Dec. 9, 1930. J. BENES 1,784,170

FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Filed May 29, 1929 2 Sheets-Sheet 1

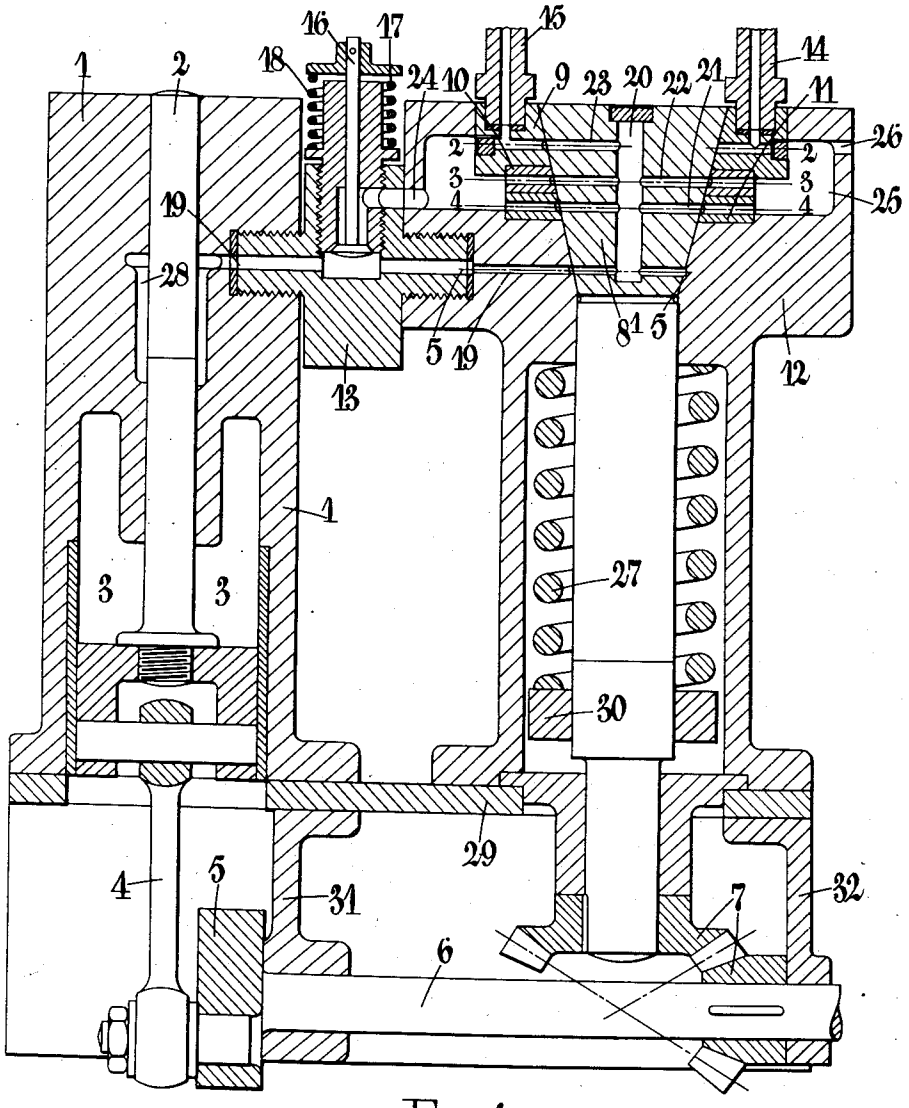


Fig. 1

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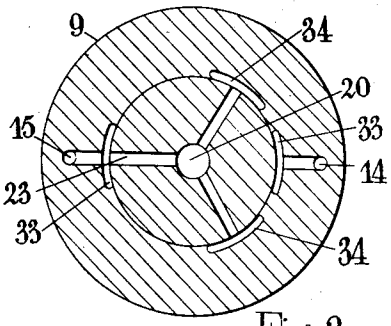


Fig. 2

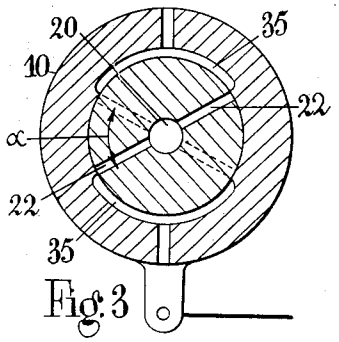


Fig. 3

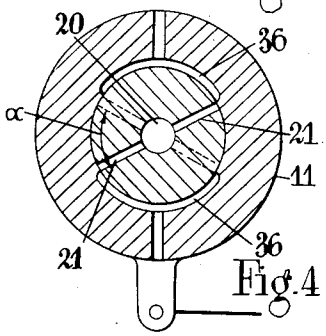


Fig. 4

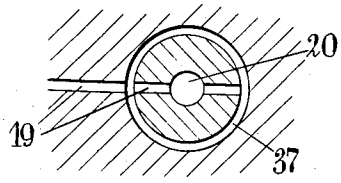


Fig. 5

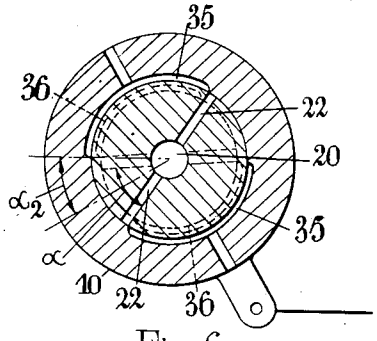


Fig. 6

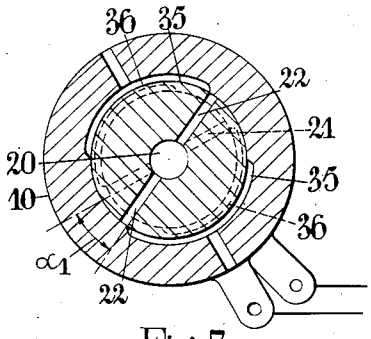


Fig. 7

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Patented Dec. 9, 1930

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UNITED STATES PATENT OFFICE

JOSEF BENES, OF VSETIN, CZECHOSLOVAKIA

FUEL PUMP FOR INTERNAL-COMBUSTION ENGINES

Application filed May 29, 1929, Serial No. 367,108, and in Great Britain March 12, 1929.

This invention relates to a fuel pump with a pressure pump and a distributor, which in this form can be employed for a multi-cylinder oil engine with self-ignition, the regulating of the fuel injected being effected with a preferably conical rotating valve, and the bore of which, during each revolution, travels over two recesses or grooves provided in two rotatable valve saddles, through which recesses the fuel under pressure escapes back into the suction chamber. Not only the quantity of fuel but also the advancement of the injection admits of being regulated by means of the rotatable saddles.

By this invention the result is obtained that earlier or later injections (advanced ignition), and also the exact quantity of fuel injected with a definitely adjusted advance ignition can be regulated by the position of the two rotatable valve saddles. The quantity of fuel is regulated by the two radial bores of the rotating valve coming simultaneously into communication with the recesses in the two rotatable saddles, the delivery chamber of the fuel pump being connected with the suction chamber, so that upon the valve bore moving over the saddle recesses the delivery pipe is relieved of pressure, owing to the fuel flowing into the suction chamber. On the other hand, when, during the turning of the valve, the mouths of the valve bores leave the recesses in the saddles and bear upon the ground conical surface of the saddles, the pressure fuel cannot escape into the suction chamber, and it flows to the nozzle. The injection time also, or the diminution in volume of the compression spaces, can be adjusted by corresponding rotation of the two rotatable saddles relatively to one another. Besides this, by joint rotation of the two saddles, the advanced ignition can be adjusted with a definitely regulated quantity of fuel injected.

The invention also has the advantage that by the construction of the preferably conical distributor the result is obtained that only one pump, in conjunction with a distributor, is employed for operating a motor with any number of cylinders; and it may be emphasized that the pump and distributor operate with precision, owing to the fact that the regulating apertures are located on the surface of the conical valve plug, whereby faultless sealing is obtained, which on the other hand is self-evident with a conical valve. The device also has the further advantage that the distributor containing the regulating mechanism already mentioned automatically passes the pressure naphtha or other fuel into the individual cylinders in the injection periods, as necessitated by the method of working of a multi-cylinder engine. so that by this means one distributor in conjunction with one pressure pump suffices for operating a multi-cylinder engine.

From what has been stated above it is obvious that by this invention all the sensitive or delicate parts are eliminated from the fuel pump, the piston can if desired be made satisfactorily fluid-tight on both sides, and the distributing mechanism is arranged on the conical valve face of its saddle, whereby perfect sealing is obtained. Owing to this, the pump maintains the high pressure that is necessary for the complete atomization of the fuel, so that by this construction any inexactitude is eliminated, and the pump does not lose its accuracy even after long use, since the distributing mechanism is the conical valve and saddle, which form an oil-tight seal even after wear.

The invention is illustrated by way of example in the accompanying drawings, in which—

Fig. 1 shows a sectional elevation of the pump and the distributor.

Figs. 2, 3, 4 and 5 show cross-sections of the regulating and distributing mechanisms on the lines 2—2, 3—3, 4—4 and 5—5 respectively in Fig. 1, and

Figs. 6 and 7 show further cross-sections on the line 3—3 in Fig. 1 with the saddles and the valve plug in different positions.

Fig. 1 shows a pump 1, having a differential piston 2, which delivers at each stroke a quantity of fuel proportional to the difference in area of the upper and lower pistons. The piston 2 is moved by a connecting rod 4 and a crank 5 mounted on a shaft 6. On the same shaft is mounted a toothed bevel wheel 7, which meshes with a similarly toothed bevel wheel 7 secured to the shaft

8 of a distributing valve 8′. The rotation of the valve is therefore dependent upon the speed of the pump 1 and therefore upon the speed of the engine, the transmission ratio of the bevel wheels 7, 7 being determined according to the number of engine cylinders. The valve 8′ revolves in a valve saddle 12, in the framework of which are inserted two regulating saddles 10 and 11, which are rotatable relatively to one another and also both at once, and also a saddle 9, which carries the fuel delivery pipes to the individual cylinders. This saddle 9 is not rotatable but is firmly secured to the main saddle framework. The space 25 is a fuel-storage chamber. Fuel is supplied to the chamber 25 from a main fuel tank through an aperture or duct 26. The valve 8′ is pressed on to the saddle 9, 10, 11, 12 by a spring 27. The pump 1 is connected with the main saddle framework 12 of the distributor by means of a member 13, which is screwed into both, and which contains a small suction valve 16, which serves as an air outlet valve or vent. This valve 16 is positively actuated in such a way that it opens even before the termination of the delivery or feeding stroke of the pump 1 and closes after the end of the suction stroke, just when the air venting begins, and it does this by virtue of the fact that at the commencement of the delivery stroke the fuel is discharged through this valve and passes through a bore or duct 24 into the storage chamber 25. The mechanism for opening this valve is not shown in the drawings, as it does not form part of the subject-matter of this invention.

The drawing illustrates by way of example the arrangement of the pump and distributor for a two-cylinder engine working on the four-stroke cycle. The pump acts in the following manner:—

When the piston 2 sucks fuel into the compressor chamber 28, at the commencement of the delivery stroke, and only for a short time, the valve 16 still remains open, and the fuel, together with any air or vapor forced in, escapes through this valve into the storage chamber 25. Obviously the fuel can also escape into the storage chamber 25 through the bores 19 and 20 and the bore 21 or 22. During the advance of the pump piston, and owing to the rotation of the valve, the valve bores 21 and 22 are disconnected from the saddle recesses or grooves 35 and 36. The volume of the compression space is diminished, and the fuel is forced to the nozzle, and hence injection occurs, which continues until the bores 21 and 22 have rotated so far that they come into communication again with the recesses 35 and 36. The fuel under pressure now escapes into the storage chamber 25, thereby relieving the nozzle valve, which closes quickly owing to spring pressure. The valve bores 21 and 22 are then in communication with the recesses 35 and 36 until a fresh injection period occurs, which, in the case under consideration, always occurs after half a revolution of the valve, since when the pump is executing one revolution, the valve 8′ executes half a revolution, as the engine has two cylinders. This operation is illustrated in Figs. 3 and 4.

Now if the regulating saddles 10 and 11 are rotated together in such a way that their recesses move out of the position shown in Fig. 4, into the position shown in Fig. 6, the valve bores 22 and 21 now leave the recesses 35 and 36 earlier, or in other words there arises an earlier diminution in volume of the delivery spaces and therefore also an earlier injection and advanced ignition.

Now if in the case of Fig. 6 the single regulating saddle 11 or 10 is rotated in such a way that it comes into the position shown in full lines in Fig. 7, with a given advanced ignition, the quantity of fuel injected is reduced to about one half, since, as will be obvious from Fig. 7, the bore 21 comes into communication with the recess 36 in the lower regulating saddle 11 before the bore 22 comes into communication with the recess 35 in the upper saddle 10, so that through the recess in the lower saddle the naphtha under pressure already escapes upon the valve being rotated through an angle, α_1. It is clear that α_1 may have any value from zero to α, that is to say, the quantity of fuel injected can be regulated from zero up to a maximum value, and from a maximum down to zero, this being done merely by rotating the saddle 10 relatively to the saddle 11, whereas by joint rotation of the two saddles out of their mean position, the advance ignition is adjusted.

The distributing of the fuel under pressure to the individual cylinders is illustrated in Fig. 2. Since the example illustrated relates to a two-cylinder engine, the distribution saddle 9 is provided with two outlet pipes 14 and 15 for conveying the fuel under pressure to the individual nozzles. In this figure, besides the bore 23, further radial bores are provided, which are shown as being separated by angles of 120°. These three bores are for the purpose of relieving the valve of the radial pressures. In other respects the action is obvious from the drawing itself.

The supplying of fuel to the rotating valve 8^1 is effected by providing the valve saddle 12 or the valve plug itself with a recess or groove 37 round the entire periphery, as shown in Fig. 5, so that the bore 19 is in uninterrupted communication with the recess 37, so that the bores 19 and 20 are always connected with the pump chamber 28.

It is obvious that alternatively the saddle 12 might rotate and the inner portion, that is to say the valve plug 8^1, might be station-

ary, without going outside the scope of the invention.

The valve may be made cylindrical instead of conical and the other details for carrying the invention into effect may be modified without departing from the spirit of the invention. I also wish it to be understood that the invention may also be applied for use in place of the carburettor in internal-combustion engines for automobiles and aeroplanes.

What I claim is:

1. A fuel pump for multi-cylinder internal-combustion engines working with self-ignition and with fuel injection without the help of air, comprising a single pressure pump in combination with a fuel distributor capable of supplying fuel to the nozzles of the various cylinders and having a stationary saddle, a revolvable valve plug within the said saddle and an annular passage between the saddle and the valve plug and the valve plug having an axial bore and radial bores leading from the said axial bore to the said annular passage and radial bores leading to the nozzles, and in further combination with a pump delivery chamber with which the said axial bore is in open communication and with means for revolving the valve plug for establishing an open communication from the said axial bore to the various injection nozzles in turn, as set forth.

2. A fuel pump as claimed in claim 1 and in which the means for establishing an open communication between the pump delivery chamber and the axial bore in the valve plug comprise a complete circumferential passage between the stationary saddle and the revolvable valve plug, a passage leading from the said circumferential passage to the pump delivery chamber and a radial bore leading from the said circumferential passage to the axial bore in the valve plug.

3. A fuel pump for multi-cylinder internal-cumbustion engines working with self-ignition and with fuel injection without the help of air, comprising a single pressure pump in combination with a fuel distributor capable of supplying fuel to the nozzles of the various cylinders and having a stationary saddle, two saddles within the stationary saddle and capable of rotating relatively to the latter, a valve plug within the said stationary and rotatable saddles, a complete circumferential passage between the stationary saddle and the valve plug and segmental passages between the said two rotary saddles and the valve plug and the valve plug having an axial bore and radial bores leading from the circumferential and segmental passages to the said axial bore and from the latter to the nozzles of the various cylinders, whereby the regulation of the fuel injected can be effected by adjusting the position of the rotary saddles relatively to the stationary saddle and whereby the beginning and end of the injection can be adjusted by an adjustment of the movable saddles relatively to one another in a circumferential direction.

4. A fuel pump as claimed in claim 3 and having a fuel storage chamber between the single pressure pump and the rotary saddles and the latter having radial passages in open communication with the said fuel storage chamber and the segmental passages between the rotary saddles and the valve plug, as set forth.

In testimony whereof I have signed my name to this specification.

JOSEF BENES.