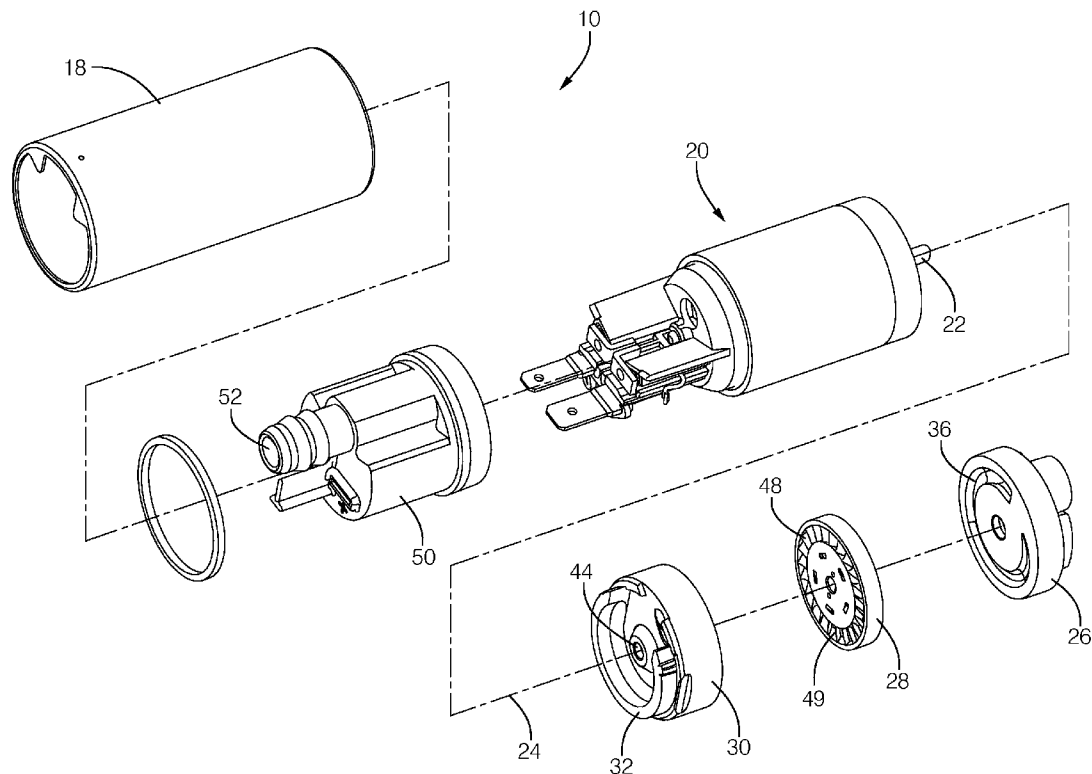


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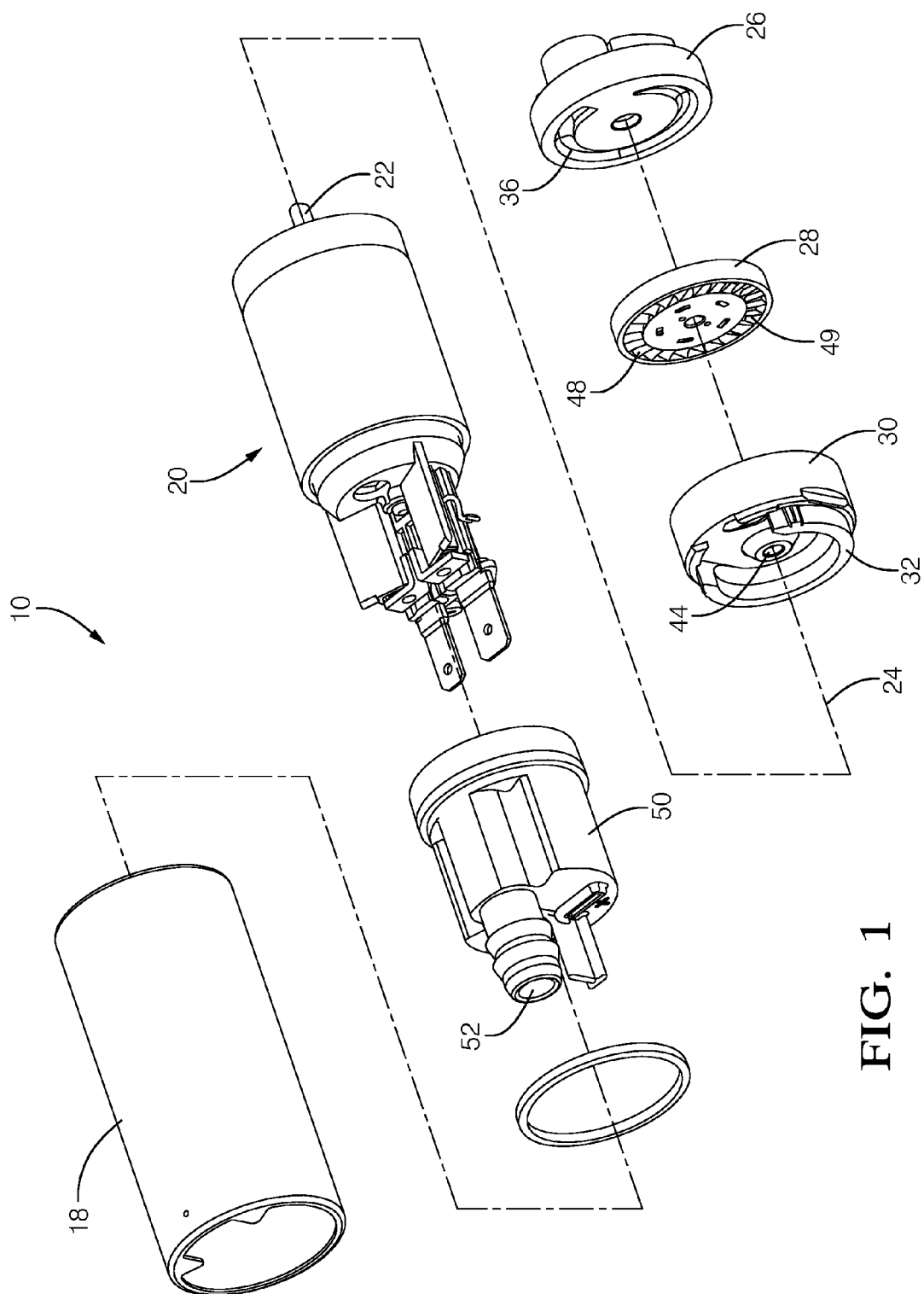
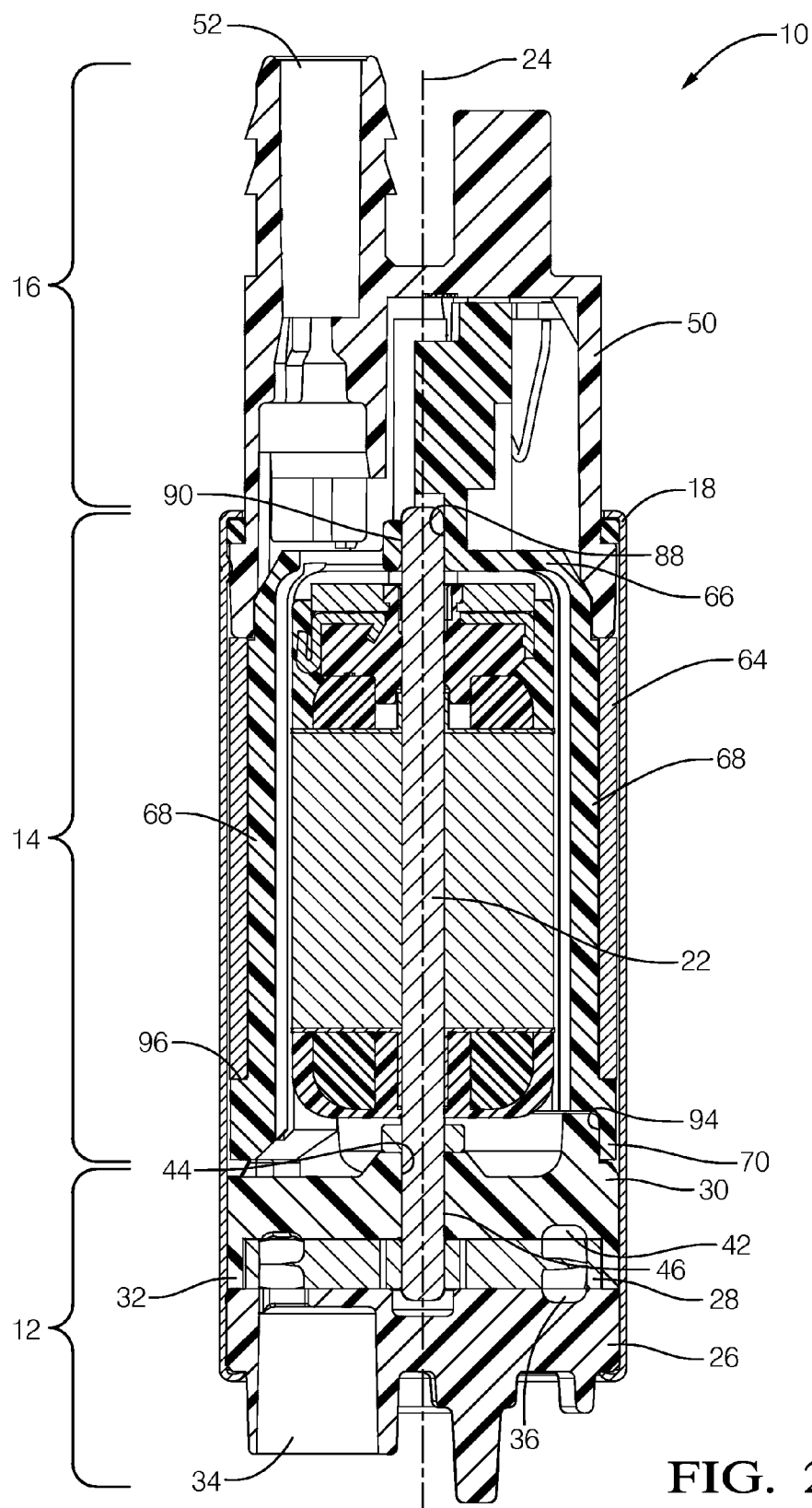


FIG. 1



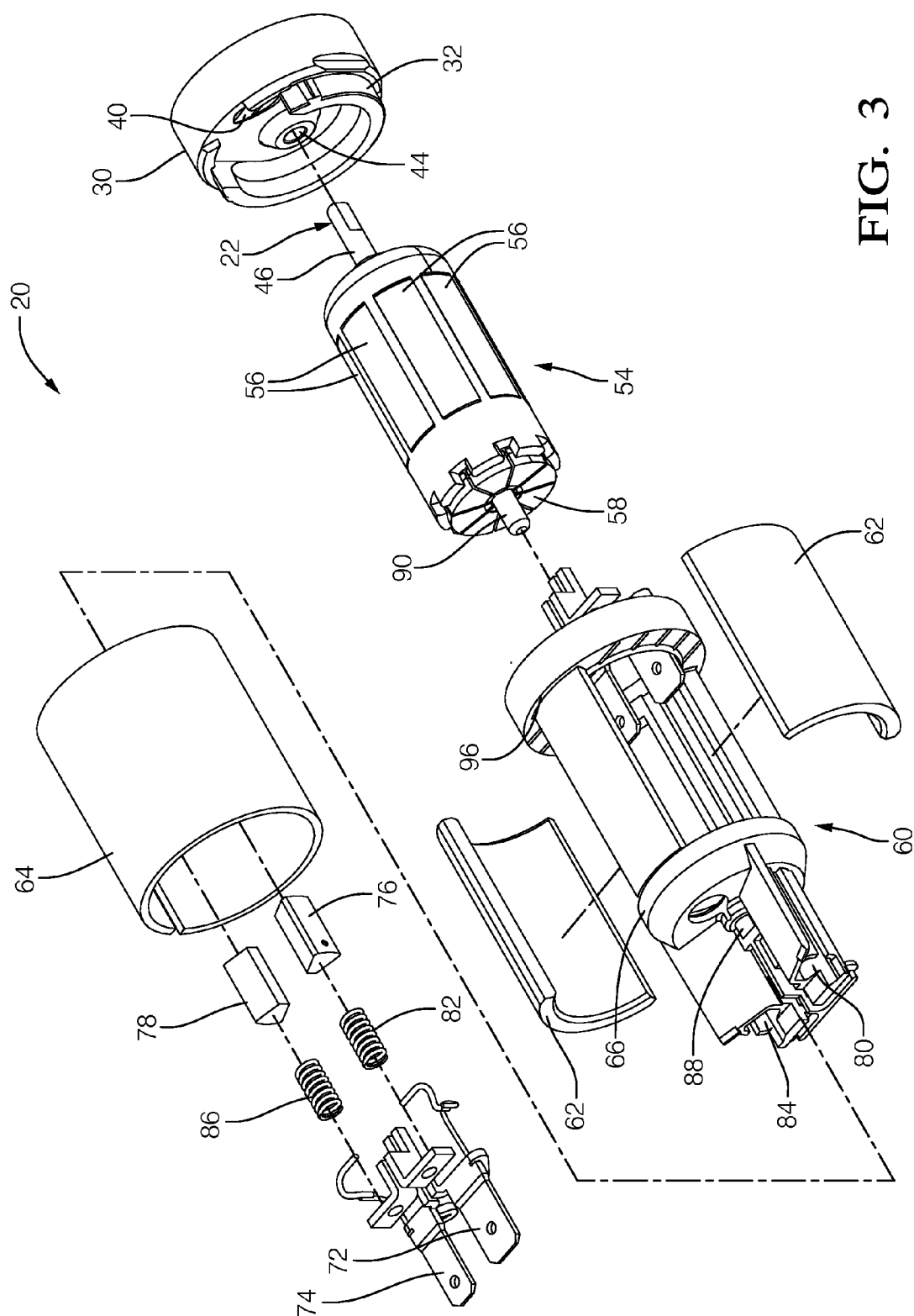


FIG. 3

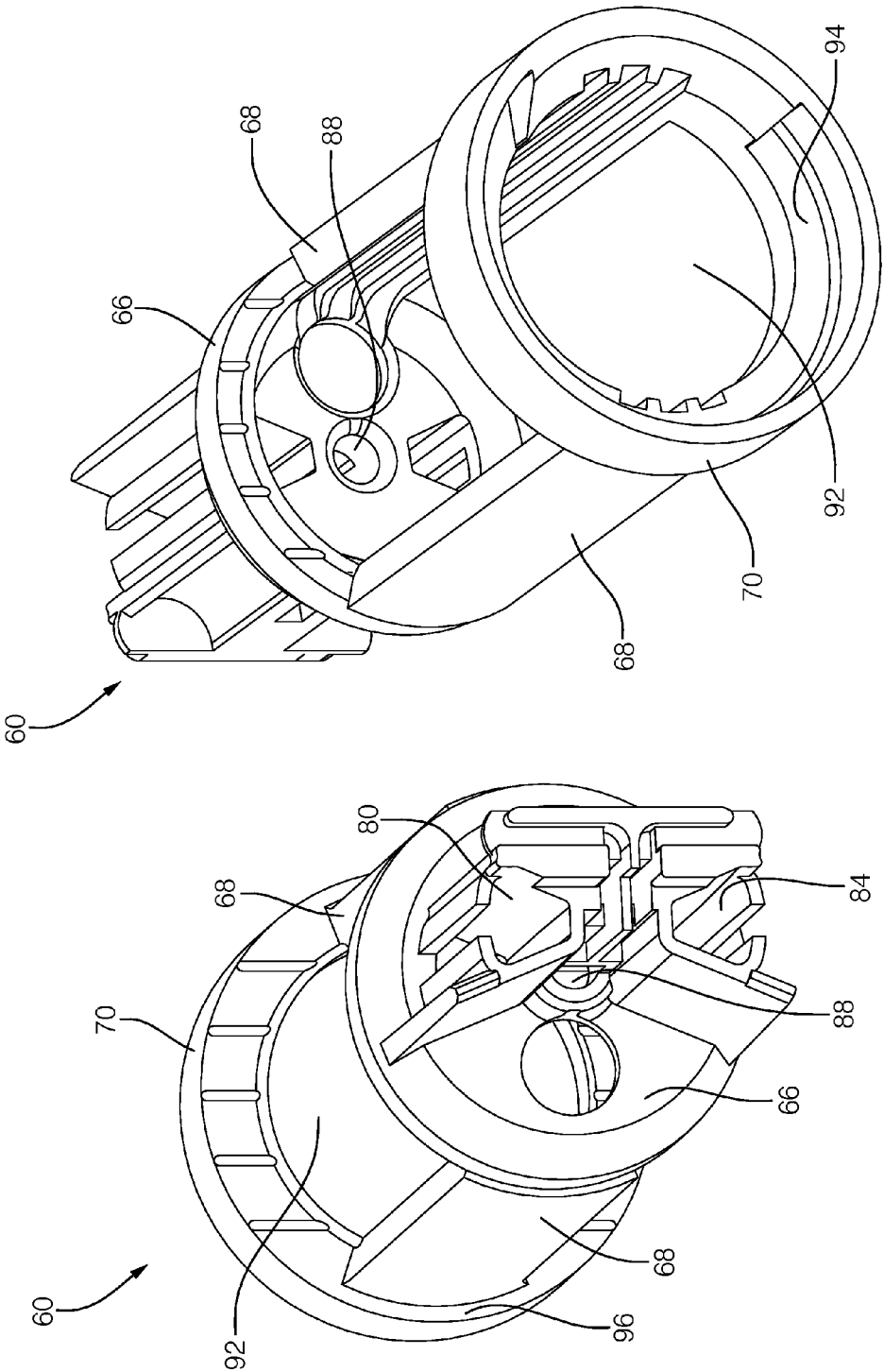


FIG. 5

FIG. 4

FLUID PUMP

TECHNICAL FIELD OF INVENTION

[0001] The present invention relates to a fluid pump; more particularly to a fuel pump; and even more particularly to a fuel pump with an electric motor with a motor frame that defines an upper bushing and maintains a coaxial relationship of a lower bushing with the upper bushing.

BACKGROUND OF INVENTION

[0002] Fluid pumps, and more particularly fuel pumps for pumping fuel, for example, from a fuel tank of a motor vehicle to an internal combustion engine of the motor vehicle, are known. United States Patent Application Publication No. US 2010/0047090 A1 shows one type of fuel pump which includes an impeller. An inlet plate is disposed adjacent to one face of the impeller and an outlet plate is disposed adjacent to the face of the impeller that is opposite the inlet plate. An electric motor of the fuel pump includes a shaft which is coupled to the impeller. One end of the shaft is supported radially by a lower bushing formed integrally with the outlet plate while the other end of the shaft is supported by an upper bushing formed in a base of the motor. The radial position of the lower bearing is determined by the outside diameter of the outlet plate and the inside diameter of a housing while the radial position of the upper bushing is determined by the outside diameter of the base of the motor and the inside diameter of the housing. Since separate tooling is used to manufacture the housing, the base of the motor and the outlet plate, it may be difficult to maintain a sufficient coaxial relationship between the upper bushing and the lower bushing.

[0003] What is needed is a fuel pump which minimizes or eliminates one or more of the shortcomings as set forth above.

SUMMARY OF THE INVENTION

[0004] Briefly described, a fluid pump includes an inlet for introducing fluid into the fluid pump and an outlet for discharging fluid from the fluid pump. The fluid pump also includes a motor having a shaft with an upper end and lower end that rotates about an axis. The fluid pump also includes a motor frame having a top section, a base section, and a plurality of legs that axially separate the top section and the base section. The fluid pump also includes a lower bushing for radially supporting the lower end of the shaft. The top section defines an upper bushing therein for radially supporting the upper end of the shaft and the base section maintains a coaxial relationship between the lower bushing and the upper bushing.

BRIEF DESCRIPTION OF DRAWINGS

[0005] This invention will be further described with reference to the accompanying drawings in which:

[0006] FIG. 1 is an exploded isometric view of a fuel pump in accordance with the present invention;

[0007] FIG. 2 is an axial cross-sectional view of the fuel pump in accordance with the present invention;

[0008] FIG. 3 is an exploded isometric view of a portion of the fuel pump in accordance with the present invention;

[0009] FIG. 4 is an isometric view of a motor frame of the fuel pump in accordance with the present invention; and

[0010] FIG. 5 is an isometric view of the motor frame of FIG. 4 now shown in a different orientation.

DETAILED DESCRIPTION OF INVENTION

[0011] Reference will be made to FIGS. 1 and 2 which are an exploded isometric view and an axial cross-sectional view respectively of a fluid pump illustrated as fuel pump 10 for pumping liquid fuel, for example gasoline or diesel fuel, from a fuel tank (not shown) to an internal combustion engine (not shown). While the fluid pump is illustrated as fuel pump 10, it should be understood that the invention is not to be limited to a fuel pump, but could also be applied to fluid pumps for pumping fluids other than fuel. Fuel pump 10 generally includes a pump section 12 at one end, a motor section 14 adjacent to pump section 12, and an outlet section 16 adjacent to motor section 14 at the end of fuel pump 10 opposite pump section 12. A housing 18 of fuel pump 10 retains pump section 12, motor section 14 and outlet section 16 together. Fuel enters fuel pump 10 at pump section 12, a portion of which is rotated by motor section 14 as will be described in more detail later, and is pumped past motor section 14 to outlet section 16 where the fuel exits fuel pump 10.

[0012] Motor section 14 includes an electric motor 20 which is disposed within housing 18. Electric motor 20 includes a shaft 22 extending therefrom into pump section 12. Shaft 22 rotates about an axis 24 when an electric current is applied to electric motor 20. Electric motor 20 will be described in greater detail later.

[0013] With continued reference to FIGS. 1 and 2, pump section 12 includes an inlet plate 26, an impeller 28, and an outlet plate 30. Inlet plate 26 is disposed at the end of pump section 12 that is distal from motor section 14 while outlet plate 30 is disposed at the end of pump section 12 that is proximal to motor section 14. Both inlet plate 26 and outlet plate 30 are fixed relative to housing 18 to prevent relative movement between inlet plate 26 and outlet plate 30 with respect to housing 18. Outlet plate 30 defines a spacer ring 32 on the side of outlet plate 30 that faces toward inlet plate 26. Impeller 28 is disposed axially between inlet plate 26 and outlet plate 30 such that impeller 28 is radially surrounded by spacer ring 32. Impeller 28 is fixed to shaft 22 such that impeller 28 rotates with shaft 22 in a one-to-one relationship. Spacer ring 32 is dimensioned to be slightly thicker than the dimension of impeller 28 in the direction of axis 24, i.e. the dimension of spacer ring 32 in the direction of axis 24 is greater than the dimension of impeller 28 in the direction of axis 24. In this way, inlet plate 26, outlet plate 30, and spacer ring 32 are fixed within housing 18, for example by crimping the end of housing 18 proximal to outlet plate 30. Axial forces created by the crimping process will be carried by spacer ring 32, thereby preventing impeller 28 from being clamped tightly between inlet plate 26 and outlet plate 30 which would prevent impeller 28 from rotating freely. Spacer ring 32 is also dimensioned to have an inside diameter that is larger than the outside diameter of impeller 28 to allow impeller 28 to rotate freely within spacer ring 32 and axially between inlet plate 26 and outlet plate 30. While spacer ring 32 is illustrated as being made as a single piece with outlet plate 30, it should be understood that spacer ring 32 may alternatively be made as a separate piece that is captured axially between outlet plate 30 and inlet plate 26.

[0014] Inlet plate 26 is generally cylindrical in shape, and includes an inlet 34 that extends through inlet plate 26 in the same direction as axis 24. Inlet 34 is a passage which introduces fuel into fuel pump 10. Inlet plate 26 also includes an inlet plate flow channel 36 formed in the face of inlet plate 26

that faces toward impeller 28. Inlet plate flow channel 36 is in fluid communication with inlet 34.

[0015] Outlet plate 30 is generally cylindrical in shape and includes an outlet plate outlet passage 40 that extends through outlet plate 30 in the same direction as axis 24. Outlet plate outlet passage 40 is in fluid communication with outlet section 16 as will be describe in more detail later. Outlet plate 30 also includes an outlet plate flow channel 42 formed in the face of outlet plate 30 that faces toward impeller 28. Outlet plate flow channel 42 is in fluid communication with outlet plate outlet passage 40. Outlet plate 30 also includes an outlet plate aperture, hereinafter referred to as lower bushing 44, extending through outlet plate 30. Shaft 22 extends through lower bushing 44 in a close fitting relationship such that shaft 22 is able to rotate freely within lower bushing 44 such that radial movement of shaft 22 within lower bushing 44 is substantially prevented. In this way, lower bushing 44 radially supports a lower end 46 of shaft 22 that is proximal to pump section 12.

[0016] Impeller 28 includes a plurality of blades 48 arranged in a polar array radially surrounding and centered about axis 24 such that blades 48 are aligned with inlet plate flow channel 36 and outlet plate flow channel 42. Blades 48 are each separated from each other by a blade chamber 49 that passes through impeller 28 in the general direction of axis 24. Impeller 28 may be made, for example only, by a plastic injection molding process in which the preceding features of impeller 28 are integrally molded as a single piece of plastic.

[0017] Outlet section 16 includes an end cap 50 having an outlet 52 for discharging fuel from fuel pump 10. Outlet 52 may be connected to, for example only, a conduit (not shown) for supplying fuel to an internal combustion engine (not shown). Outlet 52 is in fluid communication with outlet plate outlet passage 40 of outlet plate 30 for receiving fuel that has been pumped by pump section 12.

[0018] With continued reference to FIGS. 1 and 2 and with additional reference to FIGS. 3 and 4, electric motor 20 includes a rotor or armature 54 with a plurality of circumferentially spaced motor windings 56 and a commutator portion 58, a motor frame 60, a pair of permanent magnets 62, and a flux carrier 64. Each magnet 62 is in the shape of a segment of a hollow cylinder. Motor frame 60 includes a top section 66 that is proximal to outlet section 16, a plurality of circumferentially spaced legs 68 extending axially from top section 66 toward pump section 12, and a base section 70 axially spaced apart from top section 66 by legs 68. Top section 66, legs 68, and base section 70 are preferably integrally formed from a single piece of plastic, for example only, by a plastic injection molding process.

[0019] Top section 66 of motor frame 60 includes a first electrical terminal 72 and a second electrical terminal 74 extending therefrom and protruding through end cap 50. First electrical terminal 72 and second electrical terminal 74 are arranged to be connected to a power source (not shown) such that first electrical terminal 72 and second electrical terminal 74 are opposite in polarity. First electrical terminal 72 and second electrical terminal 74 may be disposed within preformed openings in top section 66 or first electrical terminal 72 and second electrical terminal 74 may be insert molded with top section 66 when motor frame 60 is formed by a plastic injection molding process. First electrical terminal 72 is in electrical communication with a first carbon brush 76 while second electrical terminal 74 is in electrical communication with a second carbon brush 78. First carbon brush 76 is

disposed within a first brush holder 80 that is defined by top section 66 and is urged into contact with commutator portion 58 of armature 54 by a first brush spring 82 that is grounded to end cap 50. Second carbon brush 78 is disposed within a second brush holder 84 defined by top section 66 and is urged into contact with commutator portion 58 of armature 54 by a second brush spring 86 that is grounded to end cap 50. First carbon brush 76 and second carbon brush 78 deliver electrical power to motor windings 56 via commutator portion 58, thereby rotating armature 54 and shaft 22 about axis 24.

[0020] Top section 66 of motor frame 60 defines an upper bushing 88 therein which radially supports an upper end 90 of shaft 22 that is proximal to outlet section 16. Shaft 22 is able to rotate freely within upper bushing 88 such that radial movement of shaft 22 within upper bushing 88 is substantially prevented.

[0021] Legs 68 are preferably equally circumferentially spaced around top section 66 and base section 70 and define motor frame openings 92 between legs 68. Motor frame openings 92 extend axially from top section 66 to base section 70. One magnet 62 is disposed within each motor frame opening 92. Magnets 62 may be inserted within respective motor frame openings 92 after motor frame 60 has been formed. Alternatively, magnets 62 may be insert molded with motor frame 60 when motor frame 60 is formed by a plastic injection molding process. In this way, magnets 62 and legs 68 radially surround armature 54. While two legs 68 and two magnets 62 have been illustrated, it should be understood that other quantities of legs 68 and magnets 62 may be used.

[0022] Base section 70 may be annular in shape and connects legs 68 to each other. Base section 70 includes a base section recess 94 extending axially thereinto from the end of base section 70 that faces away from top section 66. Base section recess 94 is coaxial with upper bushing 88 and receives outlet plate 30 closely therein such that radial movement of outlet plate 30 within base section recess 94 is substantially prevented. Since base section recess 94 is coaxial with upper bushing 88, a coaxial relationship is maintained between lower bushing 44 and upper bushing 88 by base section 70. Base section 70 also defines an annular shoulder 96 that faces toward top section 66. Annular shoulder 96 may be substantially perpendicular to axis 24.

[0023] Flux carrier 64 is made of a ferromagnetic material and may take the form of a cylindrical tube. Flux carrier 64 closely radially surrounds legs 68 of motor frame 60 and magnets 62. Flux carrier 64 may be made, for example only, from a sheet of ferromagnetic material formed to shape by a rolling process. The end of flux carrier 64 that is proximal to base section 70 of motor frame 60 axially abuts annular shoulder 96 of base section 70 while the end of flux carrier 64 that is proximal to top section 66 of motor frame 60 axially abuts a portion of end cap 50 that radially surrounds top section 66 of motor frame 60. In this way, flux carrier 64 is captured axially between end cap 50 and annular shoulder 96 of base section 70.

[0024] Since motor frame 60 may be made as a single piece, for example only, by a plastic injection molding process, upper bushing 88 and base section recess 94 can be made by a single piece of tooling, thereby allowing a high degree of control over the relative positions of upper bushing 88 and base section recess 94. Consequently, lower bushing 44 can more easily be maintained in a coaxial relationship with upper bushing 88. Similarly, since first brush holder 80 and second brush holder 84 may be defined by top section 66, for

example only, by an injection molding process, first brush holder **80**, second brush holder **84**, and upper bushing **88** may be formed by a single piece of tooling, thereby allowing a high degree of control over the relative positions of first brush holder **80**, second brush holder **84**, and upper bushing **88**. Consequently, first brush holder **80** and second brush holder **84** can be easily maintained parallel to axis **24** which may be important for first carbon brush **76** and second carbon brush **78** to adequately interface with commutator portion **58** of armature **54**.

[0025] In operation, inlet **34** is exposed to a volume of fuel (not shown) which is to be pumped to, for example only, an internal combustion engine (not shown). An electric current is supplied to motor windings **56** in order to rotate shaft **22** and impeller **28**. As impeller **28** rotates, fuel is drawn through inlet **34** into inlet plate flow channel **36**. Blade chambers **49** allow fuel from inlet plate flow channel **36** to flow to outlet plate flow channel **42**. Impeller **28** subsequently discharges the fuel through outlet plate outlet passage **40** and consequently through outlet **52**.

[0026] While this invention has been described in terms of preferred embodiments thereof, it is not intended to be so limited.

We claim:

1. A fluid pump comprising:
 - an inlet for introducing fluid into said fluid pump;
 - an outlet for discharging fluid from said fluid pump;
 - a motor having a shaft that rotates about an axis, said shaft having an upper end and a lower end;
 - a motor frame having a top section, a base section, and a plurality of legs axially separating said top section and said base section; and
 - a lower bushing for radially supporting said lower end of said shaft;
 wherein said top section defines an upper bushing therein for radially supporting said upper end of said shaft; and wherein said base section maintains a coaxial relationship between said lower bushing and said upper bushing.
2. A fluid pump as in claim 1 wherein said plurality of legs define motor frame openings spaced circumferentially therebetween.
3. A fluid pump as in claim 2 further comprising a plurality of magnets wherein each one of said plurality of magnets is disposed within a respective one of said motor frame openings.
4. A fluid pump as in claim 1 wherein said base section connects each of said plurality of legs.
5. A fluid pump as in claim 4 wherein said base section includes a recess extending axially thereinto.
6. A fluid pump as in claim 4 wherein said base section is annular in shape.
7. A fluid pump as in claim 5 further comprising:
 - an impeller having an array of blades radially surrounding said axis, said impeller being rotatable by said shaft of said motor wherein rotation of said impeller pumps fluid from said inlet to said outlet;
 - an inlet plate adjacent to said impeller and including said inlet, said inlet plate includes an inlet plate flow channel aligned with said array of blades; and
 - an outlet plate adjacent to said impeller on the side said impeller that is opposite said inlet plate, said outlet plate having an outlet passage in fluid communication with said outlet and an outlet plate flow channel aligned with said array of blades;

wherein said outlet plate defines said lower bushing; and wherein said outlet plate is disposed coaxially within said recess.

8. A fluid pump as in claim 7 wherein said base section is annular in shape.

9. A fluid pump as in claim 4 wherein said base section defines a shoulder facing toward said top section.

10. A fluid pump as in claim 9 further comprising a flux carrier radially surrounding said plurality of legs and axially abutting said shoulder.

11. A fluid pump as in claim 10 wherein said shoulder is annular in shape.

12. A fluid pump as in claim 10 further comprising an end cap positioned over said top section and defining said outlet.

13. A fluid pump as in claim 12 wherein said flux carrier is captured axially between said end cap and said shoulder of said base section.

14. A fluid pump as in claim 1 further comprising:

an armature having a plurality of circumferentially spaced windings wherein said armature is fixed to said shaft; and

a pair of brushes to deliver electrical power to said windings;

wherein said pair of brushes are supported in respective brush holders defined by said top section of said motor frame.

15. A fluid pump comprising:

an inlet for introducing fluid into said fluid pump;

an outlet for discharging fluid from said fluid pump;

a motor having a shaft that rotates about an axis, said shaft having an upper end and a lower end;

a motor frame having a top section, a base section, and a plurality of legs axially separating said top section and said base section;

an impeller having an array of blades radially surrounding said axis, said impeller being rotatable by said shaft of said motor wherein rotation of said impeller pumps fluid from said inlet to said outlet;

an inlet plate adjacent to said impeller and including said inlet, said inlet plate includes an inlet plate flow channel aligned with said array of blades; and

an outlet plate adjacent to said impeller on the side said impeller that is opposite said inlet plate, said outlet plate having an outlet passage in fluid communication with said outlet and an outlet plate flow channel aligned with said array of blades, said outlet plate defining a lower bushing for radially supporting said lower end of said shaft;

wherein said top section defines an upper bushing therein for radially supporting said upper end of said shaft; and wherein said base section maintains a coaxial relationship between said lower bushing and said upper bushing.

16. A fluid pump as in claim 15 wherein said base section includes a recess extending axially thereinto.

17. A fluid pump as in claim 16 wherein said base section connects each of said plurality of legs.

18. A fluid pump as in claim 17 wherein said base section is annular in shape.

19. A fluid pump as in claim 16 wherein said wherein said outlet plate is disposed coaxially within said recess.

20. A fluid pump as in claim 19 wherein said base section defines a shoulder facing toward said top section.

21. A fluid pump as in claim **20** further comprising a flux carrier radially surrounding said plurality of legs and axially abutting said shoulder.

22. A fluid pump as in claim **21** further comprising an end cap positioned over said top section and defining said outlet.

23. A fluid pump as in claim **22** wherein said flux carrier is captured axially between said end cap and said shoulder of said base section.

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