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(54) **AUTOMOTIVE FUEL PUMP IMPROVEMENT**

(57)

ABSTRACT

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A multi-stage turbine fuel pump (10) for automotive vehicles includes an inlet section (12) through which low pressure fuel is drawn into the pump, a first pump stage (14a) and a second pump stage (14b), and an outlet section (16) through which high pressure fuel is discharged from the pump. Components (13, 22a and 22b) comprising a pump inlet and respective first and second pump stages are aligned together by spring pins (32) inserted in open channels (36, 38, 44a and 44b) extending through the components so to improve fuel flow through the pump and prevent fuel leakage between the stages. Each pin has a hollow, cylindrical shape with a longitudinal slot (34) extending the length of the pin. The pins are made of a spring material, and each pin is compressed when inserted in place for the pin to thereafter press against a sidewall of the channel in which it is inserted, the force exerted by the pin on the channel sidewall maintaining alignment of the components.

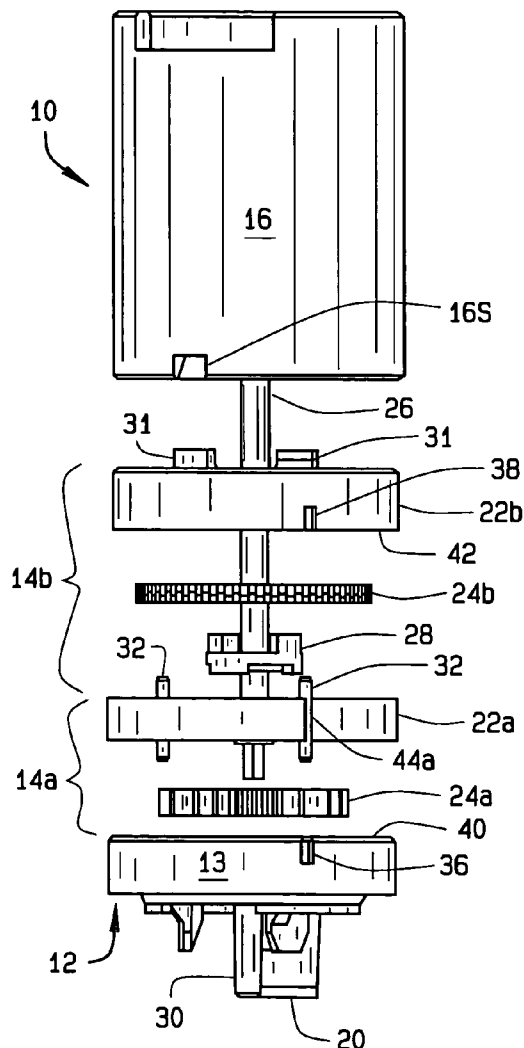
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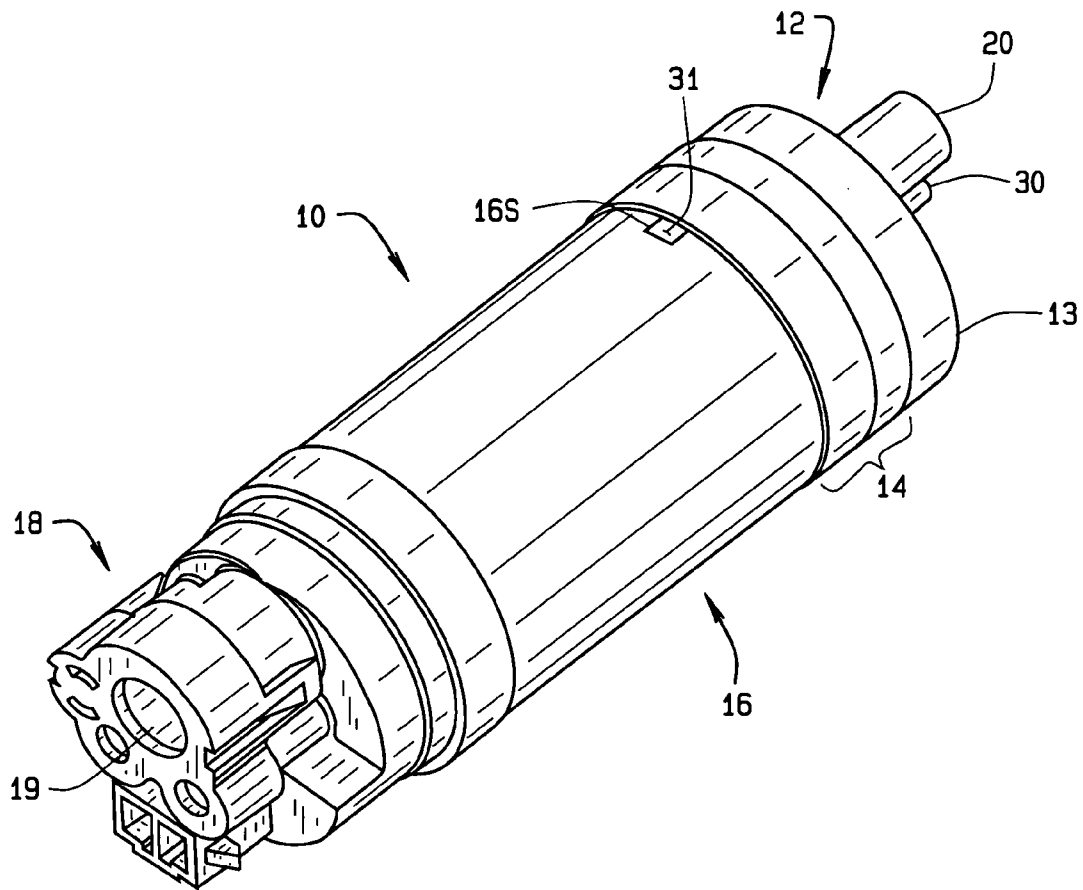


FIG. 1

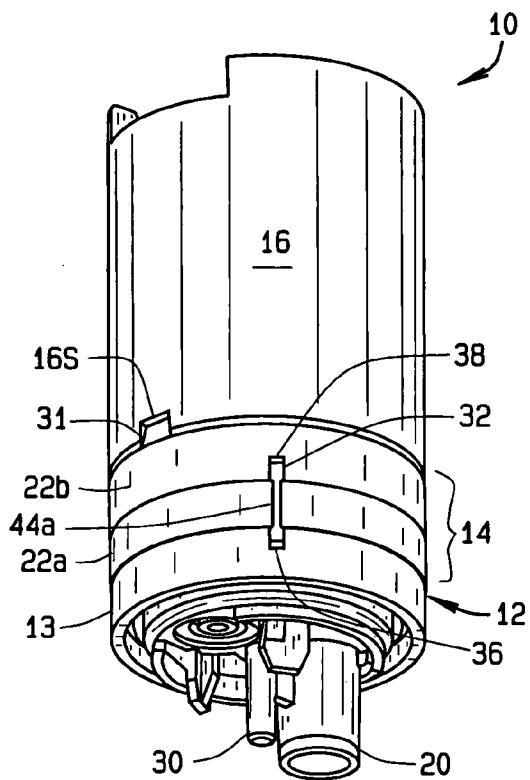


FIG. 2A

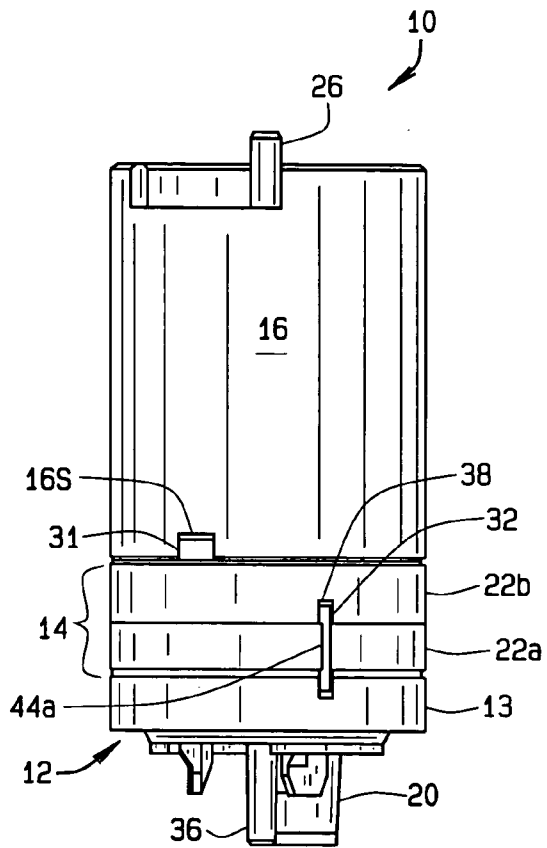


FIG. 2B

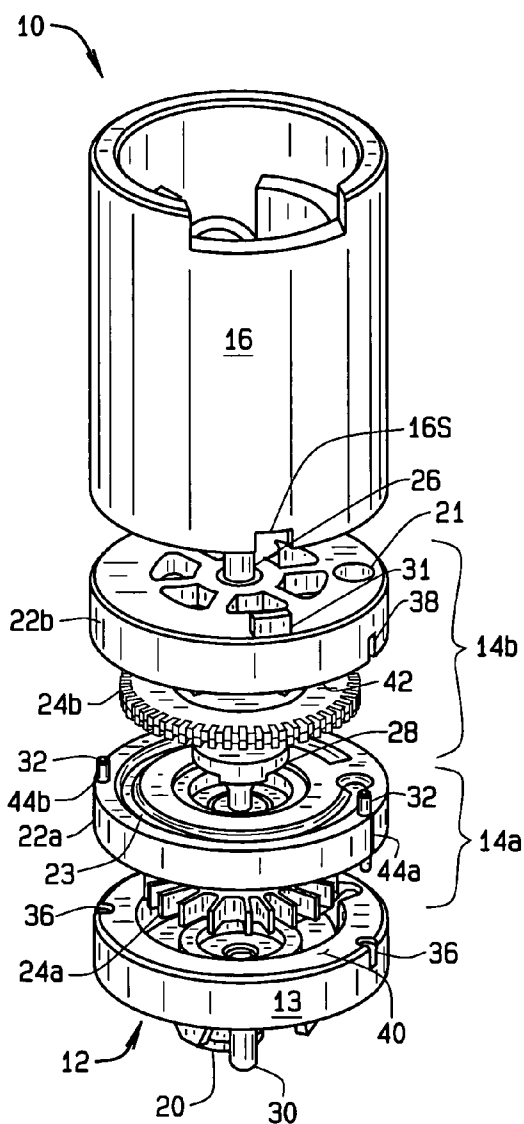


FIG. 3A

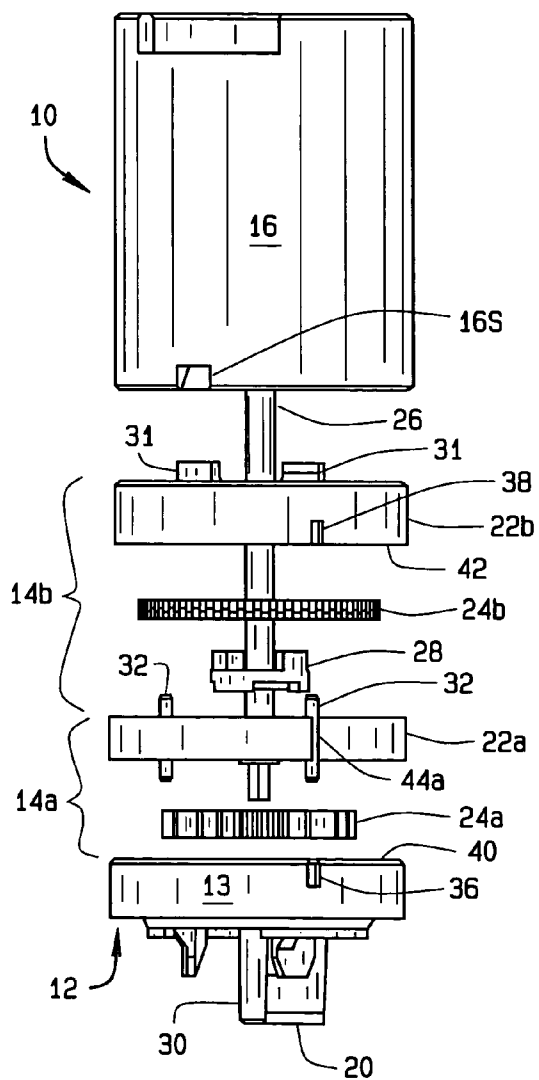


FIG. 3B

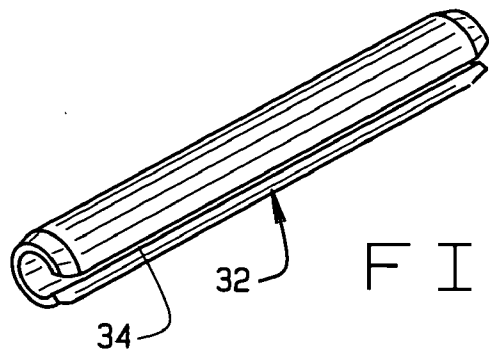


FIG. 4A

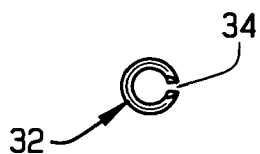


FIG. 4B

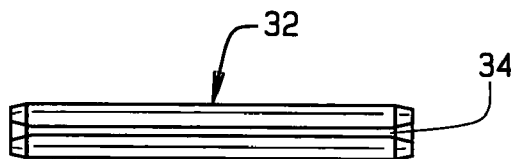


FIG. 4C

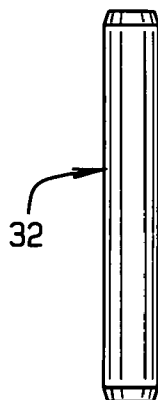


FIG. 4D

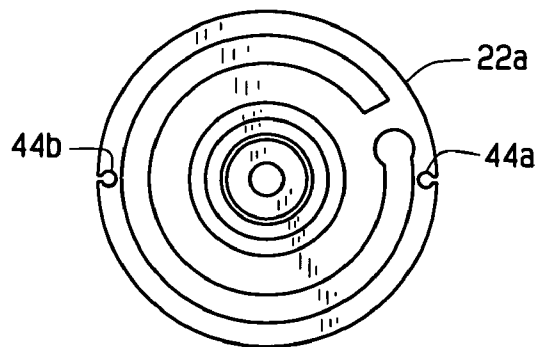


FIG. 8

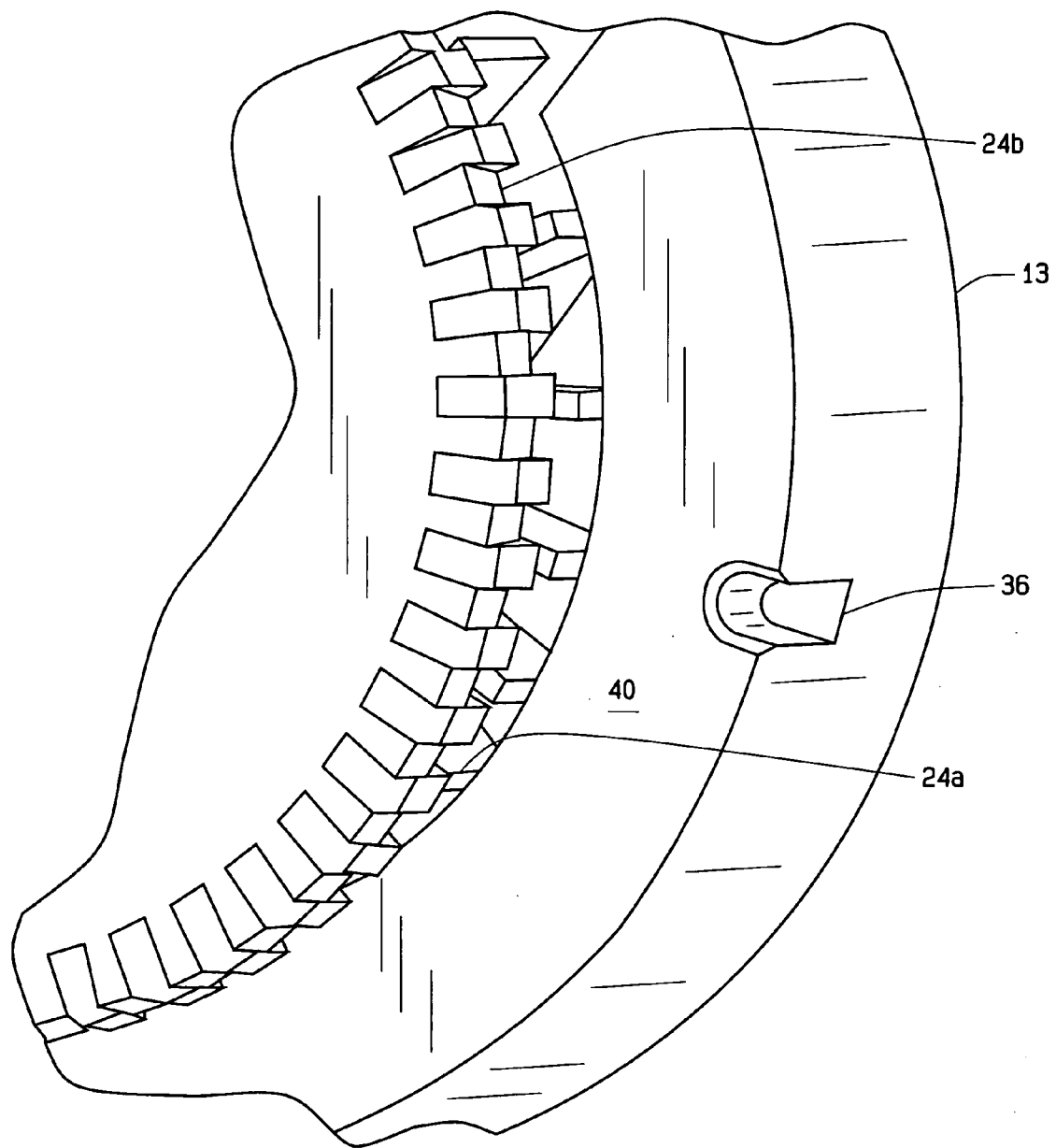


FIG. 5

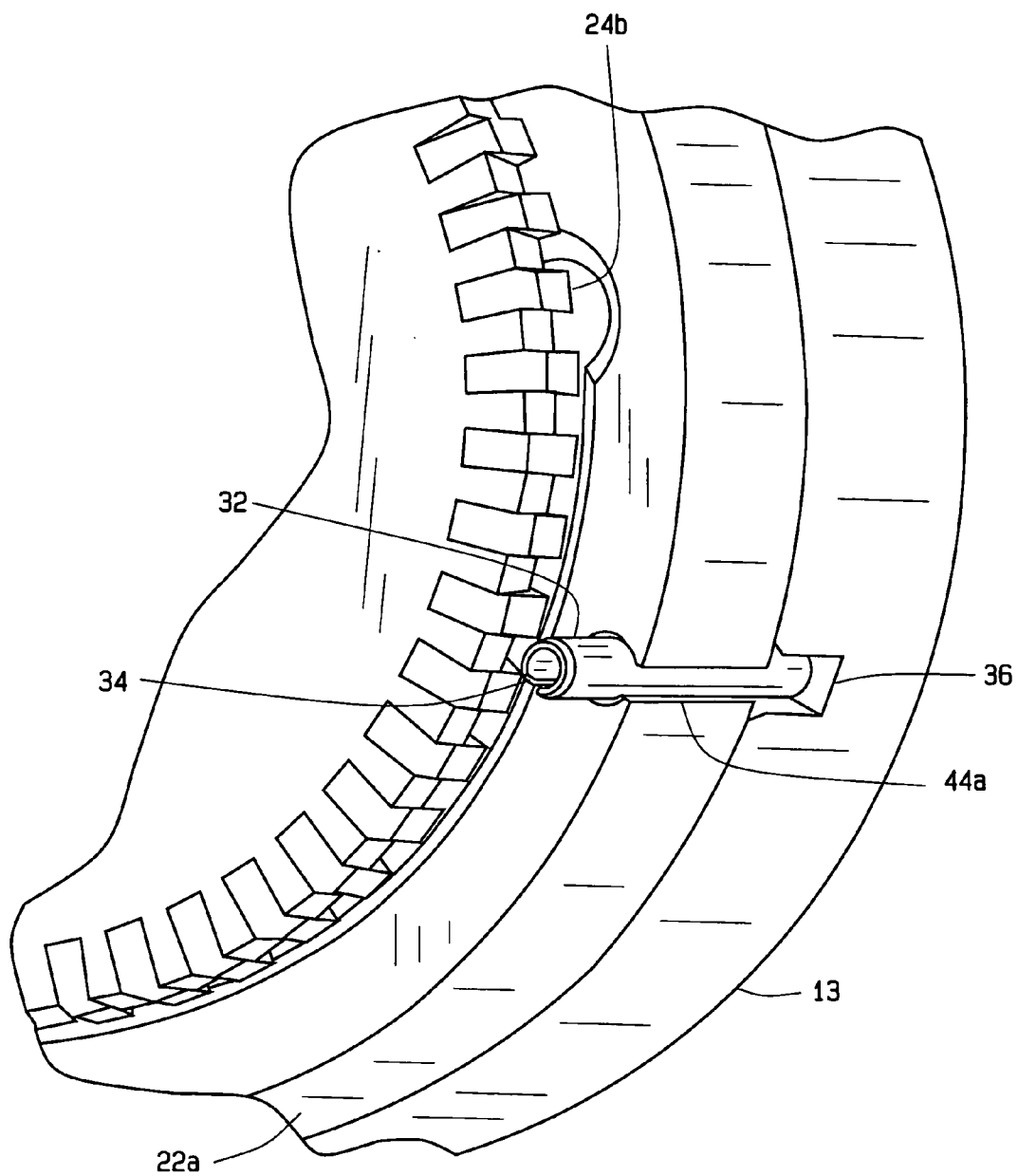


FIG. 6

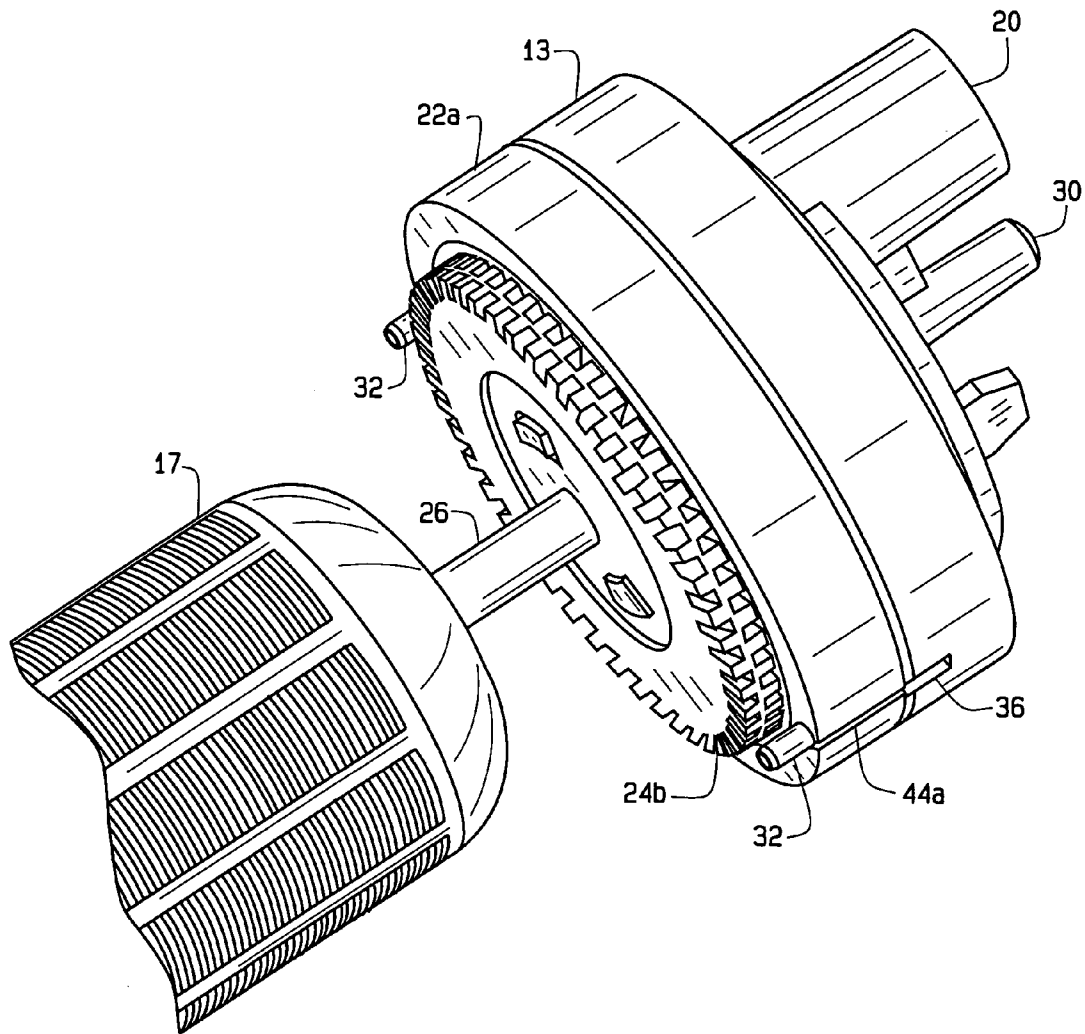


FIG. 7

AUTOMOTIVE FUEL PUMP IMPROVEMENT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] None

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] N/A

BACKGROUND OF THE INVENTION

[0003] This invention relates to electrical fuel pumps for use in automobiles and other vehicles; and more particularly, to a slotted spring pin and slot construction for aligning and holding components of the pump stages together and which prevents cracking of pump components in which the slots are formed so to prevent failure of a pump.

[0004] Multi-stage fuel pumps for use in automotive vehicles are known in the art. The pump typically is a two-stage pump having a first and low pressure inlet stage followed by a second and high pressure outlet stage. The two pump stages, together with the electric motor driving the pump and the respective end caps in which inlet and outlet ports are formed must be accurately aligned during pump assembly in order for the pump to efficiently pump fuel from a tank to the engine in which the fuel is combusted. One way of achieving this alignment is to use screws which are inserted through holes in the respective components with a threaded end of the screw being threaded into a bore correspondingly threaded to receive the screw. An alternative approach is use of a pin inserted through bores in the pump components. The pins, which are enclosed or encapsulated within the bores formed in the parts, are compressed when the components are assembled together. Another alternative approach is use of either one or two spring clips applied to the outside perimeter of the pump components.

[0005] It has been that, over time, problems occur with each of these installations. With threaded screws, vibrations and shocks to which the pump is subjected will tend to loosen the screws. Even a slight loosening of the screws will affect pump performance since small gaps will appear between parts causing leakages which effect pumping efficiency. With pins, the vibrations and shocks to which the pins are subjected are transmitted to the portion of the parts surrounding the pins, and will cause cracks to occur about the bores in these components. This weakens these parts and can ultimately lead to their failure. With the spring clips, alignment of the components is inconsistent and can result in low fuel flow through the pump and/or high amperage failures.

[0006] The present invention is directed to a spring pin and slot construction by which proper alignment of pump components is achieved and subsequent problems caused by shock and vibrations are avoided.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention, briefly stated, is directed to a multi-stage turbine fuel pump for automotive vehicles. The fuel pump includes an inlet section through which low pressure fuel is drawn into the pump, a first pump stage and a second pump stage, and an outlet section through which

high pressure fuel is discharged from the pump. Components comprising the respective first and second pump stages are aligned together by pins inserted in channels extending through the components to properly orient the parts. Each pin has a hollow, cylindrical shape with a longitudinal slot extending the length of the pin. The pins are made of a spring material, and each pin is compressed when the pump components are assembled together. The channels in each of the parts through which the pins are inserted comprise slots or pockets which open into the outer surface of the part. This construction helps distribute forces exerted by the pins against the sidewalls of the channels when the pump is subjected to shocks and vibrations, so to prevent the parts from cracking about the area where the channels are formed, weakening the parts.

[0008] Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] The objects of the invention are achieved as set forth in the illustrative embodiments shown in the drawings which form a part of the specification.

[0010] FIG. 1 is a perspective view of an automotive electric fuel pump incorporating the improvement of the present invention;

[0011] FIGS. 2A and 2B are assembled views of the fuel pump illustrating the an open channel construction for spring pins used to align the parts;

[0012] FIGS. 3A and 3B are exploded views of the fuel pump with its outer cover removed;

[0013] FIGS. 4A-4D are respective perspective, end and two side views of a spring pin of the present invention for aligning components of a two-stage turbine assembly portion of the fuel pump;

[0014] FIG. 5 is a close-up view of an open channel, socket portion of one component of the turbine assembly in which one end of a spring pin is received;

[0015] FIG. 6 is a view similar to FIG. 5 with a spring pin installed;

[0016] FIG. 7 is a perspective view of the turbine assembly with spring pins installed for aligning the parts of the assembly; and,

[0017] FIG. 8 is a plan view of a port plate illustrating the channels formed therein for the spring pins.

[0018] Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF INVENTION

[0019] The following detailed description illustrates the invention by way of example and not by way of limitation. This description will clearly enable one skilled in the art to make and use the invention, and describes several embodiments, adaptations, variations, alternatives and uses of the invention, including what I presently believe is the best mode of carrying out the invention. As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter

contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

[0020] Referring to the drawings, an electric fuel pump for use with automotive vehicles is indicated generally **10**. Pump **10** is a two-stage turbine pump having an inlet section **12**, a fuel pumping section **14** including a first pump stage **14a** and a second pump stage **14b**, a housing **16** in which is housed a pump motor **17** (see **FIG. 7**), and an outlet section **18** in which a fuel outlet **19** is formed.

[0021] Inlet section **12** comprises an end cap **13** which is of a molded plastic material and has formed therein a fuel inlet **20** by which fuel at a low pressure is drawn into the pump from a fuel tank (not shown). Pump section **14a** comprises end cap **13** and a port plate **22a**. Pump section **14b** includes also includes port plate **22a**, and a casing **22b**. The port plate and casing are each formed of a molded plastic material and are arranged in a stacked configuration with port plate **22a** mounted between end cap **13** and casing **22b**. Each pump section further includes an impeller, **24a**, **24b** respectively. The port plate and casing are each formed with central cavities in which the respective impellers are rotatably installed, the impellers each being mounted on a shaft **26** of the pump motor **17**. As shown in **FIGS. 3A and 3B**, casing **22b** is first fitted over shaft **26**, then impeller **24b** is mounted on the shaft. Next, an impeller drive **28** is fitted onto the shaft. Port plate **22a** is then fitted over shaft **26**, and impeller **24a** is then mounted onto the shaft. Finally, end cap **13** is fitted onto the outer end of the shaft, the end cap having a housing **30** formed therein in which the outer end of shaft **26** is received.

[0022] Operation of a two-stage turbine pump is known in the art. Fuel is drawn into the pump through inlet **20** in end cap **13**, and drawn to the first and lower pressure stage of the pump by impeller **24a**. From this first stage, the fuel is drawn into the higher pressure second pump stage by impeller **24b**. Port plate **22a** has a flow path **23** formed therein (see **FIG. 3A**) by which fuels flows from the first to the second pump stage. Similarly, casing **22b** has a flow path formed therein (not shown) by which high pressure fuel is directed from the second pump stage to pump outlet **19** via an outlet **21** in the casing. Tabs **31** are formed on the outer margin of casing **22b**, the tabs fitting in slots **16s** in housing **16** to aid in assembly of the fuel pump.

[0023] For proper and efficient operation of fuel pump **10**, the various components comprising the turbine assembly need to be properly aligned and precisely fitted together.

[0024] Referring to **FIGS. 5-8**, end cap **13**, and port plate **22a**, and casing **22b** are held together during assembly using a pair of spring pins **32**. As shown in **FIGS. 4A-4D**, each spring pin is of a hollow, elongate cylindrical shape with a longitudinal slot **34** extending the entire length of the pin. The pins are formed of a spring material such as a spring steel. The length of each pin is such that it extends between end cap **13**, through port plate **22a**, and into casing **22b**. This is as shown in **FIGS. 2A and 2B**.

[0025] Because it is important to not cause cracking in these components after the pump is assembled, the present invention includes open channels formed in the sidewall of end plate **13** and port plate **22a**, and casing **22b** for receiving the pins **32**. In **FIG. 5**, an open sided pocket or recess **36** is

shown to be formed in end plate **13**. A similar open sided pocket or recess **38** is formed in casing **22b**. Each pocket comprises a semi-circular opening formed in the outer wall of the end cap or port plate respectively, the opening extending from an inner face **40** of end cap **13**, or an inner face **42** of casing **22b**, into the body of the respective part. In each part, the depth of the pocket is approximately one-half the thickness of the part; while, the diameter of the pocket generally corresponds to that of the spring pin.

[0026] Port plate **22a** has opposed channels **44a**, **44b** formed therein through which the pins **32** are inserted when fuel pump **10** is assembled. The diameter of each channel corresponds to that of the spring pin inserted through the channel. Both channels open into the outer face or sidewall of the port plate. Thus, while the channels facilitate insertion of the spring pins for accurately aligning the pump components; they encapsulate the spring pins, while the pockets **36**, **38** do not encapsulate them. Channels **44a**, **44b** in the outer wall of port plate **22a** have the advantage of allowing forces transmitted through the spring pins, when shocks and vibrations occur, to dissipate through the end cap and port plate, rather than cracking radially to the outside of the port plate. Preferably the open channels formed in end cap **13**, port plate **22a**, and casing **22b**, for receiving the spring pins, are approximately five degrees (5°) less than being diametrically opposite each other. This facilitates correct alignment of the parts during assembly.

[0027] During manufacture of the fuel pump, the spring pins **32** are first installed in the respective channels in port plate **22a**. The pins are inserted so that the ends of the pins extend from opposite sides of the port plate. Next, the various components comprising the two stages of the turbine pump are mounted on motor shaft **26**. Casing **22b** is first rotated until the tabs **31** formed on the outer face of the port plate align with the slots **16s** in the housing **16** in which pump motor **17** is housed. Housing **16** and casing **22b** are then correctly aligned. Next, impeller **24b** is installed on shaft **26**, with impeller drive **28** then being fitted onto the shaft. At this time, the inner ends of the spring pins **32** are inserted into the respective pockets **38** formed in the casing. Next, impeller **24a** is mounted on shaft **26**. End cap **13** is then rotated until the pockets **36** formed in the end cap align with the channels **44a**, **44b** in port plate **22a**. When they are, the end cap is properly held in alignment with port plate **22a** for the outer ends of the spring pins received in the pockets **36**.

[0028] The spring pins are slightly compressed when they are installed in port plate **22a**. During the final stages of pump assembly, when an outer shell (not shown) of pump **10** is fitted into place, the expansion force exerted by the springs against the sidewalls of the channels **44a**, **44b** and the slip fit of the pins with the pockets **36**, **38** hold these components tightly together so to retain the proper alignment between the pump inlet, the first and second pump stages, and the pump outlet. Importantly, because the channels and pockets are open sided rather than completely enclosing and encapsulating the spring pins, forces which otherwise could damage the end cap and port plates are readily distributed through these parts and not concentrated about the channels where damage could occur.

[0029] In view of the above, it will be seen that the several objects and advantages of the present invention have been achieved and other advantageous results have been obtained.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a multi-stage turbine fuel pump for automotive vehicles, the pump having an inlet section through which low pressure fuel is drawn into the pump, a first pump stage and a second pump stage, and an outlet section through which high pressure fuel is discharged from the pump, the improvement comprising alignment means for assembling together and properly aligning components comprising the respective first and second pump stages, the alignment means maintaining alignment of the components during and after pump assembly and dissipating forces which otherwise would be concentrated about the alignment means which could cause failure of the components.

2. The fuel pump improvement of claim 1 in which the inlet section includes an end cap having an opening therein through which fuel is drawn into the pump, the first pump stage includes including an impeller and a port plate in which the impeller is installed, the second stage the port plate and a casing in which a second impeller is installed, and the alignment means includes means extending between the end cap, port plate, and casing to align the inlet section and pump stages.

3. The fuel pump improvement of claim 2 in which the alignment means includes a spring pin extending between the end cap and the casing for the second pump stage to align the components together, and an open channel formed in each of the end cap and casing in which the spring pin is received.

4. The fuel pump improvement of claim 3 further including a second spring pin for aligning the components, and a second open channel formed in each of the end cap, port plate, and casing in which the second spring pin is received.

5. The fuel pump improvement of claim 4 in which the end cap has first and second recesses formed therein for receiving one end of each spring pin and the casing has first and second recesses formed therein for receiving the other end of each spring pin.

6. The fuel pump improvement of claim 5 wherein the port plate has open sided, spaced channels formed therein through which each of the spring pins extends.

7. The fuel pump improvement of claim 6 in which each spring pin has a hollow, cylindrical shape with a longitudinal slot extending the length of the pin.

8. The fuel pump improvement of claim 7 in which the recesses formed in the end cap and casing and the channels formed in the port plate through which the spring pins are inserted to align the components all open into a sidewall of the respective component so forces transmitted from a spring pin to the component are dissipated through the component rather than concentrated about the recess or channel, thereby to prevent cracking of the component.

9. The fuel pump improvement of claim 8 in which the pins are made of a spring material, the springs being compressed when the inserted in the channels of the port plate with the pins thereafter expanding against a sidewall of the channel with the force exerted by the pin on the channel sidewall maintaining alignment of the components.

10. The fuel pump improvement of claim 4 in which the two spring pins and the open channels formed in the end cap, port plate, and casing are arranged in a predetermined angular relationship with each other for proper alignment of the fuel pump components during pump assembly.

11. A multi-stage turbine fuel pump for automotive vehicles comprising:

an inlet section through which low pressure fuel is drawn into the pump;

a first pump stage and a second pump stage;

an outlet section through which high pressure fuel is discharged from the pump; and,

alignment means for aligning the components comprising the respective first and second pump stages, the alignment means maintaining alignment of the components during and after the pump is assembled and dissipating forces which otherwise would be concentrated about the alignment means which could cause failure of the components.

12. The fuel pump of claim 11 in which the inlet section includes an end cap having an opening therein through which fuel is drawn into the pump, a first pump stage including an impeller and a port plate in which the impeller is mounted, and a second pump stage including a casing and an impeller mounted between the port plate and casing, the alignment means including at least one spring pin extending between the end cap, through the port plate, and into the casing to properly align the inlet section and pump stages together, and an open channel formed in the end cap, port plate, and casing in which the spring pin is received.

13. The fuel pump of claim 12 including a pair of spring pins for connecting the components together, the spring pins being installed on opposite sides of the fuel pump, and an open channel formed in the end cap, port plate, and casing in which each of the spring pins is received.

14. The fuel pump of claim 13 in which the end cap has first and second open sided pockets formed therein for supporting one end of each spring pin and the casing has first and second open sided pockets formed therein for supporting the other end of each spring pin.

15. The fuel pump of claim 14 wherein the port plate for the first pump stage, which is intermediate the end plate and port plate for the second pump stage, has a pair of open sided channels formed therein through which the spring pins extend.

16. The fuel pump of claim 15 in which each spring pin has a hollow, cylindrical shape with a longitudinal slot extending the length of the pin, the pins being made of a spring material, and each pin being compressed when inserted in place for the pin to thereafter press against a sidewall of the channel in which it is inserted, the force exerted by the pin on the channel sidewall maintaining alignment of the components.

17. An alignment means for use in a multistage turbine fuel pump for aligning components comprising respective stages of the pump, the alignment means including a spring pin made of a spring material and the fuel pump components each having an open channel formed therein with the spring pin, when installed in the channel, exerting a force on the components to maintain them in alignment.

18. The alignment means of claim 17 including a pair of substantially identically formed spring pins, the fuel pump components including respective open channels for each pin.

19. The alignment means of claim 18 each spring pin has a hollow, cylindrical shape with a longitudinal slot extending the length of the pin, each pin being compressed when

inserted in a channel for the pins to thereafter press against a sidewall of the channel in which it is inserted, the force exerted by the pin on the channel sidewall holding the components in alignment.

20. The alignment means of claim 19 in which the two spring pins and the open channels formed in which the spring pins are received are arranged in a preferred orientation to properly align the components during pump assembly.

21. The alignment means of claims 19 in which the fuel pump is a two stage fuel pump having an inlet end cap, a first stage port plate and a second stage casing, the inlet end cap, port plate, and casing each having open channels formed therein in which the respective spring pins are received, thereby to dissipate forces transferred from the spring pins to these components rather than concentrating the forces thereabout and causing damage to the components.

* * * * *