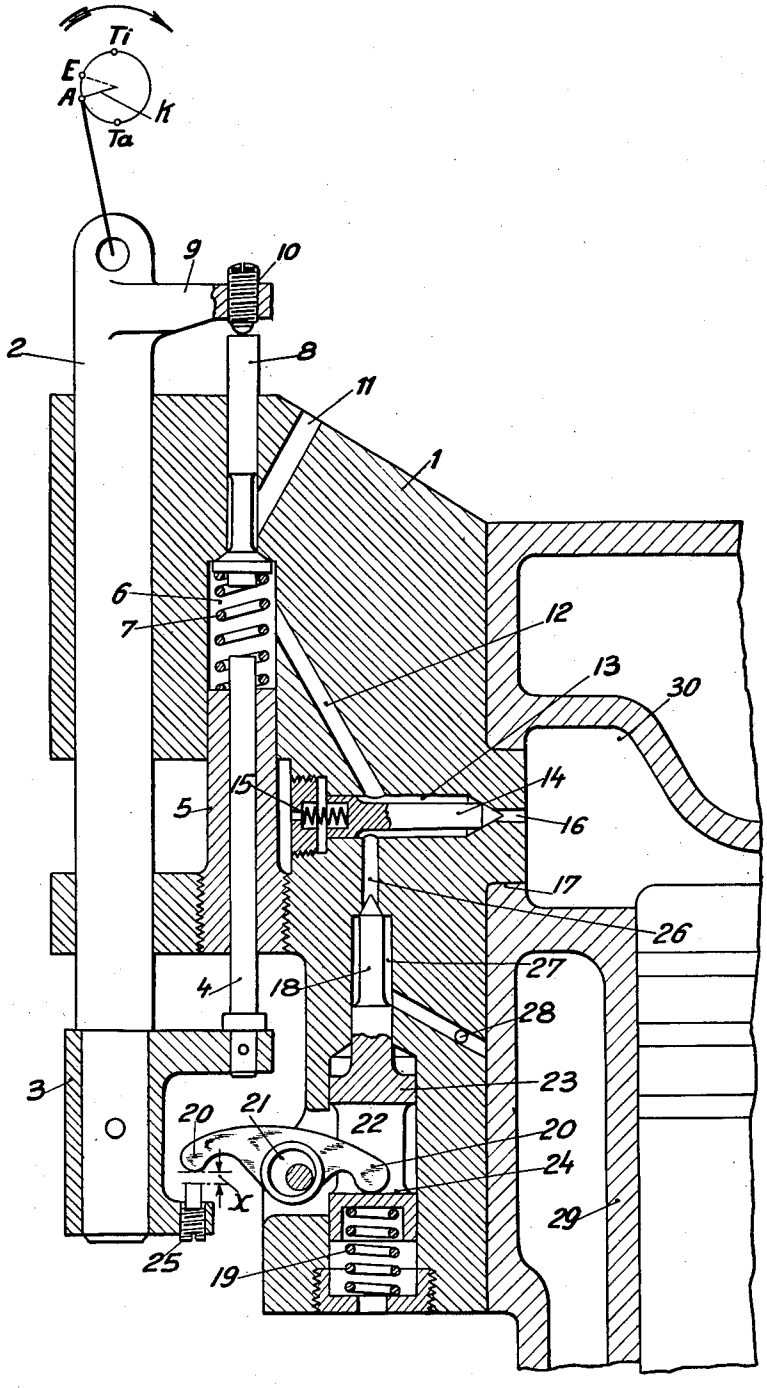
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OIL INJECTION APPARATUS FOR INTERNAL COMBUSTION ENGINES

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OIL-INJECTION APPARATUS FOR INTERNAL-COMBUSTION ENGINES

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My invention relates to Diesel-engines, and more particularly to a Diesel-engine operating with solid fuel injection and designed for operation at a high speed. Considerable difficulties have been encountered in the construction of internal combustion engines of this type.

In order to separate extremely small quantities of liquid fuel and to inject these quantities at the proper time and at a constantly high atomizing pressure, it has been suggested to reduce the pressure in the pump chamber at the first part of the pressure stroke up to the commencement of the injection by positively holding the suction valve open, and at the last part of the pressure stroke after injection has taken place, to bring about, at a point depending on the load, another abrupt reduction of the pressure in the pump chamber by the positive opening (pushing up) of a regulating valve.

Injecting apparatus of this kind cannot work satisfactorily if air or gas bubbles are present in the liquid fuel. For this reason it has already been suggested to use a pump by which the air is effectively removed, but this is still insufficient, if in addition care be not taken to prevent air or gas bubbles from collecting or remaining in the course which the liquid fuel traverses after leaving the pump and in its passage to the injection valve. This would be the case if there are air pockets in this course, such as are formed in known apparatus by the space surrounding any pressure valve and also in an ascending pressure pipe. In such air pockets bubbles of air and gas collect, as do bubbles of steam which are liable to be formed during the heating of the liquid fuel owing to the high compression, and which cause all kinds of disturbances. In the case of slight leakages, small air bubbles can also pass into the space behind the injection valve.

I has therefore been suggested to overcome the above mentioned difficulties by dispensing with an injection valve on the cylinder and using an open nozzle, to which the liquid fuel is supplied from the pressure valve of the pump, through an open continuously ascending pipe. In this case however it is necessary apart from the further elastic action of the pressure pipe, to take into account the great disadvantage that the open nozzle will only effect an adequate atomization of the fuel when the motor is running at a high speed. When it runs at a lower speed the atomization is insufficient, because the fuel pressure falls approximately with the square of the number of revolutions. The motor would therefore work at a low speed with imperfect combustion and correspondingly reduced turning moment.

One object of my invention is the provision of a fuel pump capable of separating exact quantities of fuel and of individually injecting these quantities under an effective atomization regardless of the speed at which the engine is operated.

Another object of my invention is the provision of a fuel pump from which any air or gas bubbles will automatically be removed.

Other objects of my invention will appear from the description hereinafter and the features of novelty will be pointed out in the claims.

The invention is illustrated by a constructional example in the accompanying drawing.

In body 1 which may be conveniently made of steel and combines the pump and the injection nozzle 16, the driving rod or cross head 2 executes a stroke movement prescribed by the diagrammatically shown crank drive, or by a cam and spring drive or the like, suitably arranged in driving connection with the crank shaft of the engine. The outer dead point is denoted by Ta and the inner one by Ti. Pinned to the rod 2 is a cross-head 3, by which the stroke movement is transmitted to the pump piston 4. This piston works in the sleeve or bushing 5 screwed into the body 1. At the uppermost point of the pump chamber 6 is arranged a non-return valve 8 controlled by the spring 7, and this non-return valve 8 is held open during the first part of the pressure stroke, until the commencement of the injection, by an arm 9 on the rod 2, by means of a set screw 10, until the crank K rotating in the direction indicated by the arrow, has reached the point A. When

the suction valve is opened, the liquid fuel can pass through the passage 11 connected to a suitable source of fuel, not shown, into the pump chamber 6. In the position shown, and in the direction of rotation of the driving crank indicated by the arrow, the suction valve has just reached its seat. On further penetration of the pump piston, the pressure in the unitary pressure space formed by the chamber 6, the nozzle conduit or conduit 12, the annular space 13 and a passage 26 described hereinafter, will rise to a point at which it opens the injection valve 14 provided with stepped piston, against the pressure of the spring 15, which tends to keep the valve 14 closed. The liquid fuel will now be forced through the mouth 16 of the nozzle passage 16 in the form of mist into the combustion chamber 30 of the motor cylinder 29 to which the body 1 is attached by means of the pin 17 which engages in a suitable hole.

The injection of the liquid fuel is intended to continue only over a short section of the stroke, which lies approximately at about the middle of the stroke of the pump piston 4, and will therefore be interrupted by the pushing up of a regulating valve 18, at a point in the pressure stroke which depends on the load. This regulating valve 18 is kept closed during the injection of the liquid fuel by a spring 19. The pushing up of the valve against its closing spring is effected by a two armed regulating lever 20, which is adapted to rotate around the eccentrically mounted pin 21 in the body 1, as soon as the crank K has reached the point E. At the proper time for opening the regulating valve, the regulating lever 20 presses by one end which can move freely in a slot 22 in the valve 23, which is enlarged in diameter, against the pressure surface 24 of the regulating valve, as soon as the other end of the lever is pressed upwards by the adjusting screw 25 of the cross-head 3. In the position shown in which the injection is initiated, the adjusting screw 25 is still spaced from the regulating lever, and it will be apparent that the interruption of the injection will not take place until the piston 4 has passed over the distance x inwards, and until a corresponding quantity of liquid fuel has been delivered. By lowering the eccentric pin 21 the distance x the regulating valve would be opened when the crank reaches the point A and therefore the quantity of liquid fuel injected can be reduced to zero.

As soon as the regulating valve has been opened, the liquid fuel will escape out of the pressure chamber through the passage 26 into the hollow space 27, and thence through the outlet passage 28, and the resulting pressure drop in the pressure space formed by the chamber 6, the conduit 12, the annular space 13 and the passage 26 permits the valve 14 to be closed by action of spring 15. The passage 28 must be filled with oil, so that when the suction stroke takes place, no air can pass through into the pump chamber.

If there is air in the fuel pump after it has stood idle for a long time, or after it has been assembled again recently, this air is carried off through the ascending passages 26 and 12 and through the suction valve 8, which is positively opened before each injection and arranged at the highest point of the pressure space, so that the motor starts with certainty. The oil flowing back from the pressure space through the suction valve just before the beginning of the injection carries with it all gas or air bubbles which may be present in the pressure space. Consequently, proper injection is ensured, that is injection without sluggishness and misfiring of the smallest quantities of fuel, e. g. such as are used when multi-cylinder vehicle motors are allowed to run idly.

An injecting apparatus of this kind operates at any speed and under any load with a constant high atomization secured by the spring loading of the injection valve, and with efficient combustion.

What I claim is:

1. In a Diesel-engine operating with solid fuel injection, the combination comprising a working cylinder, a pump body mounted thereon provided with a pressure space in its interior and with a nozzle passage leading from said space to a combustion chamber in said cylinder, a pump piston mounted in said body to produce pressure in said pressure space, a suction valve arranged at the highest point of said space to open inwardly, an injection valve separate from said suction valve and arranged to control the communication between said combustion chamber and said nozzle passage and to be opened by action of the pressure prevailing in the latter, said pressure space being free from pockets capable of keeping air or gas bubbles from rising to the highest point of said pressure space, and means to keep said first mentioned valve open during the first part of the pressure producing stroke of said piston.

2. In a Diesel-engine operating with solid fuel injection, the combination comprising a working cylinder, a pump body mounted thereon provided with a pressure space in its interior and with a nozzle passage leading from said space to a combustion chamber in said cylinder, a pump piston mounted in said body for reciprocating movement to produce pressure in said pressure space, a valve arranged at the highest point of said space, an injection valve arranged to control the communication between said combustion chamber and said nozzle passage and to be opened by action of the pressure prevailing in the latter, said pressure space being free from pockets capable of

keeping air or gas bubbles from rising to the highest point of said pressure space, a regulating outlet valve arranged to relieve said pressure space, means to temporarily open said regulating outlet valve during the end of the pressure producing stroke of said piston, and means to keep said first mentioned valve open during another part of the pressure producing stroke of said piston.

3. In a Diesel-engine operating with solid fuel injection, the combination comprising a working cylinder with a combustion space, a pump body laterally mounted upon said cylinder and provided with a pump chamber and with an inclined boring leading therefrom downwardly to said combustion space, an injection valve arranged to control the communication between said combustion space and said inclined boring and to be opened by action of the pressure prevailing in said boring, a spring tending to keep said injection valve closed, a suction valve arranged at the highest point of said pump chamber to open inwardly, a piston mounted in said body for substantially vertical reciprocating movement to produce pressure in said pump chamber, a connection between said piston and said suction valve to positively keep the latter open during the first part of the pressure producing stroke of the piston, a regulating outlet valve arranged in said body to relieve the pressure prevailing in said pump chamber, and an adjustable connection between said piston and said regulating outlet valve to positively open the latter at a desired point during the end of said pressure producing stroke of the piston.

4. In a Diesel-engine operating with solid fuel injection, the combination comprising a working cylinder with a combustion space, a pump body laterally mounted upon said cylinder and provided with a pump chamber and with an inclined boring leading from said pump chamber downwardly to said combustion space, an injection valve arranged to control the communication between said boring and said combustion space and to be opened by action of the pressure prevailing in said boring, a spring tending to keep said injection valve closed, a suction valve arranged at the highest point of said pump chamber to open inwardly, a piston mounted in said body for substantially vertical reciprocating movement to produce pressure in said pump chamber, a cross head rigidly connected with said piston to move in unison therewith, a lateral extension on said cross head projecting into the path of said suction valve to push the latter open during the first part of the pressure producing stroke of the piston, a regulating outlet valve arranged in said body to open downwardly to relieve the pressure prevailing in said pump chamber, and a two-armed lever adjustably pivoted on said body and having one arm arranged for engagement with said cross head during the upward stroke of the latter and having the other arm arranged for engaging said regulating valve to pull the same open.

5. Fuel injection apparatus for a Diesel-engine operating with solid fuel injection, comprising a pump body adapted to be mounted on a working cylinder and provided with a pressure space in its interior and with a nozzle passage leading from said space to a mouth provided in said pump body and adapted to open into the combustion chamber of the working cylinder a pump piston mounted in said body to produce pressure in said pressure space, a suction valve arranged at the highest point of said space to open inwardly, an injection valve separate from said suction valve and arranged to control said mouth and to be opened by action of the pressure prevailing in said pressure space, the latter being free from pockets capable of keeping air or gas bubbles from rising to the highest point thereof, and means to keep said suction valve open during the first part of the pressure producing stroke of said piston.

6. Fuel injection apparatus for a Diesel-engine operating with solid fuel injection, comprising a pump body adapted to be mounted on a working cylinder and provided with a pressure space in its interior and with a nozzle passage leading from said space to a mouth provided in said pump body and adapted to open into the combustion chamber of the working cylinder, a pump piston mounted in said body for reciprocating movement to produce pressure in said pressure space, a valve arranged at the highest point of said space, an injection valve arranged to control said mouth and to be opened by action of the pressure prevailing in said pressure space the latter being free from pockets capable of keeping air or gas bubbles from rising to the highest point thereof, a regulating outlet valve arranged to relieve said pressure space, means to temporarily open said regulating outlet valve during the end of the pressure producing stroke of said piston, and means to keep said first mentioned valve open during another part of the pressure producing stroke of said piston.

7. Fuel injection apparatus for a Diesel-engine operating with solid fuel injection, comprising a pump body adapted to be laterally mounted upon a working cylinder and provided with a pump chamber, with a mouth adapted to open into the combustion chamber of the working cylinder and with an inclined boring leading from said pump chamber downwardly to said mouth, an injection valve arranged to control said mouth

and to be opened by action of the pressure prevailing in said boring, a spring tending to keep said injection valve closed, a suction valve separate from said injection valve and arranged at the highest point of said pump chamber to open inwardly, a piston mounted in said body for substantially vertical reciprocating movement to produce pressure in said pump chamber, a connection between said piston and said suction valve to positively keep the latter open during the first part of the pressure producing stroke of the piston, a regulating outlet valve arranged in said body to relieve the pressure prevailing in said pump chamber, and an adjustable connection between said piston and said regulating outlet valve to positively open the latter at a desired point during the end of said pressure producing stroke of the piston.

8. Fuel injecting apparatus for a Diesel-engine operating with solid fuel injection, comprising a pump body adapted to be laterally mounted upon a working cylinder and provided with a pump chamber, with a mouth adapted to open into the combustion chamber of the working cylinder and with an inclined nozzle passage leading from said pump chamber downwardly to said mouth, an injection valve arranged to control said mouth and to be opened by action of the pressure prevailing in said passage, a spring tending to keep said injection valve closed, a suction valve arranged at the highest point of said pump chamber to open inwardly, a piston mounted in said body for substantially vertical reciprocating movement to produce pressure in said pump chamber, a cross head rigidly connected with said piston to move in unison therewith, a lateral extension on said cross head projecting into the path of said suction valve to push the latter open during the first part of the pressure producing stroke of the piston, a regulating outlet valve arranged in said body to open downwardly to relieve the pressure prevailing in said pump chamber, and a two-armed lever adjustably pivoted on said body and having one arm arranged for engagement with said cross head during the upward stroke of the latter and having the other arm arranged for engaging said regulating valve to pull the same open.

In testimony whereof I have affixed by signature.

ERNST FREY.