

March 5, 1946.

N. FODOR

2,395,964

FUEL PUMP

Filed Nov. 19, 1942

3 Sheets-Sheet 1

Fig. 2.

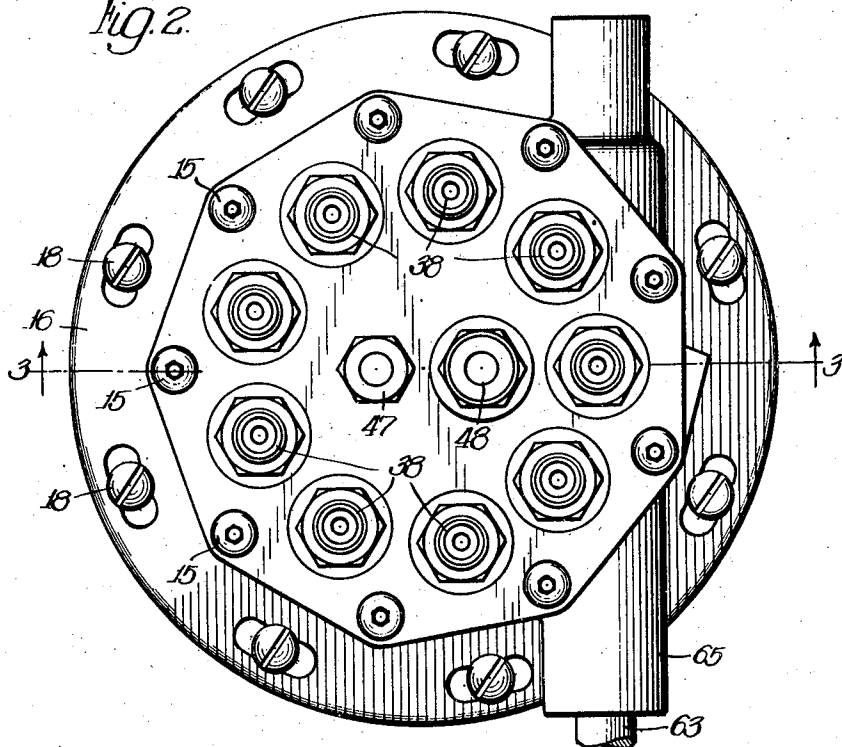
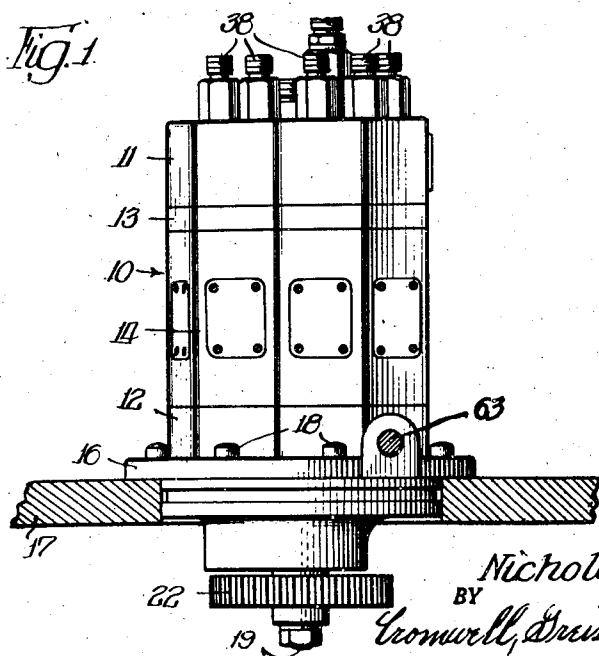


Fig. 1.



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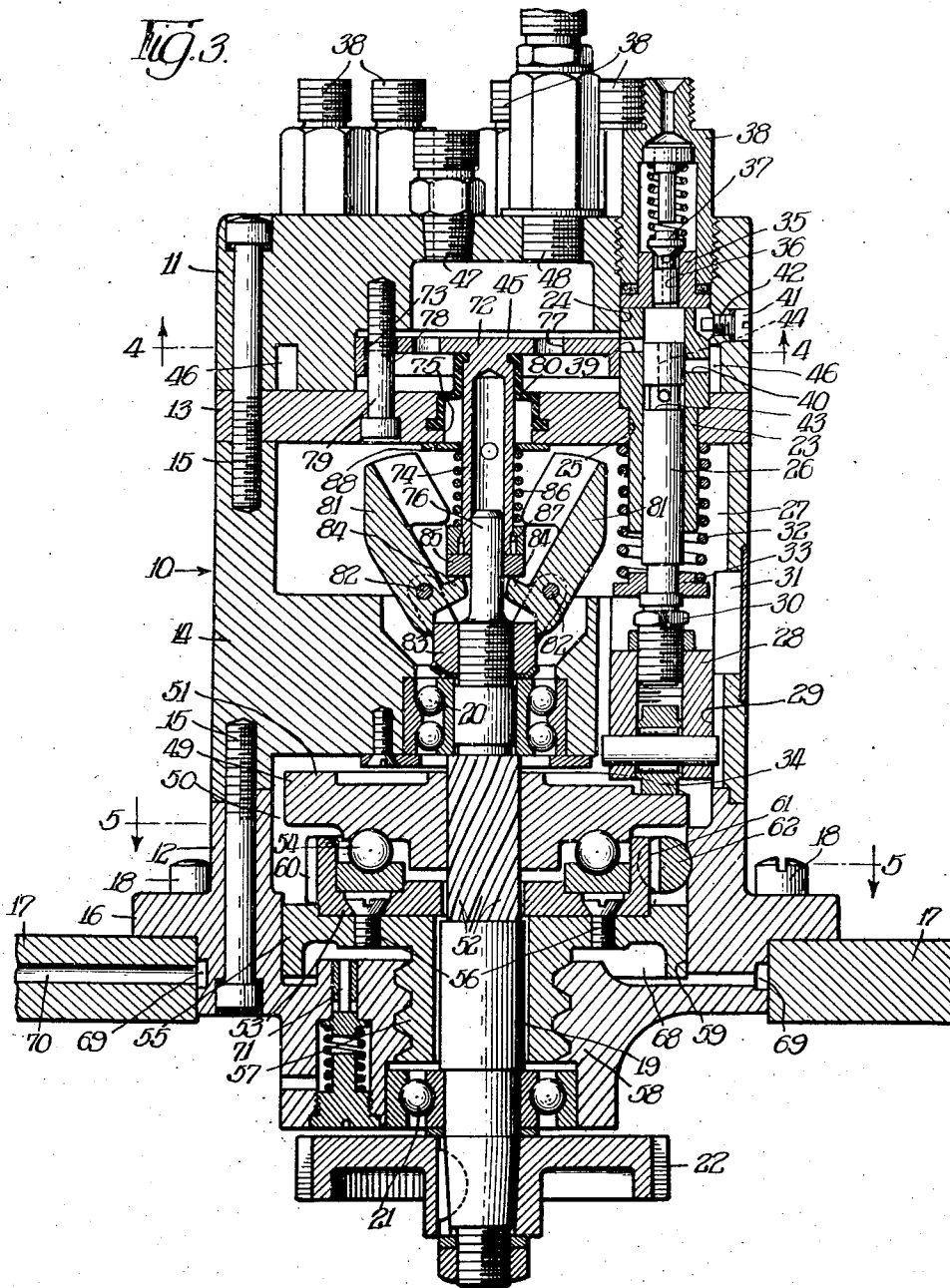
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3 Sheets-Sheet 2



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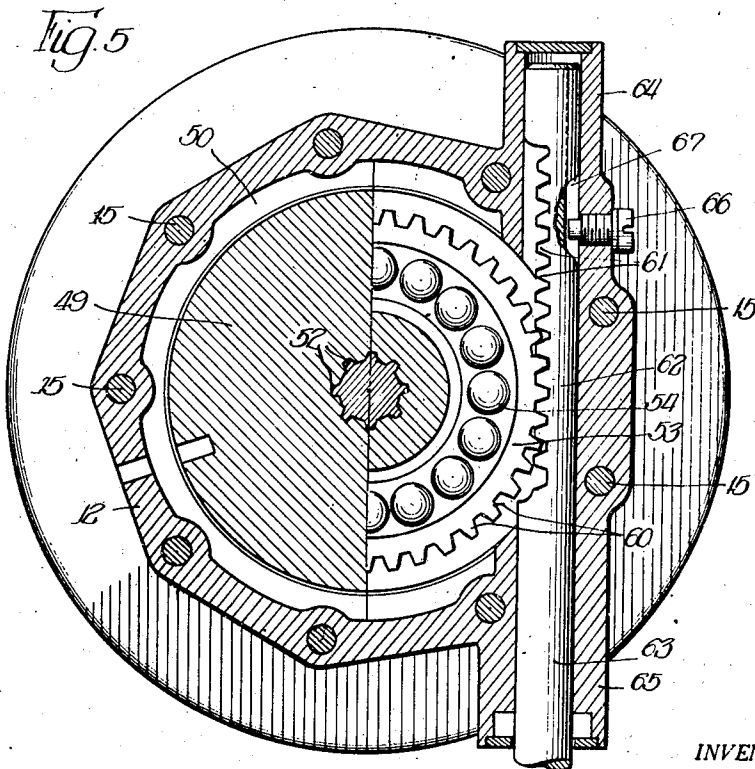
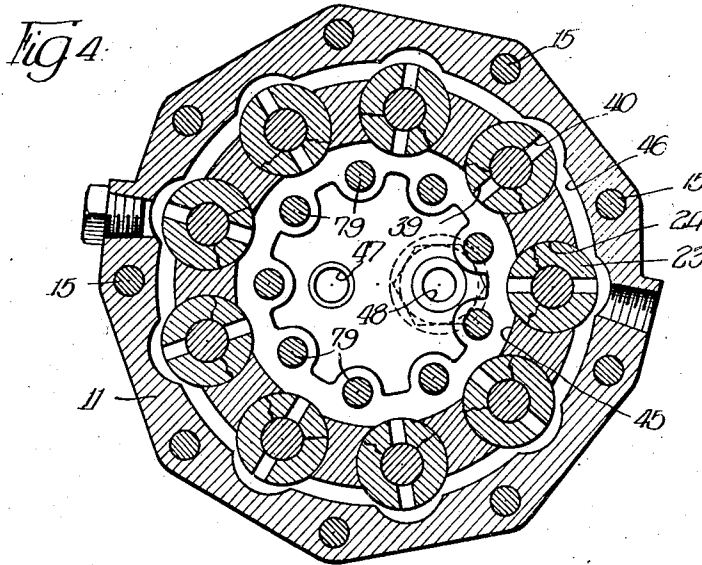
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,395,964

FUEL PUMP

Nicholas Fodor, Wilmette, Ill.

Application November 19, 1942, Serial No. 466,093

5 Claims. (Cl. 123-139)

This invention has to do with fuel pumps for use with multi-cylinder engines, and is particularly concerned with fuel pumps of the type adapted to deliver Diesel fuel under high pressure to the injectors in the cylinders of Diesel engines.

The principal object of the invention is to provide an improved pumping unit of the type described in which the charges of fuel delivered by the unit may be easily and accurately controlled.

While the foregoing statement is indicative in a general way of the nature of the invention, other more specific objects and advantages will be apparent to those skilled in the art upon a full understanding of the construction, arrangement and operation of the improved pumping unit.

One embodiment of the invention is presented herein for the purpose of exemplification, but it will of course be appreciated that the invention may be incorporated in other structurally modified forms coming equally within the spirit of the invention and the scope of the appended claims.

In the accompanying drawings:

Fig. 1 is a reduced side view of the new pumping unit;

Fig. 2 is a plan view of the same;

Fig. 3 is a vertical diametric section through the unit, taken on the line 3-3 of Fig. 2;

Fig. 4 is a horizontal section, taken on the line 4-4 of Fig. 3; and

Fig. 5 is another horizontal section, taken on the line 5-5 of Fig. 3.

The pump unit includes an upright housing 10 of generally cylindrical form which is composed of top, bottom and intermediate sections 11, 12, 13 and 14. The several sections are fastened rigidly together by screws 15, and the bottom section 12 is provided with a mounting flange 16 which is adapted to be secured to a portion 17 of the crank case of the associated engine by screws 18. A shaft 19 is journaled in the housing 10, coaxially of the latter, in upper and lower bearings 20 and 21, and a drive gear 22 is attached to the lower end of the shaft 19 at a point adjacent the bottom of the housing.

A plurality of barrels 23 (one for each of the cylinders of the multi-cylinder engine with which the unit is to be used) are seated in axially aligned bores 24 and 25 formed in the top and upper intermediate sections 11 and 13 of the housing 10. The barrels 23 are arranged in a circle about the shaft 19, in equally spaced relation to each other, with their axes parallel to that of the shaft. The barrels 23 contain closely fitting pumping plungers 26. The lower ends of the plungers 26 project from the lower ends of the barrels 23 into a relatively large cavity 27 formed in the upper portion of the lower intermediate section 14. The lower ends of the plungers 26 engage with cam followers

28 which are vertically slidable in guideways 29 formed in the section 14. The cam followers 28 are provided with screw tappets 30 to which access may be had for adjustment through suitably covered side openings 31 in the section 14. The plungers 26 are provided with return springs 32 which are compressed between the under surface of the section 13 and thrust washers 33 on the lower headed ends of the plungers. The cam followers 28 are provided at their lower ends with anti-friction rollers 34.

The barrels 23 are closed off at their upper ends by circular valve plates 35 which contain discharge ports 36, and the discharge ports 36 are normally closed by downwardly spring-pressed valves 37 which are located within coupling members 38. The coupling members 38 are adapted to be connected by suitable piping (not shown) with the usual injectors in the cylinders of the associated engine. The barrels 23, with their associated valve plates 35, are clamped together and held in position by the coupling members 38, which members are screwed into the top 11 of the housing. The barrels 23 are provided on the sides thereof toward the center of the housing with inlet ports 39, and are provided on the sides thereof away from the center of the housing with spill ports 40. Set screws 41 project laterally from the top section 11 into slots 42 in the outer sides of the barrels 23, whereby to position the barrels with the ports 39 facing inwardly and the ports 40 facing outwardly. The plungers 26 are provided adjacent their upper ends with annular grooves 43, which grooves communicate in a well known manner with the spaces above the tops of the plungers through passages 44. The inlet ports 39 on the inner sides of the barrels 23 all communicate with a centrally located fuel chamber 45 formed in the underside of the top section, while the spill ports 40 in the outer sides of the barrels all communicate with an annular passage 46 in the outer portion of the section 11. The fuel which is to be pumped enters the chamber 45 through an inlet 47. A relief valve 48 also communicates with the chamber 45.

A circular cam 49 is located within the lower portion of the housing, within a cavity 50 formed in the bottom section 12. The cam 49 is arranged concentrically with respect to the shaft 19 and is connected for rotation with the latter by means which will later be described. The cam 49 is provided with an upwardly facing circular cam surface 51, which surface underlies all of the cam followers 28 and engages with the anti-friction rollers 34 of the cam followers.

The dwell of the circular cam surface 51 extends almost entirely about the circumference of such surface, with the result that all of the inlet ports 39, with the exception of preferably not more than one, are shut off at any given instant

by the sides of the upper ends of the raised plungers 26. In Fig. 3 the particular plunger 26 which is shown in vertical section is the only one which is not raised. As will be observed in that view the inlet port 39 has just been uncovered by the side of the upper end of the plunger and the cam follower roller 34 has just left the dwell of the cam surface 51 and is about to start up again on the lift leading to the dwell. Since the charges of fuel can enter the barrels 23 only during the very short period of time in which the cam follower rollers 34 are out of engagement with the dwell, and since the maximum rate of flow through the small inlet ports 39 is more or less determined by the size of such ports, any tendency of the engine to speed up, for example, from the particular speed for which the engine has been manually set will be effectively counteracted by the decreased amount of fuel getting through the inlet ports 39 during the shortened time period in which such ports are uncovered, and vice versa with respect to any tendency of the engine to slow down, with the result that the speed of rotation of the engine will tend to remain constant for any particular setting.

The cam 49 instead of being fixedly keyed to the shaft 19, is connected with the latter through a number of helical splines 52. The helical shape of the splines 52 acts to alter the angular position of the cam with respect to the shaft when the cam is either raised or lowered—any raising of the cam from the position shown in Fig. 3 serving both to cut down the amount of fuel being pumped to the injectors and to retard the time at which the decreased amount of fuel is pumped.

The cam 49 is supported for rotation on a stationary backing plate 53, through an interposed thrust bearing 54. The plate 53 is secured to the upper surface of a piston-like member 55 by screws 56. The member 55 is provided with a downwardly extending tubular portion 57 which is exteriorly threaded for screw-threaded engagement with a correspondingly threaded portion 58 of the bottom section 12. The periphery of the member 55 is arranged in closely fitting but vertically slidable engagement with the wall 59 of the cavity 50 and functions as a piston. The backing plate 53 is provided about its periphery with teeth 60, which teeth at one side of the plate mesh with teeth 61 on a horizontally shiftable rack 62. The rack 62 is formed on a rod 63 which is supported in apertured bosses 64 and 65 projecting from the bottom section 12. A set screw 66 extends from the boss 64 into a slot 67 in the back of the rack 62, whereby to position the rack properly with respect to the backing plate 53.

To facilitate the raising of the backing plate 53 against the substantial pressure opposed to the same, the space 68 in the cavity 50 beneath the member 55 may be filled with oil under pressure from the engine—the oil entering the space 68 from an annular duct 69 which communicates at one point with a duct 70 formed in the adjacent portion 17 of the crank case. The pressure of this oil acts to counterbalance to a considerable extent the load on the backing plate 53, thus permitting the backing plate to be screwed upwardly by the rack 62 with but little resistance. A relief valve 71 may be provided in the bottom section 12 for the oil confined within the space 68.

As previously stated, the fuel which is pumped from the barrels 23 to the several injectors by

the reciprocating movement of the plungers 26 enters the barrels from the chamber 45 by way of the inlet ports 39. The flow of the fuel through the ports 39 is progressively cut down above a predetermined maximum speed of the engine by a slide valve 72 in the chamber 45. The valve 72 is of generally circular form and is characterized by a peripheral skirt portion 73 which fits against the inwardly facing sides of the barrels 23 in more or less overlapped relation to the ports 39. When the speed of the engine exceeds a predetermined maximum the valve 72 will move into its uppermost position. In the uppermost position (which position is the one shown in Fig. 3) the skirt portion 73 of the valve acts to cut off practically all flow of the fuel through the ports 39. Downward movement of the valve 72 from its uppermost position acts to progressively increase the effective size of the ports 39 and permit of an increased rate of flow through the same.

The valve 72 is provided at its center with a tubular stem portion 74 which extends downwardly through an aperture 75 in the upper intermediate section 13 of the housing into sleeved association with the reduced upper end 76 of the shaft 19 in vertically slidable and freely rotatable association with the latter. The valve 72 is apertured at 77 for equalization of pressure above and below the same, and is apertured at 78 for the passage of screws 79 employed to clamp the upper intermediate section 13 of the housing to the top section 11. A flexible diaphragm 80 of synthetic rubber or other suitable material is connected at its upper end to the valve 72 and at its lower end to the section 13 for sealing off the compartment 45 at the location of the aperture 75.

The valve 72 is automatically regulated by a pair of centrifugally operated governor weights 81 which are located in the cavity 27 in the lower intermediate section 14. The weights 81 are pivotally attached at 82 to opposite sides of a bracket 83 carried by the shaft 19, and are provided with cam fingers 84 which extend inwardly into engagement with the underside of a bearing washer 85 attached to the lower end of the tubular stem portion 74 of the valve 72. When the speed of rotation of the shaft 19 starts to exceed a predetermined maximum the weights 81 will move outwardly, raising the valve 72 and progressively restricting the flow of fuel through the ports 39. This upward movement of the valve 72 is opposed by the action of a coil spring 86 which is compressed between a washer 87 overlying the bearing washer 85 and a washer 88 positioned against the underside of the upper intermediate section 13. The speed at which the valve 72 will come into action can be varied by selecting a coil spring which will present the desired amount of resistance to compression.

The improved pumping unit, while especially designed for use with a radial engine, can of course be employed with engines in which the cylinders are not arranged radially.

The operation of the above described pumping unit is in brief as follows: The fuel enters the chamber 45 through the inlet 47 and flows from the chamber 45 into the barrels 23 through the partially restricted inlet ports 39. The fuel is then pumped by the plungers 26 under higher pressure from the barrels 23 through the discharge ports 36, with the fuel in excess of the quantity required in each charge escaping from the barrels through the spill ports 40 by way of

the grooves 43 and returning to the supply. The lowermost position of the plungers 26 (which position determines the quantity of fuel pumped before the groove 43 in the plunger starts by-passing the excess fuel through the spill port 40) is varied uniformly and simultaneously for all of the plungers by shifting the rack 62 to either raise or lower the backing plate 53. Raising of this plate reduces the quantity of fuel pumped by each of the plungers, while lowering it increases the quantity pumped. The helical spline connection 52 between the cam 49 and the shaft 19, by changing the angular position of the cam relative to the shaft, retards the time of pumping when the quantity pumped is decreased and advances the time when the quantity is increased. The hydraulic counterbalance for the backing plate, obtained by admitting oil under pressure to the underside of the piston-like support 55 for the backing plate, permits the cam 49 to be raised or lowered with but little effort. The centrifugally operated weights 81, by determining the position of the slide valve 72 in conformity with a predetermined maximum speed of the engine, prevents the speed from becoming excessive.

I claim:

1. In a fuel pump for multi-cylinder engines, a shaft, means for rotating the shaft, a circular cam associated with the shaft for rotation with the latter, a plurality of barrels arranged in a circle about the shaft in front of the cam, plungers in the barrels operatively associated with the cam, fuel inlets and outlets for the barrels, said plungers operating with strokes of fixed length to pump fuel received from the inlets into the outlets in amounts which vary according to the positions of the plungers relative to the barrels when the plungers are at the lower ends of their strokes, a stationary thrust plate in back of the cam, means for raising or lowering the plate, whereby to vary the position of the cam and change the amount of fuel pumped from each barrel, and means for automatically modifying the angular position of the cam with respect to the shaft when the plate is raised or lowered, whereby to alter the time when the fuel is pumped from each barrel.

2. In a fuel pump for multi-cylinder engines, a shaft, means for rotating the shaft, a circular cam associated with the shaft for rotation with the latter, a plurality of barrels arranged in a circle about the shaft in front of the cam, plungers in the barrels operatively associated with the cam, fuel inlets and outlets for the barrels, said plungers operating with strokes of fixed length to pump fuel received from the inlets into the outlets in amounts which vary according to the positions of the plungers relative to the barrels when the plungers are at the lower ends of their strokes, a stationary thrust plate in back of the cam, means for raising or lowering the plate, whereby to vary the position of the cam and change the amount of fuel pumped from each barrel, and means controlled by the speed of rotation of the shaft for automatically metering the fuel entering the barrels through the inlets.

3. In a fuel pump for multi-cylinder engines, a shaft, means for rotating the shaft, a circular cam associated with the shaft for rotation with the latter, a plurality of barrels arranged in a circle about the shaft in front of the cam, plungers in the barrels operatively associated with the

cam, fuel inlets and outlets for the barrels, said plungers operating with strokes of fixed length to pump fuel received from the inlets into the outlets in amounts which vary according to the positions of the plungers relative to the barrels when the plungers are at the lower ends of their strokes, a stationary thrust plate in back of the cam, means for raising or lowering the plate, whereby to vary the position of the cam and the area of the inlet ports uncovered by the plungers, and thereby change the amount of fuel pumped from each barrel, and means controlled by the speed of rotation of the shaft for automatically metering the fuel entering the barrels through the inlets, said means consisting of a dwell on the cam which extends about the greater part of the circumference of the latter, whereby to allow the plungers to uncover their associated inlets for but a relatively short period of time during each revolution of the cam, thus reducing the amount of fuel passing through the inlets upon an increase in the speed of rotation.

4. In a fuel pump for multi-cylinder engines, a shaft, means for rotating the shaft, a circular cam associated with the shaft for rotation with the latter, a plurality of barrels arranged in a circle about the shaft in front of the cam, plungers in the barrels operatively associated with the cam, fuel inlets and outlets for the barrels, said plungers operating with strokes of fixed length to pump fuel received from the inlets into the outlets in amounts which vary according to the positions of the plungers relative to the barrels when the plungers are at the lower ends of their strokes, a stationary thrust plate in back of the cam, means for raising or lowering the plate, whereby to vary the position of the cam and change the amount of fuel pumped from each barrel, and means for automatically modifying the angular position of the cam with respect to the shaft when the plate is raised or lowered, whereby to alter the time when the fuel is pumped from said barrel, said last mentioned means consisting of a helical spline connection between the cam and the shaft.

5. In a fuel pump for multi-cylinder engines, a shaft, means for rotating the shaft, a circular cam associated with the shaft for rotation with the latter, a plurality of barrels arranged in a circle about the shaft in front of the cam, plungers in the barrels operatively associated with the cam, fuel inlets and outlets for the barrels, said plungers operating with strokes of fixed length to pump fuel received from the inlets into the outlets in amounts which vary according to the positions of the plungers relative to the barrels when the plungers are at the lower ends of their strokes, a stationary thrust plate in back of the cam, means for raising or lowering the plate, whereby to vary the position of the cam and change the amount of fuel pumped from each barrel, and means controlled by the speed of rotation of the shaft for cutting down the rate of flow of the fuel entering the barrels through the inlets when the speed of rotation exceeds a predetermined amount, said last mentioned means comprising a centrally arranged slide valve having portions thereof arranged in overlapped relation to the inlets for the barrels, and a centrifugal governor for actuating the slide valve to increase the extend of overlap when the speed becomes excessive.

NICHOLAS FODOR.

Certificate of Correction

Patent No. 2,395,964.

March 5, 1946.

NICHOLAS FODOR

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 71, for "higher" read *high*; page 3, second column, line 43, claim 4, for "said barrel" read *each barrel*; line 71, claim 5, for "extend" read *extent*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of May, A. D. 1946.

[SEAL]

LESLIE FRAZER,

First Assistant Commissioner of Patents.