Oct. 1, 1946. C. N. GUERASIMOFF 2,408,394

DIESEL ENGINE AND METHOD OF OPERATING SAME

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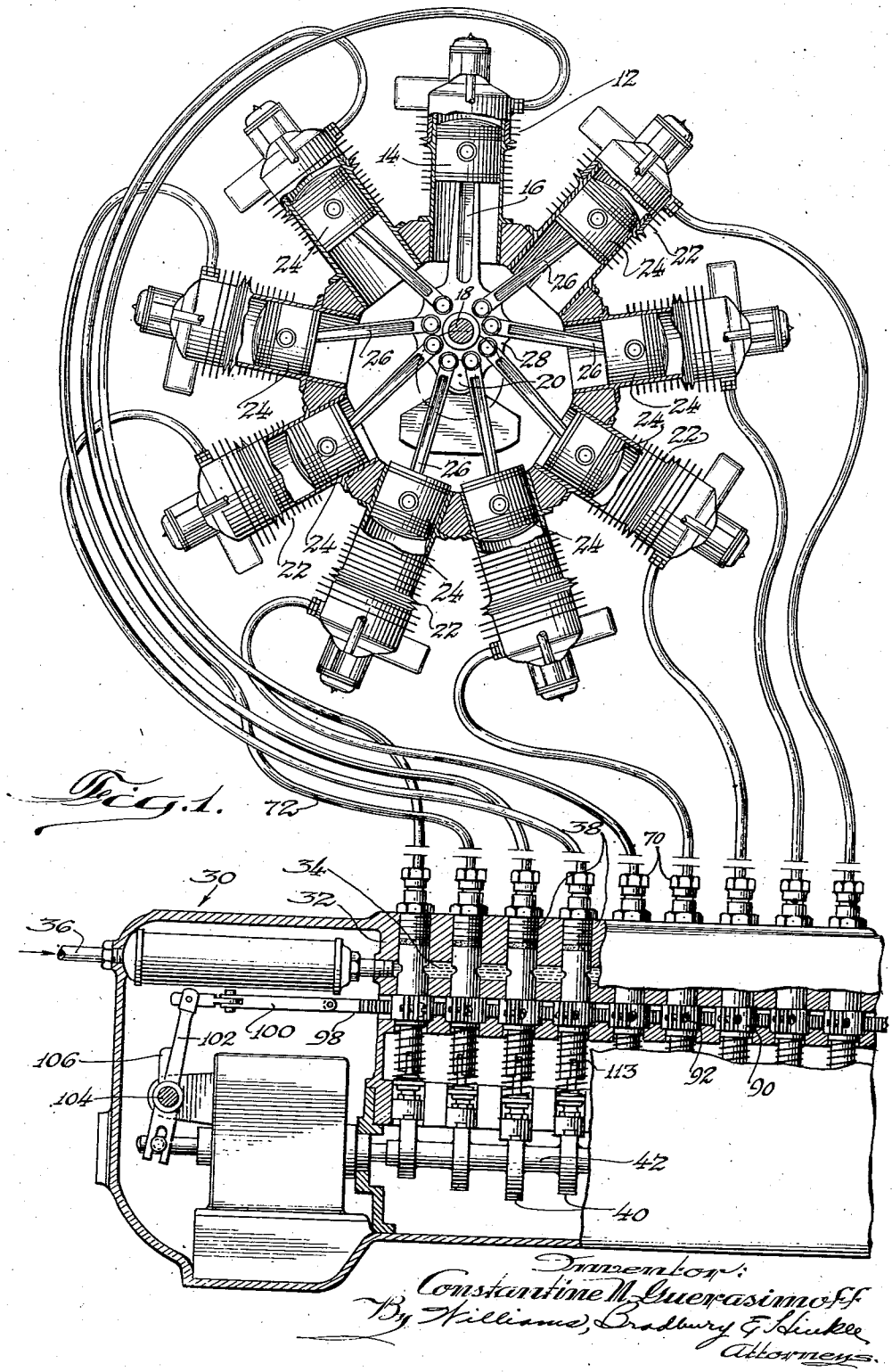


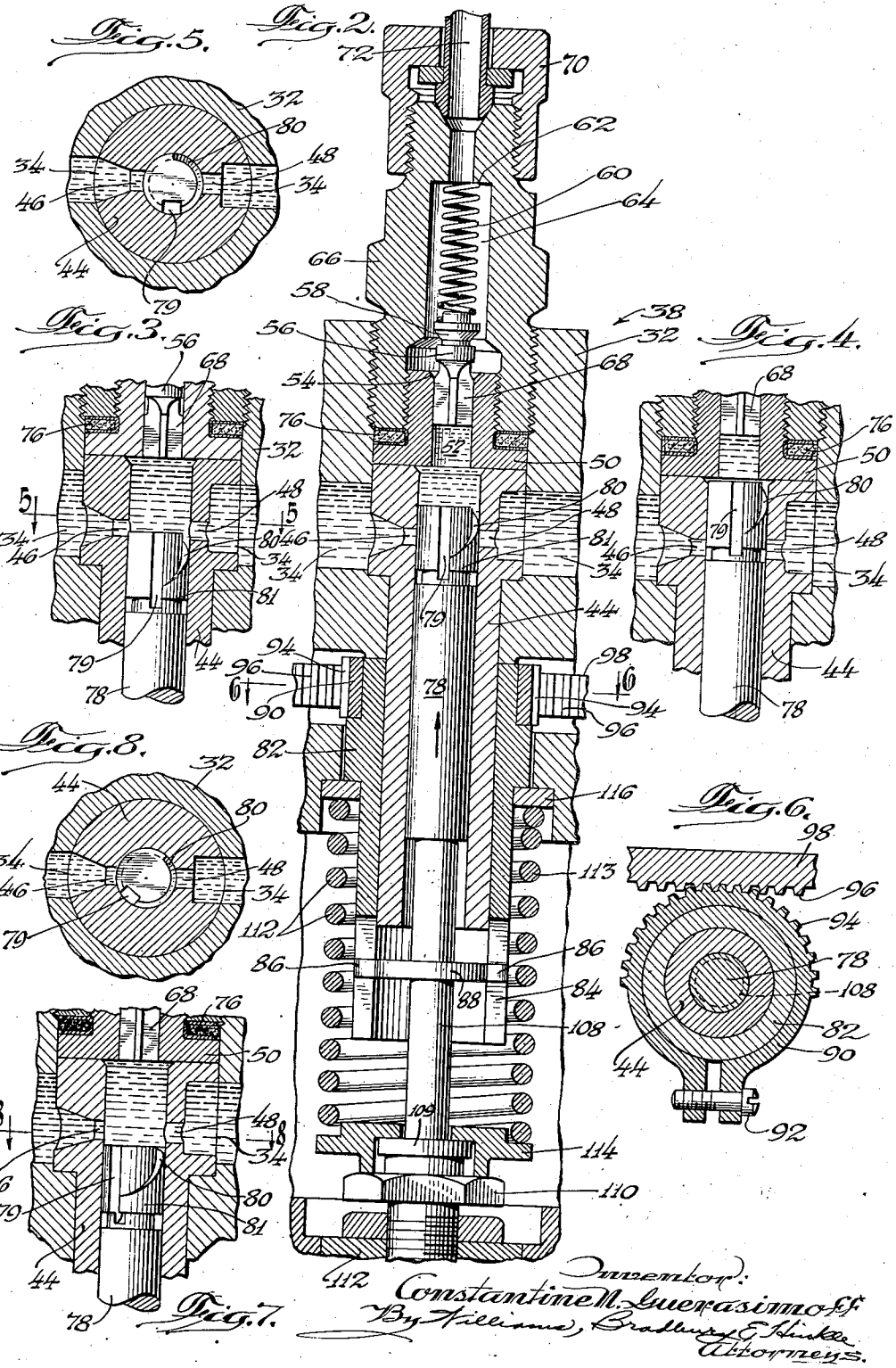

Fig. 1.

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Fig. 9.

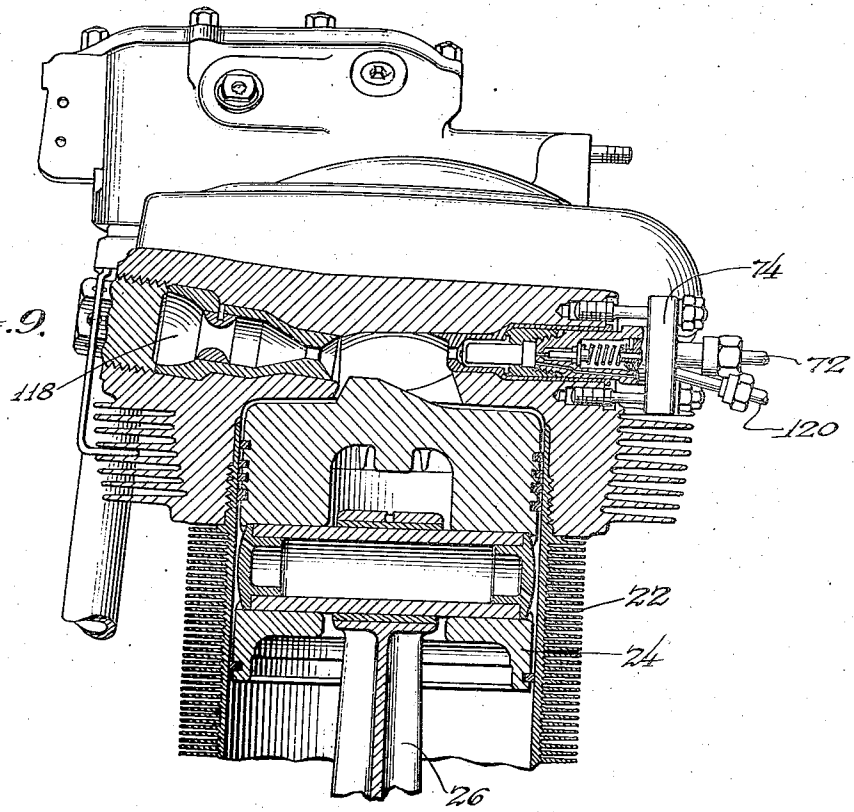
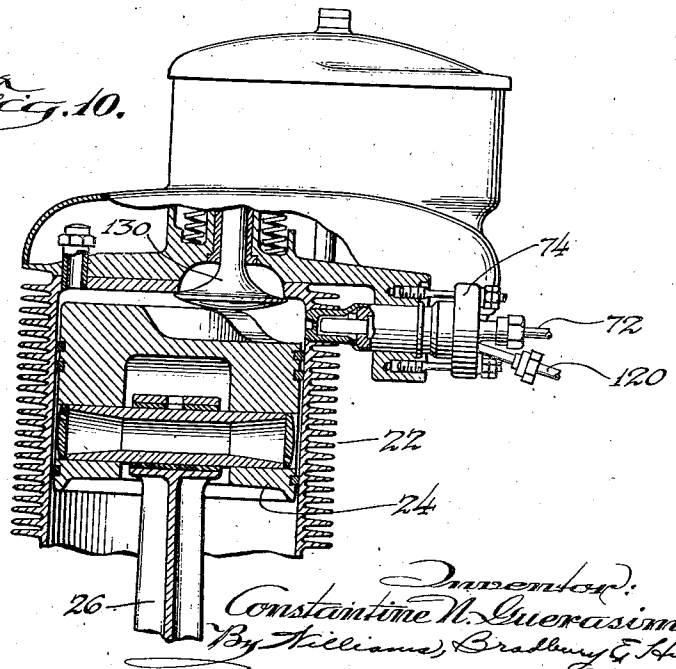



Fig. 10.




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# UNITED STATES PATENT OFFICE

2,408,394

## DIESEL ENGINE AND METHOD OF OPERATING SAME

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Application December 23, 1942, Serial No. 469,854

9 Claims. (Cl. 123—55)

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My invention relates to Diesel engines and to a method of operating the same.

In radial Diesel engines having a single row of cylinders, it is common to utilize a crank shaft having only a single crank pin and to connect a master connecting rod to this crank pin. The other end of the master connecting rod is attached to the master piston in the master cylinder, whereas the pistons in the other cylinders are attached to articulated or link rods which in turn are attached to bearings carried by the large or crankshaft end of the master connecting rod. Where the engine has a plurality of rows of cylinders, the crank shaft has a crank pin for each bank of cylinders and one cylinder of each bank constitutes a master cylinder and has its piston connected to one of the crank pins by a master connecting rod. The pistons of all the other cylinders in the same row are attached by articulated rods to the large end of the master connecting rod for that row.

I have found that the master cylinder or master cylinders of an engine of the aforesaid type heat up more than do the articulated rod cylinders and an object of my invention is to provide such an engine in which the temperature of the master cylinder or cylinders is maintained as low as the temperature of the articulated rod cylinders.

Another object of my invention is to provide an engine of the aforesaid type in which the temperature of the master cylinder or cylinders is reduced without decreasing the power output of the engine.

Another object of my invention is to provide an engine of the aforesaid type wherein the master cylinder performs a reduced amount of work, but wherein the work accomplished by the other cylinders is increased to compensate for the decreased work of the master cylinder.

Another object of my invention is to provide an engine of the aforesaid type in which the foregoing advantages are accomplished without any increase in cost of manufacture or number of parts.

Another object of my invention is to provide a new and improved method of operation for an engine of the aforesaid type.

Another object of my invention is to provide a new and improved method of operation for an engine of the aforesaid type which may be easily applied to an existing engine.

Other objects and advantages will become apparent as the description proceeds.

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In the drawings:

Fig. 1 is a diagrammatic view of an engine embodying my invention;

Fig. 2 is a view showing a vertical section through one of the fuel injection pumps;

Fig. 3 is a partial view similar to Fig. 2, but showing the piston in a different position;

Fig. 4 is a partial view similar to Fig. 3, but showing the piston in a third position;

Fig. 5 is a view showing a transverse section on the line 5—5 of Fig. 3;

Fig. 6 is a view showing a transverse section on the line 6—6 of Fig. 2;

Fig. 7 is a view similar to Fig. 3, but showing the piston rotated to a different position to vary the quantity of fuel discharged;

Fig. 8 is a view showing a transverse section on the line 8—8 of Fig. 7;

Fig. 9 is a view showing a partial section through one of the engine cylinders; and

Fig. 10 is a view showing a partial section through a different type of engine cylinder.

In Fig. 1, I have diagrammatically illustrated my invention as embodied in a single row radial Diesel engine having a master cylinder 12, a master piston 14, reciprocable in the master cylinder 12, a master connecting rod 16, connecting the master piston 14 to a single crank pin 18 of the engine crank shaft 20. The particular engine illustrated is of the nine cylinder type wherein the cylinders and pistons may be of the same size and otherwise interchangeable. In addition to the master cylinder 12 there are eight other cylinders 22, each having a piston 24 connected by an articulated or link rod 26 to the larger end 28 of the master connecting rod 16

The master cylinder 14 and articulated rod cylinders 22 are supplied with fuel by a fuel pump 30 which may be of any conventional or suitable type. The fuel pump 30 comprises a casting 32 providing a sump 34 which is supplied with fuel through a fuel supply pipe 36. The fuel pump 30 includes a fuel injection pump 38 for each of the engine cylinders and these fuel injection pumps are operated by cams 40 on a cam shaft 42 which is driven from the engine crank shaft 20 through any suitable driving mechanism.

Fig. 2 is a vertical, sectional view through one of the fuel injection pumps 38 and illustrates this pump as comprising a stationary barrel 44 having an inlet port 46 and a bypass port 48 communicating with the sump 34. A stationary head 50 closes the upper end of the barrel 44 and has an outlet passage 52 terminating in a valve seat 54. A valve member 56 has a seat engaging sur-

face 58 adapted to contact the seat 54 and is urged toward this seat by a spring 60 confined between the valve member 56 and a shoulder 62 formed in the two-diameter bore 64 of a tubular valve holder 66 which is screwed into the casting 32 and serves to hold the barrel 44 and head 50 therein. The valve 56 has a guide portion 68 which extends into the delivery passage 52 and serves to guide movements of the valve member toward and from the seat 54.

A tubular nut 70 is threadedly attached to the upper end of the valve holder 66 and serves to secure thereto one end of a fuel delivery pipe 72. The other end of this pipe 72 is connected to a spray nozzle 74 attached to one of the articulated rod cylinders 22. A gasket 76 is preferably located between the lower end of the delivery valve holder 66 and a head 50 to prevent escape of fuel.

A plunger or piston 78 is located in each barrel 44 and has a helix 80 formed on its upper end and positioned to control the bypass port 48. Pumping discharge of fuel does not begin until the particular part of the helix opposite the port 48 closes this port and fuel discharge continues until the edge 81 uncovers the ports 46 and 48. This permits fuel to flow past the upper end of the plunger by way of vertical groove 79 and to escape through both ports 46 and 48. The delivery stroke of the plunger can be varied by rotating the plunger to bring different portions of the helix in registry with the bypass port 48 and this is accomplished by rotating a sleeve 82 which surrounds the lower end of the barrel 44 and has slots 84 slidably receiving the projecting tongues 86 of a disc 88 to which the lower end of the plunger is attached. The upper end of the sleeve 82 is gripped by a collar 90 which can be adjusted relative to the sleeve 82 by loosening and tightening a clamp bolt 92 which secures the collar 90 in any adjusted position relative to the sleeve 82.

The collar 90 is provided with teeth 94 which engage the teeth 96 of a rack bar 98 which extends lengthwise of the fuel pump 30 and engages the teeth of all of the collars 94. A link 100 has one end pivotally connected to the rack 98 and a second end pivotally connected to an arm 102 attached to a shaft 104 having a second arm 106 connected to any suitable manual or automatic control for shifting the rack 98 and plungers 78 to vary the fuel input to the engine cylinders and the power output of the engine.

The disc 88 attached to the lower end of each plunger 78 is secured to the upper end of a push and pull rod 108 having a head 109 resting on the adjustable screw 110 of a cam follower 112 which, in turn, rests upon one of the cams 40 on the cam shaft 42. The screw 110 is adjustable relative to its cam follower 112 to permit individual adjustment of the vertical position of each plunger. Each plunger is actuated on its upper or discharge stroke by a cam 40 and is returned by a spring 113 confined between a retainer 114 and an annular washer 116 which holds sleeve 82 in proper vertical position. Spring 113 and retainer 114 hold head 109 of rod 108 against screw 110 and cause the plunger 78 to move up and down with its cam follower 112.

In Fig. 9, I have shown a partial cross-section through one of the engine cylinders. This view indicates my invention as being applied to a Diesel engine having an energy cell 118 into which part of the air is compressed as the piston 24 moves upwardly in the cylinder 22. The nozzle 74 is so positioned that part of the fuel sprayed from this nozzle is directed into the adjacent end of the energy cell 118. Admission of air to the cylinder 22 and exhaust of the products of combustion therefrom are controlled by air inlet and exhaust valves in accordance with usual practice. The nozzle 74 is illustrated as being provided with a bleeder tube 120, but this tube may be dispensed with if desired.



In the ordinary radial Diesel engine having a master cylinder and master connecting rod assembly, the master cylinder heats up more than the other so-called articulated rod cylinders and a primary purpose of my invention is to provide an engine of this type and a method of operating the same which will result in equal operating temperatures for all cylinders without decreasing the total power output of the engine. I accomplish this by reducing the fuel supply to the master cylinder by a predetermined amount, such, for example, as 10% and by dividing this decrease of 10% among the other cylinders so that in the nine cylinder engine shown in the drawings the master cylinder would receive 90% of its normal fuel supply and each of the other eight cylinders would receive 101.25% of normal. My experiments have shown that this novel method of operating the engine eliminated overheating of the master cylinder without decreasing the total power output of the engine and without overheating the articulated rod cylinders.

In the embodiment illustrated in Figs. 1 to 9 of the drawings, my novel method of engine operation can be accomplished by changing the settings of the fuel injection pumps. In Fig. 1, the master cylinder 12 is supplied with fuel by the lefthand fuel injection pump. The collar 90 and plunger of this pump have been rotated in a direction to reduce the fuel supply to the master cylinder as compared to the fuel supply to the other cylinders, as is clearly shown by the position of the collar adjusting screw 92 of the lefthand fuel injection pump as compared with similar screws of the other fuel injection pumps.

This changing of the lefthand fuel injection pump is effected at a time when the rack 98 is out of engagement with the collars 90 and after the position of the pump plunger has been changed the rack 98 is replaced and thereafter maintains the same proportional reduction in quantity of fuel supplied to the master cylinder for all positions of the manual or automatic control which varies the quantity of fuel supplied to all of the engine cylinders in accordance with load and speed requirements. In order to change over an existing engine, it is only necessary to turn the plunger of the fuel injection pump for the master cylinder to obtain the desired ratio between the quantity of fuel discharged by this plunger and the plungers of the fuel injection pumps for the other cylinders, as the increased discharge of fuel to the other cylinders can then be obtained simultaneously by a longitudinal shifting of the rack 98 by means of the usual adjustments in the control mechanism.

In Figs. 2, 3, 4 and 5, I have shown the position of the plunger of the fuel injection pump for the master cylinder for a given condition of engine operation and in Figs. 7 and 8, I have shown the corresponding position of the plungers in the fuel injection pumps for the articulated rod cylinders. A comparison of these several figures will readily show that the plunger of the master cylinder fuel injection pump shown in

Figs. 2 to 5, inclusive, does not close its bypass port 48 until an appreciable time after the plungers of the other fuel injection pumps have closed their bypass ports and have started to deliver fuel to their respective nozzles.

My invention is not limited to a Diesel engine having an energy cell like that shown in Fig. 9 or having any particular design of cylinder head or valve arrangement. In Fig. 10, I have shown a cross-section through the cylinder of an entirely different design of radial Diesel engine having a master connecting rod assembly. The engine of Fig. 10 has no energy cell and has only a single valve 130 controlling the admission of air to the engine cylinder and the exhaust of the products of combustion from this cylinder. The cylinder head design and piston construction of Fig. 10 also differ materially from that shown in Fig. 9.

The engine of Fig. 10 is illustrated as having a fuel injecting nozzle similar to, or identical with, that shown in Fig. 9. My invention, however, is not limited to an engine having any particular form of fuel injecting nozzle and other usual or suitable forms of nozzles may be utilized in lieu of the particular form shown. Likewise my invention is not limited to an engine having a fuel pump of the particular kind disclosed in the drawings and any usual or suitable fuel pump or multiplicity of separately driven pumps may be used in lieu of the single drive box-type pump shown in the drawings. In fact, my invention is not necessarily limited to Diesel engines, but applies to any internal combustion engine of the fuel injection type having a master connecting rod assembly.

While I have illustrated and described a preferred embodiment of my invention, it is to be understood that my invention is not limited to the details shown and described, but may assume numerous other forms and that the scope of my invention is to be construed as including all modifications and variations coming within the appended claims.

I claim:

1. That method of operating a multi-cylinder fuel injection engine of the radial type having a master cylinder and master connecting rod assembly, which comprises supplying a reduced quantity of fuel to the master cylinder and supplying increased quantities of fuel to the other cylinders to eliminate over-heating of the master cylinder without reducing the power output of the engine.

2. That method of operating a multi-cylinder fuel injection engine of the radial type having a master cylinder and master connecting rod assembly, which consists of supplying a lesser quantity of fuel to the master cylinder and supplying greater and equal quantities of fuel to all of the other cylinders.

3. That method of operating a multi-cylinder Diesel engine of the radial type having a master cylinder and master connecting rod assembly, which consists of supplying a lesser quantity of fuel to the master cylinder and supplying greater and equal quantities of fuel to all of the other cylinders.



4. That method of eliminating over-heating of the master cylinder of a multi-cylinder fuel injection engine having a master connecting rod assembly, which comprises reducing the fuel supply to the master cylinder, increasing the fuel supply to the other cylinders by an amount sufficient to compensate for the reduced power of the master cylinder, and maintaining the same relationship between the quantity of fuel supplied to the master cylinder and the quantity of fuel supplied to each of the other cylinders throughout all conditions of engine operation.

5. In a multi-cylinder fuel injection engine having a master cylinder and a master connecting rod assembly, the combination of fuel injection means for supplying a less than normal quantity of fuel to the master cylinder, and means for supplying more than normal quantities of fuel to each of the other cylinders.

6. In a multi-cylinder fuel injection engine having a master cylinder and a master connecting rod assembly, the combination of a fuel injection pump for supplying a predetermined quantity of fuel to the master cylinder, fuel injection pumps for supplying greater quantities of fuel to the other cylinders, and common means for varying the quantities of fuel discharged by all of said pumps without changing the ratio of fuel supplied to the master cylinder as compared with the fuel supplied to each of the other cylinders.

7. In a multi-cylinder Diesel engine having a master cylinder and a master connecting rod assembly, the combination of a fuel injection pump for supplying a predetermined quantity of fuel to the master cylinder, fuel injection pumps for supplying greater quantities of fuel to the other cylinders, and common means for varying the quantities of fuel discharged by all of said pumps without changing the ratio of fuel supplied to the master cylinder as compared with the fuel supplied to each of the other cylinders.

8. In a multi-cylinder fuel injection engine having a master cylinder and a master connecting rod assembly, means for preventing overheating of the master cylinder, said means comprising means for supplying a predetermined quantity of fuel to each cylinder other than the master cylinder, and means for supplying a lesser quantity of fuel to the master cylinder.

9. That method of operating a multi-cylinder fuel injection engine having a master cylinder and master connecting rod assembly to prevent overheating of the master cylinder which consists of supplying a given quantity of fuel to each of the cylinders other than the master cylinder and supplying a lesser quantity of fuel to the master cylinder.

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