Nov. 19, 1929. A. C. ATTENDU 1,736,242

FUEL PUMP

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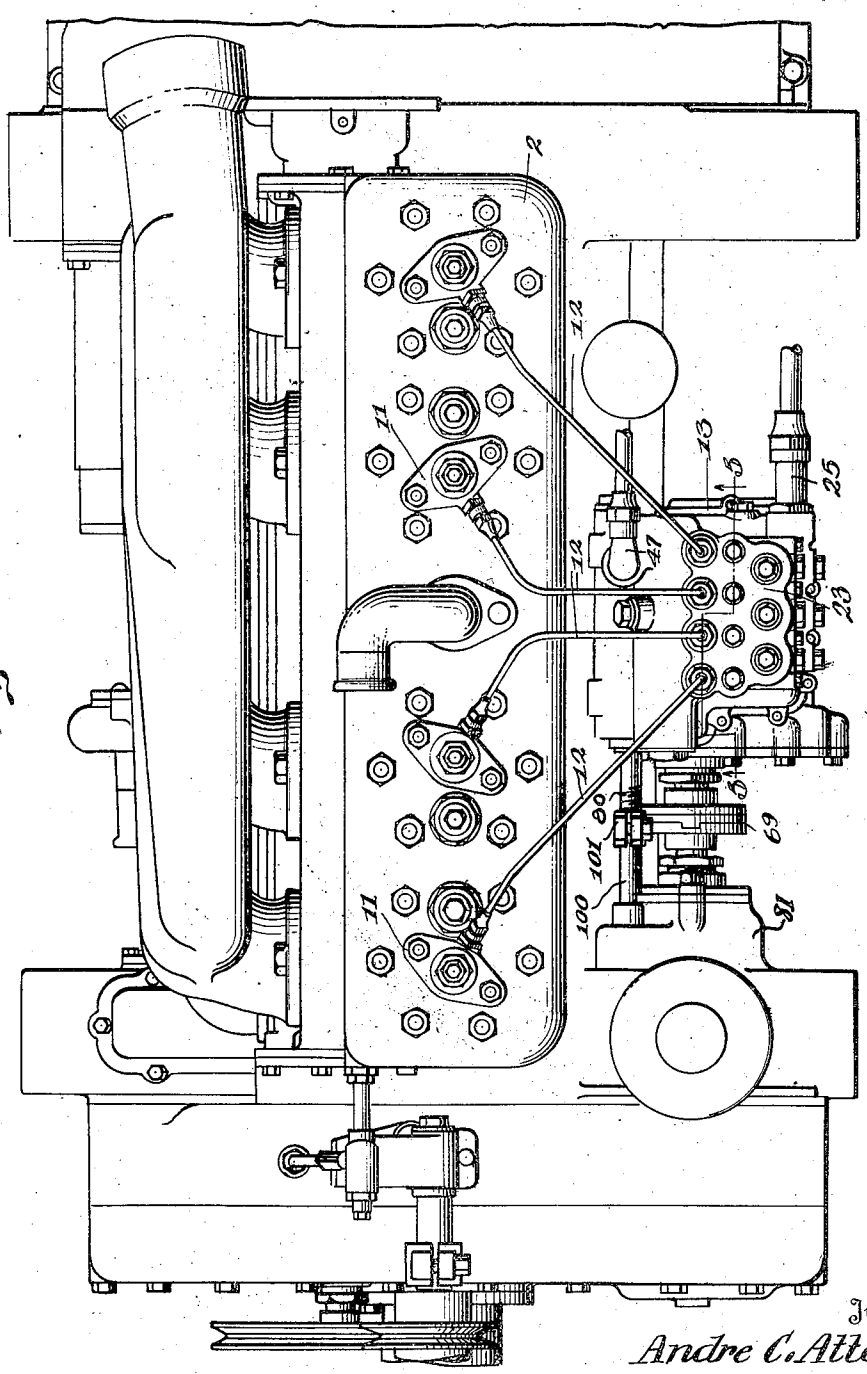


Fig. 1.

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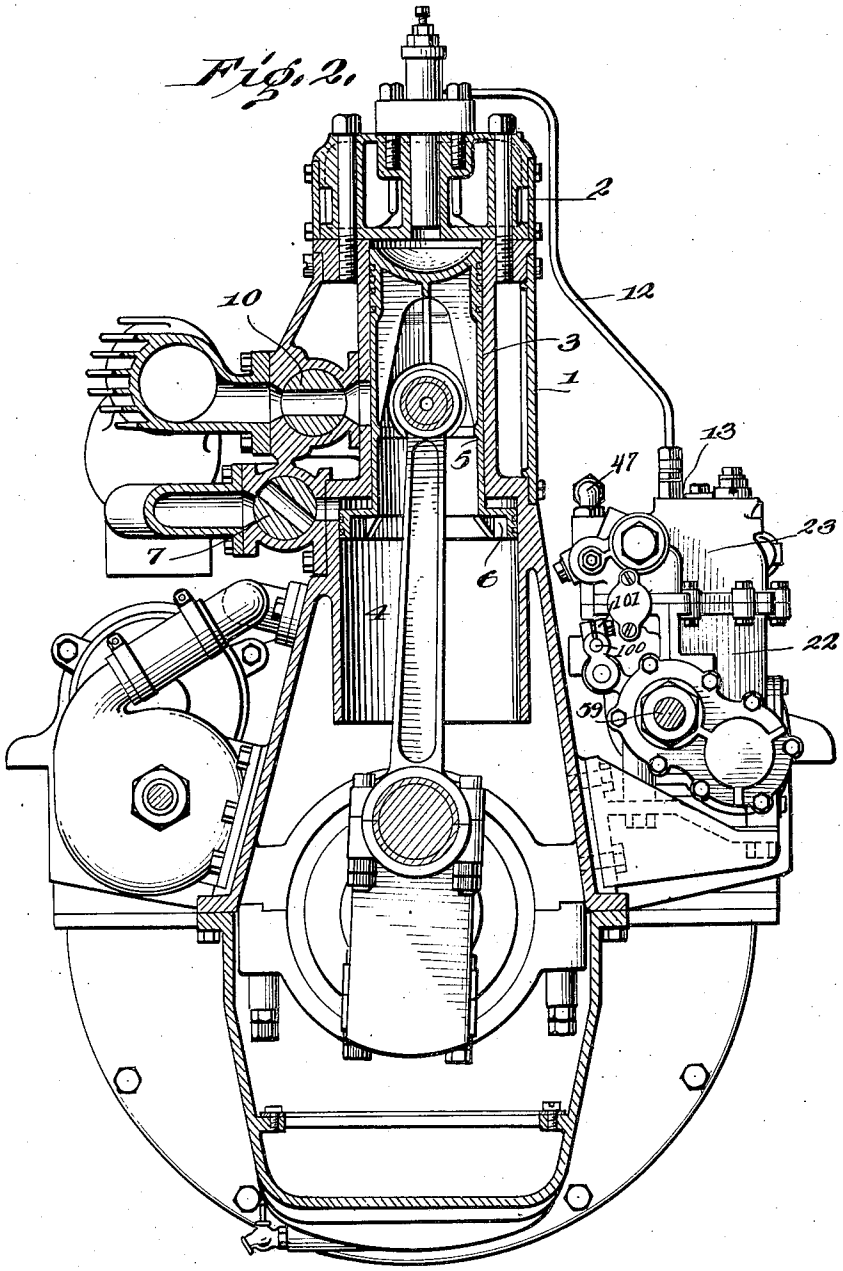
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FUEL PUMP

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Fig. 2.



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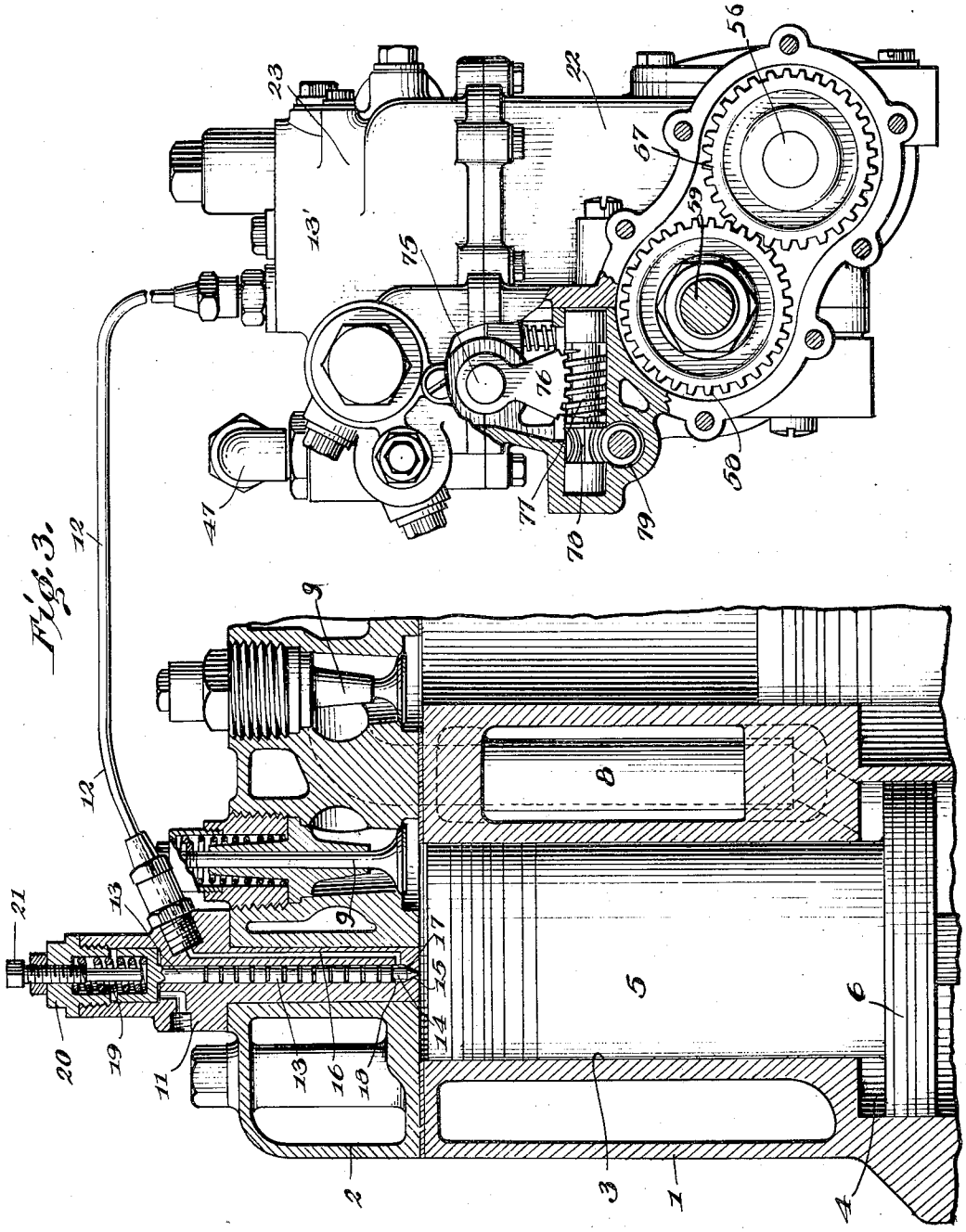
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Fig. 3.



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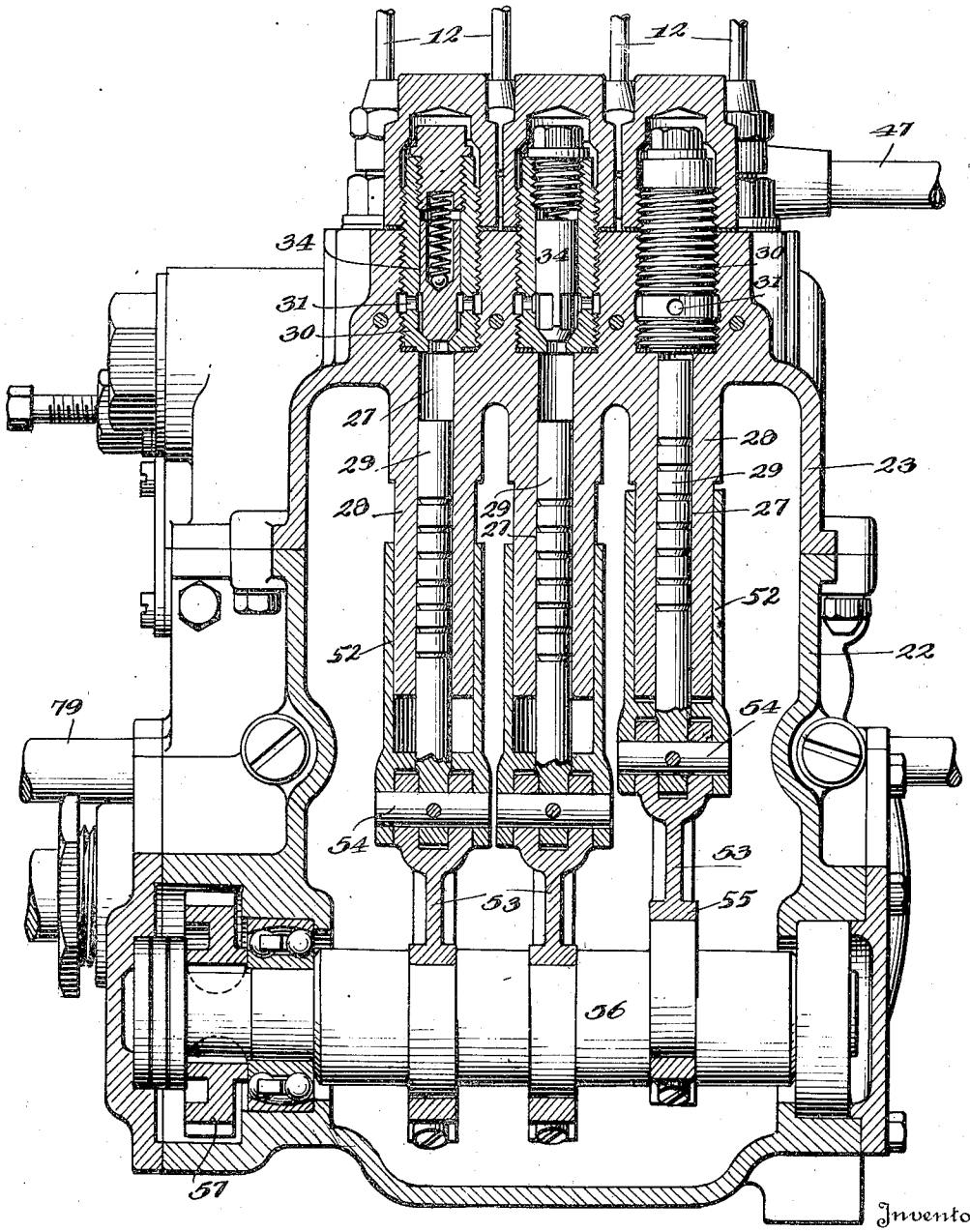
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Fig. 4.



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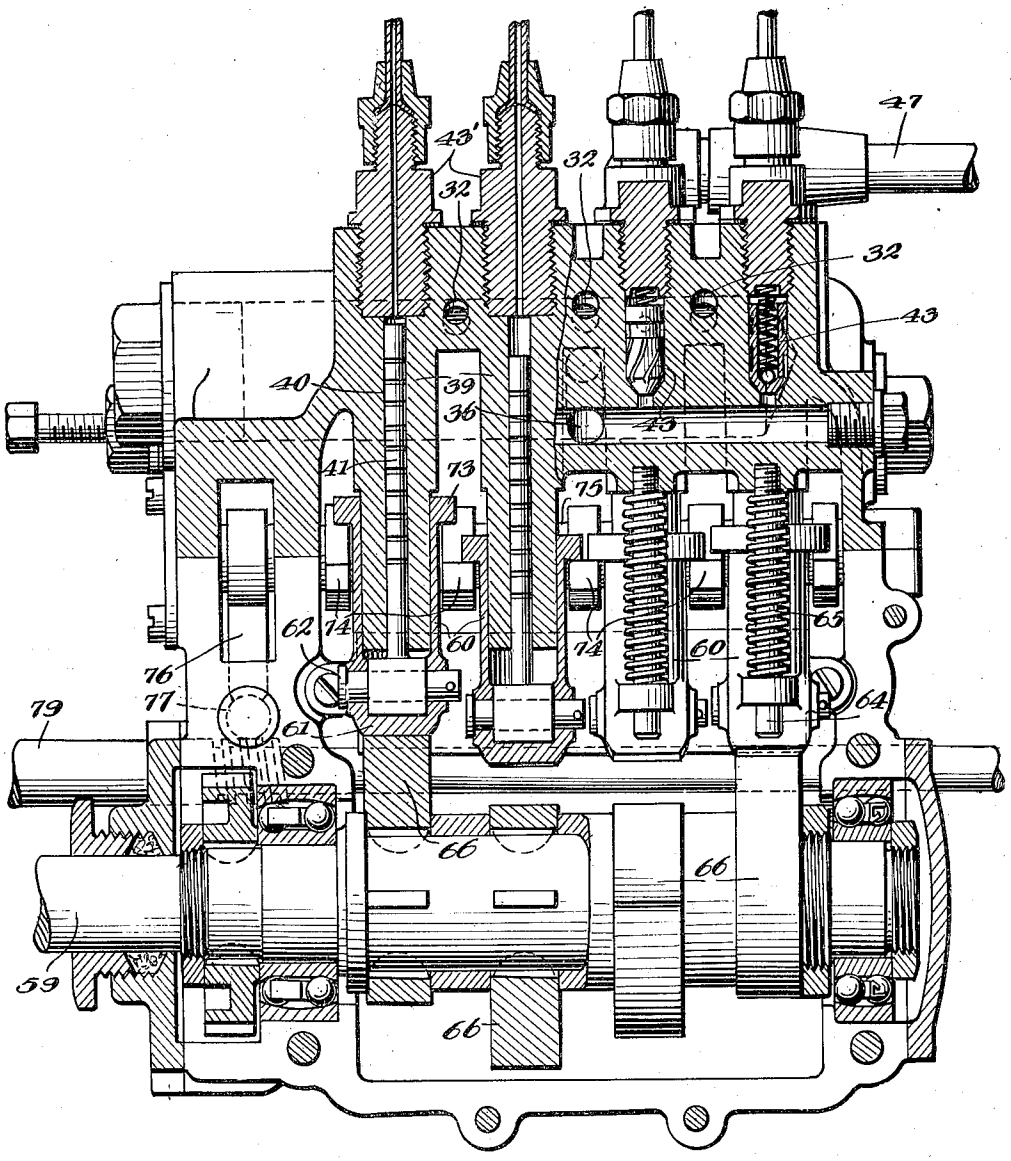
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Fig. 5.



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Fig. 6.

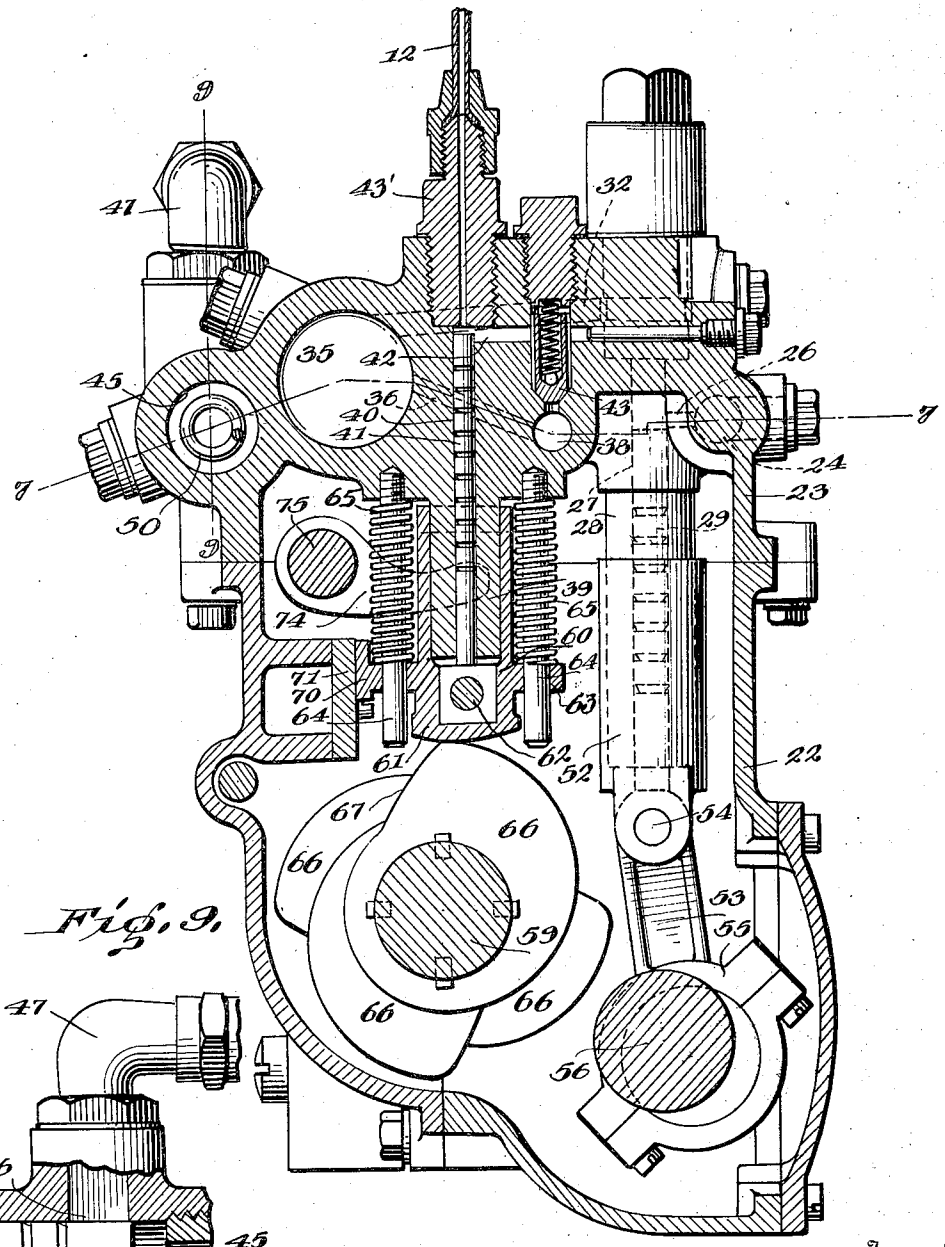


Fig. 9.

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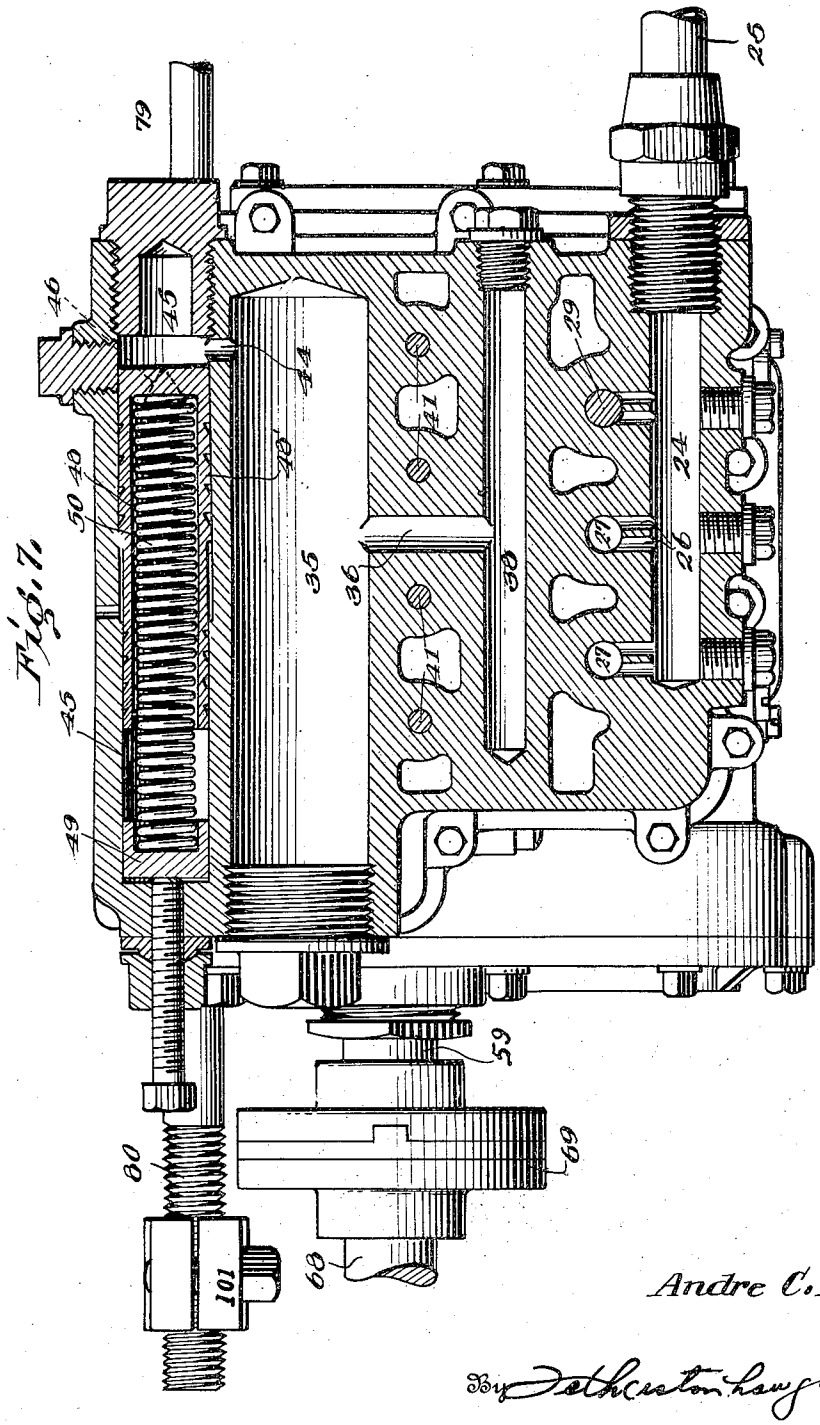


Fig. 7.

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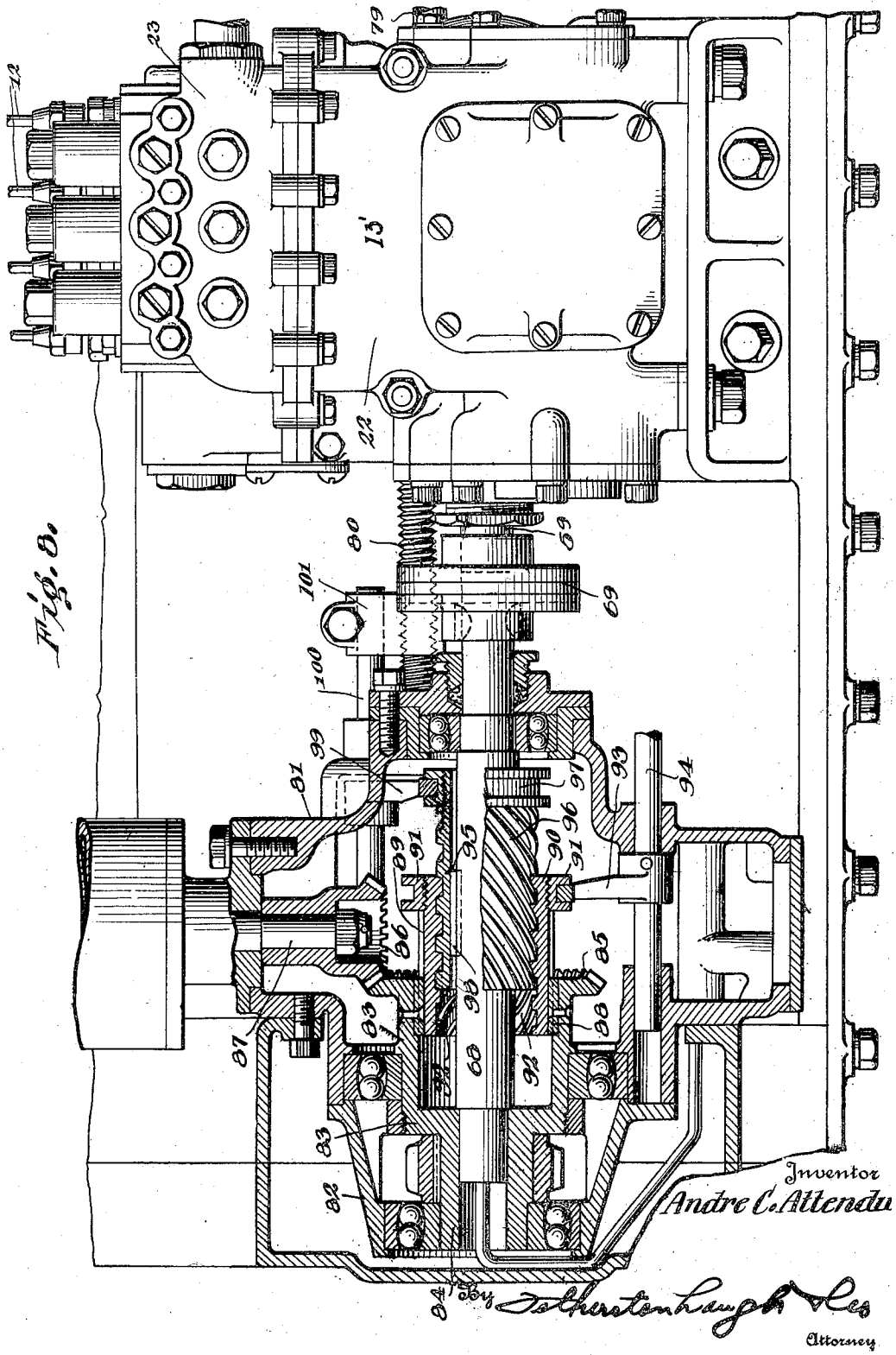
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Patented Nov. 19, 1929 1,736,242

UNITED STATES PATENT OFFICE

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FUEL PUMP

Application filed January 25, 1924. Serial No. 688,591.

This invention generically relates to internal combustion engines, more especially it is directed to a mechanism for injecting solid fuel under the requisite working pressure, into the power cylinders of those internal combustion engines, characterized by the ignition of fuel through the heat of compression.

In internal combustion engines of the high compression type, it has been the prevailing practice, to accelerate injection through the agency of compressed air. This arrangement owing to its complicated mechanical details has proved objectionable and it is therefore one of the objects of this invention to provide for the operation of the injector and the injection of a solid fuel in a single operation by increasing the pressure normally existing in the supply circuit of the pumping mechanism.

Another important object of this invention is to provide a fuel pumping mechanism including means for changing within predetermined limits the time when the injection of fuel should commence and also for determining the amount of fuel injected.

Other objects of this invention are to produce a pumping mechanism permitting independent or simultaneous variation in both the quantity of and time at which the fuel injection occurs, and finally to design a fuel pump which is accurate, devoid of complicated parts and so constructed as to permit convenient disassembly when occasion demands.

With these and other objects in view, this invention consists in certain novel details of construction, combination and arrangements of parts to be more specifically hereinafter set forth and claimed.

Briefly stated, this invention embodies a fuel supply circuit, means for developing and maintaining an approximately constant circuit pressure, means for increasing this pressure at predetermined intervals to operate the injector and effect fuel injection under the requisite pressure, and a timing device including a mechanism to independently or simultaneously vary either the amount of fuel injected or time at which such injection should commence.

Referring to the accompanying drawings, in which the corresponding parts are designated by similar reference characters:

Fig. 1 is a top plan illustrating the general assembly of engine and fuel injecting mechanism.

Fig. 2 is a sectional view partly in elevation illustrating the position of the pump with respect to the engine.

Fig. 3 is a fragmentary sectional assembly partly in elevation of the pumping mechanism and engine.

Fig. 4 is a sectional view of the fuel injecting mechanism in the plane of the pressure pumps.

Fig. 5 is a sectional view partly in elevation on the line 5—5 of Fig. 1.

Fig. 6 is a transverse sectional view partly in elevation of the fuel injecting mechanism.

Fig. 7 is a horizontal section taken on the line 7—7 of Fig. 6.

Fig. 8 is a fragmentary sectional view partly in elevation of the fuel injecting and timing mechanisms.

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 6.

In the illustrated embodiment characterizing this invention there is shown in Figs. 1 to 3, of the drawing an engine such as that described and claimed in pending application Serial No. 671,181, and which for the present purposes may be briefly outlined as a cylinder block 1, a head 2, and power and pumping cylinders 3 and 4, respectively, the head and block being suitably water jacketed for obvious reasons. Each power cylinder 3 contains a piston 5 of the usual trunk form, which is elongated and formed with its lower end 6 of enlarged diameter to provide a piston head for the pumping cylinder, making one piston function for both cylinders.

Operatively associated with respect to the pumping cylinder is an air intake 7 through which air is drawn for compression. Intermediate each pair of cylinders is a passage 8 controlled by an intake valve 9, to permit the air under compression to be transferred to adjoining working cylinders to scavenge and like-

wise establish a predetermined precompression pressure regulated through the medium of exhaust valve 10. Obvously air may be admitted at the bottom of the cylinder and allowed to escape with exhaust gases through an exhaust valve at the top of the cylinder.

To effect an injection of fuel into the power or working cylinders, head 2 is provided with injectors 11, such as that described and claimed in my co-pending application, Serial No. 688,815, and hereinafter to be referred to. Each injector is connected to one end of a supply line 12, the opposite end of which is connected to the fuel injecting means designated in its entiety as 13'. The respective injectors for the purpose of this description may be said to embody a suitable housing, in which is positioned a reciprocatory plunger 13 reduced at its lower extremity to form a needle valve 14 for cooperation with seat 15. A passageway 16, formed in the injector communicates at one end with injector line 12 and at its opposite end with an annular space 17 underlying a shoulder 18 on the lower end of plunger 13. A balancing spring 19 confined between the upper end of plunger 13 and cap 20 serves to normally maintain the valve in its seated position, the upward throw or lift of plunger 13 being regulated by a stop 21 adjustable in the aforementioned cap 20.

To facilitate further discussion of the pump, it shall be considered in the order of its components:

(A) Means for effecting fuel injection;
(B) Mechanism for varying the quantity of fuel injected; and
(C) Timing means.

Means for effecting fuel injection

To elevate the injector plunger 13 and atomize the requisite fuel into the power cylinder 3, a fuel pump 13' is provided and in the present form comprises a base 22, and a head 23 suitably bolted thereto. Within the head 22 is a fuel intake chamber 24 closed at one end and communicating with the fuel supply line 25. Intake chamber 24 communicates via passages 26 with the upper ends of plunger bores 27 formed in a trio of equispaced aligning tubular dependents 28. Within each bore 27 is a reciprocatory plunger 29 actuated in a manner hereinafter to be defined.

Plungers 29 functioning in bores 27 constitute the pressure pumps of the mechanism by which the requisite fuel supply pressure is developed and maintained.

The upper extremites of bores 27 terminate in valve chambers 30 having outlet ports 31 opening into passages 32 leading to supply reservoir 35. Check valves 34 suitably positioned in the valve chambers 30, when unseated, established communication between pump bores 27 and passages 32 via ports 31.

The fuel reservoir 35 communicates via passage 36 with distributing chamber 38.

Depending from the head immediately to the rear of the tubular extensions forming the pressure pumps are another series of similarly formed dependents 39, four in number, and likewise arranged in spaced and aligning relation. Each of the dependents 39 is formed with a bore 40 in which is reciprocally mounted a plunger 41, the lower end of which is actuated in a manner hereinafter to be described. The plungers 41 functioning in their respective bores furnish a means by which the pressure in the supply circuit is increased to elevate the valves 14 in the injectors 11 and thus effect the injection of fuel into the power cylinders. The upper ends of the pump bores 40 are in communication with the distrubuting chamber 38 via passages 42 and a suitably mounted check valve 43. A nipple 43' connects the free ends of the injector lines 12 with the bores of the respective delivery pumps as clearly shown in Fig. 6 of the drawings.

Adjacent to and communicating with fuel supply chamber 35 through port 44 is a relief valve chamber 45 having a triangular shaped outlet 46 communicating with a return pipe 47. Within this chamber 45 is an adjustable relief valve 48 consisting of a plunger 48', a longitudinally adjustable head 49, and a spring 50 interposed between the head and plunger.

To actuate the plungers 29 of the pressure pumps, a slidable sleeve 52 is telescopically positioned on each of the tubular dependents 28; the lower extremities of plungers 29 and those of the sleeves being pivoted to crank arms 53 through the wrist pin connection 54. Crank arms 53 are carried by the eccentric straps 55 which are positioned on the shaft 56 with a 120° angular displacement.

To operate shaft 56 it is provided at one end with a gear 57 driven through gear 58 keyed to shaft 59.

To operate the plungers of the delivery pumps, each of the tubular dependents 39 have their lower ends in telescopic engagement with a slidable sleeve 60, the lower end of which is formed with a tappet in the nature of the cross head 61, which is connected to plunger 41 by wrist pin 62. The crosshead 61 is formed at its opposite ends with openings 63 to receive guides 64, the upper ends of which are threaded in the under surface of the pump head 23. Springs 65 interposed between crosshead 61 and the pumphead 23 function to quickly return the plunger to its initial position.

Cams 66 keyed to shaft 59 engage the crossheads 61 to give the requisite movement of the plungers. Owing to the peculiar shape of the cams, they will impart a "smart kick" to the delivery plungers upon initial contact. Shaft 59 is connected to and driven by shaft

68 of the timing mechanism hereinafter to be referred to, through a coupling 69 as shown in Fig. 8 of the drawings.

To overcome the effect of lateral stresses on the sleeves 60 due to impact of the actuating cams 66, crosshead 61 is formed with a wear plate 70 which is slidable over the surface of complemental plate 71 laterally offset from the base of the pump, as clearly shown in Fig. 6. Each of the sleeves 60 is also formed at its upper end with projections 73 adapted to be engaged by fingers 74, carried by shaft 75 journaled longitudinally of the pump and at the rear of its base.

The function of fuel pump and injector valve

Having outlined the structure of the means for effecting fuel injection, its operation is as follows:

Descent of the plunger 29 uncovers passage 26 and fuel is drawn from the intake chamber 24 into the bore 27 of the pump.

On the ascent of the plunger the fuel unseating check valve 34 is forced through ports 31 and passage 32 into fuel reservoir 35 wherein it is confined under a predetermined pressure maintained approximately constant by the adjustable relief valve 48 in chamber 45. With this arrangement, should the normal pressure of 1500 lbs. be exceeded, the fuel acting on the plunger 48′ will cause the latter to uncover the outlet 46 communicating with return pipe 47. Owing to the triangular configuration and the disposition of the apex of outlet 46 with respect to the plunger, as the pressure of the fuel on the plunger increases, it will uncover a greatly increasing area of the outlet and thus permit an increase in the quantity of fuel escaping.

From reservoir 35, fuel passes through passage 36, into distributing chamber 38 and thence via check valve 43 and passage 42, through nipple 43′ and into injector line 12 and thence into injector passage 16 of the injector to annular space 17. The pressure of oil in the fuel reservoir and hence in the circuit, just established is approximately 1500 lbs. per square inch which is maintained constant by the relief by-pass hereinbefore mentioned. The oil when under its normal pressure of 1500 lbs. is prevented from entering the cylinder through the injector by means of balancing spring 19 retaining the injector valve in seated position. At the time of fuel injection, the fuel pressure is increased upon ascent of the plunger 41 of the delivery pump. This increase in pressure acting upon the check valve 43 effects its seating and disrupts communication between distributing chamber and that part of the supply circuit embraced by the pump bore 40 and injector line 12, so that the excess pressure developed acting upon shoulder 18 will unseat the needle valve 14 against the tension of balancing spring 19. As the plunger of the delivery pump descends on the return stroke the resultant drop in pressure permits the spring 19 to return the valve to its seat thus terminating injection. Simultaneous with this action, check valve 43 is unseated and the normal pressure of the circuit is reestablished.

From the preceding it is evident, whenever the delivery plungers are actuated and excess pressure is developed in a certain portion of the supply circuit to elevate the injector and effect an injection of fuel.

Mechanism for varying the quantity of fuel injected

It is necessary to vary the quantity of fuel injected in order to compensate for various load requirements and for this reason the fingers 74 on shaft 75 are arcuately movable and engage the projections 73 carried by the slidable sleeves 60 of the delivery pumps, to enable the sleeves to be raised or lowered. As these sleeves carry the plungers of the delivery pumps, the stroke of the plungers will be accordingly increased or diminished dependent on the exigency of the situation. To actuate the fingers, shaft 75 is formed with a segmental rack 76, meshing with an appropriately journaled worm 77, the free end of which is formed with a worm gear 78, adapted to mesh with the worm of shaft 79 journaled longitudinally of the pump and extended at both ends exteriorly of the pump casing.

One extremity of shaft 79 may be provided with an operating handle (not shown) so that it may be rocked in its bearings and through means of the instrumentalities noted the delivery pump sleeves vertically adjusted to vary the stroke of the plungers and therefore the quantity of fuel injected.

Assuming that it is desirable to merely increase the quantity of fuel injected, without changing the time fuel injection should commence, it is manifest, since the variation in the quantity of fuel injected is accomplished by lowering the sleeves, the cams actuating such sleeves, must be simultaneously reset to maintain the same relative position between cams and sleeve tappets with which they contact and thus retain the time of fuel injection constant. For this purpose the free end of the shaft 79, hereinbefore referred to is extended and externally threaded to form a follower shaft 80, which coacting with a timing mechanism 81 hereinafter referred to, rotates the previously mentioned shaft 68 journaled at one end in the timing mechanism and coupled at its opposite end to the cam shaft 59 by coupling 69, so that the shaft 59 and thereupon the cams 66 keyed thereon are rotated through an angle suitable to maintain the same relative position between the cams and the tappets which they engage at the beginning of injection strokes.

Timing mechanism

In order to vary the time at which the injection of fuel begins, without changing the quantity of fuel injected and inversely, to change the quantity, the time of injection remaining constant or altering both simultaneously, the timing mechanism 81 is provided, comprising a suitable casing 82 in which is rotatably journaled a drum 83 formed at one end with a suitably journaled tubular extension 84. The opposite end of the drum 83 is formed with a beveled gear 85 which meshes with a driving gear 86 on the shafting 87 and operates a starting and lighting unit (not shown).

Drum 83 is interiorly provided with a series of keys 88 designed to slidably engage key-ways 89, exteriorly formed on a longitudinally adjustable sleeve 90. This sleeve is provided with a collar 91 and interiorly formed with curved splines 92 for a purpose hereinafter to appear. A yoke 93 encircles collar 91, and is carried by the control rod 94, slidable in the casing 92, as shown in Fig. 8 of the drawings.

Telescopically positioned in the sleeve 90, is a longitudinally movable sleeve 95, formed externally with curved splines 96 which coact with those of sleeve 90, to effect rotation of sleeve 95, when the latter is moved longitudinally into or out of the former. Sleeve 95 is provided at its free end with a collar 97 and is keyed to shaft 68 by the keys 98 filling suitably arranged key-ways in the sleeve. The collar 97 of sleeve 95 is embraced by a yoke 99, carried by a longitudinally shiftable rod 100. One end of this rod is secured in a suitable manner to move with a follower 101, through which is threaded the follower shaft 80, hereinbefore mentioned.

Having described the structure of the timing mechanism, its operation is as follows:

As the shaft 79 is rotated through a predetermined angle and in a given direction, it will through the worm gear 78, worm shaft 77, segmental rack 76, shaft 75 and finger 74 lower the sleeve 60 of the delivery plungers 41 and in consequence increase the amount of fuel injected. At the same time the cams 66, as viewed in Fig. 6, are shifted clockwise a distance predetermined with respect to the extent to which the sleeves 60 are lowered to thereby maintain the same time of contact between said sleeves and the cams and consequently keeping the time of fuel injection constant. This simultaneous movement of the cams is obtained through the instrumentality of worm shaft 80, follower 101, rod 100, yoke 99, collar 97, sleeves 95 and 90, their interacting splines 92 and 96 and the keyways of sleeve 95 coacting with the keys 98 on the shaft 68, which, through coupling 69, is connected with cam shaft 59 of the pump. As to the operation of these elements, it will be apparent that as follower shaft 80 rotates, the follower 101 traveling thereon acts through rod 100, yoke 99 and collar 97 to move the sleeve 95 in or out of the non-rotatable sleeve 90 dependent upon the direction of rotation of shaft 80. Through this movement of sleeve 95 and the cooperation of splines 92 and 96, the sleeve 95 and consequently shaft 68 are rotated to effect the proper setting of the shaft 59 and cam lifts 66.

If, on the other hand, running conditions of the engine are such that it is merely desirable to vary the time at which injection should begin, then control rod 94 is moved longitudinally in its bearings to shift the relative position of the cams 66 with respect to the tappets 61 so as to advance or retard the time of contact between the cams and tappets, dependent upon the direction in which said rod has moved. Specifically this variation in the setting of the cams is accomplished through rod 94 in conjunction with yoke 93, collar 91 and sleeve 90. As this sleeve is moved in or out of the drum 83 it will, through cooperation of the splines 92 and 96, effect rotation of sleeve 95, it being evident that at this time sleeve 95 is held against longitudinal movement by the yoke 99. As shaft 68 is keyed to sleeve 95 it will necessarily rotate therewith and thus shift the cams as hereinbefore described.

When it is necessary to change both the time at which fuel injection should begin, as well as the quantity of fuel injected, control rod 79 is rotated to shift the tappets 61 in a manner hereinbefore stated, thus varying the stroke of delivery plungers 41. Inasmuch as varying the stroke of plungers 41 to control the quantity of fuel delivered simultaneously acts to adjust the setting of the cams as previously stated it becomes necessary to offset this automatic adjustment by operating control rod 94 so that the position of the cams with respect to the tappets 61 may be independently adjusted to give the desired timing of injection.

In conclusion, it is evident that the foregoing structure furnishes a mechanism by which the fuel supply circuit is established and maintained with a normal pressure of approximately 1500 lbs. per square inch, that varying amounts of fuel may be injected and the injector actuated by a periodical increase in the normal pressure of the supply circuit and the time of fuel injection may be readily varied to meet the engine load requirements.

What I claim as my invention is:

1. A fuel pump comprising a delivery plunger, a cam for operating said plunger in one direction, means for operating said plunger in the opposite direction, a cam shaft carrying said cam, means for regulating the stroke of the plunger and simultaneously rotating the cam shaft to change the setting of the cam in such manner as to vary the quan-

tity of fuel delivered by the plunger without changing the time of delivery, and means for rotating the cam shaft to effect an independent adjustment of the cam when it is desired to change the time of delivery for any quantity of fuel within the delivery capacity of the pump.

2. A fuel pump comprising a delivery plunger, an operating cam therefor, mechanism for varying the stroke of the plunger, mechanism for varying the angular displacement of the cam with reference to the plunger, means for operating both mechanisms simultaneously to vary the quantity of fuel delivered by the plunger without changing the time of plunger operation and means for operating the cam displacing mechanism independently to change the time of delivery for any given quantity of fuel.

3. A pump comprising a delivery plunger, an operating cam therefor, an adjustable stop for varying the suction stroke of the plunger, mechanism for varying the angular displacement of the cam with reference to said plunger and means for changing the position of said stop including provision for simultaneously operating the cam displacing mechanism whereby the quantity of fuel delivered by the plunger is varied without varying the time of delivery.

4. A pump comprising a delivery plunger, an operating cam therefor, mechanism for varying the stroke of the plunger including a longitudinally movable element, a pair of telescoping sleeves provided with interengaging curved splines adapted to produce rotation of one sleeve in response to relative longitudinal movement of the sleeves, means controlled by said element for effecting the aforesaid relative longitudinal movement of the sleeves and means controlled by the resulting turning movement of the rotary sleeve to vary the angular displacement of said cam with reference to the plunger to maintain a constant time of injection irrespective of the plunger stroke variations.

5. A pump as recited in claim 4 including provision for effecting relative longitudinal movement of said sleeves independently of said element in order to change the time of plunger operation for any given stroke of the plunger.

6. A fuel pump comprising a delivery plunger, an operating cam engageable therewith, means for adjusting the stroke of the plunger and means for advancing or retarding the time of contact between the plunger and the cam lift simultaneously with the adjustment of the plunger stroke so as to maintain the same timing of injection.

In testimony whereof I hereunto affix my signature.

ANDRÉ C. ATTENDU.