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FUEL SUPPLYING AND INJECTING PUMP FOR INTERNAL COMBUSTION ENGINES OF THE SELF IGNITION TYPE

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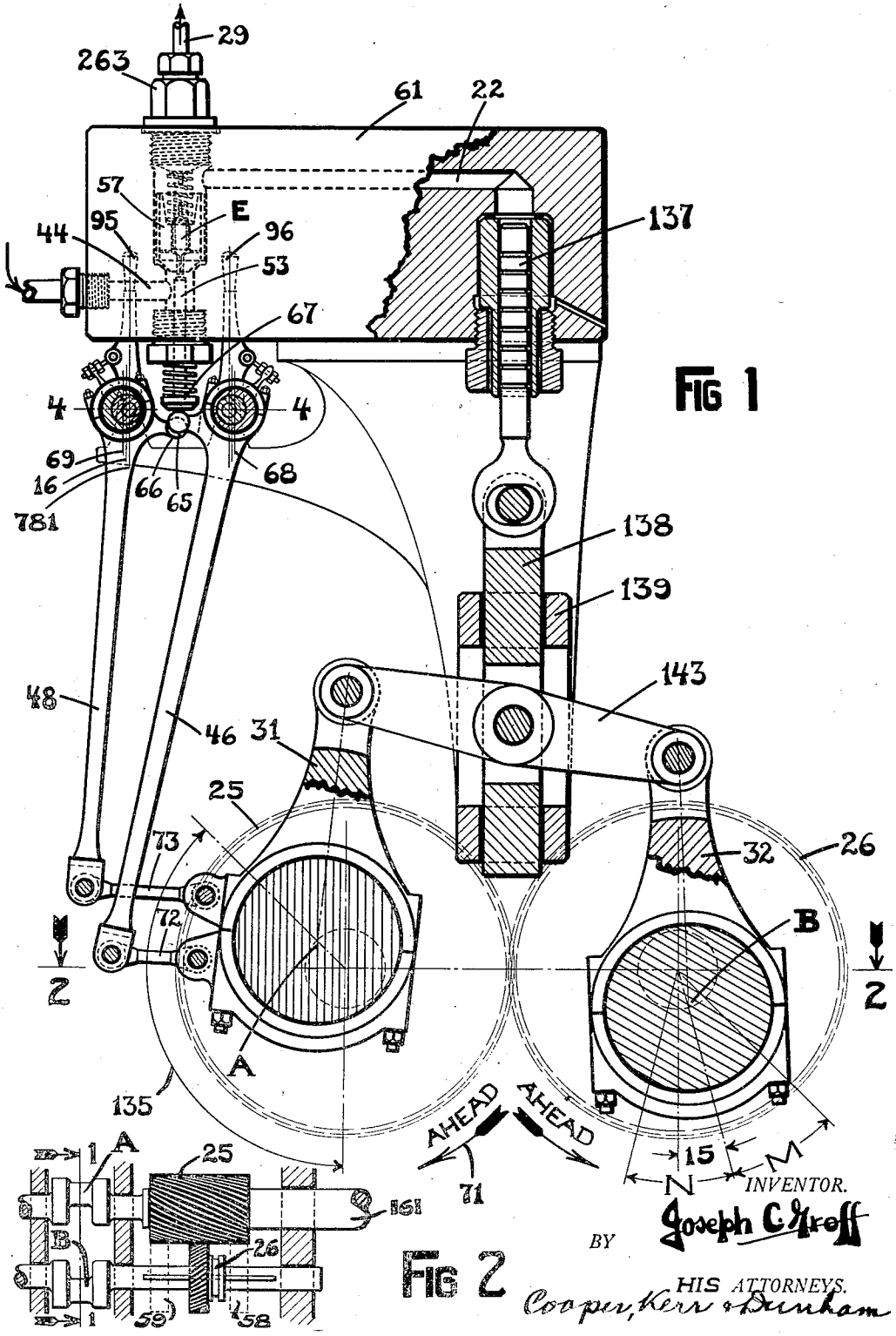


FIG 1

FIG 2

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FUEL SUPPLYING AND INJECTING PUMP FOR INTERNAL COMBUSTION ENGINES OF THE SELF IGNITION TYPE

Original application filed March 26, 1927, Serial No. 178,537. Divided and this application filed March 27, 1928. Serial No. 265,095.

This invention relates to improvements in fuel-supplying pumps for internal combustion engines of the fuel-injection type.

The present application constitutes a division of my co-pending application Serial Number 178,537 filed March 26, 1927.

According to the foregoing application provision was made for securing so-called airless injection of the fuel without the use of mechanically controlled fuel-injecting valve devices located remotely from the fuel-supplying pump. The velocity of fuel injection (i. e. velocity of the fuel during its passage into the combustion space through the spray nozzles of the injecting device) was determined by changing the rate at which the pump delivered fuel to the said injecting device. Such variation in the rate of fuel delivery was accomplished by changing the phase relation existing among a plurality of driving means for operating the pumping means.

The pumping means might comprise a plurality of pumping plungers or a single pumping plunger and the present invention is directed to the particular species wherein a single pumping plunger is provided and wherein provision is made for effecting its operation from dual driving means. Further, the velocity of fuel-injection for any given engine speed, and as determined by the rate at which fuel is supplied by the pump, may be changed at will by changing the phase relation of one driving means with respect to the other.

The present invention, therefore, has for its object the provision of novel means for desirably varying the rate of fuel-injection for any given operating speed of the engine and furthermore is directed to the provision of means for effecting such variation while utilizing a single pumping-plunger.

In the drawings:

Fig. 1 shows in cross-section view a preferred embodiment of my invention.

Fig. 2 shows another view of the device illustrated in Fig. 1, but in reduced scale, and is taken substantially on line 2—2 in the direction of the arrows in Fig. 1.

For the sake of clearer illustration, certain of the parts shown in Fig. 1 are not shown in Fig. 2 and vice versa. Also, certain of the parts shown in Figs. 1 and 2 bear the same reference characters as do similarly acting parts shown in my aforementioned co-pending application.

In more detail, 137 is the single fuel-pumping plunger which is preferably connected to and driven by any suitable crosshead member such as 138 working within suitable guiding parts such as 139. The crosshead 138 in turn is actuated by a member such as 143 which is pivotally connected thereto and which in turn is also adapted to be pivotally connected to dual driving members such as 31 and 32. Connecting rods 31 and 32 are in turn actuated from cranklike or eccentric driving members A and B respectively.

These parts, A and B, constitute the conjointly-acting driving means and their phase of drive, with relative angular respect to each other, may be varied by any suitable known means, such as, by sliding the spiral gear 26 axially, along a splinded portion of shaft B, with respect to the fixed spiral gear 25 as shown in Fig. 2.

Preferably, cranklike shaft A is driven directly off and/or by an extension 161 of the engine crankshaft or camshaft, or from other suitable parts depending upon the class of the engine. Cranklike shaft B is preferably driven from shaft A—161 by means of the constantly meshed helical gears 26 and 25. In this connection it is important to note, that crank A always rotates, for any given direction of rotation of the engine crankshaft, with fixed and unchanging angular relation thereto. But, on the other hand, cranklike shaft B is intentionally adapted to be angularly adjusted with respect to said angularly-unchangeable shaft A—161. The reason for this preferred method of driving A and B will be described hereinafter.

Hereinafter in this specification, and as shown in the drawings, the arrangement of my fuel-supplying pump is assumed to apply to internal combustion engines which operate on the two-stroke cycle in order to more simply and clearly describe the features and operation of my invention. However, it should

be understood that my novel fuel injecting means can be equally well adapted to engines which operate on the four-stroke cycle.

Now, as shown in Fig. 1, cranklike shafts A and B are indicated as revolving in opposite directions in accordance with the working action of the aforementioned spiral gears 25 and 26 for, say, Ahead rotation of the engine as indicated by arrow 71. Thus, as illustrativly shown in Fig. 1, clockwise revolving crank A occupies an instantaneous position which is shown as being, say, one-hundred-and-thirty-five crank degrees past its respective bottom dead center position as indicated by arc 135. And, counter-clockwise revolving crank B is shown as occupying an instantaneous position which is, say, fifteen crank degrees past its respective bottom dead center position as indicated by arc 15. In other words, while revolving in opposite directions, cranks A and B are shown in Fig. 1 as being angularly out of phase by substantially 120-crank degrees. Illustratively the aforementioned phase relation indicated by arcs 135 and 15 in Fig. 1 is assumed to result when the axially slidable gear 26 occupies its central full-lined position as shown in Fig. 2.

Here it should be explained that plunger 137 is reciprocated with a rate of movement, and with particular reference to upward fuel-pumping movement, which is the resultant effect of the axially-parallel components of the respective movements of driving means A and B with due regard to the angularity effects of connecting rods 31 and 32 with member 143.

Accordingly, it will be understood that the rate of useful upward pumping movement of plunger 137, which results with the parts related to each other as shown in Fig. 1, may be increased as desired by lessening the out-of-phase difference between driving members A and B, and vice versa. In other words, the rate of upward pumping movement approaches a substantially maximum rate as the out-of-phase difference between the conjointly-acting driving means A and B is made to approach a minimum, and vice versa. Mention should be made here, that said respective cranklike driving members A and B are considered to be in phase, to thus have no out-of-phase difference existing therebetween, when they bear such angular relation to each other that they both pass through their respective dead center positions at substantially the same instant.

Thus, referring to Fig. 1, as crank B is angularly advanced in a counter-clockwise direction and with respect to crank A, to thereby lessen the out-of-phase difference therebetween by an illustrative maximum angular adjustment indicated by arc M, the resultant rate of pumping movement of plunger 137 becomes any desired predetermined maximum for any given engine speed. Such angular adjustment between cranks A and B is effected by moving the slidable helical gear 26 axially to the right of its central position (shown in full lines in Fig. 2) to its dotted line position 58.

Similarly, as crank B is angularly retarded in a clockwise direction and with respect to crank A, to thereby lessen the out-of-phase difference therebetween by an illustrative maximum angular adjustment as indicated by arc N, the resultant rate of pumping movement of plunger 137 becomes any desired predetermined minimum for any given engine speed. Such angular adjustment between cranks A and B is effected by moving the slidable helical gear 26 axially to the left of its full lined central position in Fig. 2 to its dotted line position 59.

Before further describing the working action of my novel pump driving means, I will first briefly describe the pumping means driven thereby which I prefer to employ and as is described in more detail in my co-pending application, Serial No. 178,537.

Thus in Fig. 1, liquid fuel medium is supplied to the pumping chamber 22 in body member 61 via any suitable supply pipe and passage 44 from any suitable outside source of supply not shown in the drawings. Preferably, however, the fuel so supplied should exist in passage 44 under some relatively low, yet positive, pressure head in order to lessen any tendency for the pump to become "air-bound".

Interposed between supply passage 44 and the pumping chamber 22 is a "suction" or fuel-admitting valve of any suitable known character such as 57. Preferably, valve 57 is adapted to mount a "by-pass" valve E which is concentrically disposed therewith and which is also adapted to be engaged and operated by a tappet member 53 which is common to both of said valves E and 57. As shown in Fig. 1, tappet member 53 upon moving upwardly is adapted to engage any suitable lower stem portion of by-pass valve E, to thus raise said valve from its seat formed by suction valve 57, prior to its subsequently engaging the said valve 57 itself to thereupon raise the latter from its seat formed in body member 61. Similarly, upon downward movement of tappet 53, valve E is adapted to close on its seat in valve 57 after said valve 57 has itself closed on its own respective seat in block 61. With this arrangement, ample desired valve area is provided for the admission of fuel to the pump chamber 22 via valve 57 and at the same time the valve operating gear is relieved of the objectionable working stresses which would result from opening such a large sized valve against the pressure which exists within the pumping chamber 22 at the time of initially opening such a valve as E.

Fuel is delivered by the pump to the fuel-

injecting valve in the power cylinder (not shown) via delivery pipe 29. Preferably there is provided a non-return check valve in connection 263 for the purpose of preventing withdrawal of fuel in pipe 29 by and upon any sucking-in action of the pump plunger.

While tappet 53 may be operated and controlled in any suitable known manner, I prefer to employ the arrangement which is illustrated in Fig. 1 and which is embodied in my aforementioned co-pending application Serial No. 178,537. Thus, briefly, two bellcranklike members 46 and 48 are pivotally mounted as shown, one to either side of the axis of tappet 53 and in a reverse manner with respect to each other, and arranged to be oscillated about their respective pivot points by links 72 and 73 respectively which are in turn operated from a common member such as crank A. As was previously described, crank A always rotates with fixed and unchangeable timed relation with respect to the engine crankshaft for any given direction of engine rotation. In other words, members 46 and 48 always oscillate in fixed timed relation with said engine for any given direction of engine operation as above.

As shown in Fig. 1, bellcrank 48 has an end projection 66 carried by its shorter and horizontally disposed arm, which projection 66 faces and matingly acts in a dual manner with a similar, but forked, projection 65 carried by bellcrank member 46 to alternately engage and disengage the bottom-end portion 67 of tappet 53.

Here it should be pointed out that my novel driving means acts entirely to desirably adjust the rate at which fuel is delivered by the pump to the power-cylinder combustion chamber (not shown) via pipe 29. Such factors as, the timing of fuel-delivery commencement, and/or the timing of delivery termination, together with the quantity or amount of fuel so delivered are preferably controlled by respectively varying the timing of final closure, the timing of initial opening, and, as a result thereof, the period of closure of the aforementioned by-pass valve E. Such variations may be independently effected by the aforementioned conjointly-acting bellcranklike members 46 and 48 as will now be briefly explained.

Bellcranklike member 48 is adapted to be oscillated about an adjustably mounted fulcrum bearing which is shown as having its center at the intersection of lines 4—4 and 69. The eccentricity of said adjustable fulcrum center is indicated in Fig. 1 as being the intercept on horizontal line 4—4 formed between vertical center lines 69 and 781, and said fulcrum center may be bodily shifted through a circular arc, of radius equal to this aforementioned eccentricity, by any suitable control means such as the manually manipulative lever 95. It should be understood that the vertical component of such circular shifting of the fulcrum of member 48 acts to desirably vary the instants of engagement and/or of dis-engagement between projection 66 and tappet 67—53, and therefore, between tappet 67—53 and by-pass valve E. Angular adjustment of control member 95 acts therefore to desirably vary the instant at which (for Ahead rotation of the engine as per arrow 71) fuel delivery, to the combustion chamber via pipe 29, is terminated by and upon upward and engaging movement of tappet 67—53 with respect to by-pass valve E and as effected by bellcranklike member 48—66.

In a similar manner, angular adjustment of control lever 96 acts to desirably vary the instant at which (for Ahead rotation) fuel delivery to the combustion chamber via pipe 29 is initially commenced by varying the instant in which bellcranklike member 46—65 acts to effect downward and dis-engaging movement of tappet 67—53 with respect to by-pass valve E. In Fig. 1 the various parts are shown substantially in the positions they would instantaneously occupy in an instant just subsequent to tappet 53—67 having been lowered by bellcranklike member 46—65 to thus allow by-pass valve E to close and to thus commence delivery of fuel through pipe 29.

Having described the manner in which the timing of fuel delivery commencement and/or of delivery termination may be independently adjusted by the dual action of bellcranklike members 46—65 and 48—66 to thus desirably vary the amount of fuel delivered, I will now describe the manner in which I prefer to operate my novel means for independently varying the rate at which said fuel delivery is effected.

As previously mentioned, cranklike driving members A and B are in turn driven by the engine—consequently, their speed of driving action varies directly with the running speed of the engine. Thus, for any given angular adjustment which may exist between shafts A and B, the rate of resultant pumping movement imparted thereby to plunger 137 will vary directly with the engine speed. The objectionable result of such a condition, and which has characterized pumps heretofore used for supplying and injecting the fuel, is that the velocity of the fuel in passing through the spray nozzles varies directly with the engine speed, and furthermore, cannot be adjusted to have such velocity as may be desired.

In this connection it should be pointed out that successful airless-injection of liquid fuels, particularly the heavier grades of fuel for use in large sized engines and in engines which must necessarily operate over a wide range of speeds, is largely dependent upon imparting the proper degree of velocity to the

fuel in its passage through the spray nozzles. In other words, if the velocity is insufficient the fuel will not be properly atomized and incomplete combustion will result, and if the fuel is subjected to excessive velocity in passing through the spray nozzles the spray jets of fuel will lack ability to desirably penetrate the compressed medium in the combustion chamber.

Consequently, it is intended that the aforementioned angular phase difference existing between the dual driving members A and B be adjusted, in accordance with any given engine speed or with changes thereof, so as to secure any desired rate of fuel injection, constant or otherwise as may be desired, regardless of the running speed of the engine and of the pump driving means.

To be more specific, suppose that it should be desired to maintain the rate of fuel injection constant for all different running speeds of the engine. This would be effected by correspondingly decreasing the out-of-phase-difference between driving members A and B as the speed of the engine decreased, and vice versa. In other words, a substantially minimum out-of-phase-difference would thus exist between driving members A and B at a time when the engine was operating at its lowest running speed, and vice versa.

It should be understood that I do not imply confinement of my invention to the specific embodiments illustrated in the drawings. For example: cranklike driving members A and B, instead of being of equal radius, might have respective throws of unequal length for crank A to be of smaller or greater radius than crank B; or, crank B might revolve at a different speed than crank A to thus revolve at some even multiple or fractional speed thereof. Also, other suitable known forms of driving members might be employed in place of the dual cranklike members A and B for the purpose of imparting adjustable rates of movement to member 143.

What I claim is:

A fuel-supplying means for internal combustion engines of the fuel-injection type comprising fuel-pumping and injecting means including in combination with a single pumping plunger, a pair of driving means therefore, means for adjustably varying the phase relation of said driving means with respect to each other whereby various desired rates of fuel delivery may be effected by said single pumping plunger regardless of its speed of operation, and co-acting means for varying the quantity of fuel which is delivered by the pump while the rate of such delivery is maintained substantially constant at some particular desired velocity by the aforesaid driving means.

In testimony whereof I hereto affix my signature.

JOSEPH C. GROFF.