Jan. 30, 1968 M. KOCOLOWSKI 3,366,067

PUMP ASSEMBLY

Filed April 25, 1966 2 Sheets-Sheet 1

Fig. 1.

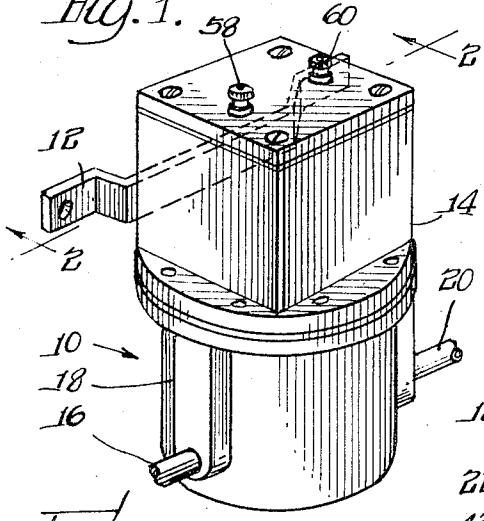


Fig. 2.

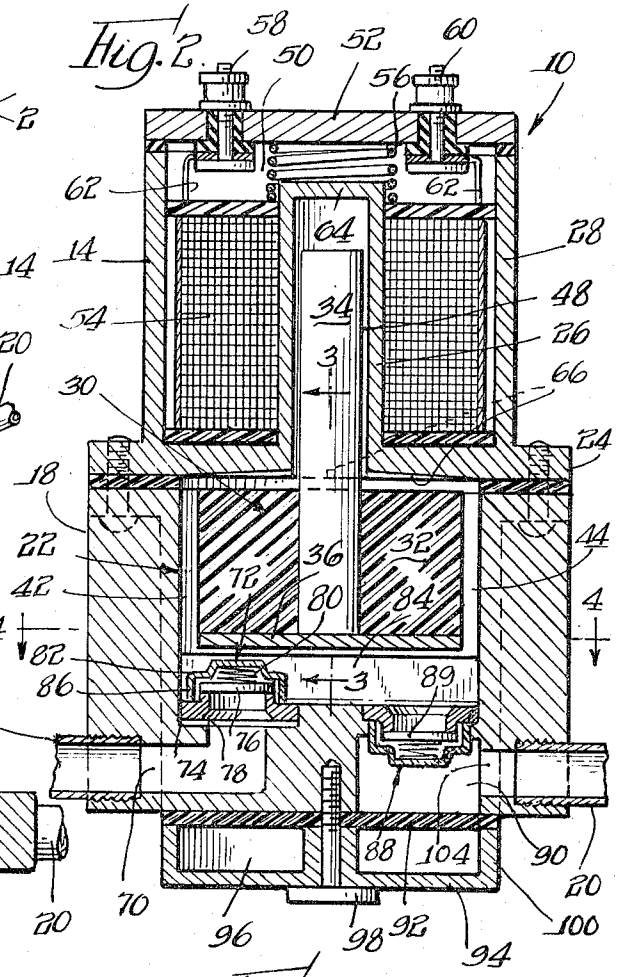


Fig. 4.

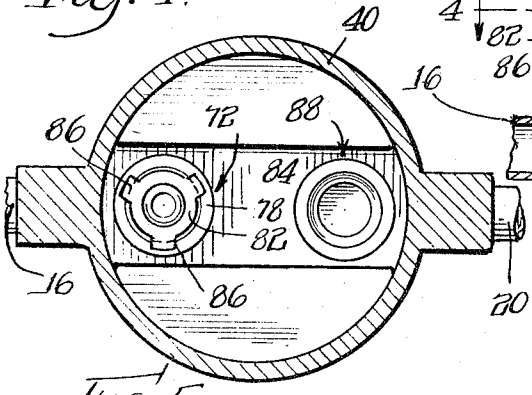


Fig. 5.

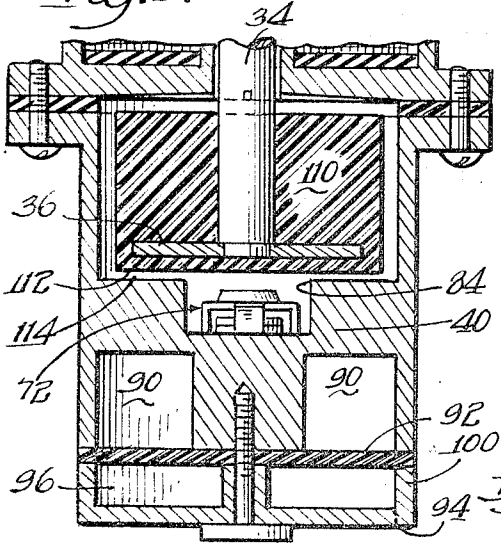
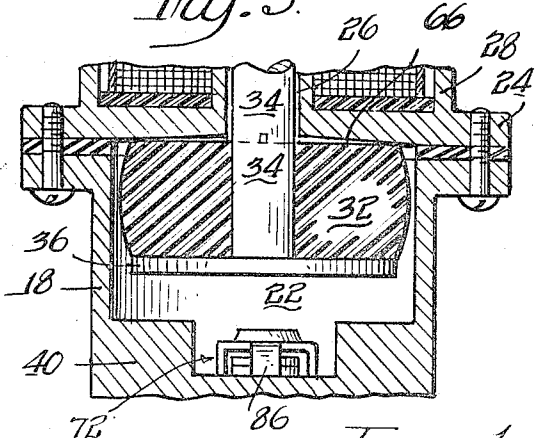


Fig. 3.



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Fig. 6.

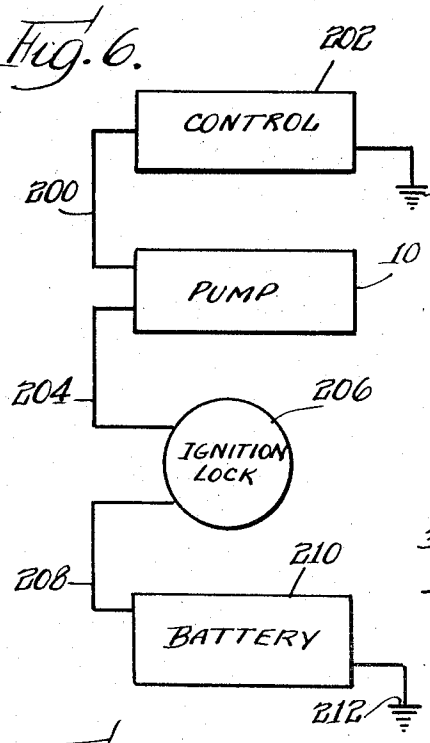


Fig. 7.

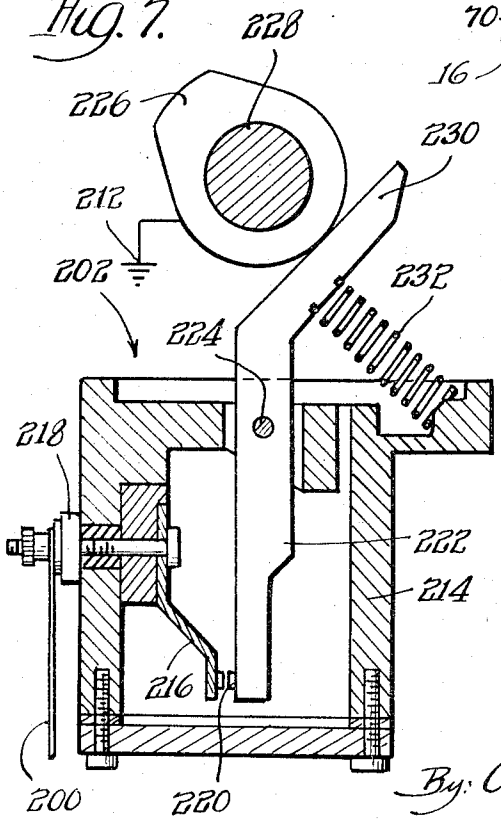


Fig. 8.

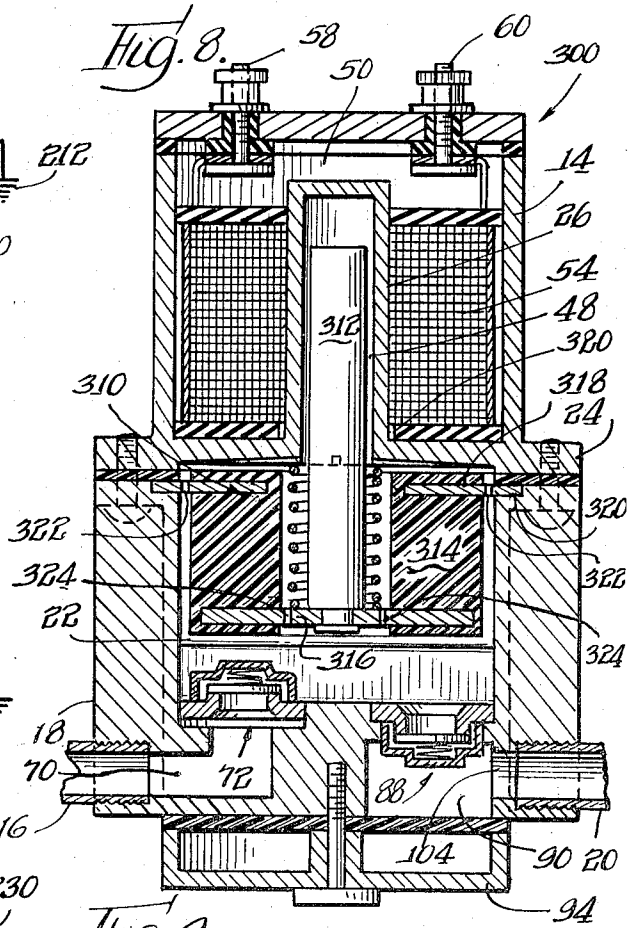
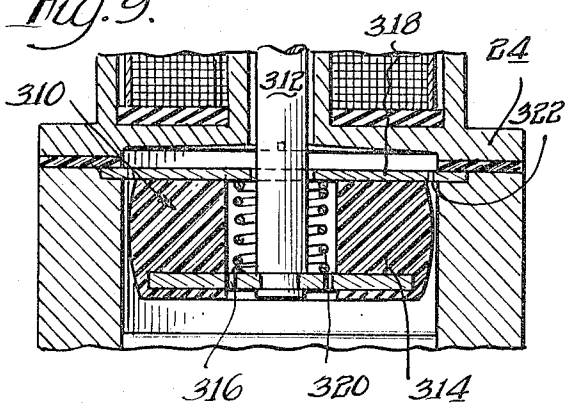


Fig. 9.



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PUMP ASSEMBLY

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17 Claims. (Cl. 103—53)

The invention in this case relates generally to a pump and more particularly to an electric fuel pump.

Fuel pumps commonly utilize a flexible diaphragm which is actuated by a mechanical or electrical drive means. The diaphragm is normally pulled inwardly by the drive means to draw fuel into the pump from a fuel line. Similarly, the diaphragm is forced outwardly by the drive means to discharge the fuel under pressure from the pump. Thus, it is through a continuous flexing of a diaphragm that prior art pumps apply a pressure differential to fuel or other liquid flowing in a line or conduit.

The generally satisfactory performance of prior art diaphragm fuel pumps is clearly indicated by their widespread use for pumping fuel. However, diaphragm pumps have several drawbacks which detract substantially from the satisfactory performance of the pump. One of the main drawbacks of a diaphragm pump is its relatively short service life. The pump often fails to operate, after a relatively short period, due to leaks in the diaphragm which are caused by the continuous flexing or a puncturing of the diaphragm. Once the diaphragm develops a leak, the pump must be replaced, since the leaking diaphragm is unable to either draw fuel into the pump or to expel fuel under pressure from the pump.

Another drawback in prior art pumps is found in the drive means utilized to actuate the diaphragm. The drive means normally includes a linkage which is connected to the engine supplied with fuel by the pump. Since the drive means for the pump is connected to the engine, the rate of actuation of the fuel pump is coordinated with the speed of the engine. However, with continuous use, the linkage usually becomes worn and does not function properly. When the linkage becomes worn, or otherwise defective, the pump is not actuated in coordination with the speed of the engine and the rate of fuel consumption.

In addition to the above defects, prior art fuel pumps often develop vapor locks. The vapor locks result from fuel in the fuel line or pump being vaporized by heat from the engine. Since prior art fuel pumps are commonly driven by a linkage connected to the engine, the pumps must be placed near the engine where they are heated and susceptible to vapor locks.

Therefore, one of the objects of this invention is to provide an improved fuel pump which overcomes the aforementioned limitations of prior art constructions. Specifically, it is an object of this invention to provide a fuel pump which utilizes a resilient piston member, rather than a diaphragm, for pumping liquid.

Another object of this invention is to provide a fuel pump which can be mounted separately from the engine while still having its rate of actuation coordinated with the speed of the engine.

Another object of this invention is to provide a pump assembly having a long service life.

Still another object of this invention is to provide a fuel pump which has a rugged, long lasting, drive means.

These and other objects and features of the invention will become more apparent upon a reading of the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a pump assembly embodying my invention;

FIG. 2 is an enlarged sectional view, taken along the line 2—2 of FIG. 1, showing the interior construction of the fuel pump of FIG. 1 with a piston member in a normal position;

FIG. 3 is an enlarged detailed sectional view of the pump assembly of FIG. 2 showing the piston member in a compressed position;

FIG. 4 is a sectional view, taken along the line 4—4 of FIG. 2, showing the placement of check valves in the pump of FIG. 2;

FIG. 5 is a detailed sectional view illustrating a second embodiment of the piston member of FIG. 4;

FIG. 6 is a schematic drawing of the control circuit for the pump of FIG. 1;

FIG. 7 is a detailed sectional view showing the structure of a control unit for coordinating the actuation of the pump with the speed of an engine;

FIG. 8 is a detailed sectional view of a second embodiment of the pump of FIG. 1, wherein a piston member is shown in the normal position in a pumping chamber; and

FIG. 9 is a sectional view of a second embodiment of the piston member utilized in FIG. 8, with the piston member in the compressed position.

Referring now to the drawings in greater detail, there is shown in FIGS. 1 and 2 a pump assembly **10** illustrating a preferred embodiment of my invention. The pump **10** is connected to a suitable wall structure by a mounting bracket **12** which is fastened to an upper section **14** of the pump. An inlet conduit **16** is secured to a base wall **18** of the pump for conducting fluid to the pump. Similarly, an outlet conduit **20** is connected to an opposite side of the base wall **18**. The pump **10** draws fluid from the conduit **16** and pumps the fluid, under pressure, into the conduit **20**.

As is best seen in FIG. 2, the pump **10** includes a generally cylindrical pumping chamber **22** which is defined by the generally cup-shaped base wall **18** and a circular end wall **24** of the upper section **14** of the pump. The end wall **24** includes a cylindrical stem portion or wall **26** which extends longitudinally upwardly from the center of the end wall **24**. The cylindrical stem portion **26** is positioned coaxially with the base wall **18** and an outer side wall **28** of the upper section **14**. It should be noted that the pumping chamber **22** extends upwardly into the stem portion **26** of the end wall **24**.

A piston member **30** is positioned in the pumping chamber **22**. The piston includes a cylindrical head portion **32** which is made of a resiliently compressible material, such as closed cell neoprene rubber sponge or other suitable polymeric material. A cylindrical rod member **34** is connected to a support plate **36** which supports the piston head **32**. Although in a preferred embodiment the piston head **32** is freely movable relative to the rod member **34**, it is contemplated that the piston head could be secured to the support plate **36** by a suitable adhesive.

The rod member **34** is made of a magnetizable material, such as iron, and extends upwardly into the stem portion **26** of the pumping chamber **22**. The cylindrical piston

30 is freely movable from a position abutting a lower end wall 40 of the base 18 to a position abutting the upper end wall 24. The piston head 32 and rod 34 are, advantageously, formed with an exterior diameter which is somewhat smaller than the interior diameter of the sidewalls 18 and 26 of the pumping chamber 22.

For purposes of clarity, the piston head has been shown in the drawings as having a smaller longitudinal dimension than the longitudinal length of the main portion 42 of the pumping chamber 22. Although the pump could be constructed in such a manner, in the preferred embodiment the piston 30 has a length at least equal to the length of the main portion 42 of the pumping chamber. However, the diameter of the piston head is smaller than the diameter of the main portion 42 of the pumping chamber. Thus, there is a space 44 between the piston head and the wall 18 of the pumping chamber. Similarly, there is a space 48 which surrounds the piston rod 34. From the foregoing remarks it is apparent that the piston 30 is not attached to either the upper section 14 or base wall 18 of the pump. Thus, the piston 30 is freely movable in the pumping chamber 22.

The outer side wall 28 defines a second cylindrical chamber 50 which is located in the upper section 14 of the pump, above and adjacent to the pumping chamber 22. The end portions of the chamber 50 are defined by the end wall 24 and an end wall or cap 52. The stem portion 26 of the pumping chamber 22 extends upwardly into the chamber 50 along a central longitudinal axis of the chamber 50.

A cylindrical electromagnet 54 is mounted in the chamber 50 in a telescopic relationship with the stem portion 26 of the pumping chamber 22. A central longitudinal axis of the electromagnet 54 is positioned coaxially with a central longitudinal axis of the pumping chamber 22 and the upper chamber 50. The electromagnet 54 is held in position in the chamber 50 by means of a spring 56 which engages the end wall 52 and an end of the electromagnet 54. A pair of contacts 58 and 60 are mounted in the end wall or cap 52 to provide electrical connections for the magnet.

Energization of the electromagnet 54, by means of electrical energy, conducted through leads 62 to the magnet from the contacts 58 and 60, causes the magnet to attract the rod 34 of the piston 30. The rod 34 is then drawn upwardly into the stem portion 26 of the pumping chamber 22. This upward movement of the rod member 34 into the stem portion 26 pulls the plate 36 upward to compress the resilient piston head 32 against the end wall 24 of the pumping chamber 22. The upward movement of the rod 34 and plate 36 is limited by the compressability of the piston head 32. A plurality of radially outwardly extending slots 66 are provided in the end wall 24 to permit fluid, which is in the stem portion 26 of the pumping chamber 22, to flow out of the stem portion as the rod 34 is attracted into the stem portion. It will be apparent to those skilled in the art that the stroke of the piston rod 34 can also be limited by shortening the length of the stem portion 26 of the pumping chamber. When the stroke of the rod 34 is so limited the upper end of the rod will engage an end wall 64 of the stem portion of the pumping chamber as the piston head 32 is compressed.

As previously explained, energization of electromagnet 54 causes the end plate 36 to compress the piston head 32 against the end wall 24 for a normal position shown in FIG. 2 to a compressed position shown in FIG. 3. The piston 30 is freely movable in the pumping chamber 22, that is the piston 30 is not connected to the wall of the pump 10 and is unrestrained against upward movement in response to the magnetic forces acting on the rod member 34. Therefore, the piston moves quickly and freely upwardly, to press the upper end portion of the head 32 against the end wall 24, in rapid response to energization of the electromagnet.

Compressing the head member 32 increases the free or unoccupied volume of the pumping chamber 22. This increase in volume of the pumping chamber 22 tends to create a partial vacuum in the pumping chamber. This tendency reduces the pressure in the pumping chamber to draw fluid from the conduit 14 into a cylindrical inlet passage 70 which is formed in the end wall 40. A check valve 72 is mounted in a seat 74 at the end of the inlet passage 70. The check valve 72 includes a circular disc member 76 which is pressed against a base portion 78 of the check valve by a spring 80 which also engages a retaining frame 82 of the check valve.

As is best seen in FIG. 4, the check valve 72 is positioned in a protective recess 84 in the end wall 40 where it will not be damaged by the plate 36. The check valve 72 permits fluid to flow from the conduit 16 through the passage 70 upwardly into the pumping chamber 22 when the piston head 32 is compressed to create a partial vacuum within the pumping chamber. The upward flow of fluid forces the circular disc 76 against the retaining frame 82, to enable fluid to flow between legs 86 of the retaining frame 82.

The piston 30 tends to spring back to its normal position when the electromagnet 54 is deenergized. The return of the piston to its normal position is expedited by the natural resiliency of the head 32. The head 32 will force the plate 36 downwardly when the electromagnet 54 is deenergized to expel fluid from the pumping chamber 22. It should be noted that the fluid cannot flow into the inlet passage 70, since the disc 76 of the check valve 72 will be firmly positioned against the base 78 of the check valve to prevent the fluid from flowing into the passage 70.

A second check valve 88, similar to the check valve 72 is also mounted in the recess 84. Since the check valve 88 is oriented oppositely to the check valve 72 fluid pressure on the check valve 88 will force disc 89 downwardly against the retaining frame for the check valve 88. Fluid can then flow under pressure from the pumping chamber 22 into an outlet chamber 90 wich is formed in the end wall 40.

The outlet chamber 90 is defined by the end wall 40 and a resiliently flexible sheet or diaphragm 92, made of neoprene or a similar polymeric material, which is held in sealing engagement with the outer surface of the end wall 40 by a cap 94. The cap 94 is formed with a generally toroidal chamber 96 which is positioned directly beneath the flexible sheet or diaphragm 92. A suitable screw, or other connector 98, holds upstanding sidewalls 100 of the cap in firm engagement with a lower surface of the sheet or diaphragm 92. Fluid, pumped in pulses from the pumping chamber 22 by the piston 30, surges downwardly against the flexible diaphragm or sheet 92. The flexible diaphragm or sheet 92 absorbs these downward impulses by stretching into the chamber 96 in the cap 94. Thus, the sheet 92 absorbs or dampens fluid impulses created by the action of the piston 30 in the pumping chamber 22. The fluid then flows smoothly, under pressure, from the outlet chamber 90 into an outlet passage 104 to the fluid conduit 20.

Referring now to FIG. 5, there is shown a second embodiment of the piston member. In the embodiment of FIG. 5 a resiliently compressible head element 110 is provided. The end plate 36 is embedded in the head element 34 so that the resiliently compressible material completely surrounds the plate 36. Since the resiliently compressible material surounds the plate 36, a lower surface 112 of the piston head resiliently engages an upper surface 114 of the end wall 40. This resilient engagement of the piston head 110 with the end wall 114 eliminates any tendency of the piston head to create vibrations and noise when the piston is returned to its normal position after the electromagnet 54 is deenergized.

The operation of the fluid pump 10, constructed as ilustrated in FIGS. 1 to 5, will be largely apparent from the foregoing description. However, a brief functional description is now provided of the mode in which parts of the pump thus far identified cooperate. The pump 10 in-

cludes a pumping chamber 22 in which a freely mounted piston 30 is movable from a first normal position, shown in FIG. 2, wherein a resiliently compressible head 32 is extended to its full or normal size to a second compressed position shown in FIG. 3. The piston rod 34, of a magnetizable material, is drawn upwardly into the stem portion 26 of the pumping chamber 22, by magnetic attraction when the electromagnet 54 is energized. The upward movement of the rod 34 compresses the head 32, as shown in FIG. 3, between the plate 36 and the end wall 24 of the pumping chamber 22. As the head 32 is compressed, a partial vacuum tends to be created in the pumping chamber 22 to draw fluid from the inlet conduit 14 through the check valve 72 and into the pumping chamber.

When the electromagnet 54 is deenergized, the resiliently compressible head 32 forces the plate 36 and the rod member 34 downwardly to expel fluid under pressure from the pumping chamber 22 through the check valve 88. The fluid will enter the outlet chamber 90 in a series of pulses, created by the downward movements of the piston 30, which are absorbed by the resilient sheet or diaphragm 92. The fluid, due to the damping action of the resilient sheet 92, will flow out of the outlet chamber 90 into the conduit 20 in a relatively smooth flow.

The piston 30 is the primary moving part in the pump 10. Since the piston 30 is not connected, by a web or other means, to the side walls 18 of the pump, the piston will have an almost indefinite service life. The resiliently compressible head member will not, under normal service conditons, tend to fail due to being repeatedly compressed and expanded. It should be noted that the plate 36 is spaced apart from the check valves 72 and 88 by the recess 84 and will, when the electromagnet 54 is not energized, rest again the end wall 40 of the pumping chamber 22.

It will also be apparent that the service life of the pump is increased since the pumping chamber 22 is fabricated in the base portion 18 and is completely separated from the upper chamber 50 in which the electromagnet 54 is placed. Thus, there will be no tendency for the fluid to leak from the pumping chamber 22 into the chamber 50 and short out the electromagnet 54, causing a failure of the pump. It will be apparent to those skilled in the art that the volume of fluid expelled by the pump, each time the electromagnet 54 is energized, can be altered by merely increasing or decreasing the size of the resiliently compressible head member 32. Thus, if the head member 32 is increased in size, while the stroke of the rod member 34 is maintained constant, the compression of the head member will result in a greater increase in the free, or unoccupied space, in the pumping chamber 22 when the head portion is compressed. This results in a tendency to create a soemewhat greater partial vacuum within the pumping chamber 22 and to draw a larger quantity of fluid into the pumping chamber each time the electromagnet 54 is energized. When the electromagnet 54 is deenergized this larger volume of fluid will be expelled from the pumping chamber into the outlet chamber 90.

Although the pump 10 can be utilized for pumping any fluid medium, it is contemplated that the pump will be utilized as a fuel pump for an engine. In FIG. 6 a schematic drawing is set forth illustrating the illustration of the pump 10 in such an environment. The electromagnet 54 of the pump 10 is connected by the lead 200 to a control unit 202. The electromagnet 54 is also connected, by a lead 204, to an ignition lock 206 for the engine which is supplied with fuel by the pump 10. The ignition lock 206 is connected by a lead 208, in the conventional manner, to a battery 210 which is grounded at 212. When the ignition lock is turned on, the pump 10 is energized with power from the battery 210 through the leads 208 and 204. The control unit 202 is sequentially actuated, in a manner to be explained in greater detail subsequently, to connect the pump 10 to the ground 212. When the electromagnet 54 of the pump 10 is connected to ground through the control unit 202 a complete electrical circuit is provided for the electromagnet 54 through the battery 210. The pump will then be actuated to draw fluid into the pump chamber 22.

A preferred embodiment of the control unit 202 is shown in FIG. 7. The control unit 202 includes a housing 214 on which a fixed contact 216 is mounted. The fixed contact 216 is connected by a terminal 218 to the electrical lead 200. A movable contact 220 is mounted on the rocker arm 222 which is pivotably connected at 224 to the housing 214. A cam member 226 is connected to a cam shaft 228 of the engine which is to be supplied with fuel. A cam follower portion 230 of the rocker arm 222 is pressed against the cam 226 by the spring member 232. When the cam shaft 228 is rotated by the engine, the cam 226 engages the cam follower 230 to pivot the rocker arm 222 and bring the contact 220 into engagement with the fixed contact 216. The engagement of the fixed contact 216 with the moving contact 220 on the rocker arm 222 will complete a circuit, through the rocker arm 222 and cam 226 to the ground 212.

If the engine should be stopped with the nose portion of the cam 226 engaging the follower 230, the contacts 216 and 220 will remain closed and continuously energize the electromagnet 54. The continuous energization of the electromagnet 54 could, over a period of time, burn out the electromagnet. However, the ignition lock 206 is provided in the circuit between the battery 210 and pump 10. Therefore, when the engine is turned off, by opening the ignition lock 206, the circuit between the pump 10 and the battery 210 will be interrupted so that the electromagnet 54 cannot be burned out when the contacts 216 and 220 happen to be in engagement when the engine is stopped.

The control unit 202 is mounted on the engine which is being supplied with fuel by the pump 10. However, the pump can be positioned at a location away from the engine. By positioning the pump in a location spaced apart from the engine, the pump is not subjected to the relatively high temperatures which are normally present in an engine compartment. These relatively high temperatures, which are commonly found in engine compartments, tend to vaporize the fuel in the pump or the conduits leading to the pump. This vaporization of fuel in the pump results in a vapor lock which renders the pump inoperative for a period of time. Since the electrical lead 200 can be connected to a remotely located control unit, the pump 10 can be positioned in a location separated from the engine compartment and is not, therefore, as susceptible to vapor lock as are prior art pumping systems.

A second embodiment of the pump assembly is shown in FIG. 8, wherein elements having the same general function and structure as those utilized in the embodiment of FIGS. 1 and 2, are designated with the same numerals as are the elements in FIGS. 1 and 2. The pump 300, shown in FIG. 8, includes an electromagnet 54 which is mounted in an upper housing 14. A piston 310 is mounted in a pumping chamber 22. The piston 310 includes an upwardly extending rod member 312 which projects into the stem portion 26 of the pumping chamber 22. The rod member 312 is made of a magnetizable material, as is the rod member 34 in the embodiment of FIG. 2, and is connected to a resiliently compressible head member 314 by a connector plate 316. The head member 314 is also secured to a base plate 318. The base plate 318 is fixedly mounted in a seat 320 in the upper end of the side wall 18.

The resiliently compressible head member 314 is held in the normal position, shown in FIG. 8, by a spring 320 which engages the end wall 24 and an inner surface of the connector plate 316. The spring 320 is compressed, when the electromagnet 54 is energized, to draw

the piston rod **314** into the stem portion **26** of the pumping chamber **22**. As the piston rod **312** is drawn into the stem portion **26** of the pumping chamber **22**, fluid which is present in the stem portion of the pumping chamber will flow through the space **48** between the piston rod and the wall of the stem portion **26**. This fluid will then flow through a plurality of spaced-apart passages **322** which are located adjacent to the outer edge of the base plate **318**. Also, a plurality of passages **324** are positioned in the connector plate **316** to permit fluid to escape from the center portion of the head member **314**.

Energization of the electromagnet **54** draws the piston rod upwardly into the stem portion **26** of the pumping chamber **22**. This upward movement of the piston rod causes the connector plate **316** to compress the head portion **314** of the piston against the base plate **318**. As previously explained, the compression of the head portion **314** of the piston **310** tends to create a partial vacuum within the pumping chamber **22**. Fluid is then drawn through the inlet passage **70** and check valve **72** into the pumping chamber **22**. Similarly, when the electromagnet **54** is deenergized, the spring **320** and the resilient nature of the piston head **314** causes the connector plate **316** to move downwardly and expel fluid under pressure from the pumping chamber **22** through the check valve **88**. The fluid then enters the outlet chamber **90** and outlet passage **104**.

Another embodiment of the piston **310** is shown in FIG. 9. In this embodiment, the spring **320** engages an inner surface of the base plate **318** and an inner surface of the connector plate **316** to cause the connector plate and piston head **314** to return to the normal position shown in FIG. 8 from the compressed position shown in FIG. 9. With the embodiment of the piston shown in FIG. 9, the assembly of the pump unit is facilitated, since the spring member **320** does not have to be positioned adjacent to the end wall **24** of the pumping chamber **22**. It is also contemplated that the spring **320** could, if desired, be placed between the lower endwall of the pumping chamber and the bottom surface of the piston.

For purposes of affording a more complete understanding of the invention, it is advantageous now to provide a brief functional description of the mode in which the component parts cooperate. As previously explained, the pump **10** includes a piston member **30** which has a resiliently compressible head element **32**. The head element **32** is compressed to decrease the fluid pressure within the pumping chamber **22**. Fluid will then flow from the inlet conduit **14** through the passage **70** and check valve **72** into the pumping chamber. When the electromagnet **54** is deenergized, the resiliently compressible head member **32** will, due to its natural resiliency, move from the compressed position shown in FIG. 3 to its normal postion shown in FIG. 2. This expanding movement of the head portion **32** of the piston forces fluid, under pressure, out of the pumping chamber **22** through the check valve **88**. The fluid will then enter, in a series of pulses, the outlet chamber **90**. A resiliently flexible sheet or diaphragm **92** forms one side of the outlet chamber **90** and absorbs or dampens the fluid pulses originated in the pumping chamber **22**. Thus, a relatively smooth flow of fluid, from the outlet chamber **90**, to the conduit **20** and the engine of a vehicle is obtained.

When the pumping assembly is utilized to pump fluid to the engine of a vehicle, a control unit **202** is provided to sequentially energize the electromagnet **54** so that the rate of actuation of the pump **10** varies directly with the speed of the engine. That is, the faster the engine goes the greater the fuel consumption by the engine and the greater the rate of actuation of the fuel pump **10**. This coordination between the speed of the engine and the rate of actuation of the pump **10** is obtained by a cam **226** which is mounted on the cam shaft **228** of the engine. Since the contacts **216** and **220** are closed once for every revolution of the cam **226**, to energize the electromagnet **54**, the rate of actuation of the pump **10** will be varied in direct proportion to variations in the speed of the engine.

The pumping assembly **10** has a relatively long service life, since it has very few moving parts to wear out, or otherwise malfunction. The primary moving part in the pumping assembly is the piston **30**. Since the piston **30** is freely movable, in the embodiment shown in FIG. 2, in the pumping chamber **22** there will be relatively little friction and wearing of the pump surfaces due to the continuous actuation of the pump. For purposes of clarity, the various embodiments of the pump have all been illustrated with the piston rod extending vertically. However, the pump will function equally well in any other desired orientation and it is not intended that the invention should be limited to any one orientation of the pump assembly.

The embodiment shown in FIGS. 8 and 9 of the pumping assembly utilizes a positively driven piston which is fixedly mounted in the sidewall of the pumping chamber **222**. The piston **10** is driven outwardly, relative to the end wall **24** of the pumping chamber, by a spring **320**. This positive drive of the piston increases the pressure applied by the piston to the fluid which is expelled from the pump and increases the rate at which the pump can be actuated.

While particular embodiments of the invention have been shown, it should be understood, of course, that the invention is not limited thereto, since many modifications may be made; and it is, therefore, contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the claims.

What is claimed is:

1. A pump assembly comprising; wall means defining a chamber means, said wall means including first passage means through which fluid enters said chamber means and second passage means through which fluid is expelled from said chamber means; piston means located in said chamber means, said piston means being positioned separate from and adjacent to said wall means to enable said piston means to move freely in said chamber means, said piston means including a first element of a magnetizable material and a second element of a resiliently compressible material; and electromagnet means supported by said wall means, said electromagnet means being selectively energizable to attract said first piston element and contemporaneously therewith causing said second piston element to move from a first normal position to a second compressed position, whereby fluid flows into said chamber means through said first passage means when said second piston element moves from said first normal position to said second compressed position and flows out of said chamber means through said second passage means when said second piston element moves from said second compressed position to said first normal position.

2. A pump assembly as set forth in claim **1**, wherein; said chamber means includes a first main portion in which said second resiliently compressible element is located and a second portion into which said first piston element of a magnetizable material extends, said second portion of said chamber means extending along a central axis of said electromagnet means to facilitate attraction of said first piston element of magnetizable material by said electromagnet means.

3. A pump assembly as set forth in claim **1** further including: control means associated with an engine and connected to said electromagnet means for selectively energizing said electromagnet means in direct relationship with the rate of rotation of the engine.

4. An assembly as set forth in claim **1**, wherein said wall means includes first and second spaced apart end walls, and said second resiliently compressible element is pressed against said second end wall when said second element is in said second compressed position.

5. A pump assembly as set forth in claim **4**, wherein an end portion of said piston means engages said first end wall when said second resliently compressible ele-

ment is in said first normal position and said end portion of said piston means is spaced apart from said first end wall when said second element of resiliently compressible material is in said second compressed position.

6. A pump assembly as set forth in claim 5, wherein said end portion of said piston means includes a plate member which engages an outer end of said second resiliently compressible element to move said second element toward said second position when said electromagnet means is energized.

7. A pump assembly as set forth in claim 5, wherein said end portion of said piston means includes a plate member which is imbedded in said second resiliently compressible element to move said second element toward said second compressed position when said electromagnet means is energized.

8. A pump assembly as set forth in claim 5, wherein said first end wall includes a recess means, said first and second passage means being connected to said chamber means at said recess means, a first check valve means being positioned in said first passage means and a second check valve means being positioned in said second passage means, whereby said recess means enables said end portion of said piston means to engage said first end wall while being spaced apart from said first and second check valve means.

9. An assembly as set forth in claim 1 further including: a second chamber means, said second chamber means being defined by said wall means and a resiliently displaceable sheet member which is held in sealing engagement with said wall means, said second passage means providing fluid communication between said first and second chamber means; and a fluid conduit means mounted in said wall means for conducting fluid from said second chamber means, wherein fluid is pumped under pressure from said first chamber means to said second chamber means and said resiliently displaceable sheet member dampens any fluid pulsations resulting from the movement of said second resiliently compressible element from said second compressed position to said first normal position to thereby provide a relatively smooth flow of fluid from said pump assembly.

10. A pump assembly as set forth in claim 9 further including a third chamber means defined by said wall means, said electromagnet means being mounted in said third chamber means; an outer end portion of said first chamber means extending into said third chamber means and the center of said electromagnet means; and said first element of magnetizable material being positioned at least partially within said outer end portion of said first chamber means to facilitate attraction of said first element by said electromagnet means.

11. A pump assembly comprising: a housing means; pumping chamber means located in said housing means, first fluid passage means connected to said pumping chamber means for conducting fluid into said pumping chamber means, and second fluid passage means connected to said pumping chamber means for conducting fluid from said pumping chamber means; and piston means mounted in said pumping chamber means, said piston means including a base plate connected to said housing means, a first element of a resiliently compressible material secured at a first end portion to said base plate, said first element being compressible against said base plate from a first normal position to a second compressed position, and a second element of a magnetizable material secured to a second end portion of said first element, said electromagnet means being selectively energizable to attract said second element to compress said first element against said base plate from said first normal position to said second compressed position, wherein movement of said first element from said first normal position to said second compressed position to said first normal position expels fluid from said pumping chamber means.

12. A pump assembly as set forth in claim 11, wherein said housing means includes an end wall means and a a sidewall means for said pumping chamber means, said base plate being connected to said sidewall means in a position substantially parallel to and spaced apart from said endwall means, and said first element is positioned on said base plate with an outer surface spaced apart from said sidewall means.

13. A pump assembly as set forth in claim 11, wherein said pumping chamber means includes a longitudinally extending end portion adjacent to said electromagnet means, and said second magnetizable element extends into said end portion to facilitate magnetic attraction by said electromagnet for moving said first resiliently compressible element from said first normal position to said second compressed position.

14. A pump assembly as set forth in claim 11 further including: a second chamber means, said second chamber means being defined by said housing means and a resiliently displaceable sheet member which is held in sealing engagement with said housing means, said second fluid passage means providing fluid communication between said pumping chamber means and said second chamber means; and a fluid conduit means mounted in said housing means for conducting fluid from said second chamber means, whereby fluid is pumped under pressure from said pumping chamber means to said second chamber means and said resiliently displaceable sheet member dampens any fluid pulsations resulting from the movement of said first resiliently compressible element from said second compressed position to said first normal position to thereby provide a relatively smooth flow of fluid from said pump assembly.

15. A pump assembly as set forth in claim 14 further including a third chamber means defined by said housing means, said electromagnet means being mounted in said third chamber means; an outer end portion of said pumping chamber means extending into said third chamber means in the center of said electromagnet means; and said second element of magnetizable material being positioned at least partially within said outer end portion of said pumping chamber means to facilitate attraction of said second element by said electromagnet means.

16. A pump assembly comprising: a wall means, said wall means defining a first pumping chamber means and a second outlet chamber means; a first passage means in said wall means connecting said first pumping chamber means to a first fluid conduit means; a first check valve means in said first passage means enabling fluid to flow from said first fluid conduit means to said first pumping chamber means; a second passage means in said wall means connecting said first pumping chamber means to a second fluid conduit means; a second check valve means in said second passage means enabling fluid to flow from said first pumping chamber means to said second fluid conduit means; said wall means defining a second chamber means positioned adjacent to said first pumping chamber means, said first pumping chamber means including a longitudinally extending stem portion which is surrounded by said second chamber means; selectively actuatable electromagnet means positioned in said second chamber means adjacent to said longitudinally extending stem portion of said first pumping chamber means; and piston means positioned in said first pumping chamber means, said piston means including a first element of a magnetizable material which extends into said stem portion of said first pumping chamber means and a second element of a resiliently compressible material; said electromagnet means being selectively energizable for attracting said first element to compress said second element from a first position to a second position; wherein movement of said second element from said first position to said second position draws fluid into said pumping chamber means and movement of said second element from said second position to said first position expels fluid from said pumping chamber means.

17. An assembly as set forth in claim 16, wherein: said second passage means includes a third chamber means, said third chamber means being defined by said wall means and a resiliently displaceable sheet member which is held in sealing engagement with said wall means, said second passage means providing fluid communication between said pumping chamber means and said third chamber means and said second fluid conduit means; whereby fluid is pumped under pressure from said pumping chamber means to said third chamber means and said resiliently displaceable sheet member dampens any fluid pulsations resulting from the movement of said second resiliently compressible element from said second compressed position to said first position thereby to provide a relatively smooth flow of fluid from said pump assembly.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,366,067 January 30, 1968

Michael Kocolowski

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 65, for "wall 24 for" read -- wall 24 from --; column 4, line 38, for "wich" read -- which --; line 64, for "surounds" read -- surrounds --; column 5, line 30, for "conditons" read -- conditions --; line 52, for "soemewhat" read -- somewhat --; column 9, line 73, after "position", first occurrence, insert -- draws fluid into said pumping chamber means, and movement of said first element from said second compressed position --.

Signed and sealed this 1st day of April 1969.

(SEAL)

Attest:

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