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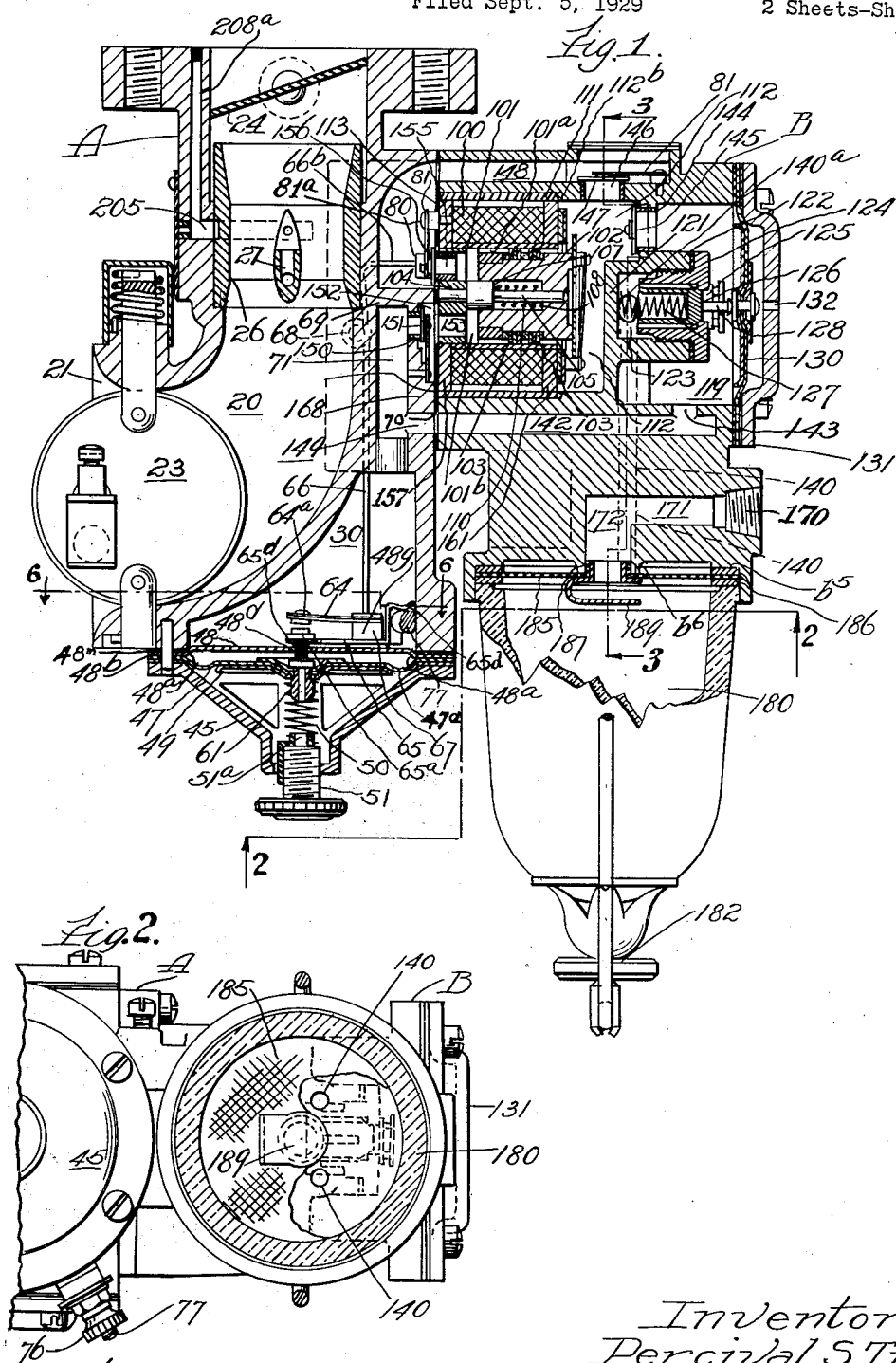
P. S. TICE

1,935,924

ELECTRIC FUEL FEED SYSTEM

Filed Sept. 5, 1929

2 Sheets-Sheet 1



Witness.  
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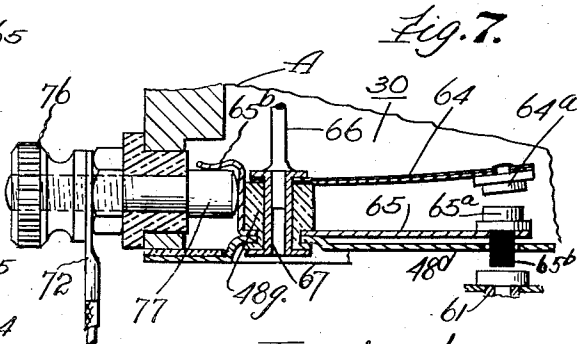
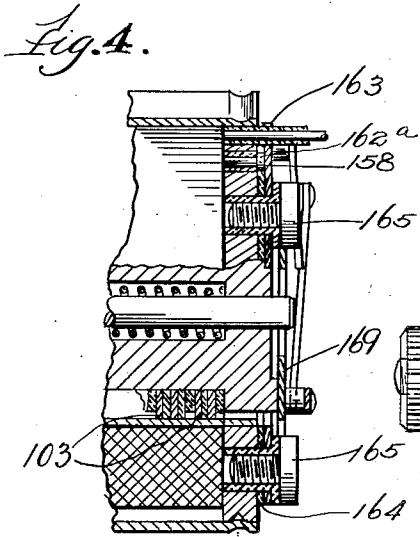
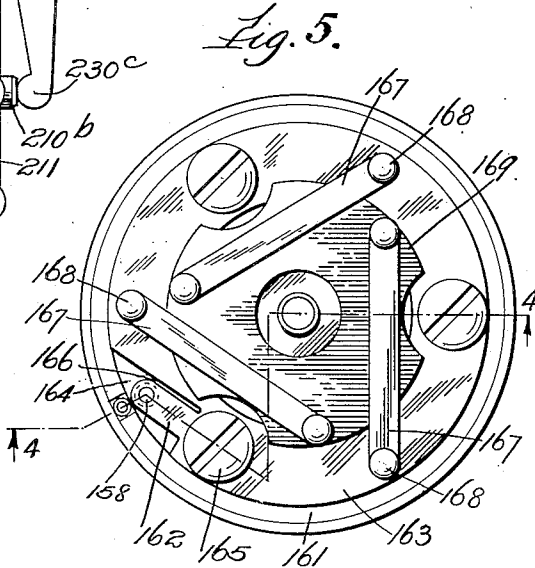
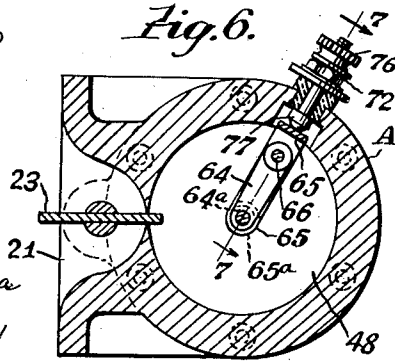
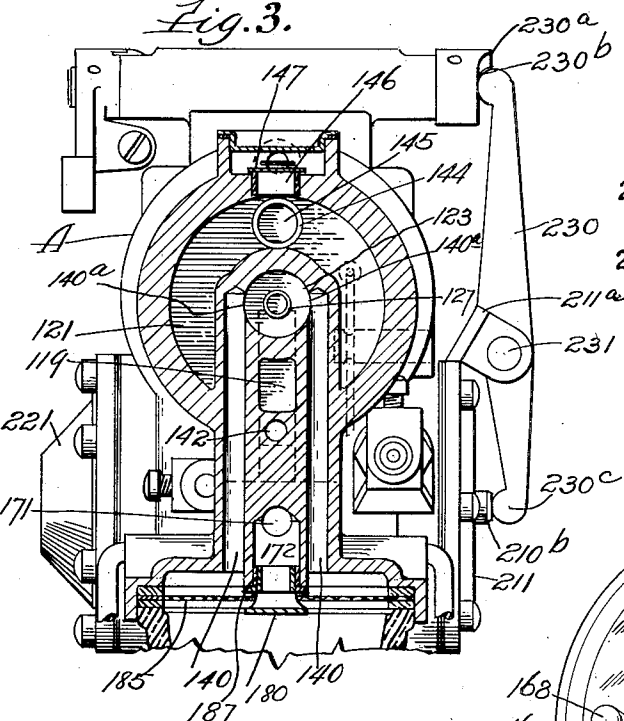
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**1,935,924**

## ELECTRIC FUEL FEED SYSTEM

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2 Sheets-Sheet 2



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*by Burton Burton*  
*his Attorneys.*

## UNITED STATES PATENT OFFICE

1,935,924

## ELECTRIC FUEL FEED SYSTEM

Percival S. Tice, Chicago, Ill., assignor to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Application September 5, 1929. Serial No. 390,602

4 Claims. (Cl. 103—40)

The purpose of this invention is to provide an improved construction for supplying fuel to an internal combustion engine in which the fuel may be pumped from a fuel source to the carbureter by electrically operated pumping apparatus mounted on the carbureter, a specific purpose of the invention being to adapt the construction to operate for supplying the carbureter suitably for requirements of the engine regardless of the level of the fuel source with respect to the carbureter. Other specific purposes are hereinafter indicated. The invention consists in the elements and features of construction shown and described as indicated in the claims.

In the drawings:—

Figure 1 is a vertical sectional view of a construction embodying this invention mounted in conjunction with and structurally as a part of an engine carbureter.

Figure 2 is a section at the line 2—2 on Figure 1.

Figure 3 is a section at the line 3—3 on Figure 1.

Figure 4 is a detail portion of a sectional view of the electric motor shown in Figure 1 on an enlarged scale.

Figure 5 is an elevation of the electric motor at the end of which Figure 4 is a section, upon the scale of Figure 4.

Figure 6 is a section at the line 6—6 on Figure 1.

Figure 7 is a section at the line 7—7 on Figure 6.

The carbureter construction shown in the drawings comprises a body member, A, having an air and fuel mixture conduit, 20, leading from the air inlet, 21, at which the air enters, substantially horizontally with a 90 degree bend upwardly to the upper end of said body member, at which the latter is adapted for mounting at the engine intake for discharge into the intake manifold, a choke valve, 23, being provided at the entrance, and the throttle valve, 24, being mounted at the upper discharge end.

In the upwardly extending part of said conduit there is mounted a Venturi sleeve, 26, having formed integrally with it a nozzle member, 27, hereinafter more particularly described.

The body member comprises also a fuel chamber, 30, extending adjacent the upwardly extending part of the air and fuel mixture conduit at the side opposite the air inlet and choke valve, said chamber extending down around and under the convex side of the 90 degree bend mentioned.

The fuel chamber extending to the lower end

of the body member, A, is closed at that end by a bottom skeleton cap, 45, conical in general form with its conical cavity at the upper side, and having a marginal exteriorly protruding flange mated in dimensions with the lower end of the body member for clamping between said lower end of the flange and said body member a flexible diaphragm, 47, which thereby becomes effectively the capacity-limiting bottom of the valve chamber; and above said diaphragm is a damping plate, 48, which is a metal stamping flexed upwardly as seen at 48<sup>a</sup> at the central area within the clamped margin, 48<sup>b</sup>, and insulated from the body member, A, by an interposed packing gasket, 48<sup>m</sup>. The diaphragm, 47, has at its under side a sheet metal disk, 49, reenforcing the diaphragm at a relatively large central portion of its area, limiting its flexure to the annular area, 47<sup>a</sup>, outside said central reenforced area.

There is provided at the under side of the diaphragm a coil spring, 50, reacting between the metal disk, 49, and thereby between the diaphragm, 47, and an adjusting screw, 51, which is screwed into the lower end of the bottom cap, 45, said spring being centered at its upper end upon the nut, 61, by which the disk, 49, is clamped to the diaphragm, the lower end of the spring being centered upon the reduced upper end, 51<sup>a</sup>, of the tensioning screw, 51.

The damping plate, 48, has a central aperture, 48<sup>d</sup>, affording restricted access to the diaphragm for the fuel in the stand pipe or lever-governing chamber, 30. Said damping plate carries an insulating post, 48<sup>e</sup>, on the upper end of which there is secured one end of an upper contact member, 64, and below which there is secured one end of a lower spring contact member, 65, said contact members both extending into alignment with the axis of the diaphragm where they are provided with contact buttons, 64<sup>a</sup>, 65<sup>a</sup>, respectively facing each other, the spring contact member, 65, having a nonconductive pin, 65<sup>b</sup>, projecting down through the aperture, 48<sup>d</sup>, in the damping plate, 48, for restricting said aperture and for encounter with the diaphragm, 47, at the center of the latter. The electric circuit in which the electro-magnetic pumping device, hereinafter described, is energized, comprises a current wire indicated in Fig. 7 at 72 leading to a binding screw, 76, of which the threaded post, 77, is insulatedly mounted laterally of the body, A, at the lower end thereof and protruding into the fuel chamber, 30, closely above the damping plate, 48, as seen in Figure 1, where the terminal of said insulated binding post is in contact with

the end of the spring contact member, 65, with which contact is maintained by the resiliency of the end portion, 65<sup>d</sup>, of said contact member which is suitably flexed for bearing against said binding post, as seen in Figure 7.

From the contact member, 64, the circuit is continued through a conductor, 66, hereinafter more particularly described.

From the foregoing it may be understood that in the intended operation the accumulation of fuel in the standpipe, 30, to a predetermined degree of hydrostatic pressure determined by the adjustment of the spring, 50, will operate the diaphragm for separating the contacts, 64<sup>a</sup> and 65<sup>a</sup>, opening the energizing circuit of the electro-magnetic pumping apparatus, and interrupting the fuel supply until the engine consumption causes the fuel level in the chamber, 30, to be reduced, reducing the hydrostatic pressure on the diaphragm, whose spring, 50, will thereupon react and cause the diaphragm to move the contact, 65<sup>a</sup>, for closing the circuit.

In the construction shown, the upper contact member, 64, is a bi-metallic bar comprising two strips of metal having different co-efficients of expansion and contraction under temperature change, the lower strip having the higher co-efficient so that the bar tends to be flexed upwardly at the end carrying the contact button, 64<sup>a</sup>, upon rise of temperature due to the fuel in the chamber, 30, becoming heated in the running of the engine.

The primary purpose of this feature of the construction is to cause the hydrostatic pressure for fuel delivery to be somewhat greater when the fuel is cold than when it is hot which is desirable for the reason that a richer mixture is needed when starting with the engine, and thereby the fuel, cold, than when the engine is warmed up by running and the fuel is correspondingly heated.

In modern engines, the engine becomes heated so quickly after starting that the normal condition may be properly considered to be the heated condition, and the above described features of the carburetor structure determining the normal depth of fuel in the carburetor fuel chamber are designed to ensure that depth with the engine heated.

Without the control afforded by the thermoresponsive contact carrier, 64, the level in the fuel chamber would be lower with the fuel cold and higher with the fuel hot, which is the reverse of the requirement of modern engines on modern cars, in which the provision of automatic temperature controlled radiator shutters and the like, causes the properly heated condition of the engine to be obtained so quickly at the starting of the engine, that the normal condition for which the level determining features are designed, is the heated and not the cold conditions; and the devices described get the necessary correction of level from normal to higher than normal when the engine, and thereby the fuel, is cold, or below what may properly be considered the normal temperature.

Accordingly, the normal form and position of the contact carrier, 64, may be considered to be its condition and form when flexed upwardly as seen in Figures 1 and 7 for holding the contact button, 64<sup>a</sup>, at a position requiring least hydrostatic pressure on the diaphragm in order to separate the contact, 65<sup>a</sup>, from said contact, 64<sup>a</sup>. And the abnormal condition may be regarded as that at which the part, 64, is straight or slightly flexed downward.

This feature also serves a secondary, but not negligible, purpose concerned with the increase of fluidity and reduction of viscosity which is concurrent with rise in temperature of the fuel. By reason of the increase of fluidity and reduction of viscosity which attend rise in temperature, the fuel will be discharged more freely, and so in greater quantity, through a given passage which is restricted so as to cause substantial friction when the fuel is hot than when it is cold.

And to maintain the desired uniformity of mixture, the pressure must decline as the temperature rises, which is the result of making the contact-carrying member, 64, bi-metallic, so that rise of temperature causes the contact button, 64<sup>a</sup>, to move in the direction for earlier opening of the circuit, i. e., opening with less depth of fuel in the fuel chamber.

Circuit connection to the upper spring contact member, 64, is made as above mentioned by a spring circuit wire, 66, which is mounted rigidly in a conductive sleeve, 67, which in turn is mounted in the post, 48<sup>a</sup>, above which said upper contact member is secured, the upper end of said sleeve being peened over the contact member, 64, for securing the latter on the post as above described. Said spring contact wire extends up in the chamber, 30, and at its upper end is bent laterally, as seen at 66<sup>b</sup>, for projecting into contact with a contact button, 80, hereinafter mentioned in the description of the electric pumping device; and for insuring some stress of the end of said spring circuit wire against said contact button, there is provided an insulated button, 68, mounted in the wall of the chamber, 30, against which the upright portion of said spring circuit wire, 66, is thrust by the button, 80, in applying and mounting the casing of the electric pumping structure hereinafter described on the outside of the chamber, 30.

The chamber, 30, is interrupted at the side opposite the air inlet, 21, for a limited part of its arcuate extent around the conduit, 20, and a limited part of its vertical extent by a hollow boss, 168, whose cavity co-operates as hereinafter described with the electro-magnetic fuel pump mounted on the carburetor body opposite said boss as hereinafter mentioned.

The electro-magnetic pumping element of the structure comprises a solenoid having energizing circuit windings, 100, wound on an axially hollow spool, 101, whose shaft, 101<sup>a</sup>, preferably of hard brass tubing, constitutes also the piston cylinder and pumping chamber of the pump, and in which the solenoid core, 102, furnished with packing rings, 103, 103, and reciprocating in the solenoid spool shaft, operates as a piston or pumping member. At one end the spool shaft, 101<sup>a</sup>, has fitted tightly in it and forming a cylinder head, a plate, 104, toward and from which the solenoid-core-piston, 102, reciprocates, said head carrying an axially positioned stem, 105, on which the solenoid core-piston slides in its reciprocation. Said stem is reduced in diameter for a substantial part of its length from the end remote from the head, 104, forming a shoulder, 107; and the solenoid core-piston, bored to fit said reduced part of the stem, is counterbored to fit the unreduced part, forming a shoulder, 108, which co-operates with the shoulder, 107, for stopping between said shoulders a coiled spring, 110, which is normally compressed for reacting on the solenoid core-piston, 102, to hold it spaced away from the head, 104, toward which it is retracted by the magnetic action when the solenoid

winding is energized, as may be understood from the relative location of the middle point of the length of the wound portion of the solenoid spool and the middle point of the length of the core, 102, as seen in Figure 1.

The solenoid spool, 101, is fitted tightly in a cylindrical casing, 111, which in turn is fitted tightly in a cylindrical cavity, 112, of the main pump and motor casing, B, said cavity being counterbored to admit said solenoid spool casing, 111, inserted from one end of the main casing, B, to the shoulder, 112<sup>b</sup>, formed by said counterbore. The main casing, B, is formed at the end at which the solenoid is inserted, with a flat face, 113, with which the end of the solenoid in which the head, 104, is located, is flush; and the carbureter body, A, is formed at the side opposite the air inlet, 21, with a mated face, 70, at which the cavity, 71, of the boss, 69, opens, and at which also the fuel chamber, 30, opens above said boss, 69.

The main motor and pump casing, B, beside the cavity, 112, into which the solenoid spool casing, 111, is fitted, as mentioned, has at the side opposite the flat face, 113, at which it is mounted on the carbureter body, a cavity, 119, partitioned from the cavity, 112, and having projecting into it from the partitioning web, 121, a hollow boss, 122, whose cavity, 123, opens toward the end of the main casing opposite the flat face, 113, said cavity having a closure plug, 124, screwed into the boss, 122, and having a port, 125, at which there is seated interiorly of said plug and boss cavity, a valve, 126, of substantial length and axially bored from the end opposite the valve head to accommodate a spring, 127, which reacts upon the bottom of the boss cavity, 123, and the valve, 126, for holding the valve normally seated at the port, 125.

The boss cavity, 123, has communication with the fuel source, as hereinafter more particularly described, by two ducts, 140, 140, formed in the casing, B, discharging in said cavity by ports, 140<sup>a</sup>, 140<sup>a</sup>, and leading up through said discharge ports from the bottom side of the casing B, at which they are open for entry of the fuel from the fuel receiving chamber hereinafter described.

The valve, 126, has a stem, 128, protruding through the port, 125; and the casing cavity, 119, formed widely open at the end toward which the valve stem projects, is closed by a flexible diaphragm, 130, clamped in place by a cover member, 131, which has an atmosphere vent, 132.

The parts are dimensioned so that at what may be termed the normally seated position of the valve, its stem is thrust against the diaphragm when the diaphragm is at a position due to a predetermined sub-atmospheric pressure in the chamber.

The casing, B, is formed and arranged, as hereinafter more particularly described, for fuel entrance by the two parallel ducts, 140, 140, leading in the partition, 121, to the boss cavity, 123, in which said ducts open at opposite sides inwardly from the inner end of the plug and valve, 126. The casing, B, has at the lower side of the solenoid structure a duct, 142, communicating at one end by a port, 143, with the cavity, 119, and at the other end opening through the flat face, 113, of the casing, B, at which it is mounted on the carbureter body as described. A port, 144, in the partition, 121, controlled by a valve, 145, leads from the upper

part of the chamber, 119, into the solenoid pump compartment, 101<sup>a</sup>, at the side of the solenoid core-piston remote from the carbureter body, A; and a port, 146, controlled by a valve, 147, leads from said compartment to a duct, 148, formed in the upper part of the casing, B, leading to and opening through said flat face of the casing. The boss, 69, of the carbureter body has its cavity formed with two openings through the flat face, 70, of the carbureter body at which the casing, B, is mounted; the opening, 149, registers with the open end of the duct, 142, and the opening, 150, provided with an inwardly opening check valve, 151, whose chamber, 152, is registered with an inlet port, 153, of the pump cylinder head, 104; said inlet port opening into the compartment, 101<sup>b</sup>, at the side of the core-piston toward the carbureter body, A.

Beside said open port, 153, the cylinder head, 104, has a port, 155, controlled by an outwardly opening check valve, 156, said port, 153, affording fluid discharge into the carbureter fuel chamber, 30.

Upon considering this construction and arrangement of passages and valves, it may be understood that the reciprocation of the solenoid core-piston, 102, operates in the stroke due to the energizing of the solenoid winding, 100, viz., the stroke toward the mated faces of the carbureter body and the casing, B,—to draw in fuel to the cavity, 112, by way of the port, 144, chamber, 119, port, 125, boss cavity, 123, ports, 140<sup>a</sup>, and ducts, 140, the fuel entering past the valve, 126, which will be held open by the diaphragm, 130, under exterior atmospheric pressure against the sub-atmospheric pressure within the chamber, 119, of the casing, B, the fuel reaching the boss cavity by way of the ducts, 140, 140, from the fuel receiving chamber which derives it from the fuel source, as hereinafter described. And in the same stroke any fuel present in the pumping compartment, 101<sup>b</sup>, will be discharged through the port, 155, past the valve, 156, directly into the carbureter chamber, 30.

On the reverse stroke of the solenoid core piston, fuel will be drawn into the solenoid pump compartment, 101<sup>b</sup>, past the valve, 151, through the cavity, 71, port, 149, duct, 142, port, 143, chamber, 119, boss cavity, 123, and ducts, 140; while fuel is discharged from the cavity, 112, past the valve, 147, through the ducts, 148, into the carbureter fuel chamber, 30.

The course of the electric circuit which includes the solenoid winding and the circuit interrupting switch for controlling the alternate energizing and de-energizing of the solenoid windings by which the reciprocation of the piston is effected, constitute part of the subject matter of my pending application Serial No. 337,932, filed February 6, 1928, and will require here only limited description.

The current led in as above described from the current source by way of the binding screw and post, 76—77, reaches the solenoid winding by way of the spring circuit wire, 66, contact button, 80, carried by the spring arm, 81, of the valve, 156, said spring arm being mounted insulatedly on the solenoid spool head, 157, by a conductive stud, 81<sup>a</sup>, whose inner end is soldered to the end of the solenoid winding at that end of the switch, said winding having its opposite end soldered to the inner end of a conductor, 158, mounted on the spool head, 161, in conductive contact with the free end of a short spring bar,

162, mounted by its opposite end insulatedly on the spool head on which there is mounted a conductive annulus, 163, with interposed insulating gasket, 164, the spring bar, 162, being secured by one of the screws, 165, which secure the annulus, 163, the latter being slotted, as seen at 166, to admit the contacting free end of the spring bar, 162, to the insulating gasket, 164, for making the contact of the spring bar from the contact button, 162<sup>a</sup>, which protrudes through said insulation, so that the conductive connection of the solenoid winding with the annulus, 163, is made through said spring bar.

A steel disk, 169, whose diameter is a little greater than the inner diameter of the annulus, 163, is carried by three spring arms, 167, each secured rigidly at one end to the spool head with intervening short posts, 168, by which said spring arms are in conductive relation with the annulus, 163, and at the other end secured to the steel disk, 169, and holding the latter normally spaced from the annulus, so that it is in conductive relation to the annulus only through the spring arms, 167, which carry it resiliently with freedom of movement in both directions from normal position.

When the solenoid core-piston makes its stroke under the reaction of the spring, 110, which occurs when the solenoid winding circuit is open and the circuit is not energized, the arrival of the solenoid core-piston into contact with the steel disk, 165, closes the circuit, which is then grounded through the solenoid core and spool, tending to cause the core-piston to be instantly retracted magnetically.

It will be seen that if the disk, 169, were positively fixed in position, the contact of the solenoid core with it would be broken instantly as soon as formed by the retraction of the core-piston, and the piston strokes would be reduced to mere trembling vibration into and out of contact with the disk.

But the disk being carried yieldingly and resiliently by the spring arms, 167, the momentum of the core-piston causes it to continue its stroke slightly after it encounters the disk, 169, and after the circuit is thereby closed for energizing the solenoid winding; and the disk being steel and magnetically susceptible, is magnetically held to the core-piston not only for the part of the retracting stroke due to the energy of the solenoid during which the spring arm reacts, but also for a further distance during which the magnetic attraction holds the disk against the resilient reaction of the spring arms due to their being flexed from normal position in the opposite direction from that in which the impact and momentum of the core-piston first flexes them.

By this means it will be seen that the closure of the circuit for energizing the solenoid is prolonged so that the piston strokes are of substantial length for the pumping action.

The fuel supply is led from the fuel source through a pipe connected with the pump body member, B, as seen at 170, the duct, 171, in the body member, B, leading from the connection, 170, for discharge downwardly as indicated at 172 into the fuel receiving and sediment trapping chamber, 180, consisting of a transparent cup clamped in any convenient manner by a yoke, 181, and clamp screw, 182, onto the under side of the member, B, which is suitably provided with an annular seat, b<sup>5</sup>, mating the upper end of the cup, 180, a strainer, 185, being clamped between the cup and the body, B, with suitable packing

gaskets, 186, interposed at both sides of the strainer. The strainer is centrally apertured, and has its aperture flanged, as seen at 187, for engaging the boss, b<sup>6</sup>, through which the duct, 172, discharges and registering said aperture with said duct; and a small disk, 189, is mounted in any convenient manner positioned a short distance below the discharge of said duct, 172, for dispersing the fuel discharged downwardly to prevent it from constituting a jet which would stir up the sediment which may be accumulated in the bottom of the cup.

It will be understood that with this construction the fuel flowing from the fuel source entering the duct, 171, and delivered in the fuel receiving chamber, 180, first fills that chamber to the top and reaches the lower end entrance of the ducts, 140, 140, only after passing through the strainer, 185; so that any solid impurities are eliminated and prevented from entering the pump or the carbureter. And in this process the sediment tends to accumulate in the bottom of the cup which can be readily detached for removing the sediment from time to time.

I claim:

1. An electrically operated pump having a discharge, the pump casing having a chamber forming part of the liquid inflow conduit to the pump, a valve controlling communication of said last mentioned chamber with the antecedent part of said conduit, said valve being arranged to seat in the direction of inflow, and a spring for holding it normally and yieldingly seated, a flexible diaphragm forming part of the outer wall of said chamber arranged to receive the thrust of the seating movement of the valve, and at normal position of the diaphragm due to predetermined sub-atmospheric pressure in the chamber to hold the valve open against the liquid inflow tending to seat it, and to yield outwardly and permit the valve to be seated by the pressure of the liquid in the chamber when said pressure exceeds atmospheric, the diaphragm being arranged extending up and down at one side of said chamber and the inflow to the pump being arranged leading out from said chamber at substantially the level of the upper margin of the diaphragm; whereby at all times during pumping operation the chamber is occupied by liquid to the depth substantially equal to the diameter of the diaphragm, and the diaphragm is thereby exposed to hydrostatic pressure of that depth of liquid over substantially its entire area.

2. The construction defined in claim 1, the pump casing having an aperture closed by the diaphragm and having a chamber for the valve located interiorly of the first mentioned chamber opposite the diaphragm, the liquid inflow conduit comprising a duct in the casing leading to said valve chamber, said chamber being open toward the diaphragm and having a closure plug containing the port and seat for the valve, the valve stem being protruded from the port for co-operating with the diaphragm for the control of the valve by the diaphragm as described.

3. An electric pumping mechanism comprising a chambered casing, a solenoid structure fitted in a chamber of the casing and having a reciprocating core; said solenoid and its core partitioning said chamber into two compartments each having liquid inlet and liquid outlet, and valves controlling the same for one-way liquid flow through the respective compartments from the liquid source to the pump discharge, said casing having at one end of the first mentioned chamber

a second chamber; a valved duct leading from the liquid source for discharge in said second chamber, said second chamber having a flexible diaphragm forming a portion of its outer wall exteriorly exposed to atmosphere and interiorly associated with the duct valve for holding the same open; whereby the diaphragm operates for opening the valve correspondingly to the degree of vacuum produced in the suction stroke of the

pump and permits the valve to be seated when the pressure in the chamber exceeds atmospheric pressure.

4. In the construction defined in claim 3, a spring reacting on the valve for seating it, and the valve being arranged for seating in the direction of the outward flexure of the diaphragm.

PERCIVAL S. TICE.

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