

A DIESEL ENGINE WITH VERTICAL CRANKSHAFT

The present invention relates to a diesel engine with a vertical crankshaft which is particularly suited for use in a marine outboard engine.

In a typical diesel engine, the fuel injection device is controlled by a rotary control pinion and a rack, and the quantity of fuel injected by the fuel injection device is increased or decreased as the control pinion is rotated in one or the other direction.

This rotary control pinion, however, does not serve as a safety device which is capable of automatically reducing the quantity of fuel injected into the engine in order to stop the diesel engine.

On the other hand, in the case of a diesel engine used as a marine outboard engine in which the crankshaft is disposed vertically, it is possible to position a control rod for controlling the fuel injection quantity to lie parallel to the crankshaft so as to be movable in the vertical direction.

The present invention seeks to provide a diesel engine having a fuel injection quantity controlling device with a vertical control rod which is movable in the vertical direction, the control rod being adapted to be displaced under the action of gravity when released from the restraining force exerted by the control linkage members whereby to restrict the quantity of fuel supplied to the injector units whereby to stop the engine.

The present invention also seeks to improve the function, performance and manoeuvrability of a diesel engine, particularly a diesel engine used as a marine outboard engine, by introducing various improvements to the fuel injection control device of the

engine.

According to the present invention, therefore, there is provided a diesel engine having a vertically directed crankshaft and a plurality of fuel injector units each having a plunger and a control lever the position of which determines the quantity of fuel injected by the unit upon depression of the plunger, in which the control levers are engageable by a fuel quantity control rod mounted generally parallel to the crankshaft, the arrangement being such that the quantity of fuel injected by the said injector units is increased or decreased as the control rod is moved upwardly or downwardly respectively, and such that, in the event of failure in the control linkage to the control rod, this latter can descend under its own weight to cause a decrease in the quantity of fuel injected.

In an engine having a fuel injection quantity controlling device as described hereinabove, if the linkage for vertically and reciprocatingly moving the control rod accidentally fails to operate, the control rod moves naturally downwardly under the action of gravity so as to cut off the fuel injection from the fuel injector units thereby to stop the engine.

Various embodiments of the invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side elevational view of a marine outboard engine equipped with a fuel injection quantity controlling device in accordance with the principles of the invention;

Figure 2 is a sectional view of a portion of a diesel engine equipped with a fuel injection quantity controlling device in accordance with the invention;

Figure 3 is a cross-sectional view of the part of the engine shown in Figure 2;

Figure 4 is a rear elevational view of the part of the engine shown in Figure 3 as viewed in the direction of the arrow I of Figure 3;

Figure 5 is a rear elevational view of a portion of the engine around the control rod;

Figure 6 is a sectional view taken along the line II-II of Figure 5;

Figure 7 is a front elevational view of a part of the control lever shown in Figure 6;

Figure 8 is a sectional side elevational view showing how the control lever engages a pin;

Figure 9 is a sectional side elevational view of another embodiment showing how the control lever engages the pin;

Figure 10 is a rear elevational view of a portion around the control rod;

Figure 11 is a side elevational view as viewed in the direction of arrows III-III of Figure 10;

Figure 12 is a front elevational view of a stop lever device of an engine;

Figure 13 is a side elevational view of the stop lever device; and

Figure 14 is a schematic side elevational view of the stop lever device shown in Figures 12 and 13 applied to a marine outboard engine.

Various different features of the invention are shown in the drawings, in which the same reference numerals are used to identify the same components throughout. Referring first to Figures 1 to 3 these, in combination, show a marine outboard engine 60 having a diesel engine 10 orientated with a vertical crankshaft 7. More specifically, the marine outboard engine 60 has a top cowling 26 accommodating the diesel engine 10 and is secured by means of a clamp to a transom 31 of a hull 30.

So-called injector units 9 each having a fuel injection pump and an injector are mounted in the cylinder head 1 of the diesel engine 10, as can be seen in Figure 1, these units lying in a plane which intersects the crankshaft 7 at a right angle. A control lever 11 is fixed to the rear portion of the plunger of the injector unit 9. The injector unit 9 is constructed such that the fuel injection quantity is decreased as the control lever 11 is rotated clockwise and increased as the control lever 11 is turned anti-clockwise as viewed in the direction of the arrow 1 of Figure 3.

A control rod 20 is disposed on the cylinder head 1 vertically, that is to extend generally parallel to the crankshaft 7. The control rod 20 is movable reciprocatingly up and down in the longitudinal direction thereof. The control rod 20 is provided with an adjuster 19 having a pin 18 which engages with the above-mentioned control lever 11. The arrangement is such that the fuel injection quantity is decreased and increased, respectively, as the control rod 20 moves downwardly and upwardly as indicated by arrows D and U.

The control rod 20 is provided with a pin 21 engaged by a lever 22 pivoted on a shaft 23. As the lever 22 rotates around the shaft 23, the control rod 20 moves reciprocatingly in the vertical direction. The rotation of the lever 22 is caused by a link which is operatively connected to a governor (not shown).

Thus, the control rod 20 is connected to the governor through a series of connecting members including the link 24, lever 22 and the pin 21. If the connection between adjacent members fails such that these members become disconnected, the control rod 20 is freed from the pulling force which has been exerted by the link 24 so that the control rod 20 can move downwardly as indicated by the arrow D due to the force of gravity. The downward movement of the

control rod 20 rotates the control lever 11 clockwise to reduce and eventually cut off the fuel supply, so that the diesel engine slows and then is stopped automatically.

5 As shown in Figure 3, in which only one of the injector units 9 can be seen, this unit 9 is adapted to be driven by a fuel valve arm 35 which is rocked by a fuel cam 34 on the cam shaft 33. Further, the control rod 20 mentioned above is mounted on the cylinder head 1 at a position closer to the crankshaft 7 than the control lever 11 of
10 the injector unit 9. With this arrangement, the control rod 20 does not hinder the mounting or demounting of the injector unit 9 on and from the cylinder head 1, so that the mounting and demounting of the injector unit 9 is facilitated. In addition, the necessity for readjustment of the adjuster 19 attached to the
15 control rod 20 following such mounting is eliminated. Referring particularly to Figure 4, a matching of the quantity of the fuel injected by two injector units such as the units 9 mounted on a diesel engine would normally be effected by a process comprising the steps of bringing the pin 18 of the adjuster 19 into
20 engagement with the control lever 11, moving the adjuster 19 along the control rod 20 until the control lever 11 contacts the upper end 12a of the collar 12 attached to the injector unit 9, and fixing the adjuster 19 to the control rod 20 by means of a clamp bolt 37 when the control lever 11 has contacted the upper end 12a
25 of each collar 12. However, any deviation of the control rod 20 in the longitudinal direction thereof or any rotation of the same around its axis makes it quite difficult to effect the required adjustment to match exactly the quantity of fuel injected by the two injector units, so that much labour and time are required for
30 this operation.

To obviate this problem, it is advisable to employ the following method. Namely, for adjusting the injector unit 9, the upper end of the control rod 20 is temporarily fixed to an idle spring mounting base 48 by means of a screw 29 which is usually used for priming or for purging air from the fuel system and, thereafter, the position of the adjuster 19 is adjusted in accordance with the procedure explained before. By so doing, it is possible easily and promptly to perform the work for matching fuel injection quantities of two injector units 9. The adjuster 19 has an elongate hole so as to be able to move relatively to the control rod 20.

Needless to say, after the matching operation, it is necessary to detach the screw 29 and return it to the air purging valve of the fuel system. If the engine is operated without replacing the screw 29 in the right place, air is leaked from the air purging valve so that one can be aware of any abnormality without delay.

It is possible to use another member than the described screw 29 as means for temporarily fixing the control rod, provided that it can impede the normal operation of the engine if left attached to the control rod 20. Such member may be fixed to another portion of the control rod 20 than the upper end of the same.

Referring now to Figures 5 and 6, the control rod 20 has a chamfered portion 20a having a polygonal cross-section. On the other hand, the adjuster 19 is shaped in a form resembling a saddle or a letter U and is fitted in the direction of the arrow I of Figure 6 so as to straddle the portion 20a of the control rod 20 having the polygonal cross-section.

The adjuster 19 has an elongate hole 36 so that it can move in the longitudinal direction of the control rod 20 when the bolt 37 is loosened.

- 5 Since the adjuster 19 is mounted to straddle over the portion 20a of the control rod 20 having polygonal cross-section, it is possible to position the adjuster 19 simply and correctly. In addition, mounting and demounting the adjuster 19 is facilitated.
- 10 Referring now to Figures 7 and 8, the control lever 11 has two arms 11a which define therebetween a U-shape notch 11b adapted to receive the pin 18 of the adjuster 19. The facing surfaces of the arms 11a are bevelled as at 42 in order to accommodate slight misalignments of the lever 11 and the pin 18; in particular
- 15 undesirable squeezing of the pin 18 is avoided to ensure smooth engagement between the arm 11a and the pin 18 in the case of such slight misalignment. Alternatively, as shown in Figure 9, the facing surfaces of the arms 11a may be smoothly rounded with a radius R. Again, this is to ensure the prevention of undesirable
- 20 squeezing of the pin 18 in the event of slight misalignment of the pin 18 as can be seen in Figure 9.

- Referring now to Figures 10 and 11, a governor device (not shown) is connected to one end of an adjusting lever 39 via a link 24,
- 25 while the other end of the adjusting lever 39 is connected to an idle spring 25 mounted on an idle spring mount 48. This adjusting lever 39 is rotatably supported to one end of the supporting shaft 23 and is connected to the control rod 20 through the pin 21 fixed to the control rod 20, so that the control rod 20 moves as
- 30 indicated by arrows U and D in accordance with the rotation of the adjusting lever 39.

On the other hand, a stop lever 38 is fixed to the other end of the support shaft 23 as shown in Figure 11. Usually, the stop lever 38 takes a position as shown by the two-dot-and-a-dash line in Figure 10. As the stop lever 38 is rotated in the direction of the arrow S_1 , the pin 28 fixed to the support shaft 23 pushes a pin 44 provided on the lever 39 thereby forcibly to rotate the lever 39 in the direction of the arrow S_1 . Consequently, the control rod 20 slides in the direction of the arrow D.

10 According to this arrangement, since the stop lever 38 and the adjusting lever 39 for reciprocatingly driving the control rod 20 are carried by the common support shaft 23, it is not necessary to use independent shafts for these levers.

15 Therefore, the number of parts is decreased correspondingly and the construction for connection between the stop lever 38 and the control rod 20 can be simplified, so that the engine can be made lighter in weight and more compact in size.

20 Referring now to Figures 12, 13 and 14, the stop lever 38 is connected to a decompression lever by a connecting portion 46 and a link 5 so that as the stop lever 38 is rotated in the direction of the arrow S_1 to stop the engine, the decompression lever 2 is also rotated in the direction of the arrow A as indicated by the
25 two-dot-and-a-dash lines, thereby slightly to open the exhaust valve.

The connecting portion 46 secured to the stop lever 38 is provided with an elongate hole 6 for engaging the link 5 so that the link 5
30 can slide regardless of the operation of the stop lever 38 when the decompression lever 2 is operated independently.

Figure 14 shows a marine outboard engine 60 incorporating the stop lever 38 and two decompression levers 2 linked to each other. It will be seen that the two decompression levers 2 are connected to each other through a link 51.

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The stop lever 38 is connected to a stop knob 4 provided near the steering handle 52 by means of a bowden wire 3.

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According to this arrangement, the fuel supply to the injector unit 9 is stopped as the stop lever 38 is rotated in the direction of the arrow S₁ to stop the diesel engine 10. Simultaneously, the decompression lever 2 is rotated in the direction of the arrow A to slightly open the exhaust valve and allow the discharge of residual gas from the cylinder.

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Therefore, no compression takes place in the cylinders when the crankshaft 7 is being rotated by the inertia of the fly-wheel 8 just before the stop of the engine, so that unfavourable vibration of the engine due to pressure rise in the cylinder is avoided advantageously.

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CLAIMS

1. A diesel engine having a vertically directed crankshaft and a plurality of fuel injector units each having a plunger and a control lever the position of which determines the quantity of fuel injected by the unit upon depression of the plunger, in which the control levers are engageable by a fuel quantity control rod mounted generally parallel to the crankshaft, the arrangement being such that the quantity of fuel injected by the said injector units is increased or decreased as the control rod is moved upwardly or downwardly respectively, and such that, in the event of failure in the control linkage to the control rod, this latter can descend under its own weight to cause a decrease in the quantity of fuel injected.
2. A diesel engine as claimed in Claim 1, in which each of the said control levers is linked by means of an adjuster pin with the control rod via an adjuster, the said control rod carrying a fixed pin pivotally engaged by a lever connected to an engine speed governor.
3. A diesel engine as claimed in Claim 1 or Claim 2 in which the control rod is disposed closer to the crankshaft than the control levers of the injector units.
4. A diesel engine as claimed in any of Claims 1 to 3, in which the control rod has a portion of polygonal cross-section, and each adjuster fitting this portion of polygonal cross-section has a saddle-like form, each adjuster being provided with an elongate hole so as to be able to move longitudinally of the control rod upon slackening of a clamping bolt which holds the adjuster in position on the control rod when tightened.



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- 11 -

5. A diesel engine as claimed in any preceding Claim, in which each control lever has two substantially parallel arms defining therebetween a recess receiving the pin of the said adjuster, the facing surfaces of the arms being bevelled or
5 smoothly rounded whereby to allow slight misalignments of the pin of the adjuster.

6. A diesel engine as claimed in any preceding Claim, further including a stop lever operable to displace the said
10 control rod in a downward direction, and a decompression lever for opening the exhaust valve, the said stop lever and said decompression lever being selectively connectable for operation together.

15 7. A diesel engine substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
