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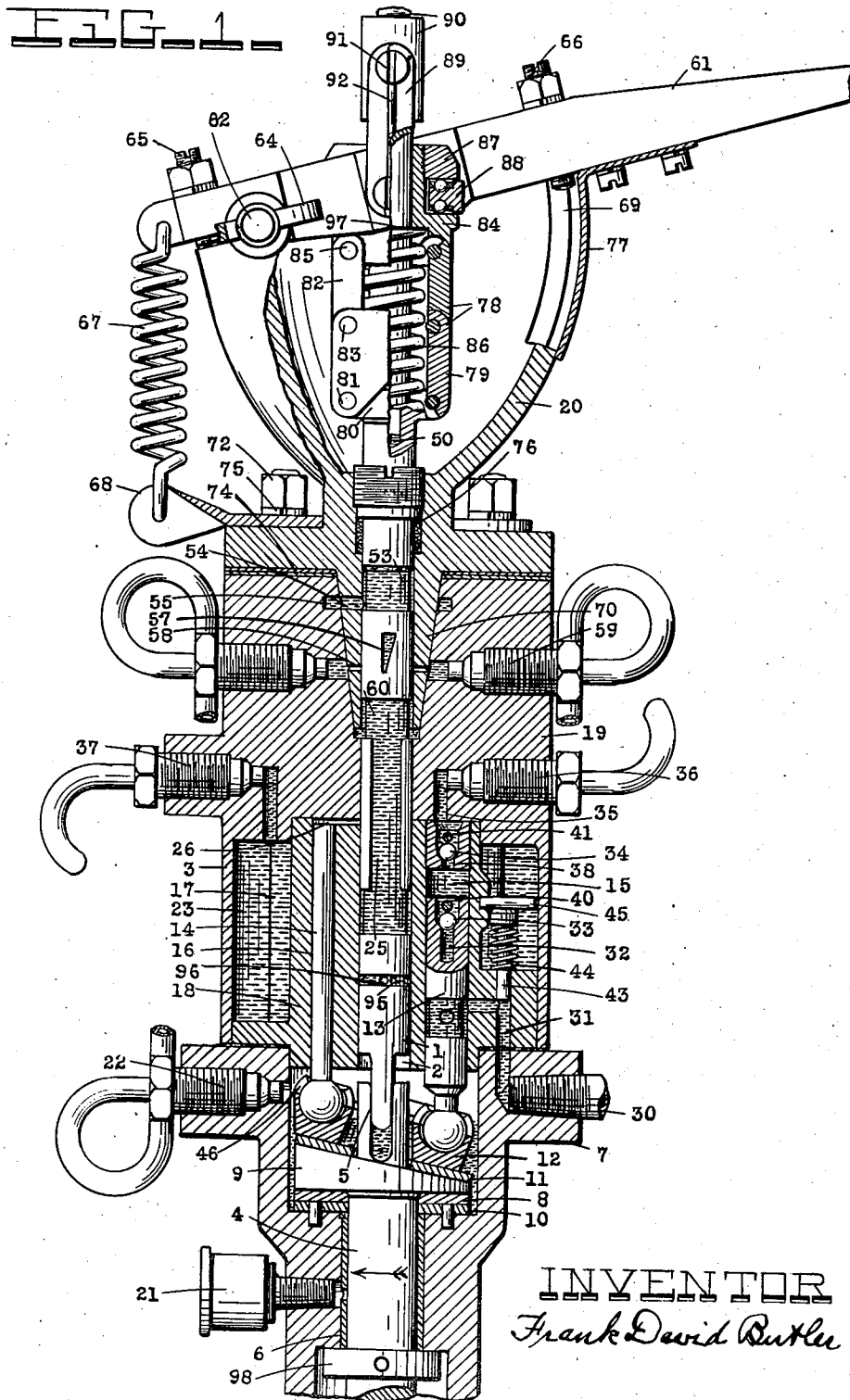
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FUEL MEASURING AND DISTRIBUTING PUMP FOR OIL ENGINES

Filed July 27, 1940

3 Sheets-Sheet 1



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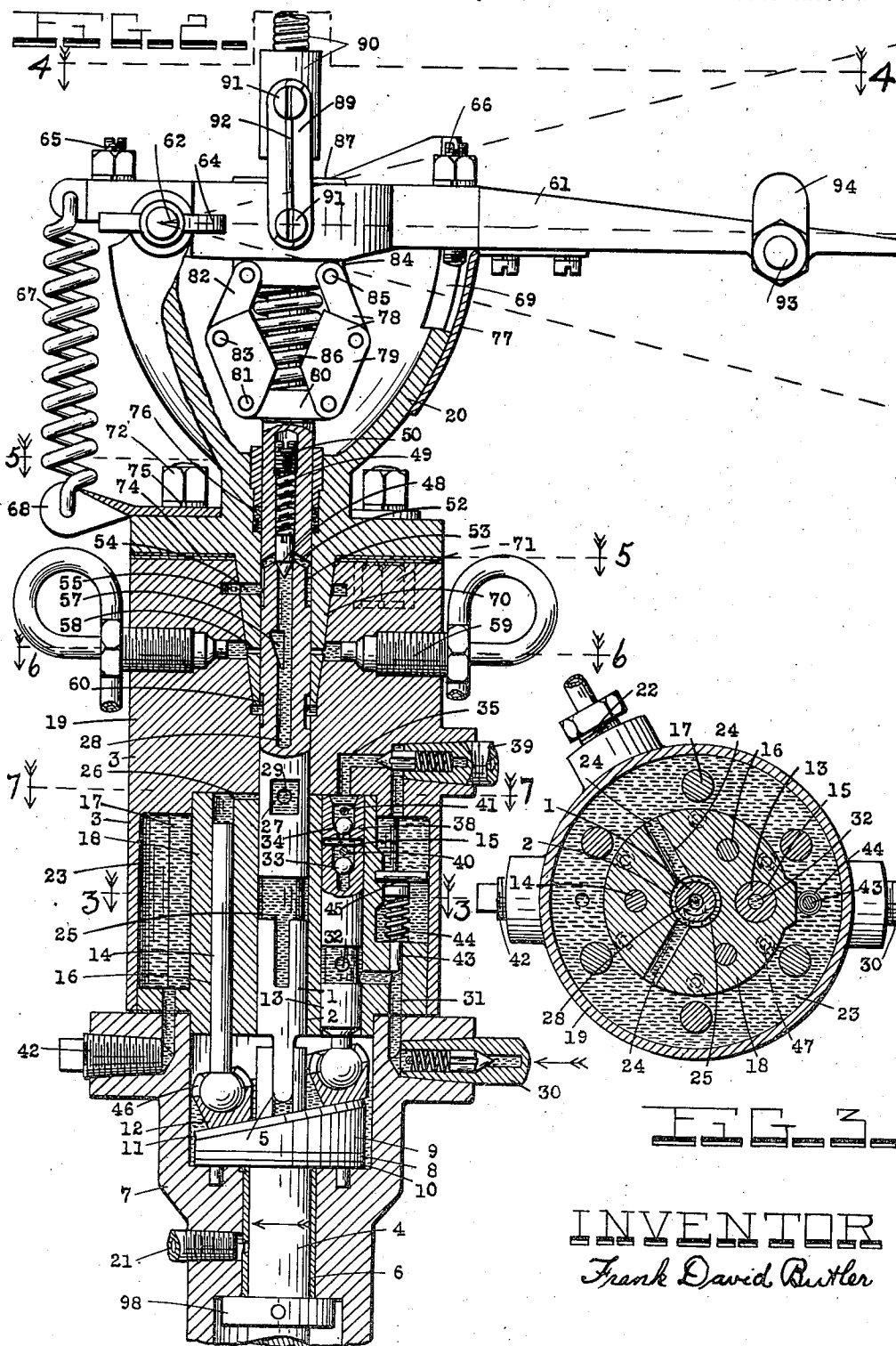
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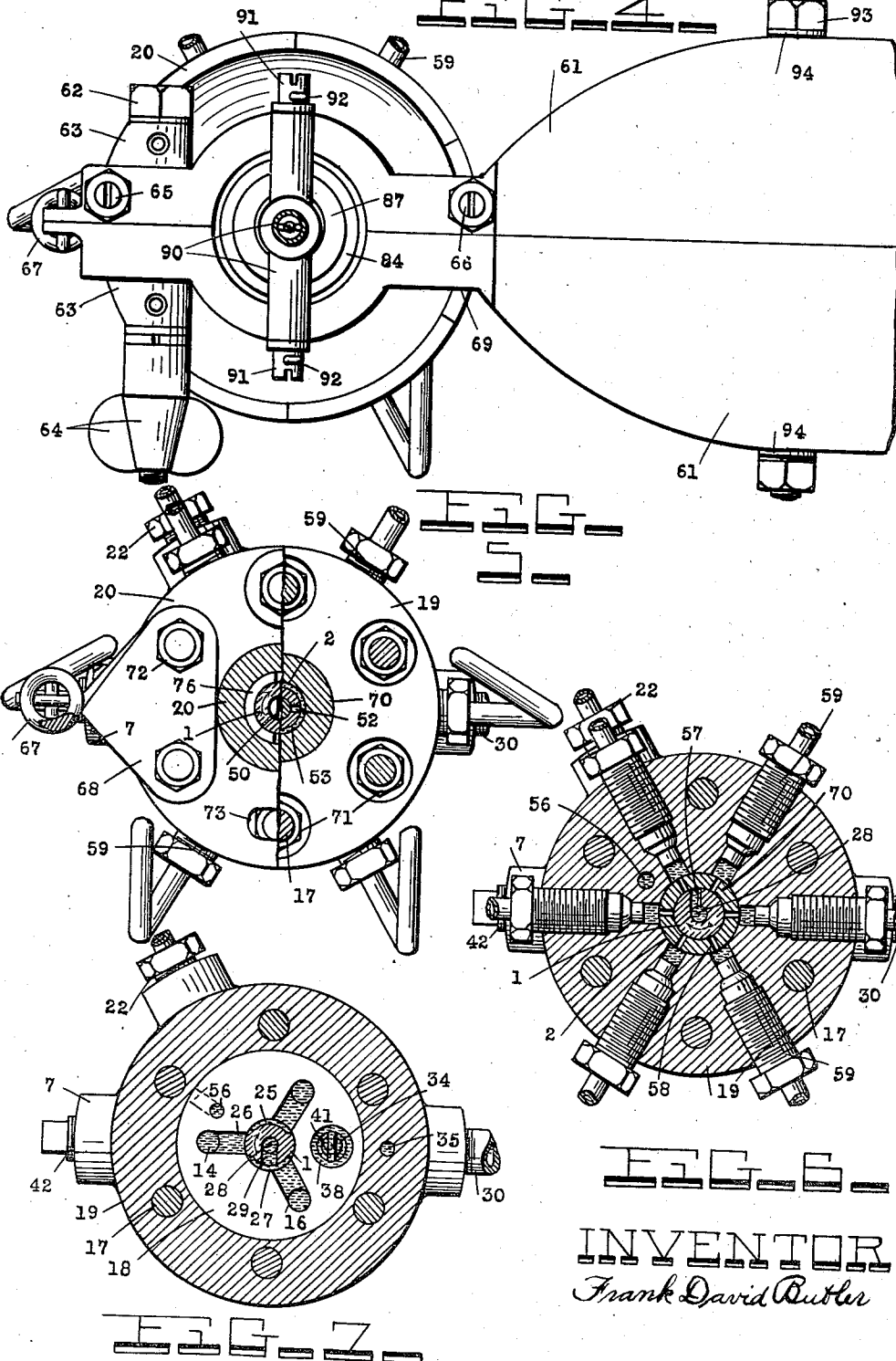
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UNITED STATES PATENT OFFICE

2,273,019

FUEL MEASURING AND DISTRIBUTING
PUMP FOR OIL ENGINES

Frank David Butler, United States Navy

Application July 27, 1940, Serial No. 347,934

6 Claims. (Cl. 123—140)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

My present invention relates to a mechanism assembly as mentioned and contemplates certain improvements in an application for similar device filed by me on June 19, 1940, Serial No. 341,501.

The specific concepts of my present invention provides, in a multiple plunger fuel delivery pump adapted to be driven from an axially operating cam and to have a concentrically located rotary liquid fuel supply and discharge valve which latter has a triangularly shaped fuel measuring and distributing port located therein and which port is adapted to intermittently form communication with a series of fuel delivery ports each having communication with one of the fuel atomizing and injecting devices of such engine, the following; a combined mechanical governor and manually controlled means for longitudinally shifting said rotary valve (having said triangularly shaped fuel distribution port therein) in relation to said fuel delivery ports for the purpose of varying the quantity of fuel delivery of said pump and for simultaneously governing the speed of such engine; an annular and conically shaped oscillatable member adapted to surround said rotary valve at the location of said triangularly shaped fuel distribution port and to contain said fuel delivery ports and being for the purpose of advancing or retarding the timing of the fuel distribution via the latter to said engine; and, various other minor improvements that will be described hereinafter.

With reference to the drawings; Fig. 1 is a longitudinal section through the assembly mechanism of my invention and illustrates the rotary fuel distribution control valve in its engine idling position of longitudinal travel; Fig. 2 is similar to Fig. 1 except illustrating the moving elements of the assembly in a different position of valve rotation and longitudinal travel and a slight variation in construction; Fig. 3 is a transverse section through the assembly on the level 3—3 of Fig. 2; Fig. 4 is a plan view on the level 4—4 of Fig. 2; Fig. 5 is a plan view partly in section on the levels 5—5 of Fig. 2; Fig. 6 is a transverse section on the level 6—6 of Fig. 2; and, Fig. 7 is a transverse section on the level 7—7 of Fig. 2.

With reference to the numerals of the drawings, the numeral 1 indicates the rotary valve member which is adapted to be a close slidable and rotatable fit within the concentric bore 2 of the fuel pump body assembly 3, and to be rotated within said bore by the combined cam and drive shaft member 4 through the slidable cou-

pling joint 5 located therebetween the upper end of the latter and the lower end thereof said valve member. The shaft 4 is adapted to be journaled in the bearing 6 which latter is secured in the housing 7, and to be connected at its lower end with a drive means (not illustrated) adapted to be operated from and in timing with the rotating elements of the oil engine to which the assembly is attached. The drive cam 9 is of the axial (non-radial) type as illustrated, is integral with the shaft 4 and rests upon the intermediate and lower thrust washers 8 and 10 respectively, has the upper thrust washer 11 inserted therebetween its upper cam surface and the lower surface of the annular and cupped shaped bearing ring 12 and is adapted to reciprocate the fuel supply pump plunger 13 and the plurality of fuel delivery pump plungers 14 vertically within their respective pump cylinders 15 and 16.

The fuel pump body assembly 3 is secured concentrically with and to the housing 7 with the plurality of elongated stud-bolts 17 and consists of three parts, the lower or fuel pump hydraulic member 18, the intermediate or fuel delivery body member 19 and the upper or oscillatable cone member 20. The fuel pump hydraulic member 18 contains all of the fuel pump plungers and cylinders arranged concentric with and parallel to valve 1 and has a flanged joint at its lower end with housing 7 and a ground joint at its upper end with body member 19. The latter in turn consists of an annular shaped lower end extension which surrounds the hydraulic member 18 and forms a joint with housing 7 adjacent member 18, a cylindrically shaped intermediate portion having a series of radially extending tapped holes therein adapted to receive suitable fuel delivery tubing connections, and a concave conically shaped upper end adapted to receive the converging conically shaped oscillatable casing member 20.

The journal of the drive shaft 4 is lubricated by the grease cup 21, while all the moving elements of the assembly within housing 7 are adapted to be lubricated with a heavy grade of lubricating oil or a light grade of grease maintained at a level in housing 7 approximately as illustrated in Figs. 1 and 2.

The cam 9, washer 11 and bearing ring 12 should all be permanently magnetized and a slight vacuum should be maintained inside of the lubricating oil well of housing 7, at the cam ends of plungers 13 and 14, through tubing connection 22 which is adapted to extend between

housing 7 and the engine inlet manifold (the latter not illustrated), both for purposes of normally retaining said plungers in a direction towards cam 9.

The fuel delivery plungers 14 are adapted (during their downward strokes) to take suction from the fuel reservoir 23 (surrounding the hydraulic member 18) via the suction passages 24 (connecting said reservoir with the bore 2) thence via the fuel suction cavity 25 (located in valve 1 and adapted to intermittently connect said passages 24 with the fuel delivery pump communication ports 26) and the ports 26 (which latter extend between bore 2 and chambers 16) into the fuel delivery pump chambers 16 thereof such plungers 14. These plungers 14 being adapted (during their upward strokes) to discharge this oil fuel in chambers 16 therefrom via said ports 26, thence the fuel discharge cavity 27 (located in valve 1 and adapted to be in communication with the fuel pressure chamber 28, internal to valve 1, via the radially extending port 29 likewise in valve 1) and into chamber 28 via port 29 as the cavity 27 intermittently forms communication with each of said ports 26.

The fuel supply pump plunger 13 is adapted (during its downward stroke) to take suction from the source of fuel supply via the fuel supply connection 30 and fuel passages 31 (the former being located in the upper portion of housing 7 and the latter being located partly in such housing and partly in the lower portion of hydraulic member 18) thence via the fuel supply passage 32 and fuel supply check-valve 33 (the former extending throughout the greater portion of the length of plunger 13 and the latter being located inside and in the vicinity of the upper end thereof said plunger) and into the fuel supply pump cylinder 15. While during the upward stroke thereof said plunger 13, this oil fuel in cylinder 15 is discharged therefrom via the fuel discharge check-valve 34 and passages 35 into the fuel reservoir 23 direct as in Fig. 2 or indirectly via the tubing connection 36 (Fig. 1) and a fuel strainer (not illustrated) and thence via the tubing connection 37 into said reservoir. The fuel supply and discharge check-valves 33 and 34 respectively can be located in the plunger 13 and discharge valve cage 38 respectively (as illustrated in Figs. 1 and 2) or can be located as illustrated to the right in Fig. 2 within the fuel supply nipple connection 30 and the fuel return discharge (to the source of fuel supply) nipple connection 39 respectively. Stop pins 40 and 41 are provided to limit the lift of valves 33 and 34 respectively. In the event that the oil fuel is to be strained before entering the fuel supply pump then the fuel connections should appear as in Fig. 2, but if such oil fuel is to be strained after it is discharged from such fuel supply pump and prior to its entrance into the fuel reservoir 23, then the fuel connections should appear as illustrated in Fig. 1. A means for draining the fuel reservoir 23 can be applied in the form of a drain plug 42 after the manner illustrated in Fig. 2. The fuel supply pump assembly is equipped with an automatically operated fuel supply cut out valve 43 having the resilient spring 44 and valve stop pin 45 (as illustrated) and being adapted to close the fuel suction passage 31 of such pump whenever the pressure on the oil fuel in reservoir 23 exceeds a predetermined limit.

As illustrated in Figs. 1 and 2, the cam ends

of the plunger 13 and plungers 14 are equipped with ball shaped journals which are adapted to fit slightly loose laterally within suitable ball-sockets located in the bearing ring 12, and to be secured in such ball-sockets by the safety plate 46 which latter is made in two semi-circular halves which are adapted to be secured to ring 12 by the screws 47 which latter are located as illustrated in Fig. 3. This safety plate 46 retains said plungers 14 and 13 in contact with ring 12 and either or both the vacuum and magnetic means mentioned may be used to retain said plungers, the bearing ring 12 and the slip ring or washer 11 all towards said cam 9.

The fuel delivery pump system is equipped with an excess pressure relief valve 48 having the resilient spring 49 and adjustment screw 50 (all located within the upper portion of valve 1 as illustrated in Figs. 1 and 2) and being adapted to relieve all excess oil fuel (above the pressure setting of such valve) from the fuel pressure chamber 28 to the fuel reservoir 23 via the diagonally extending ports 52 (in the valve 1 adjacent the valve 48), thence via the annular shaped recess 53 in valve 1, thence the radial port 54 in the casing member 20, thence via the annular shaped recess 55 in the body member 19 and thence via the passage 56 (Figs. 6 and 7 which extends between recess 55 and said reservoir 23) and into reservoir 23.

The fuel distribution port 57 is triangular in shape and extends from the fuel pressure chamber 28 internal to the rotary valve 1 through and to the outer periphery of the latter, and is adapted (during the rotation of said valve 1) to intermittently and consecutively form communication with the series of fuel delivery ports 58 arranged in the same plane and thus disposed in the walls of bore 2 and being adapted to be connected to the engine fuel atomizers (not illustrated) in the proper firing order sequence of such engine with the tubing connections 59. A plurality of pressure release grooves 53 and 60 are provided in valve 1, the former being located above and the latter below the fuel distributing port 57 and both being adapted to have communication with the fuel reservoir 23 and being in the form of fuel leak-off porting means for the purpose of preventing slight fuel leakage from around the outer edges of distributing port 57 from accumulating pressure therebetween such grooves. The leading edge of the fuel distributing port 57 (during the rotation of valve 1) should form a straight line extending parallel to valve 1 so that as the latter is elevated or depressed the timing of the fuel delivery from such distributing port 57 to the fuel delivery ports 58 will not be advanced or retarded during such operation. Likewise the following edge of port 57 (during the rotation of valve 1) should extend diagonally to the axis of valve 1 so that any vertical movement of the latter will either shorten or lengthen the period of fuel delivery between port 57 and the fuel delivery ports 58.

An engine control lever treadle 61 is provided for purposes of manually elevating or depressing the valve 1 and thus decreasing or increasing respectively the quantity of fuel delivery to the engine, and also for purposes of oscillatably rotating the conical casing member 20 having the cone 70 in relation to the valve 1 for purposes of rotatably advancing or retarding the position of the fuel delivery ports 58 in relation to the fuel distributing port 57 and thus advancing or

retarding the timing of the fuel distribution delivery periods. This treadle 61 is adapted to be pivoted at one end on the adjustment bolt 62 which latter is a press-fit therein and is a rotatable-fit within the bearing lugs 63 which latter form a part of member 20. A butterfly-nut 64 is provided for conveniently securing the treadle 61 in any position of its vertical travel. An adjustment screw 65 is provided for limiting the upward, or engine idling speed, travel of said treadle, and a similar adjustment screw 66 is provided for limiting the downward, or full fuel admission, travel of said treadle. A resilient coil spring 67 is inserted between the pivoted end of lever 61 and a metal plate 68 secured against member 20 for the purpose of retaining said lever or treadle in a direction towards its engine idling position of travel. The upper portion of casing member 20 is cupped shaped and on one side of the cup the bearing lugs 63 are provided while directly opposite thereto the slot 69 is provided, the lever 61 being adapted to fit closely between said lugs and within said slot for purposes of oscillating said casing member with said lever.

The lower set of nuts 71, of the stud-bolts 17, fit in recesses in the upper portion of member 19, while the upper set of nuts 72 are adapted to secure the casing 20 against the member 19. The casing 20 is equipped with circumferential slots 73 so that it may be oscillated in either direction of rotation an appreciable amount before striking the stud bolts 17. Suitable adjustment shims 74 and resilient lock washers 75 are provided so that the cone 70 of casing 20 can be adjusted to and maintained in close proximity to the conical surface within the upper portion of member 19 without causing binding therebetween. A stuffing box 76 is provided in casing 20 in order to prevent fuel leakage upward along valve 1. A dust guard 77, secured to treadle 61, is provided for covering the slot 69 in casing 20.

A mechanical weighted-governor 78 is provided and is adapted to govern the engine at all speeds between idling and full power, and to limit the engine speed under the latter conditions. This governor 78 is connected intermediate the control lever treadle 61 and the rotary valve member 1 and consists of the lower fly-weights 79 which are secured at their lower ends to the shoulder collar 80 of valve 1 with pins 81 and at their upper ends to the upper fly-weights 82 with the pins 83, while the weights 82 in turn are secured to the lower end of the valve shifting collar 84 with the pins 85, a governor spring 86 adapted to surround the valve 1 and to be interposed between a recess in shoulder 80 of the latter and a recess in the lower end of collar 84, an annular shaped internally threaded collar 87 adapted to be secured to the upper end of shifting collar 84 and to form together with the latter a double ball race for the ball bearing trunnion collar 88 adapted to fit therebetween, and, means not illustrated for trunnion journalling the collar 88 within the two halves of the control lever 61.

Means in the form of links 89 for securing a tachometer cable fitting 90 to the trunnion journals of collar 88 with screws 91 and locking wires 92 are provided in case a tachometer is to be operated from the pump assembly. In such case the fitting 90 is adapted to slide vertically on the valve 1 and the flexible drive member within this fitting is adapted to be rotated by the valve 1.

The two halves of the control lever treadle 61 are adapted to be secured together by both the

adjustment bolt 62 and the securing bolt 93. The latter is also adapted to secure the foot cleats 94 to the sides of treadle 61.

A recess 95 having access to the fuel pressure chamber 28 via the radially extending hole 96 in the valve 1 is provided for purposes of fuel-pressure balancing the lateral thrust on valve 1. In such balancing device, the projected area of recess 95 plus the projected area of the fuel distribution port 57 should approximately equal the projected area of the fuel discharge cavity 27 in the valve 1, and the two former should be located on the opposite side of valve 1 from the latter and at approximately an equal distance therefrom such cavity.

For purposes of adjusting the tension on the governor spring 86, adjustment shims 97 are provided and are located between the upper end of said spring and the recess in the lower end of valve shifting collar 84.

For purposes of preventing the shaft 4 from being raised vertically by vacuum within housing 7 or other means, a collar 98 secured to the shaft 4 beneath bearing 6 is provided.

In regards to the manufacture of this type of fuel delivery pump assembly, the following points should be observed: Inasmuch as the valve 1 rotates with the cam 9, the valve cavities 25 and 27 in the former have (during the rotation of valve 1 and cam 9) a fixed circumferential relation with said cam and have no direct relation to the number of suction or delivery pump plungers of the assembly; In order to maintain a non-fluctuating fuel delivery pressure, the minimum number of fuel delivery pump plungers 14 per assembly should be three; In order to allow a slight lap of valve 1 over the edges of ports 26 when the plungers 14 are at the extreme ends of their travel and simultaneously without seriously affecting or hindering such plungers in their upward travel, the ratio between the circumferential travel of valve 1 in relation to the lift of cam 9 and travel of plungers 14 should be relatively high; The number of fuel delivery plungers 14 to the number of the cylinders of the engine have no direct relation one to the other; Normally the number of the fuel delivery ports 58 should equal the number of cylinders of the engine to which the assembly is attached; In two stroke cycle engines the shaft 4 should normally rotate at engine crank-shaft speed, while in the four stroke cycle engines the rotation of shaft 4 should be at one-half crank-shaft speed; In the event that shaft 4 rotates at crank-shaft speed then the circumferential width of fuel distributing port 57 in degrees of a circle plus the similar width of one of the fuel delivery ports 58 should normally equal the period in degrees of crankshaft rotation of the duration of the fuel delivery; The amount of fuel delivered to the fuel atomizers during each fuel delivery period would normally depend upon several conditions the major ones of which are, the length of duration of such fuel delivery period, the viscosity of the oil fuel used, the delivery pressure on said fuel, the size of the restriction in the fuel delivery orifices 58 or therebeyond, and the engine compression and combustion pressures; Normally all wearing parts of the assembly should be made of some good grade of heat treated and hardened steel which should be ground to fit with close tolerances after hardening; The parts to be magnetized should be hardened or tempered prior to being magnetized so as to produce permanent magnetism; And, the character-

istics of the governor 78 should be such that with the treadle control lever 61 located in its full upward (or engine idling) position of travel and with the engine rotating at idling speed under a load, the governor weights 79 and 82 should be just starting on their outward travel, while with the treadle control lever 61 in its full downward (or engine full power) position of travel and with the engine under no load, the governor weights 79 and 82 should be out sufficiently to raise the valve 1 to a position of travel that will shorten the fuel delivery period enough to prevent the engine from exceeding a predetermined maximum number of revolutions per minute.

This method of connecting the governor 78 intermediate to the treadle control lever 61 and the rotating valve member 1, makes it possible for the former to maintain a steady engine speed at any manual setting or vertical travel location of the lever 61. For example, with the lever 61 locked by nut 64 in its mid position of travel (as illustrated in Fig. 2), then as the load would be applied to the engine and the governor 78 slowed down, the governor spring 86 would cause the weights 79 and 82 to close in towards the valve 1 and the latter would be forced downward thereby, and would thus increase the amount of fuel being distributed through distributing port 57 to the engine and would thereby restore the engine to its previous speed, and vice versa. By mounting the governor 78 on the rotary valve member 1 intermediate the shoulder 80 of the latter and the manual valve shifting control lever treadle 61, and applying the rotatably oscillatable cone valve 70 between the rotary valve member 1 and the fuel delivery tubing connections 59 and making it controllable by lever 61, makes it possible, without disturbing or moving the tubing connections 59, to form a combined manual and automatic governor control means for regulating the quantity of fuel delivered to the engine and combine it with a manual control means for advancing and retarding such fuel delivery all in a single means for completely controlling said engine.

It will be readily appreciated by those skilled in this art, that various changes may be made in the means disclosed herein which will produce the same results in substantially the same manner without digressing from my invention concept or sacrificing any of its outstanding inherent advantages.

The invention described herein may be manufactured and/or used by or for the Government of the United States of America for governmental purposes without the payment of any royalty.

Having thus set forth and disclosed the nature of this invention, what I claim and desire to secure by Letters Patent is:

1. The combination in a fuel measuring and distributing pump for an oil engine having a rotary valve member with a tapering fuel distribution port therein and manual means for longitudinally moving said valve member for purposes of varying the quantity of fuel distributed via said port, of a centrifugal spring loaded governor adapted to be applied intermediate to said rotary valve member and said manual means and to control the speed of said engine under varying load conditions at various positions of movement of said manual means.

2. The combination in a fuel measuring and distributing pump for an oil engine having a rotary valve member with a tapering fuel distributing port adapted to consecutively cooperate

with a series of fuel delivery orifices having fuel delivery tubing connections adjacent their outer ends and wherein said valve member is adapted to be moved longitudinally by manual means for purposes of varying the fuel distributed to said orifices via said fuel distributing port, of a centrifugal spring loaded governor interposed between said rotary valve member and said manual means and adapted to control the speed of said engine under varying load conditions at any position of movement of said manual means by automatically longitudinally moving said rotary valve member in relation to said orifices, and, a rotatably oscillatable member mounted between said rotary valve member and said tubing connections and containing said orifices and oscillatable by said manual means for purposes of rotatably moving said orifices in relation to said fuel distributing port, thus advancing or retarding the timing of said fuel delivery distribution without moving said tubing connections.

3. The combination in a fuel measuring and distributing pump for an oil engine having a ported rotary valve member and manual means for longitudinally moving the latter for purposes of varying the quantity of fuel distributed, of a centrifugal spring loaded governor interposed between said rotary valve member and said manual means and adapted to automatically control the speed of said engine under varying load conditions at any position of movement of said manual means and to limit the maximum speed of said engine under no load full open movement position of said manual means.

4. The combination in a fuel measuring and distributing pump for an oil engine having a hollow rotary valve member with a tapering fuel distributing port therein adapted to consecutively cooperate with the inner ends of a series of fuel delivery orifices each having a tubing connection at its outer end for fuel delivery purposes and wherein said valve member is moved longitudinally in an elongated bore by manual means for purposes of varying the period of cooperation between said fuel distributing port and each of said orifices and thus the quantity of fuel delivered depending upon the speed of rotation of said engine and said valve member, of a centrifugal spring loaded governor interposed between said rotary valve member and said manual means and adapted to control the fuel delivery to and speed of said engine under varying load conditions at any movement position of said manual means and to limit the maximum speed of said engine under no load condition full open movement position of said manual means by automatically moving said rotary valve containing said tapering fuel distributing port longitudinally in relation to said orifices and thus reducing the quantity of fuel delivery, and, a rotatably oscillatable conical shaped valve mounted between said rotary valve member and said tubing connections and containing a part of said elongated bore and all of said fuel delivery orifices and being rotatably oscillatable by said manual means for purposes of rotatably moving the location of said orifices in relation to said tapering port in said rotary valve member for the purpose of advancing or retarding the timing of said fuel delivery without having to move said tubing connections.

5. The combination in a rotary drive combined fuel pump and distributing assembly having a main body portion with a plurality of axially disposed fuel delivery pump cylinders with cam operated reciprocating pump plungers there-

in symmetrically arranged about the axis of a rotary valve member operated through a slidable coupling by said rotary drive and slidably fitting within an elongated bore in said main body portion, means for taking fuel suction with said plungers via a cavity in said rotary valve and for discharging said fuel under pressure via a recess in said valve into an elongated fuel pressure chamber within the latter, means for distributing said fuel under pressure from said pressure chamber via a tapering port in said rotary valve into a plurality of fuel delivery orifices arranged symmetrically in the walls of said elongated bore, and, a single manually controlled lever means for either simultaneously or independently moving said rotary valve longitudinally in relation to said orifices and for circumferentially rotating said bore in relation to said tapering port, of a flanged housing attached to said manually controlled lever and rotatably secured to said main body portion and having a tapering projecting valve surface containing said fuel delivery orifices and coinciding with a tapering recess located in said body portion, a prolongation of said elongated bore extending concentric with said projecting valve surface through said flanged housing and containing said fuel delivery orifices in the walls thereof, means for equalizing lateral fuel pressure thrust on said rotary valve within said elongated bore, and, a centrifugal spring loaded governor secured at one end to said manually controlled lever means and at its opposite end to said rotary valve and adapted to rotate with the latter and to automatically control (in conjunction with said manually controlled lever means) the longitudinal movement of said rotary valve during its rotation.

6. The combination in a rotary drive combined fuel pump and distributing assembly having a main body portion with a plurality of axially disposed fuel delivery pump cylinders with cam operated pump plungers therein symmetrically arranged about the axis of a rotary valve member

operated through a slidable coupling by said rotary drive and slidably fitting within an elongated bore partly within said main body portion, means for taking fuel suction through displacement of said plungers and via a cavity in said rotary valve and for discharging said fuel under pressure via a recess in said valve into an elongated fuel pressure chamber located within the latter, means for distributing said fuel under pressure from said pressure chamber via a tapering port in said rotary valve into a plurality of fuel delivery orifices arranged symmetrically in the walls of a portion of said elongated bore, and, a manually controlled lever means for moving said rotary valve longitudinally within said bore in relation to said orifices, of a flanged housing attached to said manually controlled lever and rotatably secured to said main body portion and having a tapering projecting valve surface coinciding with a tapering recess located in said main body portion, a prolongation of said elongated bore extending concentric with said projecting valve surface through said flanged housing and containing said fuel delivery orifices originating in the walls thereof and terminating in said valve surface, means in the form of said lever means for either simultaneously or independently moving said rotary valve longitudinally in said bore in relation to said orifices and circumferentially rotating said flanged housing in relation to said tapering port, a centrifugal governor secured at one end to said manually controlled lever means and at its opposite end to said rotary valve and adapted to rotate with the latter and to automatically control (in conjunction with said manually controlled lever means) the longitudinal movement of said rotary valve during its rotation, means for securing said manually controlled lever in various longitudinal valve movement positions, and, means for securing said flanged housing in various rotatable movement positions.

FRANK DAVID BUTLER.