float bowl valve of the carbureter is again opened and the pressure in the pressure chamber 26 diminishes and the stored energy of the spring 64 now moves the fuel pump unit upwardly and causes the contact spring arms 108—108 to successively cut out resistance to again increase the pumping action. Thus the effective pumping action of the pumping unit is dependent upon the amount of resistance that is cut in series with the solenoid winding. During normal operation of the pumping unit, the restoration of the piston is under the influence of the spring 56 and as the effective area against which the piston acts is comparatively small due to the differential area of the piston and plunger, the spring for restoring the piston and plunger can be comparatively light.

The circuit connections are illustrated diagrammatically in Figure 4 in which the plunger 52 is shown to be grounded through wire 112 and normally contacts with the armature 114 through the force of compression spring 56. A switch 125 is associated with the ignition switch of the motor vehicle and, when closed, the current is conducted through the supporting spring arms 116 for the armature 114 through the breaker plate 118 which is fixed with respect to the solenoid housing by being secured to and insulated from the lower cap member 44 by the disk 119, through bolts 120, which are in turn insulated from the breaker plate 118 by bushings 121, as shown in Figures 1 and 3. When the armature 114 engages the breaker plate 118 the continued movement of the plunger 52 will break the electrical contact and armature 114 will be returned to its normal position under the influence of the spring arms 116 and the spring 56 will then return the plunger to reestablish contact with the armature 114. The breaker plate 118 is connected to one end of the solenoid coil 40. The current is conducted from the coil 40 to the spring arms 108 which contact with the resistance winding 36. The resistance winding 36 is connected to a battery 122 which is grounded at its opposite terminal by wire 124.

Figures 5 and 6 illustrate another form of the fuel pump adapted to be suspended within a fuel tank. The tank 126 has an opening 128 in the top thereof large enough to receive the electric fuel pumping unit which is supported by a flanged cover plate 130. A tubular fuel conducting member 132, threaded at its upper end, extends upward through an opening in the flanged cover plate 130 and has threaded to its upper end an outlet plug 134. The plug 134 has a laterally directed threaded outlet connection 136 for connection to a pipe line leading to the carbureter. The lock nut 138 serves to secure the tube 132 tightly to the flanged cover plate 130. A wire 140 leads upwardly through the tube 132 from the fuel pumping unit to a connection 142 which is separated from the metal of the plug 134 by insulation 144. The connection 142 is intended to be electrically connected to the ungrounded terminal of the battery, as will be subsequently described.

The tube 132 has secured to its lower end in adjustable position, a cylindrical casing 146 which is fastened by the lock nuts 148 and 150 threaded to the tube 132 on opposite sides of the inwardly flanged end 152 of the casing 146. The bottom of the casing is spaced from the bottom of the fuel tank to provide free access of the fuel to the interior of the casing. A spring seat member 154 is carried by the lower end of the housing 146 and serves to support a compression spring 156 which bears at its upper end against a pressed metal ring 158 and serves to retain in place a filter member 160. The filter 160 spans the opening 162 in the ring 150 through which the fuel flows to the pumping unit. The ring 158 has an annular flanged upper portion 164 bearing against the lower cap 166 of the solenoid housing of the pumping unit but separated therefrom by insulation 168. The solenoid coil 170 which is fixed between the lower cap 166 and the upper cap 167 of the solenoid housing has fixed thereto an annular core piece 172 which forms a guide for the slidable stem 174 through a slotted bearing 176 fixed to the core piece 172. The bearing 176 forms a stop for a compression spring 178 bearing at its upper end against a stop piece 180, fixed to the slidable core piece 182. The stop member 180 is also fixed to the slidable stem 174.

The housing 166 of the pumping unit has secured to its upper side an upwardly flanged packing 184 which presses against the inner wall of the housing 146 and seals the lower chamber 186 from the upper chamber 188. The stem or sleeve 174 has a fuel passage 190 leading therethrough and has fixed to its upper end a piston 192 reciprocable in a head 194, which is fastened to the upper cap 167 of the solenoid housing of the pumping unit by screw bolts 196. The pumping chamber 198 within the lower portion of the head 194 and of which the piston 192 forms an upper movable wall, is in communication with the fuel passage 190 of sleeve 174 by the lateral openings 200 in the sleeve. The flow from the passage 190 into the chamber 198 is controlled by a check valve 202 which seats to close the communication during downward movement of the piston 192 but opens during upward movement of the piston 192. The fuel is delivered from the chamber 198 into the chamber 188 through a check valve similar to that in the first described construction, the support for which is shown at 204. The pumping chamber 206 on the upper side of the piston 192 and within the frame piece 194 is in communication with the fuel passage 190 and controlled by check valve 208. The flow of the fuel from the chamber 206 to the chamber 188 is controlled by the outlet check valve 210.

The fuel pump is therefore double-acting the same as in the former construction. Energization of the solenoid coil will draw down the core piece 182 against the resistance of spring 178 and the movement of the piston 192 therewith will reduce the chamber 198, and deliver fuel through the outlet check valve 204 into the outlet chamber 188. At the same time the chamber 206 is being enlarged to draw fuel thereinto past the check valve 208 from the passage 190. This downward movement of the piston 192 causes the spring to be compressed and again expand upon the de-energization of the solenoid to return the piston 192 and plunger 182 to their uppermost positions which effects the discharge of fuel from the chamber 206 through the check valve 210 and drawing fuel into the chamber 198 past the check valve 202 from the fuel passage 190.

In this form of the invention, one end of the solenoid coil is shown to be connected by wire 212 to the ring 158 and is thereby grounded through the spring 156, the housing 146 and the fuel tank. This connection 212 is insulated from the metal of the housing 166 of the pumping unit.

As shown in the diagram of the circuit connections in Figure 6, the reciprocable plunger core 182 is electrically connected with the resilient contact arms 214 which bear against a resistance unit 216, supported by strap 218 at the lower end of tube 132 and connected as previously described, by wire 140 with the ungrounded terminal of battery 220. The plunger core 182 normally held in upper position in engagement with an armature 222 which is connected through resilient supporting arms 224 to a stop ring 226 secured to and insulated from the cap member 167 by an insulating disk 221 and insulated screw bolts 196, similar to Figure 1, and is electrically connected to the other end of the solenoid coil. The switch 228 is associated with the ignition switch of the motor vehicle and when closed establishes the energizing circuit for the solenoid coil.

In this type of fuel pump the pressure in the pressure chamber 188 is maintained for maximum carbureter consumption at all times and when the fuel in the carbureter float chamber exceeds a predetermined level the float inlet valve is closed stopping the flow of fuel thereto. Therefore the fuel pressure in the outlet pressure chamber 188 is increased and during such time that this excess pressure prevails in the chamber 188 an energization of the solenoid coil moves the piston 192 downward against a comparatively small effective area of fuel volume due to the differential area between the piston and the solenoid plunger and thus permits a positive stroke of the pumping piston and plunger. However, upon the de-energization of the solenoid, the return of the plunger and pumping piston is under the control of the spring 172 and the energy stored in the spring upon the downward movement of the solenoid plunger now tends to restore the piston to its uppermost position. During such restoration the effective area against which the piston acts is comparatively large and in combination with the excessive pressure in the chamber 188 this restoration is comparatively slow and the rate at which the piston restores is governed by the rate of leakage past the washer 184. As long as this excessive pressure exists in the chamber 188 it is apparent that the time that it takes to restore the piston to its uppermost position is exceedingly long in comparison to the time that is consumed for energizing the solenoid. As the piston during its downward stroke acts against a small effective area of fuel, the amount of current consumed to positively energize the same is small and as each energization of the solenoid under conditions above outlined are at comparatively long time intervals, economy in current consumption is obtained. As fuel in the carbureter bowl is consumed the pressure in the chamber 188 diminishes to permit a quicker restoration of the pumping piston and solenoid plunger under the influence of the spring 172 and reduces the time interval between successive energizations of the solenoid to thus again increase the pumping action. In this type of fuel pump no movement of the pumping unit is effected by excessive pressure in the chamber 188 under conditions above outlined but should the check valve 208 remain open due to some foreign substance lodging between the valve and the seat of the same to prevent its closure, an abnormal pressure would be built up in the chamber 188 and overcome the resistance of the spring 156 which tends to maintain the pumping unit in its uppermost position and move the pumping unit downward causing the spring contact arms 214—214 to successively cut in resistance in series with the solenoid winding to thereby decrease the effective pumping action.

During normal operation of the pumping unit, the effective area against which the piston acts upon the energization of the solenoid is comparatively small and the current consumed by the solenoid to positively move the piston through its full stroke is small to thus provide for an economy in current consumption.

Figures 7 and 8 illustrate a modification of the construction shown in Figure 5. In this form the circuit breaker construction is different from that in Figure 5 in that the supporting plate 230 for the armature 232 does not act as a breaker plate in that the armature 232 is free to move through the plate 230. The armature 232 is normally held in the plate 230 by the resilient arms 234. It is found that this construction reduces noise present in the former circuit breaker construction. The magnet plunger 236 in Figure 8 is provided with a cap 238 of noncorrodible metal which is flanged over at its upper end at 240 for contact with the armature 232. The plunger 236 is secured to the reciprocable stem 242 by the beaded portion 244. The flanged leather washer 246 extends beneath the supporting plate 230. Further, in this form, the bearing 248 for the reciprocable stem 242 is not slotted as is the bearing 176 in Figure 5 and the stem is provided with an opening 250 to admit the fuel to the chamber housing the spring 252.

Figures 9 and 10 illustrate a preferred construction of the inertia check valve shown as 208 in Figure 5. The valve in Figures 9 and 10 includes a pair of bakelite plates 254 and a pair of leather washers 256 which are secured together by a rivet 258. One of the bakelite plates includes projections 260 which center the valve within the recess of the piston cap 260 and permit free flow of the fuel around the valve when the valve is in open position.

Further modifications and changes may be resorted to without departing from the spirit of the invention as expressed in the appended claims.

I claim:

1. Fuel feeding apparatus comprising a casing having an inlet from a source of fuel supply and an outlet adapted to deliver fuel to a carbureter, a fuel pump unit slidable in said casing and forming a piston dividing said casing into an inlet chamber at one end and an outlet chamber at the other end, resilient means reacting upon said fuel pump unit to normally hold said unit in position for minimum capacity of said outlet chamber and means for actuating said fuel pump unit to deliver fuel from said inlet chamber to said outlet chamber whereby fuel pressure in the outlet chamber greater than the force of said resilient means will produce movement of said fuel pump unit to enlarge the capacity of said outlet chamber.

2. Fuel feeding apparatus comprising a casing having an inlet from a source of fuel supply at one end and an outlet adapted to deliver fuel to a carbureter at the opposite end, an electric fuel pump unit slidable in said casing forming a piston dividing said casing into an inlet chamber at one end and an outlet chamber at the opposite end, resilient means normally holding said electric fuel pump unit in position for minimum capacity of said outlet chamber, an electrical circuit controlling the actuation of said electric fuel pump unit to deliver fuel from said inlet chamber to said outlet chamber whereby fuel pressure in said outlet chamber greater than the force of said resilient means will produce slidable movement of said fuel pump unit to enlarge the capacity of said outlet chamber and means in said electrical circuit controlled by the slidable movement of said fuel pump unit for decreasing the effective pumping action as said fuel pump unit is moved against the force of said resilient means.

3. A fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the opposite end adapted to deliver fuel to a carbureter, an electric fuel pump unit slidable in said casing between said inlet and said outlet forming a piston to divide said casing into an inlet chamber at one end and an outlet chamber at the opposite end, a stop in said outlet chamber, resilient means normally urging said fuel pump unit into engagement with said stop in position for minimum capacity of said outlet chamber, an electrical circuit controlling the action of said fuel pump unit for feeding fuel from said inlet chamber to said outlet chamber, said electrical circuit including a variable resistance automatically controlled by the slidable movement of said fuel pump unit in said casing whereby fuel pressure in said outlet chamber greater than the force of said resilient means will produce slidable movement of said electric fuel pump unit and increase the effective resistance in said electrical circuit.

4. Fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the

opposite end adapted to deliver fuel to a carbureter, a piston slidable in said casing between said inlet and said outlet, dividing said casing into an inlet chamber at one end and an outlet chamber at the opposite end, fuel pumping means for feeding fuel from said inlet chamber to said outlet chamber, resilient means normally holding said piston in position for minimum capacity of said outlet chamber whereby fuel pressure in said outlet chamber greater than the force of said resilient means will produce movement of said piston to enlarge the capacity of said outlet chamber.

5. Fuel feeding apparatus comprising a casing having an inlet from a source of fuel supply at one end and an outlet at the opposite end for delivery of fuel to a carbureter, a piston slidable in said casing between said inlet and said outlet and dividing said casing into an inlet chamber at one end and an outlet chamber at the opposite end, electrical fuel pumping means for feeding fuel from said inlet chamber to said outlet chamber, resilient means normally holding said piston in position for minimum capacity of said outlet chamber and means operative by the movement of said piston in response to fuel pressure in said outlet chamber greater than the force of said resilient means for controlling the action of said electrical fuel pumping means.

6. Fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the opposite end adapted to deliver fuel to a carbureter, a piston slidable in said casing between said inlet and said outlet and dividing said casing into an inlet chamber at one end and an outlet chamber at the opposite end, a compression spring in the inlet chamber reacting between said casing and said piston, a stop carried by said casing in said outlet chamber against which said piston is urged by the force of said compression spring, electrical fuel pumping means carried by said piston adapted to deliver fuel from said inlet chamber to said outlet chamber through said piston and means operative in response to movement of said piston for controlling the action of said electrical fuel pumping means.

7. Fuel feeding apparatus comprising a casing including a pressure chamber having an outlet for delivering fuel to a carbureter, a reciprocable member forming a movable wall of said pressure chamber, resilient means reacting upon said movable wall to decrease the capacity of said pressure chamber, electrical fuel pumping means for feeding fuel from a source of supply into said pressure chamber, an electrical circuit for controlling said fuel pumping means including a variable resistance and means for automatically varying said resistance in response to movement of said reciprocable wall under the influence of fuel pressure in said pressure chamber.

8. An electrical fuel pump comprising a solenoid coil, a fuel conduit leading through said solenoid coil, a head on one end of said solenoid coil, a reciprocable member including a solenoid core and a piston, said piston dividing said head into a pair of pumping chambers, resilient means for producing movement of said reciprocable member in one direction opposite to the movement produced by the energization of said solenoid coil and two pairs of check valves, each pair of check valves controlling the flow of fuel through one of said pumping chambers whereby fuel is delivered from one of said pumping chambers through the movement of said reciprocable member in either direction.

9. A double-acting electrical fuel pump comprising a fuel conduit having an inlet and an outlet, said fuel conduit including a pair of pumping chambers in separate communication with said inlet and said outlet, a piston forming a movable wall of each of said pumping chambers, a pair of check valves controlling the flow of fuel through each of said pumping chambers, resilient means for producing movement of said piston in one direction, an electrical winding and a magnet plunger movable with said piston against the force of said resilient means in response to energization of said electrical winding.

10. An electro-magnetic fuel pump comprising a reciprocable stem forming a fuel conduit, a pumping piston secured to said stem, a cylinder in which said piston is movable, a pumping chamber between said piston and the head of said cylinder, an inlet check valve for said pumping chamber carried by said piston, an outlet check valve carried by the head of said cylinder, a solenoid housing to which said cylinder is secured, a solenoid coil supported by said housing, a reciprocable solenoid core piece secured to said stem and guided for movement by said housing, resilient means for moving said stem in a direction to expand said pumping chamber, said stem being movable upon energization of said solenoid coil to contact said pumping chamber and deliver fuel therefrom, a second pumping chamber between said piston and said solenoid housing, an inlet check valve for said second pumping chamber carried by said stem and an outlet check valve for said second pumping chamber carried by said cylinder whereby energization of said solenoid coil will expand said second pumping chamber to draw fuel thereinto and movement of said stem by said resilient means will contract said second pumping chamber to deliver fuel therefrom.

11. Fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the other end for delivery of fuel to the car-

bureter, said casing including an inlet chamber at one end, an outlet chamber at the opposite end and a pair of expansible and reducible pumping chambers in said casing between said inlet and outlet chambers, separate check valve controlled inlet connections from said inlet chamber to each of said pumping chambers, separate check valve controlled outlet connections from said pumping chambers to said outlet chamber, a single reciprocable pumping member forming a movable wall of each of said pumping chambers, resilient means for moving said pumping member in one direction and electro-magnetic means for moving said pumping member in the opposite direction.

12. Fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the other end for delivery of fuel to the carbureter, said casing including an inlet chamber at one end, an outlet chamber at the opposite end and a pair of expansible and reducible pumping chambers in said casing between said inlet and outlet chambers, separate check valve controlled inlet connections from said inlet chamber to each of said pumping chambers, separate check valve controlled outlet connections from said pumping chambers to said outlet chamber, a single reciprocable pumping member forming a movable wall of each of said pumping chambers, resilient means within said casing for moving said pumping member in one direction and electro-magnetic means within said casing for moving said pumping member in the opposite direction.

13. Fuel feeding apparatus comprising a casing having an inlet at one end from a source of fuel supply and an outlet at the other end for delivery of fuel to the carbureter, said casing including an inlet chamber at one end, an outlet chamber at the opposite end and a pair of expansible and reducible pumping chambers in said casing between said inlet and outlet chambers, separate check valve controlled inlet connections from said inlet chamber to each of said pumping chambers, separate check valve controlled outlet connections from said pumping chambers to said outlet chamber, a single reciprocable pumping member forming a movable wall of each of said pumping chambers, resilient means within said casing for moving said pumping member in one direction and electro-magnetic means within said casing for moving said pumping member in the opposite direction, the effective capacity of one of said pumping chambers upon movement of said pumping member being greater than the other of said pumping chambers.

14. Fuel feeding apparatus comprising a casing having an inlet chamber at one end in communication with a source of fuel supply, an outlet chamber at the opposite end for delivery of fuel therefrom to a carbureter, a piston slidable within said casing between said inlet and outlet chambers, a pair of expansible and reducible pumping chambers supported by said piston and movable therewith and resilient means normally holding said piston together with said pumping chambers in position for minimum capacity of said outlet chamber, a reciprocable pumping member forming a movable wall of each of said pumping chambers, resilient means reacting between said piston and said pumping member to move said pumping member in one direction, electro-magnetic means supported by said piston for moving the pumping member in the opposite direction, and said pumping chambers having check valve controlled communication with said inlet and outlet chambers.

15. In combination with a fuel tank, a pump casing suspended in said tank and open at its lower end to receive fuel from said tank, said casing including an outlet pressure chamber at its upper end from which fuel is adapted to be fed to the carbureter, a pumping unit slidable in said casing forming a movable wall of said outlet chamber, resilient means reacting between said casing and said pumping unit tending to move said pumping unit in a direction for reduction of said outlet chamber and means for actuating said pumping unit to deliver fuel from said fuel tank to said outlet chamber.

16. A fuel pump comprising a pair of expansible and reducible pumping chambers, a separable pumping member forming a movable wall of both of said chambers, a magnet plunger secured to move with said pumping member, said magnet plunger also forming a movable wall of one of said pumping chambers whereby the pumping member has a decreased effective area in said last-mentioned pumping chamber, resilient means for moving said plunger and pumping member in the direction for delivery of fuel from the pumping chamber having the largest effective capacity and electro-magnetic means for moving said plunger and pumping member in the opposite direction.

17. In a fuel pump, a pair of expansible and reducible pumping chambers, a pumping member cooperating with both of said pumping chambers, one of said pumping chambers having an effective capacity greater than the other of said pumping chambers, resilient means for moving said pumping member in a direction to discharge fuel from the pumping chamber having the greater effective capacity and to produce an intake of fuel into the other pumping chamber and electro-magnetic means for moving the pumping member in the opposite direction whereby fuel is discharged from the pumping chamber having the smaller effective capacity and fuel

is drawn into the pumping chamber having the larger effective capacity.

18. In a fuel pump as described in claim 17, a common intake passage in communication with both of said pumping chambers, a common delivery passage in communication with both of said pumping chambers and means controlled by an increasing pressure in said delivery passage for reducing the rate of delivery of fuel through said delivery passage.

Signed at Chicago, Illinois, this 3rd day of October, 1931.

JOHN B. WHITTED.