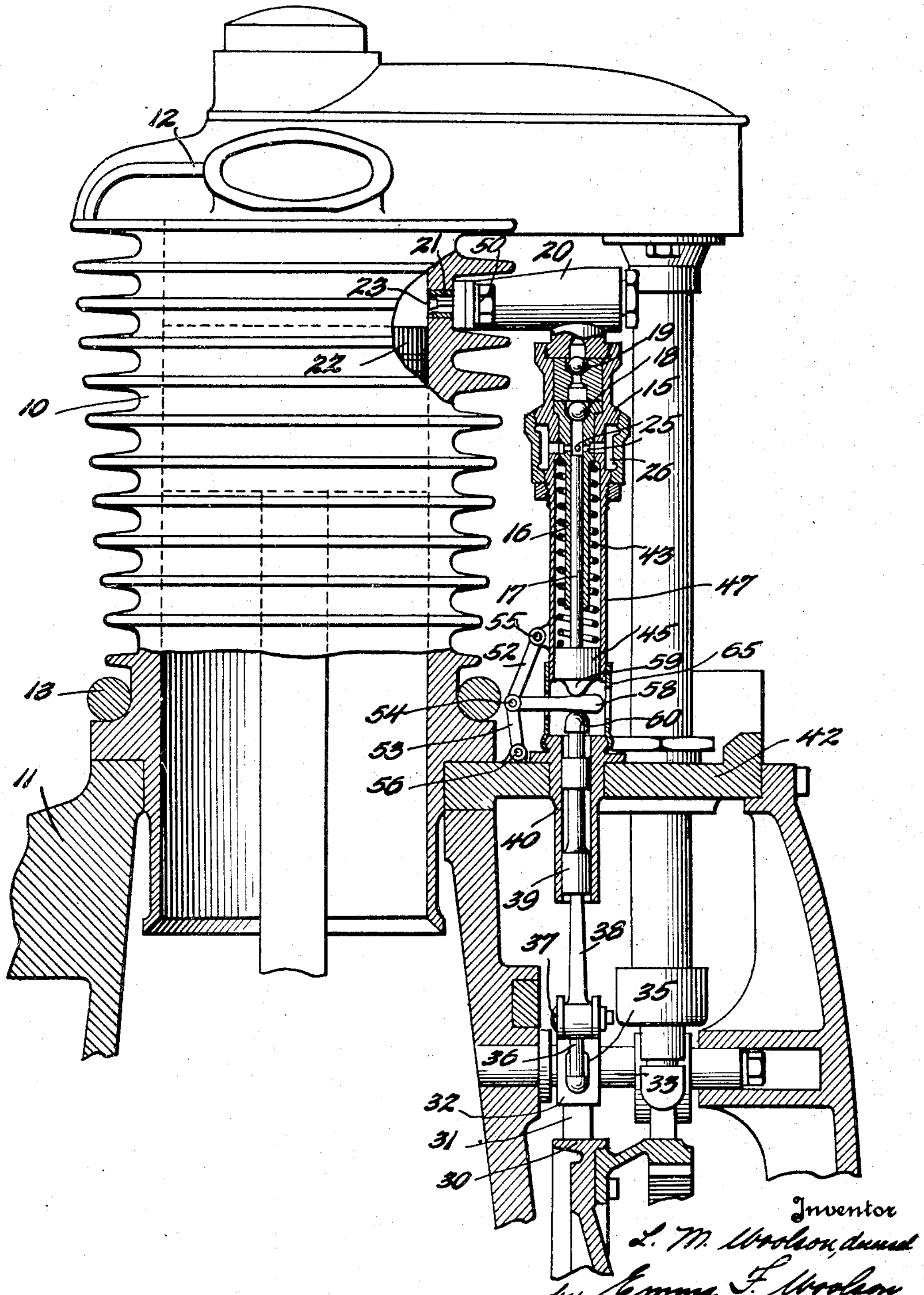
Jan. 22, 1935. L. M. WOOLSON 1,988,533

INTERNAL COMBUSTION ENGINE

Filed July 22, 1930



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UNITED STATES PATENT OFFICE

1,988,533

INTERNAL COMBUSTION ENGINE

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Application July 22, 1930, Serial No. 469,895

9 Claims. (Cl. 123—139)

This invention relates to internal combustion engines and more particularly to fuel injection mechanism for engines of the Diesel type.

It is a general object of the present invention to provide a novel and improved fuel injection mechanism for internal combustion engines.

More particularly it is an object of the invention to provide a fuel injection mechanism wherein the quantity of fuel injected in each cylinder of the engine is regulated in accordance with the temperature of that cylinder.

An important feature of the invention resides in mounting fuel injection mechanism on each cylinder in such a manner that any increase in length of a cylinder from expansion results in a decrease in the quantity of fuel delivered thereto.

Another important feature of the invention consists in so mounting the fuel injection mechanism that it is inherently subject to a reduction in delivered volume of fuel as the cylinder expands and to further provide multiplying linkage also actuated by expansion of the cylinder to augment the inherent fuel regulation.

Other and further features and objects of the invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawing and following specification wherein is disclosed a single exemplary embodiment of the invention with the understanding, however, that such changes may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawing:

The single figure is an axial section through one cylinder of a multi-cylinder, radial type, Diesel engine, the section being taken on the axis of the fuel injection mechanism and wherein parts not distinctly related to the invention are shown in elevation.

The present invention, for convenience in disclosure, is shown in connection with a radial cylinder engine of the Diesel type such as particularly constructed for aviation use although it will be apparent that it can be used with equal facility with other types of engines both of the air and water cooled types.

This invention particularly relates to that type of Diesel engine disclosed in the copending application of Lionel L. Woolson, Serial No. 358,899, filed April 29, 1929, but is not necessarily limited to such types of engines.

For the sake of convenience, but a single cylinder 10 has been shown together with a fragment 11 of a substantially cylindrical crank case which supports the cylinder at the inner or end opposite the head 12, as clearly shown, and wherein suitable clamping rings 13 secure the cylinder rigidly to the crank case.

The fuel injection mechanism is of the type which includes a separate pump for each cylinder shown in general by the reference character 15 and intended to deliver fuel in the liquid state into the cylinder prior to each explosion. This is sometimes known as solid fuel injection. The pump comprises essentially a pump barrel 16 radially disposed and having its axis substantially parallel to the axis of the cylinder. A solid rod 17 forms the plunger or piston of the pump and is arranged to reciprocate within the barrel and to discharge oil through the check valves 18 and 19 into a head 20 provided with a projection 21 which extends into the engine cylinder just above the top position of the piston 22. This projection 21 may be provided with a spring-controlled nozzle head 23 which normally is substantially closed and provides a resistance to the oil delivered by the pump.

Just below the check valve 18 there are a plurality of inlet ports 25 through the wall of the pump barrel. These ports are arranged in a ring around the periphery of the barrel and open into an annular chamber 26 surrounding the pump barrel and always supplied with fuel oil at a low pressure by any suitable means. The piston or plunger of the pump is arranged to reciprocate from a position below the ports 25 to a position above these ports. It will be seen that when it is withdrawn below the ports oil will enter through them and fill the barrel below the check valve 18, and that when the piston rises or moves outwardly it will not begin pumping oil through the atomizing nozzle until it has first closed the inlet ports 25. It can, therefore, be said that the pump is of the type wherein the quantity of discharge is dependent on the displacement of oil beyond the inlet ports. It is not so much the length of the stroke as the position of the stroke of the plunger which controls the quantity of discharge. The effective stroke of the pump plunger is that portion which takes place after the ports 25 are covered.

The pump plunger is adapted to be reciprocated, in the present instance, from a cam ring 30 which rotates in an extension of the crankcase and is suitably driven from some rotating part of the engine, not shown. Bearing on the cam is a follower 31 connected to a rocker 32 journalled on a shaft 33. This rocker is provided, along its upper surface, with a groove 35 in which the lower end of a strut 36 bears. This strut is pivoted at 37 to the lower end of a connecting rod 38 the upper end of which bears, with a suitable joint, on the lower end of the cross head slide 39 reciprocable in a sleeve 40 seated in portion 42 of the crankcase extension.

Means, fully described and shown in application Serial No. 358,899, previously referred to, are provided for adjusting the ends of the struts along the grooves to vary the strokes and the positions of the upper ends of the plungers 17 in respect to the inlet ports 25 for changing the fuel consumption of all of the cylinders simultaneously to thus vary the speed and/or power of the engine.

A coil spring 43 surrounds the pump barrel 16 and bears at its upper end on an enlargement thereof and at its lower end on a head 45 on the lower end of the plunger 17 to normally maintain the plunger in its retracted position. This spring is housed in a sleeve 47 secured to the main body of the pump. The spring causes the plunger 17 to be biased in the direction of the cross head 39 which is co-axial therewith.

The whole pump mechanism, but particularly the barrel part, is supported from the head end of the cylinder where it is seen to be secured into position by the bolts 50. The operating mechanism for the pump is all at the crankcase end of the cylinder. This arrangement provides an inherent means for reducing the quantity of oil supplied to each cylinder as its temperature increases and it will be seen that expansion resultant from an increase in temperature will move the pump barrel radially outwardly with respect to the crankcase and, therefore, will cause the pump plunger to reciprocate through a range closer toward the center of the engine and hence to have less displacement above the intake ports 25. This produces an automatic adjustment which insures that any cylinders which become overheated will of themselves reduce their fuel supply to permit a resumption of normal operating temperature and to cause any excessively cooled cylinders to take up the load which will become evenly distributed among all of the cylinders. It is self evident that the fuel injection mechanism will remain at a substantially constant temperature irrespective of changes in the cylinder temperatures.

In some cases this inherent regulation of fuel supply may be inadequate to equalize the cylinder temperatures and it can be augmented by suitable linkage mechanism controlled by the expansion of the cylinder. One convenient way of doing this is shown in the drawing wherein a pair of links 52 and 53 are pivoted together at 54 to form a toggle. The upper link is pivoted at 55 to the housing for the spring 43 and the lower link at 56 to a boss on the crankcase part 42. Likewise pivoted at 54 is one end of a wedge member 58 which extends between the pointed end 59 of the plunger head 45 and the pointed head 60 of the cross head. This wedge member increases in thickness from the pivot outwardly as shown. It will be clear that as the cylinder expands the toggle will be straightened, the wedge member 58 forced to the right and the pump plunger retracted to reduce its effective stroke. On cooling of the cylinder a converse action takes place as will be readily understood.

The major portion of the wedge member 58 is enclosed in the tubular housing 65 secured at its inner end to a boss on the bushing 40 and having a sliding fit over the inner end of the spring housing 47.

It will be clear that other mechanical expedients will be equally effective for augmenting the inherent fuel regulation of the type of pump shown and it is the intent of the following claims to cover all mechanical equivalents of this structure for essentially the invention resides in inherent fuel regulation in accordance with cylinder temperature and means for augmenting this inherent regulation. It will be appreciated that the expansion of the cylinder and its increase in length is a function of the temperature so that it can be said that the regulation of fuel supply is dependent on cylinder temperature.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In an engine of the fuel injection type, in combination, a cylinder of the air cooled type, a fuel injection pump barrel secured to the cylinder near one end, an inlet port in said barrel, a plunger operating in said barrel to deliver fuel in quantity depending on its extent of movement beyond the inlet port on its delivery stroke, actuating means associated with the opposite end of said cylinder to move the plunger on its delivery stroke, means to return the plunger after delivery, means normally spacing the plunger and actuating means and means actuated by an increase in the distance between the two ends of the cylinder from heat expansion to reduce the spacing between said actuating means and the plunger.

2. In an engine of the fuel injection type, having a cylinder, a plunger pump substantially parallel to the cylinder and of the type wherein the position of the plunger at the end of the injection stroke determines the quantity of fuel delivered, the combination of means actuated by the expansion of the cylinder by heat to withdraw the plunger from the pump barrel, and further means actuated by the increase in length of the cylinder by expansion to augment said withdrawing.

3. In an engine of the fuel injection type, in combination, a cylinder mounted on a crankcase, a plunger pump barrel fastened to the cylinder near its head end, a plunger in said barrel, a spring to move said plunger toward said crankcase, an operating mechanism in said crank-case for said plunger, means normally spacing the plunger and its operating mechanism, a linkage having its ends associated with the opposite ends of the cylinder, and means actuated by said linkage when the cylinder expands by heat to reduce the spacing between said plunger and operating mechanism.

4. In an engine of the fuel injection type, in combination, a cylinder mounted on a crankcase, a plunger pump barrel fastened to the cylinder near its head end, a plunger in said barrel, a spring to move said plunger toward said crankcase, an operating mechanism in said crankcase for said plunger, a linkage having its ends associated with the opposite ends of the cylinder, wedge means between the plunger and operating mechanism and an operative connection between the linkage and wedge means to reduce the distance between the plunger and operating mechanism as the cylinder expands.

5. In a fuel injection engine, in combination, a plurality of radially disposed cylinders, a crankcase secured to the inner ends of the cylinders, a radial fuel pump barrel attached to the outer

end of each cylinder and having a fuel inlet port near its outer end, a plunger in each barrel and determining the quantity of fuel delivered by the distance its end is projected beyond the inlet port, a part movable in said crankcase for operating each plunger, mechanism actuated by the expansion of each cylinder and means actuated by said mechanism and between each pump plunger and its operating part to reduce the distance between the adjacent end of said plunger and said plunger operating part.

6. In a fuel injection engine, the combination, a plurality of radially disposed cylinders, a crankcase secured to the inner ends of the cylinders, a radial fuel pump barrel attached to the outer end of each cylinder and having a fuel inlet port near its outer end, a plunger in each barrel and determining the quantity of fuel delivered by the distance its end is projected beyond the inlet port, a part movable in said crankcase for operating each plunger, means to adjust the delivery of all pumps simultaneously to vary engine speed or power, wedge means between each plunger and part and a linkage positioning each wedge and adapted to move the same longitudinally with changes in temperature of the associated cylinder whereby an overheated cylinder has its fuel supply automatically reduced below that of other cylinders to reduce the heating.

7. In a fuel injection engine, in combination, a plurality of radially disposed cylinders, a crankcase secured to the inner ends of the cylinders, a radial fuel pump barrel attached to the outer end of each cylinder and having a fuel inlet port near its outer end, a plunger in each barrel and determining the quantity of fuel delivered by the distance its end is projected beyond the inlet port, a part movable in said crankcase for operating each plunger, a multiplying lever system operated by the expansion of each cylinder and means actuated by said system to retract the associated plunger end from said port as the cylinder increases in length.

8. In an engine of the liquid fuel injection type, in combination, a crankcase, a plurality of air-cooled cylinders having heads, means securing the ends of the cylinders opposite the heads to the crankcase, a fuel injection pump barrel supported from the head end of each cylinder and having its axis substantially parallel to the cylinder axis, a fuel inlet port in the wall of each barrel, a plunger reciprocable in each barrel and determining the quantity of fuel injected in accordance with the extent of its movement beyond the inlet port toward the head end, and means carried by the crankcase to actuate and position said plungers, the cross-section and stroke of each plunger being determined in respect to the thermal expansion of the cylinder to prevent overheating of any one cylinder by the proper reduction in fuel delivered thereto by the consequent withdrawal of the plunger whereby the load is equalized among all cylinders.

9. In a fuel injection engine, in combination, a plurality of separate cylinders, a fuel injection device for each cylinder, means to adjust the said devices simultaneously to vary the speed of the engine and always supply the same nominal quantity of fuel to each cylinder, and regulating means actuated by expansion of any cylinder to independently reduce the quantity of fuel delivered to that cylinder by the injection device therefor, progressively as its temperature increases while the nominal fuel delivery to that cylinder remains under control of the aforesaid adjusting means.

EMMA F. WOOLSON,
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