

[54] **HOLLEY FUEL PUMP**

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[51] Int. Cl. **F04b 17/00, F04b 35/04, F04d 5/00**

[58] Field of Search **417/423, 424; 415/53 T; 310/87**

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[57]

ABSTRACT

A vehicular fuel supply system includes a fuel tank within which is situated a fuel pump and electric motor assembly. The fuel pump assembly has an impeller driven by a permanent magnet type of motor provided with a drum type commutator. The entire fuel pump and motor assembly is contained within a housing which provides inlet and outlet passage means disposed on opposite sides of the pump and motor as well as fluid passage means about the motor assembly for permitting the fuel to flow from the housing inlet to the housing outlet.

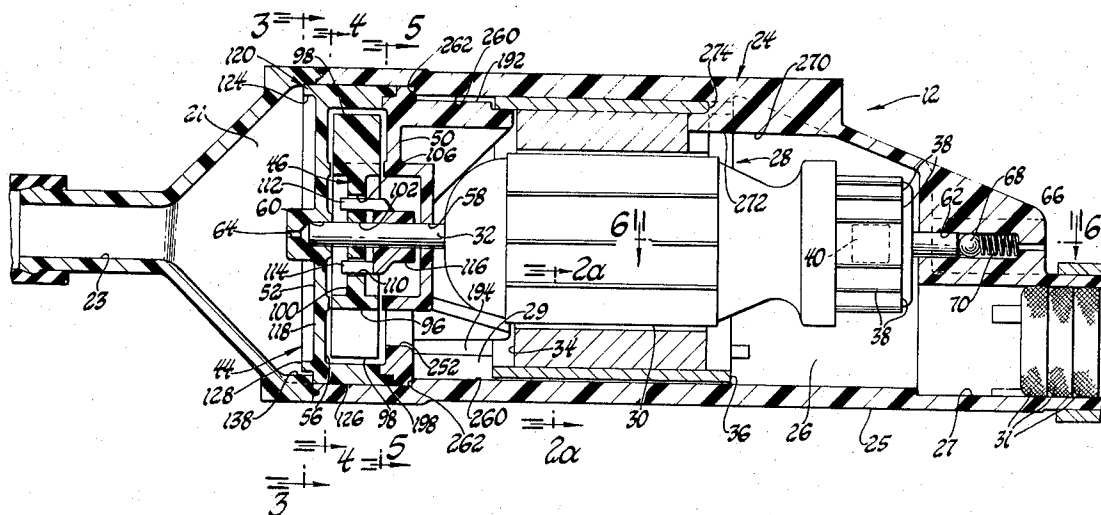
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References Cited

UNITED STATES PATENTS

3,418,991	12/1968	Shultz et al.	417/423 X
2,696,789	12/1954	Fabig.....	415/53 T

9 Claims, 15 Drawing Figures



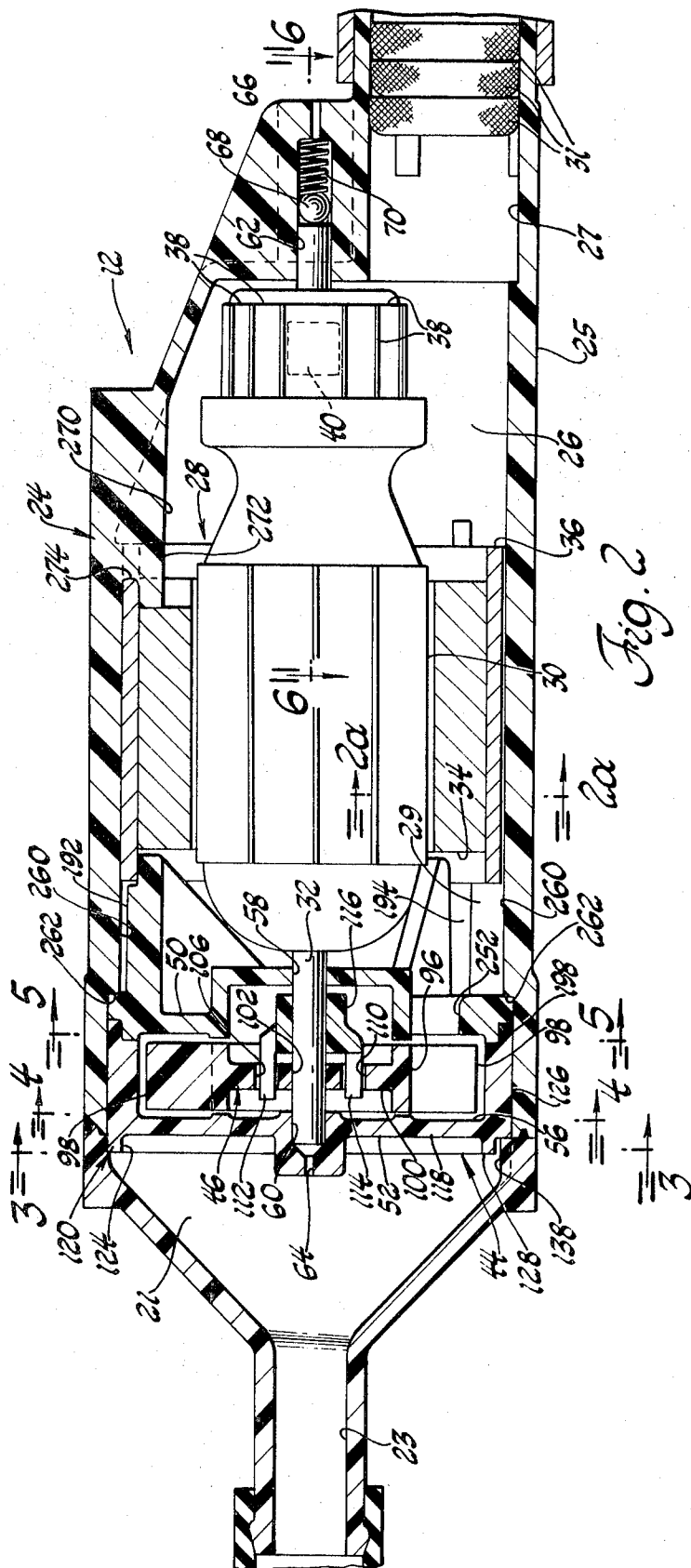


Fig. 2

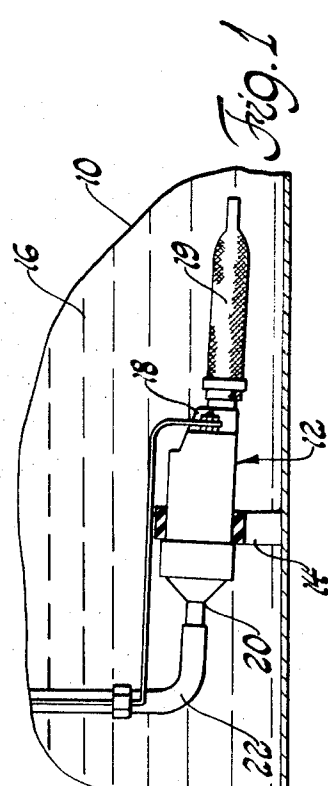
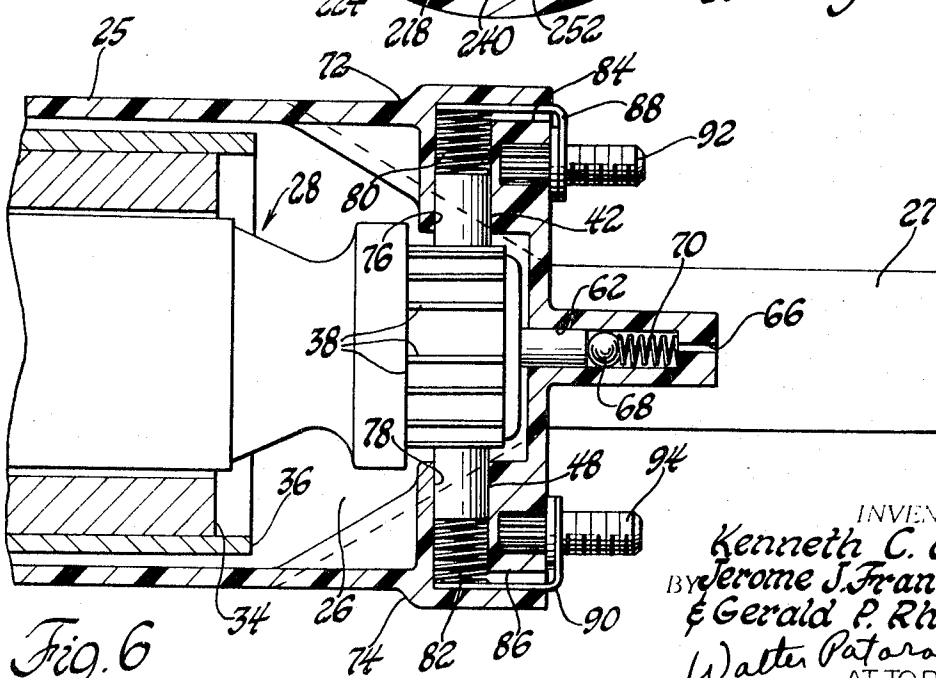
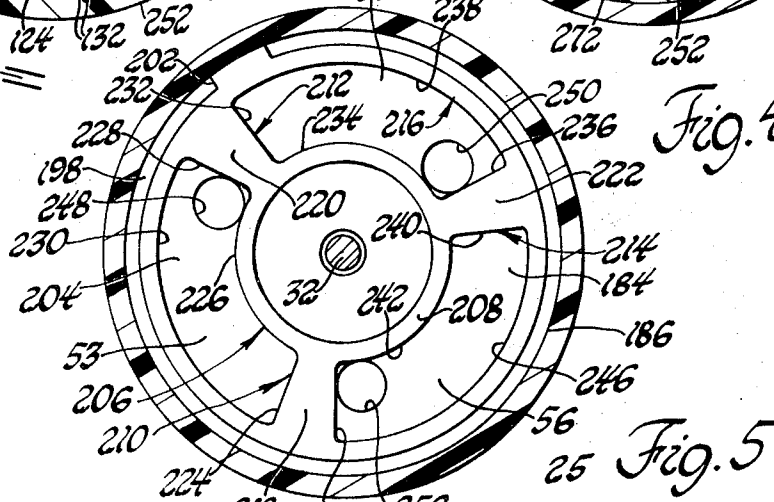
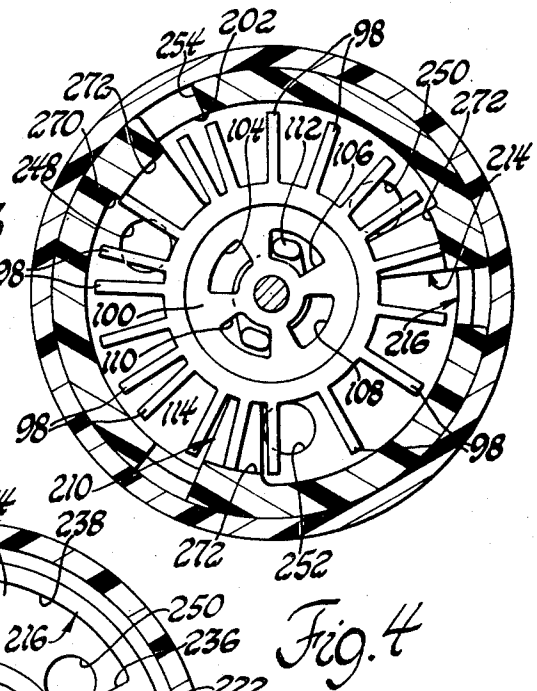
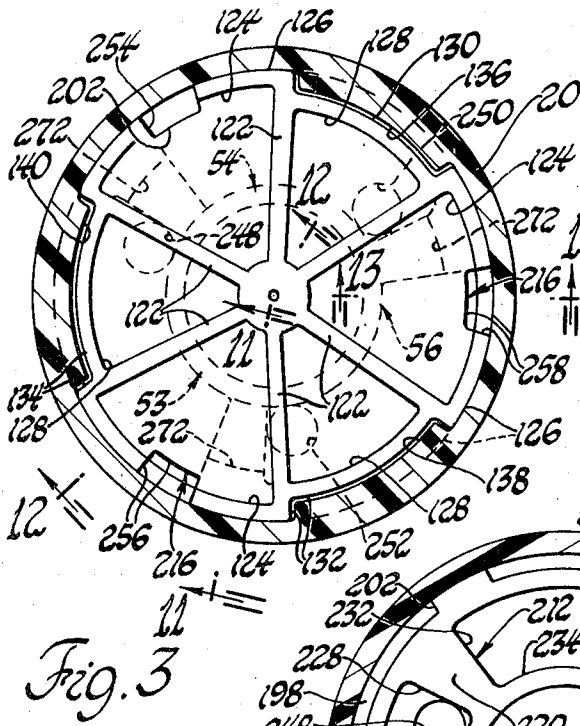


Fig. 1



Fig. 2a

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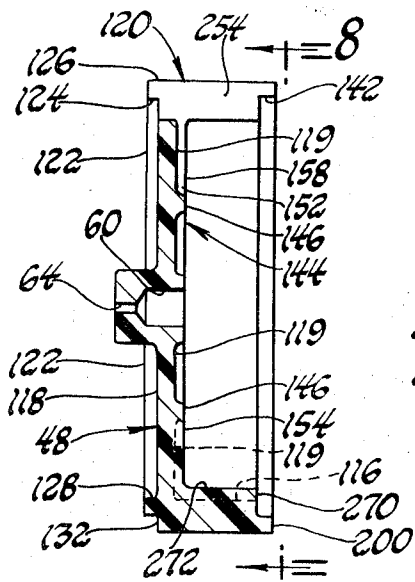


Fig. 7

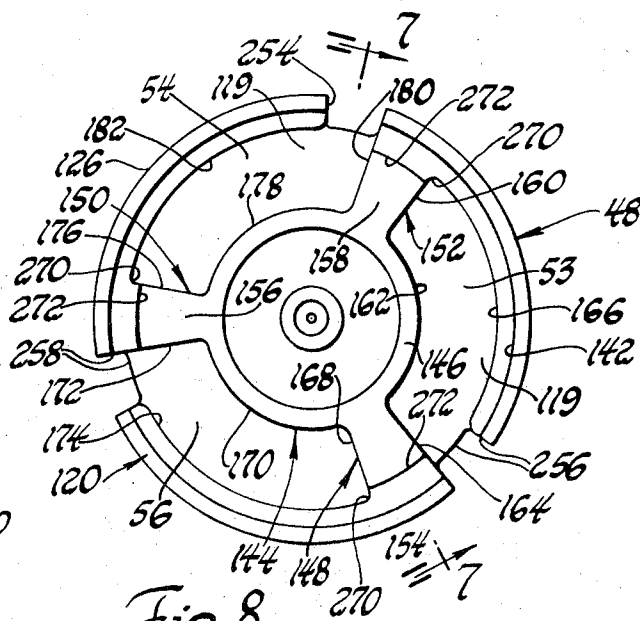


Fig. 8

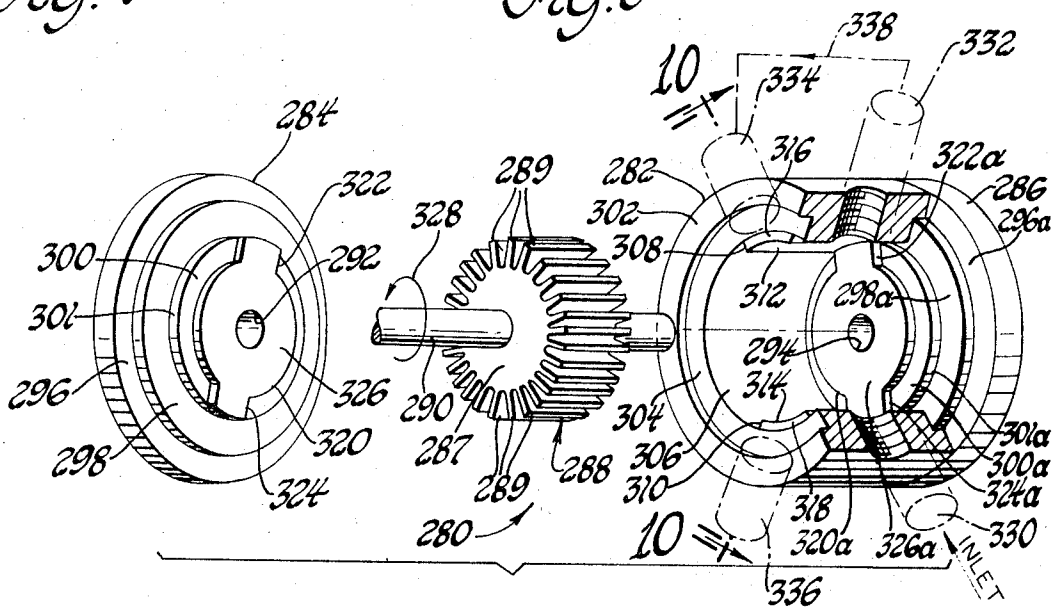


Fig. 9

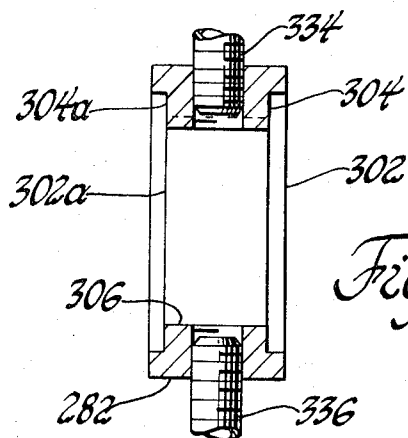


Fig. 10

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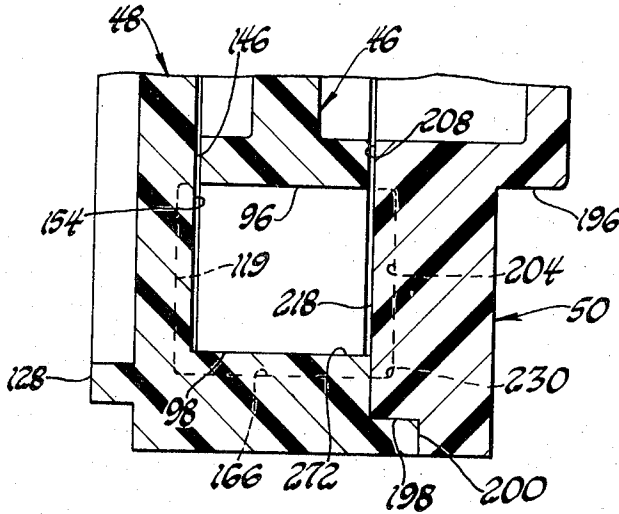


Fig. 11

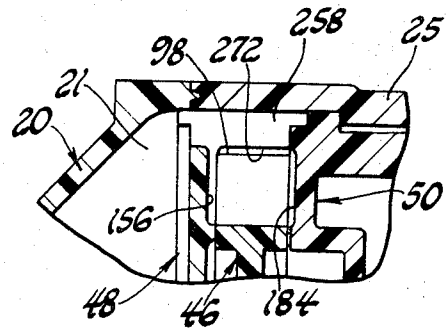


Fig. 13

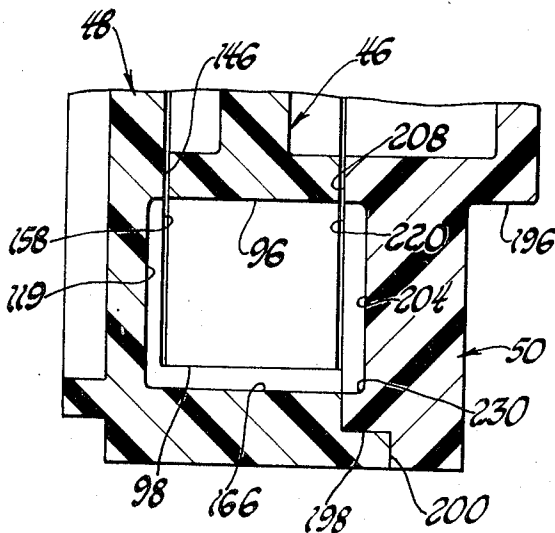


Fig. 12

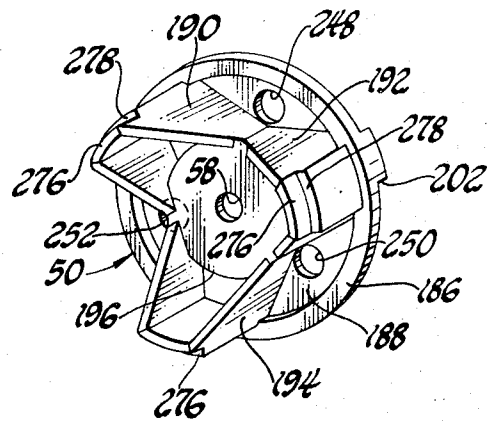


Fig. 14

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HOLLEY FUEL PUMP**BACKGROUND OF THE INVENTION**

Various forms and embodiments of fluid pumps have heretofore been proposed by the prior art. Some of these prior art structures were intended for use in a submerged condition while others were not. However, the prior art fluid pumps have not provided an arrangement whereby a multiplicity of pumping stages could be created with the use of a single impeller. Further, prior art pumps were often found lacking in their ability to raise the pumped fluid to a desired discharge pressure, especially where the physical dimensions of the pump assembly were relatively small.

Accordingly, the invention as herein disclosed and described is concerned with the solutions to the above problems or shortcomings of the prior art as well as other related problems.

SUMMARY OF THE INVENTION

According to the invention, a fluid pump assembly comprises a pump housing, chamber means formed within said pump housing, a pump impeller situated within said chamber means, means for rotatably driving said pump impeller within said chamber means, said pump impeller comprising a hub and a plurality of angularly spaced radially extending impeller vanes carried by said hub, said chamber means comprising at least first and second arcuate pumping chambers, said first and second arcuate pumping chambers being angularly spaced with respect to each other by first and second dammed portions within said chamber means, each of said arcuate pumping chambers having radially extending first and second side walls axially spaced from each other so as to provide a substantial clearance space between side edges of said impeller vanes, each of said arcuate pumping chambers also including a generally arcuate outer surface spaced radially outwardly a substantial distance from the radially outer-most ends of said impeller vanes so as to provide a substantial clearance space therebetween, each of said dammed portions comprising third and fourth side walls axially spaced from each other a distance less than the distance by which said first and second side walls are spaced from each other, said third and fourth side walls being spaced from each other so as to have the respective surfaces thereof in close proximity to said side edges of said impeller vanes so as to provide no substantial space therebetween, each of said dammed portions also including a second generally arcuate outer surface radially outwardly of the radially outer-most ends of said impeller vanes, each of said second arcuate outer surfaces being formed so as to be in close proximity to said outer-most ends of said impeller vanes so as to provide no substantial space therebetween, at least first and second fluid inlet conduit means formed in said housing for communicating fluid to be pumped to said first and second pumping chambers, said first inlet conduit means having an open first end terminating in a wall of said first pumping chamber, said open first end being so located as to be situated at least near a first arcuate end of said first pumping chamber, said second inlet conduit means having an open second end terminating in a wall of said second pumping chamber, said open second end being so located as to be situated at least near a first arcuate end of said second pumping chamber, and at least first and second fluid outlet conduit means formed in said housing for discharging pumped fluid from said first and second pumping chambers, said first fluid outlet conduit means having an open third end terminating in a wall of said first pumping chamber, said open third end being so located as to be situated at least near a second arcuate end of said first pumping chamber so as to be spaced a substantial distance from said first open end, said second fluid outlet conduit means having an open fourth end terminating in a wall of said second pumping chamber, said open fourth end being so located as to be situated at least near a second arcuate end of said second pumping chamber so as to be spaced a substantial distance from said second open end, said impeller and vanes

being effective upon rotation to cause fluid to flow into said respective pumping chambers through said first and second inlet conduit means and to move said fluid within each of said pumping chambers from the vicinity of said open ends of said inlet conduit means toward said open ends of said outlet conduit means, each of said dammed portions being effective by virtue of the closeness of said third and fourth side walls and said second generally arcuate outer surfaces to said impeller vanes to limit the volume of fluid passing therethrough and thereby cause such fluid in excess of said volume to be pumped through said open ends of said outlet conduit means.

Various general and specific objects and advantages of the invention will become apparent when reference is made to the following detailed description considered in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

In the drawings, wherein, for purposes of clarity, certain details and elements may be omitted from one or more views;

FIG. 1 is a fragmentary cross-sectional view of a vehicular fuel tank containing therein a fuel pump and motor assembly embodying the invention;

FIG. 2 is an enlarged axial cross-sectional view of the pump and motor assembly of FIG. 1;

FIG. 2-A is a fragmentary cross-sectional view taken generally on the plane of line 2-A—2-A of FIG. 2 and looking in the direction of the arrows;

FIGS. 3, 4 and 5 are cross-sectional views taken respectively on the planes of lines 3—3, 4—4 and 5—5 of FIG. 2 and looking in the direction of the arrows;

FIG. 6 is a fragmentary cross-sectional view taken generally on the plane of line 6—6 of FIG. 2 and looking in the direction of the arrows;

FIG. 7 is a generally axial cross-sectional view taken on the plane of line 7—7 of FIG. 4 and looking in the direction of the arrows;

FIG. 8 is an end elevational view of the pump discharge housing section taken generally on the plane of line 8—8 of FIG. 7;

FIG. 9 is a somewhat exploded view of a second embodiment of the invention with portions thereof broken away and in cross-section;

FIG. 10 is a cross-sectional view of the cylindrical housing of FIG. 9, taken generally on the plane of line 10—10 and looking in the direction of the arrows;

FIGS. 11 and 12 are enlarged fragmentary cross-sectional views respectively taken on the planes of lines 11—11 and 12—12 of FIG. 3 and looking in the direction of the arrows;

FIG. 13 is a fragmentary cross-sectional view taken on the plane of line 13—13 of FIG. 3 and looking in the direction of the arrows; and

FIG. 14 is a reduced perspective view of the pump inlet housing section looking at it from the side opposite to that shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in greater detail to the drawings, FIG. 1 illustrates, fragmentarily, a suitable fuel tank 10 within which is situated an electric fuel pump assembly 12 carried as by a suitable support 14 secured to a lower side of fuel tank 10. The fuel pump assembly 12, adapted for submergence within the fuel 16 contained in tank 10, has an inlet or fuel intake end 18 and a fuel discharge end 20 which, as by means of suitable conduit 22, communicates with a related fuel-receiving structure, not shown, which, for example, may be the fuel bowl of a carburetor for an internal combustion engine.

FIG. 2, a generally longitudinal cross-sectional view of the pump and motor assembly 12 of FIG. 1, illustrates the pump and motor assembly 12 as being generally comprised of an outer housing assembly 24 with a first housing section 25 having a chamber 26 formed therein which contains an electric motor assembly 28. As shown motor assembly 28 may be com-

prised of a wound armature assembly 30, provided with a coaxial armature shaft 32, a field magnet 24 and a magnet retaining ring 26. The right end of armature assembly 30 is provided with a drum type commutator assembly comprised of a plurality of commutator segments 38 which, as in a manner well known in the art, are electrically interconnected with windings of the armature and spaced from each other as to be properly sequentially engaged by radially directed commutator brushes 40 and 42 (also see FIG. 6).

A pump assembly 44, located generally within the left end of housing 24, is comprised of a rotatable impeller 46 located within a pump casing 48 and operatively connected to the left end of the armature shaft 32. The pump casing 48 is shown as being comprised of a pump inlet casing section 50 and a pump discharge casing section 52 which, when assembled as shown, define pumping cavities or chambers 53, 54 and 56.

The pump inlet casing section 50 has an aperture 58 formed therethrough for somewhat loosely receiving armature shaft 32 the left end of which is journaled within a bearing bore 60 formed in the pump discharge casing section 52. The right end of armature shaft 32 is similarly journaled within a bearing bore 62 formed in the first outer housing section 25. As best shown in FIG. 2, the bearing bores 60 and 62 are respectively provided with bleed passages 64 and 66 which respectively communicate with the interior of discharge end 20 and the interior of fuel tank 10. Such bleed passages serve to vent or exhaust leakage fuel that may pass between the armature shaft 32 and respective bores 60 and 62 so as to avoid any excessive pressure buildup within such bearing bores. Additionally, bearing bore 62 may be provided with an end thrust bearing ball 68 and spring 70 which combine to resiliently urge the entire motor assembly 28 to the left, as viewed in FIG. 2.

As can be seen in FIG. 6, the first or rear outer housing section 25 has integrally formed laterally extending body portions 72 and 74 which are respectively provided with internally formed guideways 76 and 78 slideably receiving therein commutator brushes 42 and 48 as well as electrically conductive spring-like brush biasing members 80 and 82. Slots 84 and 86, formed in body portions 72 and 74, permit the passage therethrough of fixed contact members 88 and 90, against which the springs 80 and 82 are respectively seated, which are connected to terminals 92 and 94, embedded at one end within body portions 72 and 74, adapted for connection to a suitable source of electrical potential.

As can be seen in FIGS. 2 and 4, the pump impeller 46 is shown as being comprised of a hub 96 with a plurality of radially outwardly extending pumping vanes 98 formed or carried thereby. Preferably, such vanes 98 are selectively randomly spaced about the outer periphery of hub 96. The hub 96 may also include an integrally formed inwardly disposed radiating web 100 through which is formed a clearance aperture 102 for the passage therethrough of armature shaft 32. Additionally a plurality of recesses or apertures 104, 106, 108 and 110 are also formed in web 100 so as to accommodate therein arm portions 112 and 114 of a driver or driving dog member 116 fixedly secured to and carried by armature shaft 32. As can best be seen in FIG. 4, the size of apertures 104, 106, 108 and 110 is significantly larger than arm portions 112 and 114 thereby providing for a general floating type of drive connection therebetween accommodating for variations in alignment as may occur during production of the coating components.

As best seen in FIGS. 2, 3, 4, 7 and 8, the pump discharge casing section 48 is shown as being of a generally cup-shaped configuration having an axial end wall 118 formed integrally with a peripheral flange or wall 120. The outer or forwardly disposed surface of end wall 118 is provided with a plurality of radiating rib-like portions 122 which, at their respective radially outermost ends, join a segmented circular rib 124 which extends generally about the face of end wall 118 so as to have its radially outermost side adjacent to or coincident with the outer peripheral surface 126 of cylindrical wall 120. A second set of segmented circular ribs 128, arranged in alternating relationship with circular ribs 124, are also joined to radiating

ribe 122 but disposed a distance closer to the centerline of housing section 48 than circular ribs 124 thereby defining arcuate recess portions 130, 132 and 134 for the respective reception therein of cooperating arcuate locating bosses or portions 136, 138 and 140 formed internally of the forwardly disposed second outer housing section 20.

As best seen in FIGS. 2, 7 and 8 the pump discharge housing section 48 is provided with a circular shoulder portion 142, formed generally radially inwardly of the tubular wall 120, which, as shown in FIG. 2, is, upon assembly, adapted to receivingly engage a cooperating portion of the pump inlet housing section 50.

Referring to FIGS. 7 and 8, it can be seen that the inner face 119 of end wall 118 has an annular ring 144 formed thereon with a facing surface 146 substantially normal to the axis of housing section 48. Additionally, angularly spaced radiating arm-like portions 148, 150 and 152 are also formed on the inner face of wall 118 so as to be integrally joined at their respective opposite ends to the ring 144 and the tubular wall portion 120. Such arms 148, 150 and 152 also are provided with respective facing surfaces 154, 156 and 158 which are coplanar and coextensive with ring facing surface 146. As will become apparent, the radial edge-surface 160 of arm 152, the radially outer arcuate surface segment 166 of tubular wall 120 along with the portion of surface 119 contained therewithin comprise a portion of pumping chamber 53; the radial edge surface 168 of arm 148, the radially outer arcuate surface segment 170 of ring 144, the radial edge surface 172 of arm 150 and the radially inner arcuate surface segment 174 of tubular wall 120 along with the portion of surface 119 contained therewithin comprise a portion of pumping chamber 56; while the radial edge surface 176 of arm 150, the radially outer arcuate surface segment 178 of ring 144, the radial edge surface 180 of arm 158, and the radially inner arcuate surface segment 182 of tubular wall 120 along with the portion of surface 119 contained therewithin comprise a portion of pumping chamber 54.

The pump inlet housing section 50, is shown in FIGS. 5 and 14 as being comprised of an axial wall 184 formed integrally with a peripheral flange 186. The outer or rearwardly disposed surface 188 of wall 184 is provided with a plurality of angularly spaced axially extending struts or supports 190, 192 and 194 which are respectively joined at their one ends to a cup-like portion 196. An annular recess or shoulder portion 198 is adapted to, upon assembly, receive therein the projecting portion 200 of pump discharge casing section 48 as shown in FIG. 2. The recess 198 may be interrupted as by a locating type boss or tab 202 which, upon assembly with the pump discharge casing 48, is adapted to engage and be received within one of the discharge slots to be described.

The inner face 204 of wall 184 has an annular ring 206 formed thereon with a facing surface 208 substantially normal to the axis of housing section 50. Additionally, angularly spaced radiating arm-like portions 210, 212 and 214 are also formed on the inner face of wall 184 so as to be integrally joined at their respective opposite ends to the ring 206 as well as to an outer ring portion 216. Such arm portions 210, 212 and 214 also are provided with respective facing surfaces 218, 220 and 222 which are coplanar and coextensive with ring facing surface 208.

As will become apparent, the radial edge or side surface 224 of arm 210, the radially outer arcuate surface segment 226 of ring 206, the radial edge or side surface 228 of arm 212 and the radially inner arcuate surface segment 230 of outer ring 216 along with the portion of surface 204 contained therewithin comprise a portion of pumping chamber 53; the radial edge or side surface 232 of arm 212, the radially outer arcuate surface segment 234 of ring 206, the radial edge or side surface 236 of arm 214 and the radially inner arcuate surface segment 238 of outer ring 216 along with the portion of surface 204 contained therewithin comprise a portion of pumping chamber 54; while the radial edge or side surface 240 of arm 214, the radially outer arcuate surface segment 242 of

ring 206, the radial edge or side surface 244 of arm 210 and the radially inner arcuate surface segment 246 of outer ring 216 along with the portion of surface 204 contained therewithin comprise a portion of pumping chamber 56. Further, as seen in each of FIGS. 2, 3, 4, 5 and 14, wall 184 of pump casing section 50 has a plurality of apertures 248, 250 and 252 formed therethrough which respectively serve as inlet apertures to chambers 53, 54 and 56.

As best seen in FIGS. 3, 4, 7 and 8, the pump discharge housing section 48 is provided with a plurality of slot-like openings 254 256 and 258 each of which has a radial cross-sectional configuration as typically illustrated by 254 in FIG. 7.

Referring to each of FIGS. 2, 3, 4, 5, 7 and 8, it can be seen that once the motor assembly 28 is placed within outer housing section 25, the pump assembly may be easily placed and assembled within housing section 25. For example, in the preferred embodiment of the invention, the inner diameter of outer housing section 26 closely receives therein the outer diameter of the pump inlet housing section 50 in a manner so as to have the support struts 190, 192 and 194 directed toward the motor assembly 28. Preferably the interior of outer or rear housing section 25 is provided with a plurality of angularly spaced longitudinally extending rib-like portions 260 which terminate at one end as at 262 thereby providing an effective abutment shoulder against which the pump inlet housing section 50 can be located. As shown in FIGS. 2 and 2-A, such rib-like portions 260 are of a size and configuration as to suitably contain, therebetween the magnet retainer 36 of motor assembly 28. Further, because of the angular spacing between successive ribs 260 (there being three of such in the preferred embodiment) the longitudinally extending spaces, defined therebetween and between the inner diameter of housing 28 and the outer diameter of magnet retainer 36, function as conduit means for completing communication between the inlet conduit 27, chamber 26 and chamber area 29 generally between motor assembly 28 and pump inlet casing section 50.

With casing section 50 situated within outer or rear housing section 25, and motor shaft 32 extending through aperture 58, the driving dog 116 may then be pressed or otherwise assembled to said shaft 32 so as to be generally situated within cup-shaped portion 196 and having its arms 112 and 114 projecting therefrom. Next, the impeller 46 is slipped onto shaft 32 in a manner causing the arms 112 and 114 to become engaged within, for example, apertures 106, 110 as shown in FIGS. 2 and 4. Following this, the pump discharge casing sections 48 is slid into rear housing section 25 thereby causing its outer diameter to be closely received within the inner diameter of rear housing 25 as shown in both FIGS. 2 and 4. In so assembling the discharge casing 48, it is rotated about its axis of revolution until the tab or locating abutment 202 of inlet casing is received within one of the slots 254, 256 or 258 of discharge casing 48 at which time the shoulder 142 and recess 198 of casings 48 and 50, respectively, join in mating relationships as indicated in FIG. 2.

From an inspection of FIGS. 2, 3, 4, 5, 7 and 8, it can be seen that when the inlet and discharge casings 48 and 50 are assembled, arcuate surface segments 166, 174 and 182 of discharge casing 48 and arcuate surface segments 230, 238 and 246 of casing 50 become located on a common circle; similarly, arcuate surface segments 162, 170 and 178 of inner ring 144 and arcuate surface segments 226, 234 and 242 of inner ring 206 also become located on a common circle; further respective edge or side surfaces of the radiating arms of inlet casing 50 and outlet casing 48 become coplanar. That is, for example, surfaces 160 and 180 (FIG. 8) become coplanar with 228, 232 (FIG. 5) surfaces 164, 168 (FIG. 8) are aligned with surfaces 224, 240 (FIG. 5) while surfaces 172, 176 (FIG. 8) become aligned with surfaces 240, 236 (FIG. 5).

As is illustrated by the same Figures as well as FIGS. 11, 12 and 13, when assembled, the outer diameter of hub 96 is preferably so that it also comes on the same circle containing

arcuate segments 226, 234, 242 (FIG. 5) as well as segments 162, 170 and 178 (FIG. 8). Further, as is best shown in FIGS. 2, 4, 11 and 12, there is a considerable diametrical clearance between the respective vanes 98 of the impeller 46 and the outer arcuate confines of the respective pumping chambers 53, 56 and 54 as the impeller 46 is rotated (the direction of rotation as viewed in either of FIGS. 3, 4 or 5 being counter-clockwise). However, as is best shown in FIGS. 4, 7 and 8, each of the radiating arms 148, 150 and 152 is provided with an integrally formed projection 270 respectively having an arcuate surface 272 closely juxtaposed to the free ends of vanes 98. Accordingly, it can be seen that as the impeller 46 is rotated the vanes 98 pass from a pumping chamber where there is substantial radial clearance to a location where the free ends of such vanes pass in at least very close clearance to one of the surfaces 272. As typically illustrated in FIG. 11, whenever the blades or vanes 98 pass in close proximity to a surface 272 such blades are also closely confined on opposite axial edges as by surfaces 154 and 218. The effect of such surfaces 272, 154 and 218 is to provide a dammed area and reduce the volume of the space through which such vanes are passing.

In comparison, as illustrated in FIG. 12, when the vanes 98 are passing through, for example, the pumping chamber 53, the axial edges of the vanes are spaced a substantial distance from the axial confining walls 119 and 204 and the radial outermost end of the vanes 98 is also spaced a considerable distance away from the arcuate confining surface 166.

Accordingly, it can be seen that as the vanes 98 pass through the respective pumping chambers and enter the vicinity of the radial arms 148 and 210, the confining or dammed effect at the area of such radial arms causes an increased pressure to exist in the area of such radial arms. Consequently, it can be seen that there will be a pressure gradient existing generally within each of the pumping chambers with a lesser pressure in the area of the respective inlet apertures 248, 250 and 252 while a higher pressure is developed within such respective pumping chambers adjacent to the next radial arms, comprising dammed portions, in the direction of rotation of the impeller 48.

As a result of this pressure gradient, fuel is taken into the pumping chambers 53, 56 and 54 by means of inlet conduits 248, 252 and 250, respectively, while the fuel within such pumping chambers 53, 56 and 54 is subsequently pumped out of openings or slots 256, 258 and 254, respectively. The various slots 256, 258 and 254 as typically illustrated in FIG. 13 by slot 258, each, in combination with the interior surface of the outer housing 25, define an outlet conduit or passage leading to and communicating with the interior chamber 21 of outlet or forward outer housing section 20 from where such fuel flows into the conduit portion 23 and ultimately to conduit 22 leading to an associated fuel consuming device.

In view of the above, it can be seen that with the pump and motor assembly 12 being situated within the fuel tank 10, and with the motor assembly 28 being energized, fuel would be drawn, through a suitable filter 19 and into conduit 27 (which, in turn, may contain suitable flame arrestor 31 as is well known in the art) from where it flows into chamber 26 and through the axially extending spaces, between the retainer ring 26 and the inner surface of housing section 25, which are angularly spaced generally between ribs 260. Such fuel then flows into the forwardly located chamber 29 and subsequently through inlet apertures or conduits 248, 250 and 252 into the respective pumping chambers 53, 54 and 56 where such fuel is acted upon by the rotating impeller 46 and caused to be pumped into chamber 21 via respective slot created passageways 256, 254 and 258, respectively.

As shown in FIG. 2, the interior of the rearwardly disposed housing section 25 is provided with a radially inwardly directed body portion 270 formed to have a generally axially extending tang-like portion 272 which is adapted to be received as within a slot 274 formed in the rearwardly disposed end of magnet retainer 36. The provision of such a

cooperating slot 274 and tang 272 prevent rotation of the magnet 34 and retainer 36 relative to the housing section 25.

As is best shown in FIGS. 2 and 14, the pump inlet housing section 50 includes projecting leg members 190, 192 and 194 each of which, in turn, has formed thereon a stepped arcuate surface 276 and a shoulder 278. As shown in FIG. 2, when the pump inlet housing section 50 is properly situated within outer housing section 25, the arcuate surfaces 276 function to engage the inner diameter of the magnet retainer ring 36 while the shoulder portions 278 serve to assure that the magnet retainer ring is properly axially seated against the inwardly depending body portion 270.

FIG. 9 illustrates, in somewhat simplified manner, a second embodiment of the invention wherein a pump assembly 280 is comprised of a generally cylindrical housing 282 with axial end members 284 and 286 (with member 284 being shown in exploded position) which when assembled to the housing 287 define a general chamber for the containment therein of an impeller 288 which may be mounted for rotation as on a shaft 290 journaled in bearing surfaces 292 and 294 formed in end wall members 284 and 286.

End wall member 284 is provided with annular stepped surfaces 296, 298 and 300 while end wall member 286 is similarly provided with stepped annular surfaces 296a, 298a and 300a. At assembly, stepped surfaces 296 and 298 of end wall 284 respectively seat against cooperating annular surfaces 302 and 304 of cylindrical housing 282 while surface 300 is received generally within the confines of cylindrical surface 306 of housing 282, as will become apparent, by having shoulder portion 301 closely received by the cylindrical surface 306.

As will be noted, the cylindrical surface 306 has formed therein, diametrically opposed and radially inwardly directed portions 308 and 310 having arcuate surfaces 312 and 314 serving the same function as, for example, surfaces 272 of FIG. 1. The axial length of cylindrical surface 306 so as to have the respective ends thereof, such as shown by ends 316 and 318 spaced inwardly of the surface 304.

Surface 300, on end member 284, has a ring-like portion 320 and radially extending diametrically opposed arms 322 and 324 with a coplanar surface 326. The diameter of ring-like portion 320 is substantially equal to the drum portion 287 of impeller 288 carrying the vanes 289 thereon. Accordingly, when assembled, the surface portion 326 on ring 320 is in close proximity to the opposed side edges of the vanes 289 as they are rotated thereby. In assembling, arms 322 and 324 are so positioned as to have their outer-most ends thereof juxtaposed to the inset ends 316 and 318 of portions 308 and 310. Like or similar portions of end member 286 are identified with like reference numbers with a suffix *a* and the assembly thereof to housing 282 is like that as explained with reference to end wall 284 except from the opposite end of the housing 282.

In view of the preceding, as well as in view of the discussion relative to the first embodiment of the invention, it can be seen that upon assembly of the components, two pumping chambers are defined which are diametrically opposed on opposite sides of the portions 308 and 310. With this arrangement, suitable conduits 330, 332, 334 and 336 can be provided which would communicate with the interior of the pump assembly as by having conduits 330 and 332 angularly spaced from each other and communicating with a first of the two pumping chambers and conduits 334 and 336 angularly spaced from each other and communicating with the second of the two pumping chambers. If the direction of rotation of impeller 288 is assumed to be in the direction of arrow 328 and conduit 330 assumed to be the fluid inlet, then it can be seen that if conduits 332 and 334 are interconnected by suitable conduit 338, fluid would first enter the first pumping chamber via conduit 330 and be expelled or pumped out of conduit 332 from where such fluid, now under increased pressure, would flow via conduit means 338 to the inlet conduit 334 for the second pumping chamber where the fluid would be again raised in pressure and discharged through conduit

336 to be employed wherever desired. Accordingly, it can be seen that the invention provides means whereby the final pressure of the pumped fluid can be significantly raised by creating a simple series pumping system employing a single pump rotor or impeller.

In view of the above it should be apparent that, in view of for example, FIGS. 1-8 illustrating one embodiment of the invention and FIGS. 9 and 10 illustrating a second embodiment of the invention, each configuration provides a pump assembly having a plurality of pumping stages which, depending upon the pumping performance desired, can be arranged in either parallel or series pumping relationships.

Although only two embodiments of the invention have been disclosed and described, it is apparent that other embodiments and modifications of the invention are possible within the scope of the appended claims.

I claim:

1. A fluid pump assembly, comprising a pump housing, chamber means formed within said pump housing, a pump impeller situated within said chamber means, means for rotatably driving said pump impeller within said chamber means, said pump impeller comprising a hub and a plurality of angularly spaced radially extending impeller vanes carried by said hub, said chamber means comprising at least first and second arcuate pumping chambers, said first and second arcuate pumping chambers being angularly spaced with respect to each other by first and second dammed portions within said chamber means, each of said arcuate pumping chambers having radially extending first and second side walls axially spaced from each other so as to provide a substantial clearance space between side edges of said impeller vanes, each of said arcuate pumping chambers also including a generally arcuate outer surface spaced radially outwardly a substantial distance from the radially outer-most ends of said impeller vanes so as to provide a substantial clearance space therebetween, each of said dammed portions comprising third and fourth side walls axially spaced from each other a distance less than the distance by which said first and second side walls are spaced from each other, said third and fourth side walls being spaced from each other so as to have the respective surfaces thereof in close proximity to said side edges of said impeller vanes so as to provide no substantial space therebetween, each of said dammed portions also including a second generally arcuate outer surface radially outwardly of the radially outer-most ends of said impeller vanes, each of said second arcuate outer surfaces being formed so as to be in close proximity to said outer-most ends of said impeller vanes so as to provide no substantial space therebetween, at least first and second fluid inlet conduit means formed in said housing for communicating fluid to be pumped to said first and second pumping chambers, said first inlet conduit means having an open first end terminating in a wall of said first pumping chamber, said open first end being so located as to be situated at least near a first arcuate end of said first pumping chamber, said second inlet conduit means having an open second end terminating in a wall of said second pumping chamber, said open second end being so located as to be situated at least near a first arcuate end of said second pumping chamber, and at least first and second fluid outlet conduit means formed in said housing for discharging pumped fluid from said first and second pumping chambers, said first fluid outlet conduit means having an open third end terminating in a wall of said first pumping chamber, said open third end being so located as to be situated at least near a second arcuate end of said first pumping chamber so as to be spaced a substantial distance from said first open end, said second fluid outlet conduit means having an open fourth end terminating in a wall of said second pumping chamber, said open fourth end being so located as to be situated at least near a second arcuate end of said second pumping chamber so as to be spaced a substantial distance from said second open end, said impeller and vanes being effective upon rotation to cause fluid to flow into said respective pumping chambers through said first and second inlet conduit means and to move

said fluid within each of said pumping chambers from the vicinity of said open ends of said inlet conduit means toward said open ends of said outlet conduit means, each of said dammed portions being effective by virtue of the closeness of said third and fourth side walls and said second generally arcuate outer surfaces to said impeller vanes to limit the volume of fluid passing therethrough and thereby cause such fluid in excess of said volume to be pumped through said open ends of said outlet conduit means.

2. A fluid pump assembly according to claim 1, wherein said first fluid outlet conduit means is in communication with said second fluid inlet conduit means.

3. A fluid pump assembly according to claim 1, wherein said first fluid outlet conduit means is in communication with said second fluid inlet conduit means, and wherein said second fluid outlet conduit means is in communication with associated fluid-consuming means.

4. A fluid pump assembly according to claim 1, wherein said first and second fluid inlet conduit means are each in communication with a supply of relatively low pressure fluid, and wherein said first and second fluid outlet conduit means are each in communication with an associated fluid-consuming area.

5. A fluid pump assembly according to claim 1, wherein said pump housing comprises a pump discharge housing section and a pump inlet housing section, wherein said first and second fluid inlet conduit means are formed in said pump inlet housing section, and wherein said first and second fluid outlet conduit means are formed in said pump discharge housing section.

6. A fluid pump assembly according to claim 1, wherein said pump housing is received within an outer housing assembly, wherein said pump housing comprises a pump discharge housing section and a pump inlet housing section, wherein said first and second fluid inlet conduit means are formed in said pump inlet housing section, and wherein said first and second fluid outlet conduit means are formed in said pump discharge housing section, said first and second fluid outlet conduit means comprising radially directed axially extending slots formed in said pump outlet housing section, each of said slots extending to and terminating in juxtaposed relationship to an interior

wall surface of said outer housing assembly whereby said interior wall surface and the surfaces of each of said slots combine to direct fluid flow from said respective pumping chambers.

7. A fluid pump assembly according to claim 1, wherein said pump housing is received within an outer housing assembly, wherein said outer housing assembly comprises an outer housing section, wherein said pump housing comprises a pump discharge casing and a pump inlet casing, wherein said first and second fluid inlet conduit means are formed in said pump inlet casing, and wherein said first and second fluid outlet conduit means are formed in said pump discharge casing, said outer housing section containing a permanent magnet electric motor therein, a magnet retainer ring positioned generally about said permanent magnet so as to be between said permanent magnet and the interior surface of said outer housing section, a plurality of angularly spaced axially extending supporting ribs formed on said interior surface of said outer housing section and projecting radially inwardly thereof so as to provide peripheral support for said magnet retainer ring, and wherein said pump inlet casing includes supporting surface means for operatively engaging one axial end of said magnet retainer ring.

8. A fluid pump assembly according to claim 7, wherein said outer housing section includes an inlet passage formed at one end thereof for communication with a source of fluid, wherein said pump inlet casing and said pump discharge casing are received in an end of said outer housing section opposite to said one end, and wherein said permanent magnet is situated generally between said inlet passage and said pump inlet casing.

9. A fluid pump assembly according to claim 8, wherein said supporting surface means on said pump inlet casing comprises angularly spaced axially extending support struts carried by a wall of said pump inlet casing and extending therefrom so as to terminate in respective free ends, each of said free ends including a stepped-like surface for engaging said one axial end of said retainer ring, said support struts being capable of at least limited deflection in order to achieve seated engagement with said retainer ring.

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