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(54) INTERNAL-COMBUSTION ENGINE FUEL-FEED PUMPING ASSEMBLY

(71) We, ROBERT BOSCH GmbH. a German Company, of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

- 10 The invention relates to an internal-combustion engine fuel-feed pumping assembly.

Fuel pumps are known which are electrically driven and which comprises an intermediate plate with a recess, the plate being clamped between fixed side plates. A grooved pump rotor is disposed in the recess, pumping elements being disposed in the grooves so that the elements are, in operation, urged by centrifugal force against a running track on the intermediate plate. The mutually touching surfaces of the running track and pump body in these known feed pumps tend to be subjected to a considerable amount of wear in the case of mixed friction or dry running. The result of the wear is a considerable increase in the current consumption, and a reduction in the rotational speed, the delivery quantity and the system pressure, thus finally leading to the failure of the supply of fuel to the internal combustion engine.

According to the present invention there is provided an internal combustion engine fuel-feed pumping assembly comprising a rotary pump having an intermediate plate which is provided with a circular aperture and which is clamped between fixed side plates, and a pump rotor which is arranged between the side plates and eccentrically in the aperture and which has in it periphery grooves, open towards the wall of the aperture in the intermediate plate, which grooves accommodate pumping elements which are pushed by centrifugal force against a running track on the wall of the aperture in the intermediate plate and together with the rotor and the running track define working-fluid chambers, the materials of the mutually touching surfaces of the pumping elements

and the running track being suitably paired for dry running.

In a fuel pump constructed in accordance with the present invention wear between the pump body and the running track leading to the failure of the pump, is greatly reduced in the case of mixed friction or dry running. A further advantage is the fact that the current consumption does not increase to any substantial extent even after a long period in operation. However, low energy consumption and operating reliability are advantages of considerable importance.

The invention will hereinafter be further described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a longitudinal section through an internal-combustion engine fuel-feed pumping assembly constructed in accordance with the invention; and

Fig. 2 is a section taken along the line II—II of Fig. 1.

A fuel feed rotary pump 1 of the roller-vane type and an electric motor 2 are combined to form the illustrated fuel feed pumping assembly. The pump and the motor are accommodated in a cup-shaped housing 3 whose bottom end has a suction connection 4 for a flexible fuel pipe, the housing being sealed by means of a cover 5 on which are arranged a pressure connection piece 6 and a non-return valve 7 acting as a pressure valve. A seal 8 is arranged between the housing 3 and the cover 5. The cover 5 is secured to the housing by means of a flange 9 on the open end of the housing 3.

The pump 1 and the electric motor 2 are disposed in the housing 3 in this order viewed from the suction end towards the pressure end, wherein the fuel fed under pressure by the pump 1 also flows around the electric motor 2 for the purpose of cooling the latter.

The pump 1 has a base plate 11 into the central bore of which is pressed a fixed spindle 12. An intermediate plate 13 and a support plate 14 are arranged axially adjacent to the base plate 1. The base plate, the intermediate plate and the support plate are clamped together by means of screws 16

and accommodate the pump rotor 17 therebetween, the pump rotor 17 being mounted on the spindle 12 by means of a bearing 18. The suction side of the pump 1 communicates with the chamber 19 by way of openings (not illustrated), the chamber 19 being defined by the bottom of the housing 3 and by the base plate 11. On the other hand, the pressure side of the pump 1 communicates with a chamber 20 which forms part of the electric motor 2, leads to the pressure connection piece 6, and has an opening which leads to the chamber 19 and which is controlled by means of a pressure control valve 21. The pump 1 communicates with the chambers 19 and 20 by way of passages which are only controlled by the pump rotor but which are preferably open passages.

The electric motor 2 comprises a motor rotor 23, a commutator 24 and a magnetic member 25.

The motor rotor 23 is mounted on the spindle 12 by way of bearing bushes 27. The bearing bushes are arranged in a support tube 28 to which the stack 29 of plates, the armature winding 30 and the commutator bush 31 are secured partially by pressing-on and partially by plastics filling members which, by injection-moulding them around the individual elements, ensure a satisfactory non-rotatable and axial connection. A bush 32 of this type is arranged on that end of the support tube 28 which faces the pump, and, acting as a rotary coupling, has at least one driver lug 33 which engages into a complementary recess 34 in the pump rotor 17.

The commutator brushes 35 are arranged in cages 36 and slide on the commutator bush 31. The cages 36 are connected to connection terminals (not illustrated) arranged outside the housing 3.

The magnetic member 25 of the electric motor 2 comprises a permanent magnet 38 arranged in a tubular plate 39 made from magnetically conductive material.

As may be seen in Fig. 2, rollers 42 acting as pumping members are radially movably arranged in grooves 41 in the pump rotor 17. The circular surfaces 43 of the rollers 42 are guided by side faces 44 of the grooves 41 which extend parallel to one another, and by the base plate 11 and the support plate 14. Owing to the centrifugal forces, the rollers 42 are pressed against a running track 45 disposed on the intermediate plate 13. The intermediate plate 13 is arranged eccentrically by the factor e relative to the spindle 12 or the pump rotor. Owing to the eccentricity, the crescent-shaped pump working chamber 46 is formed in front of the roller 42 in the direction of rotation (shown by an arrow). The pump working chamber 46 is reduced in size with respect to each

roller 42 during operation, so that the fuel located in the chamber is pressurized and then enters the chamber 20 of the fuel feed unit by way of a pressure opening 48. Fuel in turn enters the pump working chamber 46 from the chamber 19 by way of a kidney-shaped suction opening 49 which overlaps a wide portion of the pump working chamber provided that the crescent-shape of the pump working chamber is enlarged with respect to a specific roller during operation.

In order to minimize the wear on the surface of the running track and on the surface of the rollers 42, particularly during dry running, the following material pairings were devised. Although the composition of the pairings is unexpected in so far as one skilled in the art is concerned, the test results have proved to be extremely positive. The pairings are also unexpected in that materials having completely different coefficients of expansion and hardness are specified. The surface of the running track may be hard-chromium-plated, it can be coated with polyimide lacquer or polyester-imide lacquer, it can be sealed-in as a polyimide foil, or the running track can be in the form of a pressed-in composite bush, such as a composite bush made out of steel/epoxide resin or steel/tin-bronze, which bush is impregnated with PTFE. Alternatively, however, the intermediate plate can be made from aluminium, the raceway 45 having an oxidized surface, produced by electrolytic surface oxidation, or hard coated. Alternatively, however, the intermediate plate can be made from a laminated resin fabric impregnated with phenol resin. By way of example, it is also conceivable to make the intermediate plate 13 from steel, since the polyimide running track is sintered-in or pressed-in in the form of a ring. It is advantageous to provide graphite fillings in the running track in order to improve the sliding ability, particularly in the case of polyimide. The following materials on the surfaces of the rollers 42 co-operate, as sliding partners, with the aforesaid materials. The rollers may be hard-chromium-plated, boronated, or chemically nickel-plated. Alternatively, they can be made from aluminium having an oxidized surface (Eloxal or Hartcoat), although, alternatively, they may be made from polyimide with or without a graphite filling, it being preferable to use a metal core in order to obtain the weight required for the centrifugal force. Alternatively, however, the rollers may be made from ceramics or artificial carbon, such as CuPb graphite. "Eloxal" and "Hartcoat" are Trade Marks.

In order to obtain the advantages mentioned initially, any material specified for the running track is suitable for pairing with any material specified for the rollers.

WHAT WE CLAIM IS:—

1. An internal-combustion engine fuel feed pumping assembly comprising a rotary pump having an intermediate plate which is provided with a circular aperture and which is clamped between fixed side plates, and a pump rotor which is arranged between the side plates and eccentrically in the aperture and which has in its periphery grooves, open towards the wall of the aperture in the intermediate plate, which grooves accommodate pumping elements which are pushed by centrifugal force against a running track on the wall of the aperture in the intermediate plate and together with the rotor and the running track define working fluid chambers, the materials of the mutually touching surfaces of the pumping elements and the running track being suitably paired for dry running.
2. A fuel-feed pumping assembly as claimed in claim 1 which comprises an electric motor.
3. A fuel-feed pumping assembly as claimed in claim 1 or 2 in which the pumping elements are rollers.
4. A fuel-feed pumping assembly as claimed in any preceding claim in which the intermediate plate is made from steel, and the running track is hard-chromium-plated.
5. A fuel-feed pumping assembly as claimed in any of claims 1 to 3 in which the surface of the running track has a coating of polyimide in the form of lacquer, polyester lacquer, sealed-in foil or sintered-in polyimide.
6. A fuel-feed pumping assembly as claimed in claim 5, in which the running track has a filling of graphite particles.
7. A fuel-feed pumping assembly as claimed in any of claims 1 to 6, in which the running track is oxidized, anodized, or hard-coated.
8. A fuel-feed pumping assembly as claimed in claim 1, in which the running track is a composite bearing bush which is made from steel epoxide resin or steel-tin bronze and which is pressed into the intermediate plate.
9. A fuel-feed pumping assembly as claimed in any of claims 1 to 3 in which the intermediate plate and the running track are made from phenolic resin laminated hard fabric.
10. A fuel-feed pumping assembly as claimed in any preceding claim in which the pumping elements are made from steel whose surface is hard-chromium-plated or chemically nickel-plated.
11. A fuel-feed pumping assembly as claimed in any of claims 1 to 9, in which the pumping elements are made from boronated steel.
12. A fuel-feed pumping assembly as claimed in any of claims 1 to 9, in which the pumping elements are made from aluminium, and in which the surface is oxidized, anodized or hard-coated.
13. A fuel-feed pumping assembly as claimed in any of claims 1 to 9, in which the pumping elements have a metal core coated with polyimide.
14. A fuel-feed pumping assembly as claimed in claim 13, in which graphite is contained in the polyimide coating facing the running track.
15. A fuel-feed pumping assembly as claimed in any of claims 1 to 9, in which the pumping elements are made from artificial carbon.
16. A fuel-feed pumping assembly as claimed in claim 15 in which the artificial carbon is CuPb graphite.
17. A fuel-feed pumping assembly as claimed in any of claims 1 to 9 in which the pumping elements are made from ceramics.
18. An internal combustion engine fuel-feed pumping assembly constructed and adapted to operate substantially as hereinbefore particularly described with reference to and as illustrated in the accompanying drawings.

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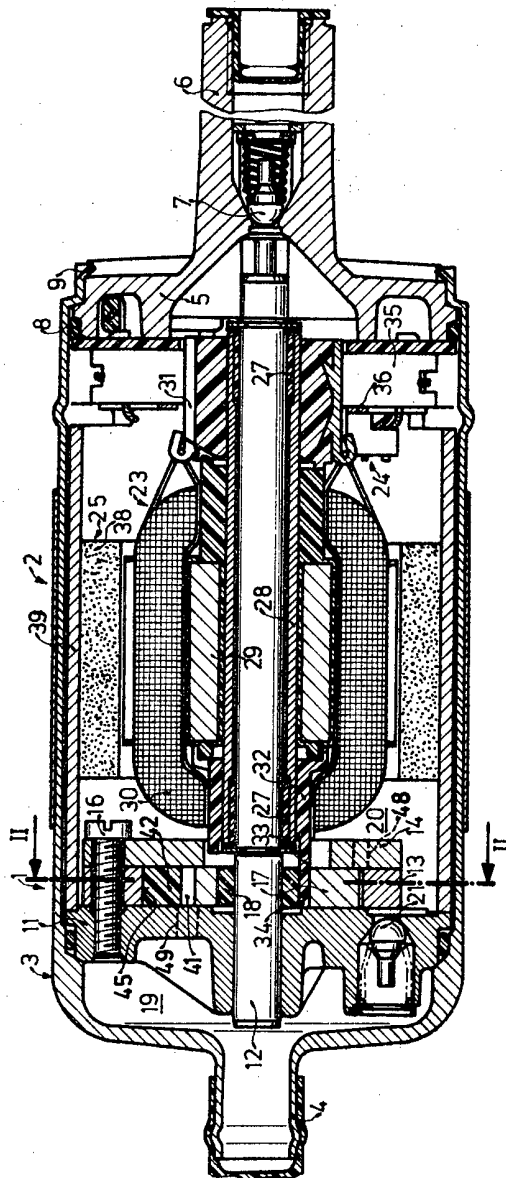
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Sheet 1

Fig. 1



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COMPLETE SPECIFICATION

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Sheet 2

Fig. 2

