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(54) Title: FUEL PUMPING DEVICE FOR TWO-STROKE ENGINES WITH AN ADDITIONAL DRIVING UNIT			
(54) Bezeichnung: KRAFTSTOFFPUMPVORRICHTUNG FÜR ZWEITAKTMOTOREN MIT EINER ZUSÄTZLICHEN ANTRIEBS-EINHEIT			
(57) Abstract			
A fuel pumping device for two-stroke engines has a housing at least in one part upon which are arranged a pulsed air connection (14) pneumatically connected to the crank housing of the two-stroke engine, a fuel aspirating connection and a fuel feeding connection. A membrane (41) to which pulsed air is applied drives together with a membrane disk (42) a pump piston (22). During the suction hub of the pump at the fuel aspirating connection, fuel which flows out of the tank (1) is sucked through a check valve (61) into the compression chamber (51) located upstream of the pump piston, and during the feeding hub, fuel is pumped through another check valve (71) into the fuel feeding connection and into a reservoir (73) and/or injection valve (5). The pulsed air connection (14) opens into a cavity (13) in the housing located between the membrane (41) and the pump piston (22). At least one spring element (15, 35, 94) acts on each side of the membrane (41). The spring element (15) arranged in the cavity (13) of the housing is supported on the membrane (41) by the separate pump piston (22). In the housing cavity (33) located at the other side of the membrane (41) is arranged an electromagnetic driving unit (90) which supports by means of its armature (91) the compression stroke of the pump piston (22) in synchrony with the compression stroke of the two-stroke engine.			

Fuel Pumping Device for Two Stroke Motors with an Additional Drive Unit

Prior Art

- 5 The invention proceeds from a fuel pumping device for an internal combustion engine operating on the two-stroke principle.

A fuel pumping device of this type is known from DE 37 27 266 A1. This publication describes a membrane piston pump which delivers and condenses the fuel for the operation of an injection device. For this, fuel is pumped to the membrane piston pump from a fuel tank through a forepump. The fuel compressed there is directed to the injection valve. The membrane piston pump receives its drive from the pulsed air from the housing of the internal combustion engine. To this end a membrane is attached to the piston compressing the fuel, the membrane being on the side away from the side to which pulsed air is applied. The overpressure resulting in the housing during a working cycle operates the compression piston.

In DE 41 25 593 A1 a comparable membrane piston for fuel injection is described, in which the return stroke of the compression piston takes place by means of a spring leaf. The spring rate of the spring leaf can be mechanically adjusted by means of an adjusting screw.

Advantages of the Invention

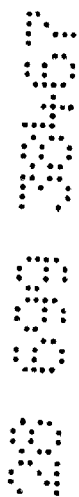
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The fuel pumping device of the invention contains at least one membrane piston pump with which the pulsed air connection leads to a housing area between the membrane and the pump piston. At least one spring element acts on each side of the membrane, the spring element arranged in the housing area being supported by



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the separate pump piston on the membrane. In this construction variant, the pulsed air is in direct contact with the pump piston. This has, on the one hand, the advantage that the pulsed air containing oil coats the moveable parts in this section of the housing so that the spring seatings and the seal between the pump piston
5 and the housing section directing it will close less securely. On the other, in the case of a leakage between the pump piston and the housing section directing it, the fuel appearing there would be sucked up during the compression stroke of the two-stroke engine. The fuel, then, does not leak out as with the membrane piston pumps.



In addition, the fuel pumping device is equipped with a drive unit which supports it at least in the starting and/or idling phase. The drive unit operates by means of an armature oscillating in synchrony with the pressure pulsation of the quantity of gas inside the housing via the membrane on the pump piston. By this means, at least when starting and idling, ie. with low pressure pulsation, a minimum injection required for the functioning of a two-stroke motor is produced.

The drive unit can be, for example, a permanent magnet generator which, at the appropriate moment, directs the required energy to the magnet. The dynamic coordination of the electromagnetic adjuster takes place ideally with respect to the optimal function at starting and idling. The electrical support is not required at higher revolutions of the motor. The pressure pulsation, then, is adequate to produce the minimum injection pressure.

The armature of the drive unit can, of course, be supported on the one spring element which, i.a. causes the compression stroke of the pump piston.

Furthermore, it is not a stiff, mechanical connection which exists here between the pump piston and the membrane disc to which pulsed air is applied. The lift of the membrane is transferred to the pump piston without lateral force. This also reduces the closure of the pump.

The membrane piston pump can be equipped with a hand probe. In addition, the armature of the electrical drive unit is, for example, brought out of the housing section opposite the rear side of the membrane in the form of a hand probe. Pressing the hand probe produces a compression stroke of the pump piston. In this way, eg. in small two-stroke motors as used in hand-operated work devices, after a complete emptying of a fuel tank or after a long period of non-use, the injection line and the injection valve can be pre-filled so as to shorten the starting procedure.

The described membrane piston pump is so constructed that the valves and the compression chamber can be separated from the components which contain the membranes and drive the pump piston. This simplifies maintenance and repairs on the one hand and manufacture on the other.



Diagram

Further details of the invention are provided in the following description of a schematically represented embodiment form:

Figure 1: Fuel pumping device for direct injection;

Description of the Embodiment Example

Figure 1 shows the functioning schema of a fuel pumping device for a direct injection system as can be used by two-stroke motors. The fuel pressure is produced by a membrane piston pump (10). The membrane piston pump (10) draws the fuel in through a suction valve (61) arranged inside the pump housing (11), for example through a filter (2) out of a fuel tank (1). The fuel, drawn in in this way, arrives in a compression chamber (51) into which a pump piston (22) is immersed. The displaced fuel flows through a pressure control valve (71) into a fuel pressure storage device (73) and to, eg. an electrically controlled injection valve (5). On the discharge side, part of the fuel escapes over a relief valve (80), eg. into the fuel tank (1).

The pump piston (22) extends with its rear end into the space (13) of the pump housing (11) which is pneumatically connected to the housing of the internal combustion engine operating on the two-stroke principle. In this cavity (13) the pump piston (22) is pushed via a spring element (15) against a membrane (41) reinforced with a membrane disc (42). On the rear side of the membrane (41) is a housing cavity (33) enclosed by a housing lid (31) in which two further spring elements (35) and (94) are arranged. Both spring elements (35, 94) counteract the other spring element (15). The biased spring elements (15, 35, 94) hold the membrane (41) in a central position, provided the same air pressure is applied, and a drive unit (90) arranged on the housing lid (31) is switched to the rest position.

The drive unit (90) is a lifting magnet which features an armature (91) as an anchor. The armature (91) which is arranged in the housing lid coaxially to the pump position (22) consists of a shaft (92) and a yoke plate (93). The shaft (92) acts directly on the spring element (94). Around it is arranged a coil (96) arranged in a shell core (95).



In a running two-stroke motor, the pulsed air flows with overpressure into the cavity (13) and moves the membrane (41) downwards, the spring element (15) following the pump piston (22) of the membrane (41) and the spring element (35) being further cocked. The membrane piston pump (10) draws fuel over a suction valve (61) into a compression chamber (51). As soon as the overpressure falls, the

5 partially untensioned spring elements (35, 94) push the pump pistons (22) into the compression chamber (51). The fuel flows over the pressure valve (71) to the injection valve (5) and/or to the fuel pressure storage device (73). The compression stroke goes beyond the central position of the membrane (41) as, toward the end of the stroke, the underpressure - now in the housing - acts on the membrane (41). The membrane (41) is drawn upwards.

With the increase in pulsed air pressure, the pumping movement of the pump piston (22) is repeated.

At least in the start or idle phase of the two-stroke motor, the coil (96) is supplied with power synchronous with the compression stroke. With this, the yoke plate (93) is drawn toward the shell core (95), the armature loading the spring element (94) against the membrane (41) additionally supporting the compression stroke of the pump piston (22).

The supplying of power to the coil is provided by an automatic control (99). The signal for the supplying of power is given by a pressure sensor (97) which is connected, for example, pneumatically, to the pulsed air connection (14).

The claims defining the invention are as follows:

1. Fuel pumping device for two-stroke motors, said fuel pumping device having at least one one-piece housing on which a pulsed air connection is pneumatically connected to an engine housing of the two-stroke motor, a fuel suction connection and a fuel compression connection is arranged in which a membrane to which pulsed air is applied drives a pump piston, the fuel flowing through a check valve into the compression chamber in the pump suction stroke at the fuel suction connection into the compression chamber in front of the pump piston and, in the compression stroke, is pumped through a further check valve into the fuel compression connection, the pulsed air issuing into a first cavity or space into which the pump piston extends and is limited to one side of the membrane, wherein at least one spring element acts on each side of the membrane, the spring element arranged in the first cavity or space is supported over the separate pump piston on the membrane and that the spring element arranged in a second cavity or space on the rear side of the membrane and/or a spring element connected parallel to it supports, at least at low revolutions of the motor at the compression stroke of the pump piston in an armature operating in the compression direction coupled to a drive unit operated from elsewhere, the spring element holding the membrane in a middle position when the same air pressure is applied to both sides of the membrane and in the case of a drive unit being attached turns it to a rest position so that the membrane can go out over the middle position in the suction stroke and the pressure stroke.

2. Fuel pumping device as claimed in Claim 1, wherein the drive unit is an electromagnet.

3. Fuel pumping device as claimed in Claim 2, wherein the electromagnet has a coil arranged in a shell core.

4. Fuel pumping device as claimed in Claim 2 or 3, wherein the electromagnet has, as an armature, an anchor constructed of a cylindrical shaft and a disc-shaped yoke plate arranged on it.

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5. Fuel pumping device as claimed in any one of the preceding Claims 2-4, wherein the electromagnet is energised via a control during the compression stroke of the pumping device in the pressure pulsation cycle in the housing of the two-stroke motor, the cycle being registered by a pressure sensor, an ignition device or a reference mark signal on the crank shaft.

6. Fuel pumping device as claimed in Claim 5, wherein the pressure sensor in the housing of the two-stroke motor is arranged on the pneumatic line to said first cavity or in said first cavity itself.

Dated this 24th day of June, 1999

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