Feb. 10, 1931. J. W. ONIONS 1,791,600

FUEL DISTRIBUTING PUMP FOR INTERNAL COMBUSTION ENGINES

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Fig. 4.

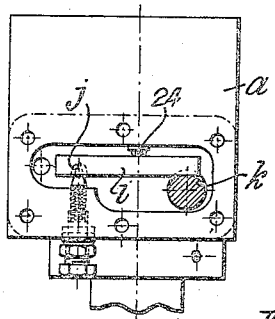



Fig. 5.

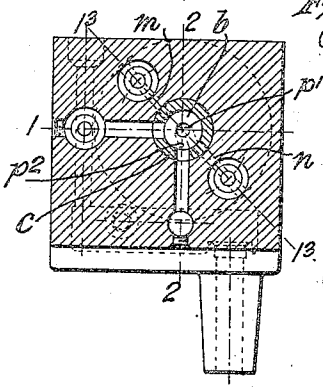
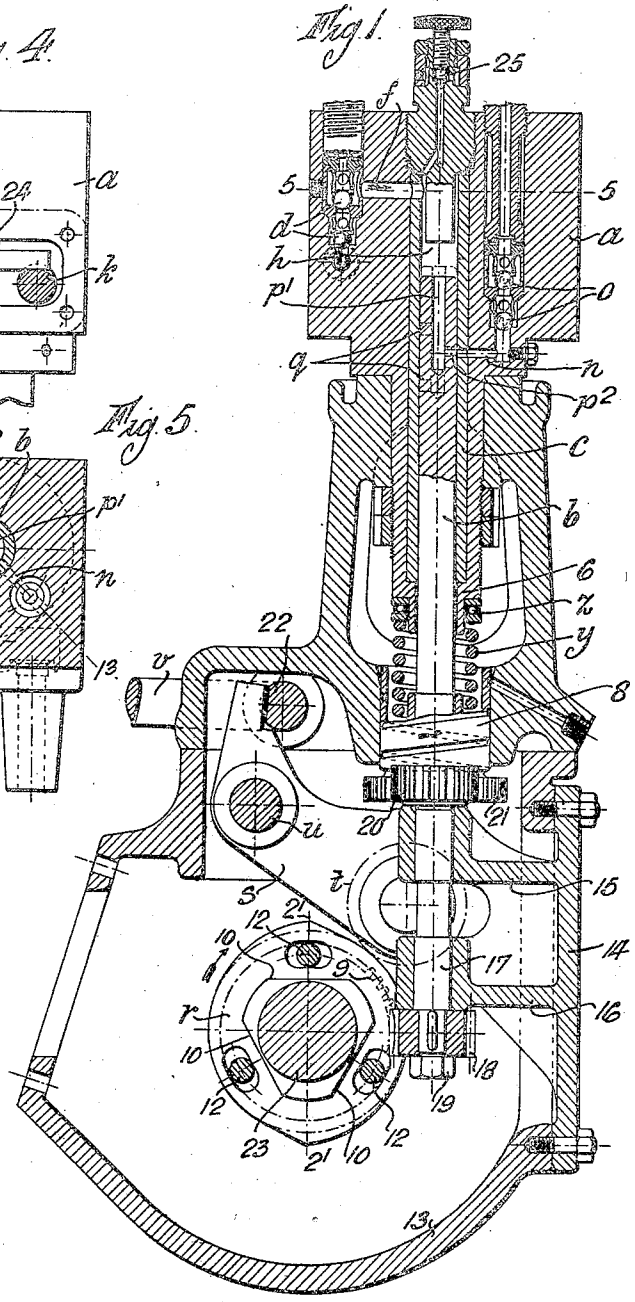



Fig. 1.




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Fig. 2

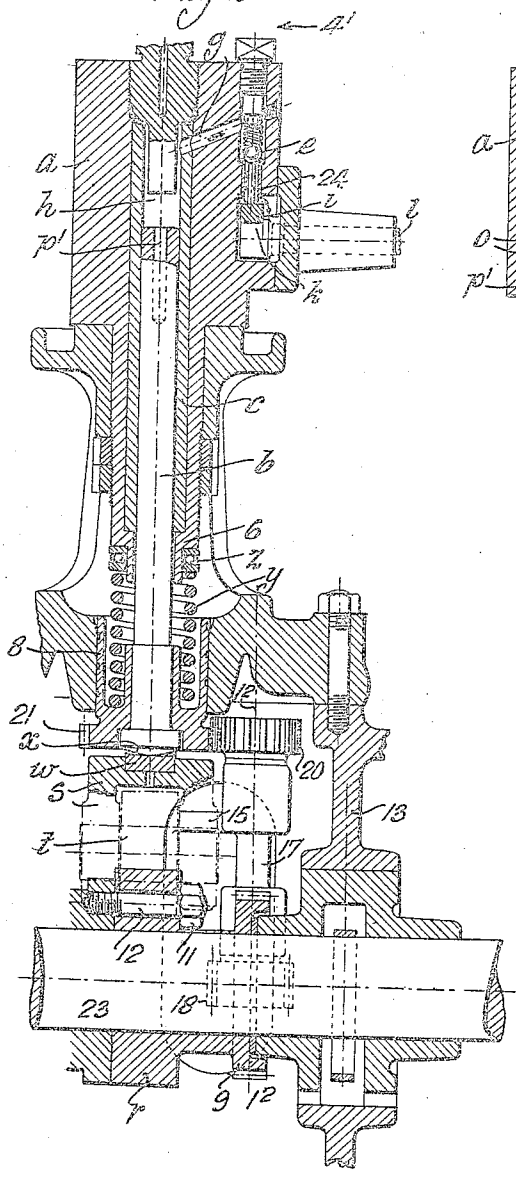



Fig. 3

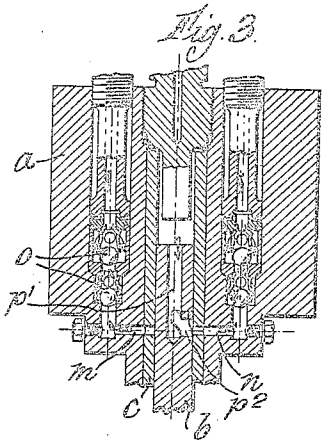



Fig. 6

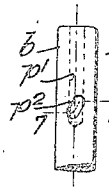
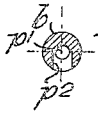



Fig. 7




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# UNITED STATES PATENT OFFICE

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## FUEL-DISTRIBUTING PUMP FOR INTERNAL-COMBUSTION ENGINES

Application filed September 22, 1928, Serial No. 307,561, and in Great Britain October 5, 1927.

In feeding liquid fuel to multiple working or combustion chambers of an internal combustion engine, it has been the practice hitherto to arrange one fuel pump to deliver the fuel to them through a separate distributing device, and although the pump plunger may or may not be arranged in the same body or casing as the distributing means, the pump plunger always acts solely to feed the fuel and in no way does it serve to distribute the fuel to the multiple working or combustion chamber.

According to the present invention, the plunger of a fuel feed pump serves also to distribute the liquid fuel to a plurality of working or combustion chambers of the engine at the required times in the cycle of operations in the working or combustion chambers.

The pump comprises essentially a body or casing, a ported plunger working in a bore of the body to which fuel oil is admitted during the suction stroke of the pump, and two or more delivery ports or passages in communication with the respective working or combustion chambers of the engine.

The plunger may have one or more distributing ports or passages which co-operate or register with multiple delivery ports or passages, and is given a combined reciprocating and rotary motion, which latter may be either intermittent or continuous, the motion or motions with respect to that of the engine being such as to give the required number of delivery strokes corresponding to the number of working strokes to be performed per cycle of operations in the cylinders of the engine unit.

Where one distributing port is provided in the plunger this may be elongated and obliquely disposed, and the plunger rotated continuously, so that, when during rotation the distributing port registers with any one of the delivery ports over more or less of its complete width, the plunger is lifted or moved inwardly, whereby open communication with the delivery will be established during the delivery stroke of the pump over the full length of the distributing port.

In the accompanying drawings, which show by way of example a pump according to the present invention, for a four stroke engine having two working or combustion chambers, Figure 1 is a sectional elevation thereof, with the distributing port just opening, preparatory to delivery, the left hand portion of the upper part, which shows the pump body, being taken on the line 1—1 of Figure 5, and the right hand part thereof on the line $1^3$—$1^3$ of Figure 5, whilst the lower part of the figure, which shows the actuating mechanism, is taken on a plane passing through the line $1^2$—$1^2$ of Figure 2, the section being taken in this manner for convenience of illustration.

Figure 2 is a further sectional elevation of the improved pump, the upper part being taken on the line 2—2 of Figure 5, and the lower portion partly on the line $2^1$—$2^1$ of Figure 1 and partly through the axis of the pump plunger.

Figure 3 is a sectional elevation of the pump body, taken on the line $1^3$—$1^3$ of Figure 5, showing the positions of the two delivery ports in relation to the distributing port in the plunger, and with the distributing port about to close as the plunger reaches the end of the delivery stroke.

Figure 4 is an elevation of the pump body as seen in the direction of the arrow $4^1$, Figure 2 and with the cover plate on the pump body removed.

Figure 5 is a sectional plan view of the pump body, taken on the line 5—5 of Figure 1, and with the valves removed.

Figure 6 is an elevation of a fragment of the pump plunger showing the arrangement of the distributing port.

Figure 7 is a cross section through the plunger on the line 7—7 of Figure 6.

In carrying out the present invention as illustrated, the pump comprises a body or casing *a*, bored out to receive a plunger *b* which fits closely therein or in a liner *c* suitably secured against rotation or made a tight fit within the said bore. The body or casing *a* is fitted with a suitable suction valve or valves *d* and a by-pass or relief valve *e* both in communication, through the passages *f* and *g* respectively, with the chamber or cavi-

ties *h* formed by the space beyond the inner end of the plunger, whilst 25 is the usual air relief tap. The by-pass valve *e* is connected with the engine governor in a similar manner to fuel pumps at present in use, to control the quality of fuel delivered. The control arrangements shown and described in prior British patent specification No. 20,582 of 1909 may be used and, as illustrated in the drawings accompanying the present specification, the means comprise a lever *i* under a fluted lifter rod 24, the by-pass or relief valve *e* and supported at or towards one end on an adjustable fulcrum *j*. The lever *i* is supported at a second point preferably at or towards its other end on a floating fulcrum formed by a cam *k* on a spindle *l* connected with the engine governor, whereby the by-pass or relief valve will be lowered or raised by the lever *i* acting through the fluted rod 24 to throttle more or less the oil passing through it, and also through the flutes or channels in the lifter rod 24 to the suction side of the pump. The body or casing is also provided with two transverse delivery ports or passages *m* and *n* respectively, arranged in the same transverse plane and from each of these passages a conduit leads to an atomizer which may be of the needle valve type, lifted by the pressure of the fuel, such as disclosed in the above mentioned prior British patent specification, fuel valve such as disclosed in prior British patent specification No. 5,912 of 1900, or other fuel injecting means in communication with one of the working or combustion chambers or cylinders of the engine. In each of the delivery passages or continuations thereof outside the body or casing *a*, I prefer to fit an automatic non-return valve or valves *o*, preferably of the ball type, to maintain the pressure of the fuel oil in the system outside the body of the device, upon the closing of the atomizer, fuel valve or other fuel injecting means, the system being full of fuel oil throughout the working of the engine. A non-return valve or valves may also be provided in each fuel conduit of the atomizer or fuel valve. The inner end of the plunger is provided with a distributing port or passage in continuous communication with the pressure chamber or cavities *h* of the pump, and opening into the bore in which the plunger works, on the sliding surface of the latter at a suitable point remote from its inner end. This passage may be formed by a hole *p*1 directed axially or longitudinally from the inner end surface of the plunger and extending, leading or merging into a transverse hole, port or slot *p*2 opening at one side of the sliding surface of the plunger. The port *p*2 is elongated and is directed obliquely and so shaped as to keep the pressure chamber or cavities of the device open to any one delivery port at a time for a predetermined period, while the plunger is moving with a combined axial and rotary movement on its delivery strokes.

With this construction, to relieve side thrust of the plunger against the bore opposite the distributing port under the action of the pressure of the fuel, a port or ports *q* may be provided in the opposite side of the plunger to lead into the axial portion *p*1 of the distributing passage which may be lengthened as shown in chain lines, the port or ports *q* being arranged so as not to register with the delivery ports in the body during the working of the pump.

According to one way of actuating the plunger as shown, a cam *r*, mounted upon the half-speed shaft 23, drives the plunger *b* positively on its delivery or in-stroke through a pivoted two-armed lever *s* carrying a cam bowl or roller *t*. This lever is mounted on a pivot *u*, whilst an arm or lever *v* on a shaft 22 formed with a cam surface, serves for actuating or priming the pump by hand at starting, and also for putting the pump out of action when desired by rotating the said shaft through 180°, whereby the lever *s* is moved by the concentric portion of said shaft, out of the path of the operating cam *r*. The lever *s* is forked, as shown, to accommodate the roller *t*, and carries a pad *w* which engages a head upon the lower end of the plunger, the engaging surface *x* of which is curved or lies on the surface of a sphere. The suction or out-stroke of the plunger is effected by a spring *y* which is compressed during the in-strokes. This spring is arranged between a ball bearing *z* on the fixed guide sleeve 6 projecting from the lower or outer end of the pump body, and a sliding cup-shaped guide 8 secured to or made a tight fit on the lower end of the plunger. The ball bearing lessens the resistance of the plunger to rotational movement. The driving cam *r* is suitably shaped as shown, to give a delivery stroke corresponding to each of the working strokes of the engine cylinders to be supplied throughout each cycle of operations.

Obviously, the cam may drive the plunger positively on its suction or out-stroke, the spring means being employed to actuate it on its delivery or in-stroke, the arrangement being such that the maximum energy stored in the spring suddenly acts upon the plunger which transmits it to the fuel oil to effect delivery at a rapid rate.

Again, if desired, the plunger may obviously be moved positively in both axial directions by a suitable cam or cams, or eccentric driving means may be employed instead of the cam or cams.

In order to impart continuous rotational movement to the plunger while it is being reciprocated, the following arrangement of gearing is employed.

Preferably integral with the cam *r* for reciprocating the plunger axially, is formed a helical or screw gear 9 with the sleeve or neck portion between these members cut away at 10 to clear the nuts 11 of the studs 12 for adjustably securing the cam in position on the half speed shaft 23. The casing 13 containing the mechanism for driving the plunger is provided with a cover plate 14 which has brackets 15 and 16 carrying bearings for a countershaft 17. Fast upon the lower or outer end of this shaft is disposed a helical or screw gear 18 meshing with the gear 9 and held in position axially by the nut 19. At the upper or inner end of the countershaft 17, a spur wheel 20 is secured and meshes with a spur pinion 21 integral with the sliding cup-shaped guide.

The head of the lower end of the plunger fits in a recess in the spur wheel 21, leaving the engaging surface *x* projecting from it. It will be observed that the spur wheel 20 is formed deeper than the spur wheel 21 to allow for a predetermined sliding movement of the latter with the pump plunger. The arrangement of the gears 20 and 21 upon a shaft supported by the cover plate 14 facilitates the assemblage of the parts of the driving mechanism. The ratio of this gearing is such that the plunger will be rotated at such a speed as to cause the distributing port to communicate with each delivery port in turn at the required moment in the cycle of operations in the engine cylinders.

In operation, as the plunger *b* moves outwardly, fuel oil is drawn into the chamber or cavities *h* through the suction valve *d*, whilst upon the delivery stroke, the distributing port *p2* being then in communication with one of the delivery ports *m* or *n*, fuel oil will be forced therethrough to the atomizer or other fuel injecting device, whilst the by-pass or relief valve *e* causes more or less of the fuel that is being delivered by the plunger to be by-passed to the source of supply, according to its adjustment by the governor. During the next in and out stroke of the plunger, precisely the same series of operations will occur, but on this delivery stroke, on account of the rotational movement imparted to the plunger *b*, the fuel will be forced through the other delivery port *m* or *n* in communication with the second working or combustion chamber or cylinder of the engine, the delivery port leading to the first mentioned working or combustion chamber or cylinder being cut off from the pressure chamber or cavities *h* of the pump at this time.

Although there is particularly described above one form of the fuel pump according to this invention, with some modifications in the means for moving the plunger axially, it is to be understood that considerable modifications may be made without departing from the spirit of the invention. Several modifications will now be referred to.

If desired, the plunger may be fitted with a packed gland where it passes out of the body instead of relying upon the fit of the plunger in a long bore, as in the example illustrated.

Instead of the suction valve or valves described above, the plunger may control the inlet of fuel oil by a port or ports leading to an interior passage in communication with the pump chamber, and co-operating at predetermined times with a suitable port or ports in the body.

In controlling the quantity of fuel delivered by the pump, the means herein referred to above may be arranged to act upon a suction valve instead of the by-pass or relief valve.

Instead of arranging the by-pass or relief valve in the pump body, it may be arranged separately therefrom and in such case preferably in a casing on the working or combustion chamber, and controlled also by the engine governor.

In cases where an atomizer valve is not used, a non-return valve or valves may be arranged in the fuel conduit near to the point of injection of the fuel into the working or combustion chamber or cylinder of the engine.

The delivery ports may, in some cases, be arranged in different transverse planes for co-operation with more than one fuel distributing port or passage in the plunger.

The drive for the pump plunger may be taken from the engine shaft or lay shaft other than the usual half speed shaft.

Instead of the gearing described above, the plunger may be rotated from the half speed shaft through spur gears which drive a counter-shaft parallel with the half speed shaft and from this counter-shaft rotary motion is imparted to an outward or downward extension of the plunger through bevel gears permitting the extension of the plunger to slide axially while rotating.

The plunger may be rotated intermittently in such a manner that during the dwell in the rotary movement, distribution of the fuel takes place. Furthermore, the plunger may be given a partial turn at the end of the suction stroke, or alternatively, at a point in the delivery stroke when it is desired to terminate delivery.

In the application of the invention to an engine having three or four working or combustion chambers, a corresponding number of delivery ports may be arranged at equal angles in the same transverse plane; thus, for a four cylinder engine the axes of adjacent ports would be disposed at 90° to each other, and if one distributing port is provided in the plunger, this will register with each delivery port in turn at the required times in

the cycle of operations, and each time the pump plunger will perform a delivery stroke.

In some cases, according to the times of firing the charges in the working or combustion chambers, the delivery ports may not be disposed at equal angles about the circumference of the pump plunger.

What I claim is:—

1. In means for supplying liquid fuel under pressure to an internal combustion engine having a plurality of working chambers, the combination of a pump body, means for supplying fuel thereto, a plurality of delivery passages spaced around the periphery of said body, a plunger in said body, means for reciprocating said plunger to compress the fuel, a single port in said plunger in communication with the pump chamber of said body, and means for angularly moving said plunger about its axis to place said port successively into communication with the delivery passages.

2. In means for supplying liquid fuel under pressure to an internal combustion engine having a plurality of working chambers, the combination of a pump body, means for supplying fuel thereto, a plurality of delivery passages spaced around the periphery of said body, a plunger in said body, means for reciprocating said plunger to compress the fuel, a single oblique and elongated port in said plunger in communication with the pump chamber of said body, and means for angularly moving said plunger about its axis to place said port successively into communication with the delivery passages.

3. In means for supplying liquid fuel under pressure to an internal combustion engine, the combination of a pump body, means for supplying fuel to said body, a plurality of delivery passages in said body, a pump plunger in said body, cam and spring means for reciprocating said plunger to compress the fuel, an elongated and inclined port in said plunger, means for placing said port in constant communication with the pump chamber, gearing means adapted to move said plunger angularly about its axis to, place said port successively in communication with the delivery passages, and means for neutralizing side thrust on said plunger, comprising passages extending to the periphery of said plunger and in communication with the compressed fuel and located diametrically opposite the line of action of said side thrust.

4. In means for supplying liquid fuel under pressure to an internal combustion engine having a plurality of working chambers, the combination of a pump body, means for supplying fuel thereto, a plurality of delivery passages spaced around the periphery of said body, a plunger in said body, means for reciprocating said plunger to compress the fuel, a port in said plunger in communication with the pump chamber of said body, and means for angularly moving said plunger about its axis to place said port successively into communication with the delivery passages.

In testimony that I claim the foregoing as my invention I have signed my name this sixth day of September, 1928.

JOHN WILKINSON ONIONS.