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PUMPING MEANS FOR INTERNAL COMBUSTION ENGINES

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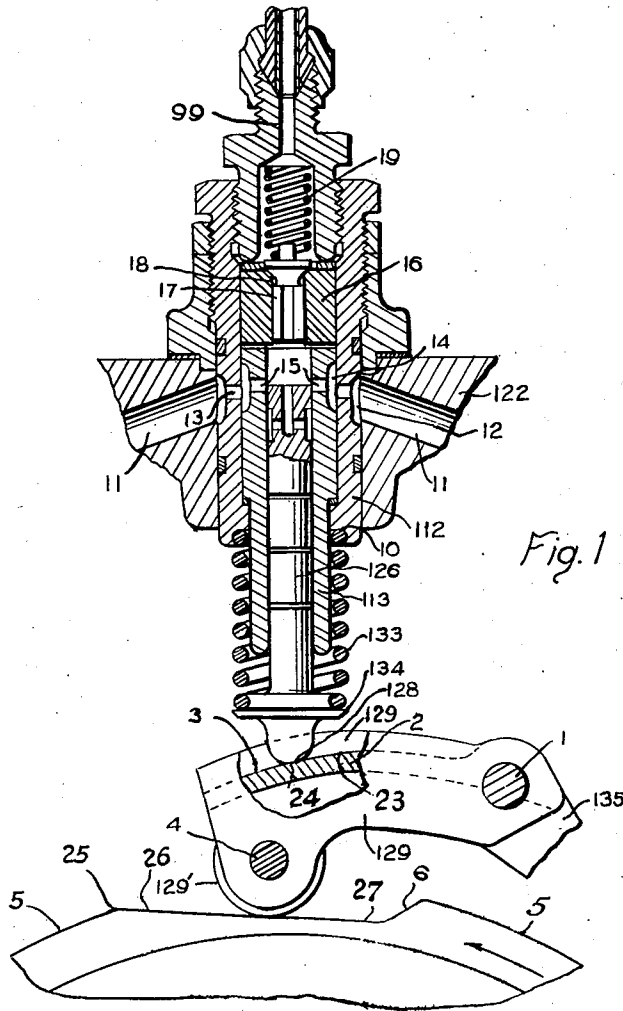


Fig. 1

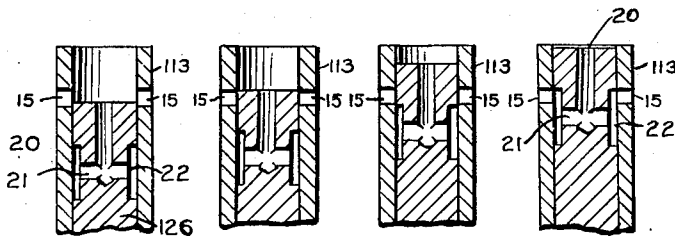


Fig. 2

Fig. 2a

Fig. 2b

Fig. 2c

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## PUMPING MEANS FOR INTERNAL COMBUSTION ENGINES

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6 Claims. (Cl. 123—139)

The object of this invention is to provide a variable stroke for a fuel pump of an internal combustion engine. Or, more broadly, the object of the invention might be expressed as a mechanism to govern the fuel intake port so that more or less fuel might be allowed to enter the chamber above a plunger, which plunger will pump the fuel into the engine.

In my Patent 1,859,541, I have shown, in Fig. 9, a movable fulcrum 135 which may be displaced to the right or the left of the position shown in said figure, so as to bring the fulcrum of the lever 129 closer to or further removed from the foot 128 of the plunger 126, so that when the cam 142 engages the roller 129', carried by said lever 129, the stroke of the plunger 126 might be varied. In that patent, however, the shifting of the fulcrum point 135 would merely vary the stroke and the timing.

The invention, as shown by way of illustration in the drawing of this application, embodies many of the essential features shown in the said Patent 1,859,541, but one distinction of the present invention over that shown in the said patent is that the upper surface of the lever 129 is not concentric with the crank shaft and the cam mounted thereon, but instead it slopes downwardly away from the fulcrum point, so that if the said lever is shifted to the right the plunger will be lowered and if it is shifted to the left the plunger will be raised, partly closing the intake port for the fuel, but the stroke will now be less than in the first instance. As a matter of fact, when the lever is shifted to the right as far as it can be moved, the plunger will almost entirely uncover the intake port so that a maximum amount of fluid can pass into the compression chamber of the pump, whereas, if the said lever is shifted as far as possible to the left, the said intake port will almost entirely be closed, which would be the idling position. Or, if desired, the slope of the cam surface on the said lever can be made so that it would entirely close the intake port so that no fuel could enter.

Regardless of how the lever is shifted the said plunger would always reach substantially the same height, but it would move downwardly different distances depending upon the position of the said lever.

Attention is called to the fact that when the plunger moves downwardly, a vacuum is created until the intake port is opened. The amount of fuel that can be drawn in through the intake

port depends upon the amount of intake port opening and duration of time that is open.

Another object of the invention is to provide a by-pass in the upper end of the pump plunger so that while the plunger is being raised to its maximum position, the by-pass will allow the fuel to be cut off before the actuating cam has fully raised the said lever. This is extremely important, for this mechanism almost entirely eliminates the objectionable smoke that has heretofore existed. This smoke is eliminated by having a sharp cut-off while the plunger is at maximum speed. It is desirable to spray the fuel into the center of the air in the engine cylinder, and then to cut off the spray before the actuating cam has completed the movement of the plunger. The by-pass is the means whereby this desirable result can be obtained.

The invention may be more readily understood from the reading of the following specification and by referring to the accompanying drawing, in which I have shown by way of illustration, but not by way of limitation, several forms of the invention, and wherein Fig. 1 is a vertical view partly in cross section and is comparable to Fig. 9 of said Patent 1,859,541. Figs. 2, 2a, 2b, and 2c are cross sectional views of the upper part of the pump plunger showing the plunger in various positions in regard to the fuel intake port, the parts being drawn to a scale slightly larger than that employed in Fig. 1.

Referring to the drawing, a lug 135 is provided which is movable to the right or left as is fully shown and described in said Patent 1,859,541. This lug 135 carries a fulcrum pin 1 on which are mounted two levers 129, connected by means of a cam web 2. The upper side of the web 2 forms a cam surface 3 sloping gradually downwardly away from the fulcrum point or from point 23 to point 24. In other words, the highest point of the cam surface is the point 23 nearest the fulcrum point, and the lowest effective part is the point 24. The levers 129 carry a pin 4 on which is mounted a roller 129', which roller rides on the periphery of a disc 5, which has a cam surface 6, which elevates the roller when the said cam surface 6 reaches the said roller. After the roller has passed beyond the cam surface 6, it rides on the disc 5 until it reaches the next cam. In ordinary practice, as is well known, the disc is provided with a plurality of such cams, usually four for aeronautical purposes. The roller, after reaching the point 25 rides downwardly on the surface 26 to the point 27 where the cam

6 joins the surface 26. The roller is now raised by the cam surface 6, thereby elevating the plunger 126 giving it its pumping stroke.

The plunger 126 is slidable in a liner 113 and is provided at its lower end with a flange 134 and terminates in a convex boss 128. A spring 133 is positioned between the flange 134 and a recess 10 in the lower end of the pump barrel 112. The boss 128 rides on the cam surface 3, and the spring 133 holds it in contact therewith.

As shown in the said Patent 1,859,541, there is a fuel pump designated by the numeral 168 in Fig. 2 of said patent, which pumps fuel through a pipe 170 which leads to a T 171, which is connected to the distributor pipes 121. I employ similar pipes not shown which lead to a connection 122 through which extend bores 11, and in the jacket 112 and communicating with the bores 11 is a circular channel 12, similar to the channel shown in Fig. 10 of the said patent. Fuel intake ports 13 extend through the jacket 112 into the interior thereof.

The liner 113 is also provided with an annular passageway 14 similar to the channel 12, and ports 15 extend through the liner 113 into the interior of the compression chamber. The bores 11 are always full of oil, and this oil passes into the channel 12 through the ports 13 into the passageway 14 and through the ports 15 into the compression chamber of the pump mechanism.

Above the liner 113 and within the jacket 112 is a stationary valve housing 16 provided with a bore 17, and a valve member 18 is seated at the upper end of the said bore, which valve member is normally closed by means of a spring 19. When oil is pumped by the plunger 126 it unseats the valve member 18 and forces oil upwardly through the passageway 99 which, as shown in the said Patent 1,859,541, communicates with a nozzle mechanism, best shown in Fig. 20 of said patent, whereby the oil which has been pumped is sprayed into the internal combustion chamber above the piston therein.

The upper portion of the pump plunger 126 is provided with a vertically extending bore 20, which extends from the upper end of the said plunger downwardly to and communicates with a laterally extending bore 21, which communicates with an annular channel 22 in the pump plunger, the said bores 20 and 21 and channel 22 constituting a by-pass as will hereinafter be described.

When the lug 135 is moved to the position shown in Fig. 1, so as to position the point 24 of the cam surface 3 beneath the boss 128, the plunger 126 will be lowered so that its upper end is approximately at the lower end of the ports 15. This allows the greatest possible quantity of fuel to pass into the pump chamber. The position of the plunger 126, when the lever 129 is in the position shown in Fig. 1, would be slightly above the position shown in Fig. 2 and will assume the position shown in Fig. 2 when the roller reaches the point 27. If, however, the lever 129 should be shifted to the left of the position shown in Fig. 1 or to the point 23, the pump plunger would be raised into approximately the position shown in Fig. 2a substantially closing the port 15.

It will therefore be apparent that when the roller is at the point 27 the opening of the intake port can be varied from wide open position to closed position by merely shifting the lever having the cam surface 3. As before stated,

the amount of fuel which will enter through the intake port 15 on each stroke will depend upon how much of the intake port is closed and also upon the length of the time that it is open, which of course would depend upon the speed of the engine.

If the lever 129 were, however, shifted as far to the left as possible, the plunger would be raised to an extent to entirely close the ports 15, in which case no fuel would be pumped to the engine.

If we desired the engine to idle, the lever 129 would be moved to the left, from the position shown in Fig. 1 almost to the point 23, so as to almost but not entirely to close the ports 15.

Attention is called to the fact that in order to eliminate smoke, I cut off the introduction of fuel pumped while the plunger 126 is moving at high velocity. I accomplish this result by providing a by-pass. Referring to Figs. 2 to 2c inclusive, Fig. 2 shows the plunger in its depressed condition with the lever 129 in approximately the position shown in Fig. 1, but with the point 27 of the cam disc below the roller. It will be noted that the ports 15 are almost entirely opened. If desired the cam can be arranged to entirely open the ports. When the roller 129 engages the cam 6 the plunger is moved upwardly to substantially the positions shown in Figs. 2a, 2b, and 2c. In Fig. 2a it will be noted that the ports 15 are completely closed. No pumping action occurs until the ports 15 are completely closed and all pumping action will cease when the plunger has reached the position shown in Fig. 2b, and any additional upward movement will cause the ports 15 to communicate with the channel 22 so that the oil will pass downwardly into the channel 20 and communicating channels 21, to the channel 22, and thence out of the ports 15, thereby relieving the pressure above the plunger so that no additional fuel is pumped. Even with the port 15 completely opened, the space above the piston would not be completely filled with fuel except in those cases where the engine was stopped and with the port 15 uncovered. In normal running, however, this space above the port would never be completely filled with oil even with the port entirely opened for the port is too small to allow a sufficient quantity of fuel to enter the space above the piston during the short period of time which it has to so enter. Obviously, much less fuel could enter when the port 15 is only minutely opened. In any case, however, the pumping stroke commences on the upward movement of the piston after it has entirely closed the port 15 but this does not mean to say that the effective part of the pump stroke commences at that instant, that is, it does not follow that fuel would commence to pass by the valve 18 at the same instant that the piston completely closed the port 15. As a matter of fact, the piston would have to move up a distance corresponding to the amount of the unfilled portion of the space above the piston before oil would start passing by the valve 18. For instance, if this chamber above the piston was half full of oil, the piston would have to move further than if the said chamber was three-fourths full before any fuel would be forced by the valve 18. When the plunger continues to move from the position shown in Fig. 2b to that shown in 2c, no fuel will be pumped. This means that the fuel injection is given a sharp cut-off while the plunger is moving at its highest ve-

locity. If the by-pass above described were eliminated so that the fuel would continue to be injected while the plunger moved from the position shown in Fig. 2b to that shown in Fig. 2c the last part of this movement would result in the slow injection of fuel into the combustion chamber, which would mean that it would not be sprayed into the combustion chamber, but a part at least thereof would simply dribble into the same, which would result in faulty combustion, which would produce a great quantity of smoke. This smoke is almost completely eliminated by the cut-off above described.

It is obvious that many changes in the construction and details shown in the drawings and described in the specification may be made without departing from the spirit of this invention, and I reserve the right to make all changes and modifications which may fairly fall within the scope of the appended claims. Having now described my invention, I claim:

1. In combination, a plunger, a lever having a cam surface contacting the end of said plunger, the fulcrum of said lever being shiftable towards or away from said plunger, a cam to operate said lever, a pump barrel having an intake port, said cam surface serving as a means to move said plunger when the lever is shifted in one direction to partially close said port while the plunger is at the bottom of its stroke, the said shifting of said lever serving as a means to delay the timing of the pumping stroke of said plunger, and a spring tending to move said plunger so as to open said port.

2. In a fuel pump having an intake port, a plunger, a spring tending to move said plunger in one direction and a shiftable lever having a cam surface contacting said plunger, said spring and cam surface serving as a means to adjust said plunger so as to close or open said port while the plunger is at the bottom of its stroke according to the amount of fuel it is desired to pump, a cam to actuate said piston on its pumping stroke, and means to render the pump stroke ineffective during the latter part of said stroke so as to make a sharp cut off.

3. In a combination, a pump barrel provided with an intake port, a plunger forming a piston, said piston having an annular channel and a by-pass leading from the upper end of the piston to said channel, the space above the piston communicating with said port when the piston is at the end of its suction stroke and the channel being brought into communication with the port before the piston has completed its pumping stroke, a lever provided with a cam surface contacting the plunger, a cam to operate said lever, said lever being shiftable transversely of the contacting portion of said plunger so as to vary the

timing when the plunger will be operated by said cam said lever serving as a means to actuate the piston so as to vary the amount of opening of the port when the piston is at the end of its suction stroke.

4. In a combination, a pump barrel provided with an intake port, a plunger forming a piston, said piston having an annular channel and a by-pass leading from the upper end of the piston to said channel, the space above the piston communicating with said port when the piston is at the end of its suction stroke and the channel being brought into communication with the port before the piston has completed its pumping stroke, a lever provided with a cam surface contacting the plunger, a cam to operate said lever, said lever being shiftable transversely of the contacting portion of said plunger so as to vary the timing when the plunger will be operated by said cam said lever serving as a means to actuate the piston so as to vary the amount of opening of the port when the piston is at the end of its suction stroke.

5. In combination, a pump barrel provided with an intake port, a plunger forming a piston, said piston having an annular channel and a by-pass leading from the upper end of the piston to said channel, the space above the piston communicating with said port when the piston is at the end of its suction stroke and the channel being brought into communication with the port before the piston has completed its pumping stroke, a lever provided with a cam surface contacting the plunger, a cam to operate said lever, said lever being shiftable transversely of the contacting portion of said plunger so as to vary the timing when the plunger will be operated by said cam and the effective throw of said lever when operated by the cam said lever serving as a means to actuate the piston so as to vary the amount of opening of the port when the piston is at the end of its suction stroke.

6. In a fuel pump, a plunger, a lever having a cam surface contacting the end of said plunger, the fulcrum of said lever being shiftable towards or away from said plunger, a cam to operate said lever, a pump barrel having an intake port, said cam surface serving as a means to move said plunger when the lever is shifted in one direction to partially close said port while the plunger is at the bottom of its stroke and a spring tending to move said plunger so as to open said port, the size of said port, even when fully open, being sufficiently small to prevent the fluid to be pumped from completely filling the pump barrel above the piston when the plunger is operated at any normal speed.

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