

A Vertical-Crankshaft type outboard-motor engine

5 The present invention relates to a vertical-crankshaft type outboard-motor engine, and more particularly to such an engine having a floating-lever type governor.

10 Generally, outboard-motor internal combustion engines must meet the absolute requirement that they are light in weight and compact in structure, and conventionally internal combustion engines for use as outboard motors have been predominantly spark-ignition petrol engines.

15 However, as the price of petroleum has been tremendously increased in recent years, it has been increasingly demanded that, in place of spark-ignition petrol internal combustion engines the fuel cost for which is relatively high, diesel engines should be designed as
20 outboard-motor engines because the fuel cost is comparatively low. With diesel engines, however, the fuel injection control involves greater complexity than with petrol engines. In addition, in the case of an outboard engine, acceleration and deceleration thereof
25 is normally effected by operating a twist grip on a steering handle disposed to project toward the bow of a ship or boat, and it is an important requirement that the operation of such a handle can be made with ease. Also, in most instances, an outboard-motor engine is
30 required to be housed in lower and upper cowlings, and it is preferable that an inspection operation and/or maintenance work can be performed simply by removing or opening the upper cowling.

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Further, with conventional outboard diesel engines, it is arranged that in starting the engine about twice as much fuel is injected as the amount injected during normal engine operation so that the engine can be
5 started easily and without fail and also in order rapidly to raise the speed of rotation immediately after the engine has been started.

Further, for the purpose of controlling the engine speed
10 by way of controlling the fuel injection, a governor is incorporated in the internal combustion engine. With conventional centrifugal-type governors, the motion of a governor spindle caused by centrifugal force exerted by governor weights is transmitted via, for example a
15 floating lever, a link and so forth, to a control rod for controlling the fuel injection whereby automatically to govern the engine speed. To increase the fuel injection upon starting of the engine, a handle provided separately of the governing or regulator handle is
20 operated.

With the governor of such a system, the arrangement and the operation are unavoidably complex and, in addition, there lies the danger that the lever for increasing the
25 fuel injection may be operated in error during normal running of the engine, in which case the engine could be caused to operate at a power above the prescribed value and may become damaged.

30 In the case of floating-lever type governors in which the motion of the governor spindle caused by centrifugal force of the governor weights is transmitted to the control rod through a linkage comprising a first lever.

5 a floating lever and a link member, and in which almost
all of the force is borne by the first lever so that no
substantial portion of the force can be transmitted to
the following members of the linkage, an idling spring
is incorporated to control the speed of rotation during
idling of the engine. The idling spring has a spring
constant such that during idling of the engine, a
balance is achieved between the force of the idling
spring and that of the governor, and as soon as the
10 speed of rotation falls below the idling speed, the fuel
injection is increased, while when the speed of rotation
rises above the idling speed, the fuel injection is
reduced or even suppressed.

15 Preferably, the idling spring should be located as far
away from the governor as possible: At each joint in
the path of transmission of force to the control rod
through the linkage components such as the governor
spindle, first lever, floating lever, link member,
20 further levers and pins and so forth, there exists a not
insignificant gap or play, and if the governor is
operated in a state where force in a certain direction
is not constantly applied to such link or joint
portions, the operation of the governor becomes
25 unreliable because of the play at the link portions.
Therefore, preferably it is arranged that the idling
spring is provided at the control rod end of the linkage
so that force in a certain direction is constantly
applied to the joint of the linkage. At the same time,
30 it may be required to adjust the spring force of the
idling spring during the engine operation so as to set
the speed of rotation of the engine at idling, and the
idling spring should therefore preferably be located at

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a position affording easy access.

Further, in an internal combustion engine for an outboard motor in which the control rod for controlling the fuel injection is located so as to be movable parallel to a vertically arranged crankshaft, it is preferred to mount a governor at an upper portion of the engine so that easy access can be obtained for maintenance, inspection and adjustment operations. Thus, an idling-spring chamber in which to house the idling spring should preferably be disposed in an upper portion of the engine.

Among conventional governors, there is one which employs the so-called torque spring system in which compensation of the difference between the force of the governor weights and that of a regulator spring constituting the main spring is effected by the function of a torque spring so that when the engine speed falls below a certain value, the fuel injection can be increased. It is not possible to employ a fuel-injection increasing or controlling mechanism of such a torque-spring system in a floating-lever type governor in which the force of a regulator spring is borne by a first lever and the force borne by this lever is almost in balance with the force of a governor weight and in which the force of the regulator spring is not transmitted to the linkage or to a lever for operating a control rod for controlling the fuel injection which are arranged downstream of a floating lever in the direction of the force transmission.

The present invention seeks to provide a governor for a

diesel engine for an outboard motor which can be operated with only a small operating force and by operating a twist grip of a steering handle, to accelerate and decelerate the engine.

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The invention also seeks to provide a diesel engine for an outboard motor, having a simple, light and compact governor mechanism for securely governing the fuel injection incorporated in the engine, the maintenance and/or inspection operation of which can be easily performed.

According to the present invention, there is provided a vertical-crankshaft type outboard-motor engine having a governor the movements of which are transmitted in use, via a floating lever and a link member to a control rod operable to control the amount of fuel injected into the engine, in which the governor is mounted above a cylinder head of the engine and a regulator handle for manually pivoting the floating lever is connected through link means to a twist grip of a steering handle.

It is a feature of the invention that the force of the regulator spring which balances the governor weights in normal operation of the engine is not transmitted via the linkage to the control rod for controlling the fuel injection when the engine is stationary so that the fuel injection can be automatically increased by suitable means provided for this purpose only at the starting of the engine thereby to improve the starting performance of the engine. Another feature of the invention is that the performance of an internal combustion engine for an outboard motor having a floating-lever type governor is

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stabilized, whilst any operations for maintenance, inspection and/or adjustment can nevertheless be performed with ease.

- 5 In a preferred embodiment of the invention the governor is arranged so as to be driven by a timing belt mounted above the cylinder block for driving a camshaft.

- 10 Likewise, it is preferred that there be provided a first lever which is rockably supported in the vicinity of the governor, the said first lever having one end disposed between a governor spindle and the floating lever, and the other end facing a regulator spring.

- 15 Preferably, the governor, comprising the governor weights and the governor spindle, is carried on a governor mount, and a shaft supporting the first lever operatively associated with the governor spindle, the regulator spring against which the said other end of the
20 first lever abuts, and a regulator-lever shaft variably supporting the fulcrum of the floating lever abutting against the said one end of the first lever, are all assembled on a governor cover member. In order to be able to vary the amount of fuel injected upon idling the
25 engine so that the engine is also governed at idling speed when the governor force is low, the control rod referred to above may be biased by an idling spring constantly urging the control rod in the direction for increasing the fuel injection, the idling spring having
30 a spring constant such that it is substantially balanced by the force of the governor when the engine is

operating at the idling speed. Further, for the purpose of being able to increase the amount of fuel injected upon starting up the engine there may also be provided an auxiliary spring for displacing the control rod via the idling spring to a position for maximum fuel injection only when the engine is stationary, whereby when the governor force is small such as at the commencement of the engine start, the fuel injection is automatically increased to a maximum value.

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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 schematic side elevational view, of an outboard-motor diesel engine suitable incorporating a governor and formed as an embodiment of the invention, mounted at the stern of a small-sized ship or boat;

Figure 2 is a sectional side view on an enlarged scale, of the inside of the diesel engine of Figure 1;

Figure 3 is a sectional side view, taken from the rear of Figure 2 showing on an enlarged scale various essential portions of a first embodiment of the floating-lever type governor;

Figure 4 is a partial sectional view taken on the line IV-IV in Figure 3;

Figure 5 is a sectional view, taken on the line V-V of Figure 2 and represents a second embodiment of the invention;

Figures 6 to 8 in combination represent a third embodiment of the invention, of which Figure 6 is a sectional side elevational view, showing in enlargement the floating-lever type governor of the third embodi-

ment, Figure 7 is a sectional view, taken on the line VII-VII of Figure 6, and Figure 8 is also a sectional view, taken on the line VIII-VIII of Figure 6; and

Figure 9 represents a fourth embodiment of the invention and is a sectional side elevation of essential portions inside a diesel engine.

Referring first to Figures 1 to 4, which in combination represent a first embodiment of the present invention, it will be seen from Figure 1 in particular that
10 securely mounted at the stern of a small-sized ship or boat 1, is an outboard-motor M, which broadly comprises an internal combustion engine, namely a diesel engine 2 and a drive unit 3. By the engine 2 and through a
15 propeller shaft 10 which is vertically housed in the drive unit 3 and connected to a crankshaft 6, a propelling screw 4 is driven to rotate so as to propel the boat 1 in the direction shown by an arrow A. For the steering of the boat 1, a steering handle 5 is
20 provided to project toward the bow in a manner capable of being operated toward the starboard and the port on the boat.

In this internal combustion engine 2, the crankshaft 6
25 extends vertically and accordingly pistons 7 of the engine are so arranged as to reciprocate horizontally in cylinders 12: As can be best seen from Figures 1 and 2 in combination, a combustion chamber is defined within the cylinder 12 between the piston 7 and the cylinder
30 head 9, which latter houses injector units 8 facing the tops of the pistons 7. As a result of the combustion of fuel injected into the combustion chambers by the injectors 8, the pistons 7 undergo reciprocating motion

slidably along the cylinders 12 to rotate the vertically disposed crankshaft 6 and, through the drive unit 3, the propeller screw 4 as before mentioned.

5 Each injector unit 8 is provided with a lever for controlling the amount of fuel injected thereby, which is not shown but which can be secured to a plunger (also not shown) and may be arranged so that by means of a
10 fork 14 secured to a control rod 11 vertically movable in directions D and E of a bidirectional arrow in Figure 3, which are parallel with the axis of the crankshaft 6, it may be operated to rotate in the directions D and E respectively for decreasing and for increasing the amount of the fuel injected.

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In an upper portion, the internal combustion engine 2 is provided with a floating-lever type governor. As shown in Figure 3, which is an enlarged partial side elevation in section viewed from the opposite side from that of
20 Figure 2, a governor pulley 16 which is rotated through a timing belt 15 is rotatably supported by a bearing 17, and carries a governor shaft 18 for rotation therewith. Mounted on the shaft 18 are governor weights 19, a governor spring 20 and a vertically slidable governor
25 spindle 21. The arrangement described above operates as follows:

When the governor weights 19 swing outwardly due to rotation of the engine 2 causing the governor to operate, the governor spindle 21 undergoes lowering in
30 its position, whereby a floating lever 23 is rotated, with a shaft 22 as the fulcrum of the motion. Then, through a control lever 26 which is mounted in the cylinder head 9 located at the left side in Figure 3, in

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a manner capable of being rotated with a shaft 25 as the fulcrum for the rotation, and which is coupled to the floating lever 23 through a link member 24 which in turn is connected to an end of the lever 23, the up and down
5 motion of the spindle 21 is transmitted to change the position of the control rod 11 for example in the direction D for increasing or reducing the amount of fuel injected.

10 In the floating-lever type governor structured as above, the spring force of the governor spring 20 borne by a spring stop 28 integrally structured with the governor housing indicated at 27 and the centrifugal force of the governor weights 19 can in combination function as
15 inwardly directed force, so that the amount of motion or change in position of the spindle 21 can change in proportion to a change in the speed of rotation of the engine 2. With this governor, further, this can be pre-assembled in a cover member 29, and simply by
20 adjusting a gap H between the governor spring 20 and the spring stop 28 (Figure 3), calibration of the governor can with ease be accomplished. A governor assembly thus prepared can be easily mounted in an upper end portion of a cylinder block 30 of the internal combustion engine
25 2.

As shown in Figure 4 showing a sectional plan view taken on line IV-IV in Figure 3, the shaft 22 supporting the floating lever 23 is rotatably secured to a regulator
30 lever 31, which in turn is connected to a regulator-lever shaft 32 having a regulator handle 33 attached thereto.

Between a pin 34 mounted on the regulator lever and a pin 35 mounted on the regulator-lever shaft 32, a torsion spring 36 is disposed, which exerts a spring force to bias the regulator handle 33 to its position for decelerating the engine. Thus, by the function of the spring 36, the pins 34 and 35 are normally in a mutually contacting position as indicated at P in Figure 3. All parts associated with the regulator lever 31 such as the spring 36 can be pre-assembled on a cover member of a regulator-handle support 37, and in the form of an assembled unit, mounted at an upper side portion of the cylinder block 9.

The regulator handle 33 is connected to the steering handle 5 located in a stern portion of the ship or boat 1 (Figure 1) through a Bowden wire (not shown) so that by rotating a twist grip of the steering handle 5 about the axis of the latter in directions shown by an arrow R in Figure 1, it may be operated to cause the regulator lever 31 to rotate, whereby the position of a shaft 38 of the lever 31 undergoes a change in position and, through a link member 39 and the control lever 26, the control rod 11 undergoes motion to effect acceleration or deceleration of the engine.

Generally speaking, if acceleration and deceleration of an internal combustion engine is effected through the operation of a regulator handle such as that shown at 33 with use of a floating-lever type governor such as the one described above, the force required for this operation can be only small. With use of the floating lever type governor according to the present invention in an internal combustion engine, the operation in

question can be effected simply by way of rotating a grip of the steering handle 5, which can be worked only with an extremely limited operating force, so that ease of the operation for acceleration and deceleration of the engine can be enhanced. That is to say, the operation for accelerating and decelerating the engine can be smoothly and at an improved efficiency performed simply by rotating the twist grip of the steering handle.

10 From the viewpoint, among others, of making the drive system lighter in weight and smaller in size, it is generally required of outboard-motor engines that they can operate at a high speed of rotation and produce a high output at a low torque. On the other hand, in case of the use of a dog clutch in the drive system as is generally practiced, there lies a difficulty in raising the minimum speed of rotation of the engine. Thus, in the case of outboard-motor engines, the range of working speeds should necessarily be broader in comparison to the cases of engines for other than an outboard motor. With the conventionally widely utilized all-speed mechanical type governors, an extremely high power is required for operating the regulator handle during a high speed navigation, and they can hardly be operated with use of such an operating grip as is generally made use of in the case of outboard motor engines. Thus, there is a need for a governor arrangement as proposed according to the present invention.

30 With conventional governor devices, the power required for their operation increases in proportion to the square of the speed of rotation, and for example in the

case of an engine of 800-5000 rpm as required with outboard motor engines, providing that the required operation power during rotation at the lowest speed is constant, the maximum required operating power is 1.92 times as great as that in the case of an engine of 800-3600 rpm:

$$\frac{(5000/800)^2}{(3600/800)^2} = \left(\frac{5000}{3600}\right)^2 = 1.92$$

In connection with the operating power during rotation at the lowest speed, this should necessarily be of a (constant) lowest required value so that the governor can operate as such during idling.

Taking the above into account, it is now feasible to make use of a diesel engine for an outboard-motor internal combustion engine even though the fuel injection control mechanism is complex.

Now, in cases of overhead cam type diesel engines, it is possible to mount the camshaft directly over the cylinders. According to the present invention, however, it is devised that in order to reduce the total length of the engine so as to make it adapted for use as an outboard-motor engine, a camshaft 41 (Figure 2) is disposed at as low a position as possible relative to the cylinder head 9, and in addition, the injector units 8 are disposed at an inclination relatively close to the camshaft 41 and operated through rocker arms.

As shown in Figure 2, further, the internal combustion

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engine 2 is enclosed by a lower cowling 42 and an upper cowling 43. Whereas the lower cowling 42 is fixed as a part of the drive unit 3, the upper cowling 43 is mounted in a manner capable of being removed with ease
5 by releasing a fixing handle 44, so that with this upper cowling 43 opened, operation can be readily carried out for such as inspection, maintenance and so forth.

Thus, according to the present invention, it advantageously is feasible to pre-assemble the structurally
10 complex governor and regulator handle mechanism on their respective cover members and mount them, in their assembled state, to an upper portion of the cylinder block. Advantageously, the number of assembling steps
15 can therefore be reduced, and any required adjustment operations can be performed with ease and accuracy. Also, as before stated, inspection and/or maintenance of the governor can easily be effected simply upon opening the upper cowling.

20 Now, with reference to Figure 5, which shows a sectional view taken on the line V-V in Figure 2 and represents a second embodiment of the invention, a governor 46 is provided at the rear of and adjacent to a crankcase 45,
25 on the right hand side of the cylinder block 30, whilst on the left hand side of the block 30, there is disposed an oil filter 47. Fuel injection pumps 48 and nozzle 49 together form the injector units, which are mounted to the cylinder head 9 again in a pre-assembled form. In
30 the illustrated internal combustion engine 2, of the relatively large-size members to be incorporated to the engine, the fuel injection pumps 48 are mounted to the cylinder block 9, whilst the governor 46 and the oil

filter 47 are separated, one being located on the right and the other on the left of the cylinder block 30, so that the engine as a whole takes a generally oval configuration in plan as seen from Figure 5, which is a suitable engine configuration for an outboard motor. Further, the whole of the engine is covered by a case (not shown). In Figure 5, the reference character 50 denotes an air intake pipe, one end of which is in communication with an induction port 51 in a right hand side wall portion of the cylinder head, while the other end opens in the vicinity of the crankcase 45. This air intake pipe 50 extends along the right hand side face of the cylinder block 30 and the crankcase 45, and adjacent its inlet is an end portion which is curved along a front end portion of the crankcase 45 to reach the vicinity of the center plane 0-0. By providing such an elongate air intake pipe 50, it is possible to enhance the inertia effect of the intake air column and thus improve the engine performance.

In addition to the above arrangement, in which an end portion of the air intake pipe 50 is curved to reach a point in front of the crankcase 45, a starter motor 52 is so disposed as to lie at a point diagonally left front of the crankcase 45, therefore the engine can as a whole be in balance with respect to its left and right halves. The injector unit 8 is disposed in a valve arm case 53 so as to project to the right hand side and a valve arm 55 is placed in a central portion, whilst elements such as a camshaft 56 and a valve arm 57 are positioned towards the left side, so that the components within the valve arm case 53 are also in balance with respect to the left and right half portions of the valve

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arm case.

In the second embodiment of the invention considered above, the crankshaft 6 extends in the vertical direction and the engine is adapted to be mounted on a ship or boat in a position in which its cylinder axis extends along the axis of the ships hull, while the governor 46 and the oil filter are disposed on opposite sides of the cylinder block 30, so that the engine as a whole has a compact structure with a configuration generally resembling an oval comprising left and right half portions in balance. Thus, an outboard-motor engine can be obtained which is comparatively light in weight and small in size and yet has a high output. Further, the pre-assembled fuel injection pump 48 is set in the cylinder head 9 to provide the structure of the injector unit 8 as before stated, whereby compactness of the engine can be further enhanced.

Figures 6 to 8 in combination represent a third embodiment of the present invention, which in particular is concerned with an improved structuring of the governor of the type considered above.

With the governor 46 of the present embodiment, when it is rotated and the governor weight 19 is therefore brought into an open position, the governor spindle 21 becomes forced downwardly in Figure 6. The downward motion of the governor spindle 21 is transmitted to one arm of a rocker lever 13 against which the spindle 21 abuts, as shown in Figures 7 and 8. This rocker lever 13 is rotatably supported intermediate its ends by a shaft 65 carried on two support member 58 secured to a

governor cover 54. At its other end the rocker lever 13 engages a regulator spring 59 mounted in the governor cover 54, so that the position of the lever 13 is determined by the balance between the force of the governor weight 19 and the load of the regulator spring 59.

At the end which abuts the governor spindle 21, the first lever 13 is provided with an abutment member 60, against which one end of the floating lever 23 abuts, while the other end of the lever 23 is connected to the control lever 26 through the link 24 (Figure 6).

As described above, and as can be seen from Figure 6, in this embodiment of the invention only an arm portion of the lever 13 lies between the governor weight 19 and the governor spindle 21, this arm of the lever 13 having abutment members 60 on its front and rear faces, so that the length of the arrangement, particularly in the axial direction, can be remarkably reduced in comparison to conventional floating-lever type governor structures in which springs are provided about the governor weight.

The control lever 28 is connected through a pin 61 to the control rod 11 for effecting an increase or a decrease in the amount of fuel injected from the injector units 8, and is constantly biased by an idling spring 62 toward the direction for increasing the quantity of fuel injected as depicted by arrow H and, in consequence of this, the floating lever 23 is constantly maintained in contact with the first lever 13. The first lever 13 therefore undergoes motion while a balance is maintained between the force exerted by the

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governor spindle 21 and that exerted by the regulator spring 59, and in accordance with such motion of the lever 13 the floating lever 23, too, undergoes motion, together with the control rod 11.

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The idling spring 62 has a lower spring force than the regulator spring 59, and therefore most of the axial force on the spindle 21 generated by the centrifugal force of the governor weight 19 is borne by the regulator spring 59.

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The shaft 22 providing the fulcrum for the rotation of the floating lever 23 is linked to the regulator lever 31 shown in Figure 6, which is rotated about the pin or regulator-lever shaft 34 to cause a change in the position of the shaft 22, and the fuel injection from the injector unit 8 can thus be adjusted externally to increase or decrease by operating on the regulator lever 34. The regulator-lever shaft 34 is set in the governor cover 54 as shown in Figure 8.

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In the floating-lever type governor 46 of this third embodiment of the invention, the regulator spring 59 which in conventional governors is disposed about the governor weight 19 is placed outside a peripheral portion of the governor weight, whereby the structure around the governor weight can be simplified and made compact. Moreover, because the height of the governor 46 can be reduced; the height of the internal combustion engine 2 in the axial direction of the crankshaft 6 can also be reduced. Further, the position at which the flywheel 63 (shown in Figure 1) is mounted on top of the crankshaft 6 can also be lowered.

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5 The governor 46 of this embodiment is also structurally characterised in that the force is mainly borne by the first lever 13 with little force being transmitted to other members such as the link 24 and so forth. Also, all the members of the governor 46 such as the governor weight 19 and governor spindle 21, and also weight support pivots 64 can be pre-assembled in the cover member 29 so as to provide a built-in structure of the governor; not only this, but also all members such as the shaft 65 for supporting the first lever 13 operatively associated with the governor spindle 21, the regulator spring 59 which abuts against the first lever 13, and the regulator-lever shaft 34 for variably and pivotally supporting the floating lever 23 which is associated in operation with the governor spindle 21 through the first lever 13 and transmits the motion of the spindle 21 to the control rod 11 to operate the latter to increase or decrease the amount of fuel injection by the injector units 8, can be pre-assembled in the governor cover 54 before assembly of the engine. Because of this, subsequent adjustment operations may hardly be required.

25 In an outboard-motor engine incorporating a governor in accordance with the present invention, the length of the vertically directed crankshaft can be reduced; thus, if a flywheel is mounted at the top end of the crankshaft, the eccentric load on the main crankshaft bearing is reduced, and the whole structure of the engine can be advantageously made compact and light in weight.

Further, with such a governor, it is possible to perform a pre-machining operation so as to adapt it to a

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particular governor mount, therefore mounting of the governor relative to the engine can be performed rapidly and with ease. Also, any required adjustment after the mounting of the governor can be easily effected. Thus,
5 the present invention is highly useful in the mass-production of internal combustion engines.

The floating-lever type governor 46 according to the invention operates as follows. As the engine 2
10 commences rotation, the governor spindle 21 may undergo lifting. At the outset of starting of the engine, there is a gap H' of about 3 mm present between the first lever 13 and the regulator spring 59 (Figure 7), and before this gap H' becomes closed, the force of the
15 governor weight 19 and that of the idle spring 62 are in balance and the governor performs governing of the idling rotation. As the speed of rotation then increases, the force exerted by the governor weights 19 becomes greater, and the regulator spring 59 commences
20 functioning through the first lever 13.

The regulator spring 59 has a certain preliminary load, and until the speed of rotation of the internal combustion engine 2 reaches a certain value and the
25 force exerted by the governor weights likewise exceeds a certain value the regulator spring 59 remains inoperative; during such time, the floating lever 23, too, remains inoperative, and the governor effects no governing action. In this respect it may be referred to
30 as a so-called maximum-minimum governor.

As the speed of rotation of the engine 2 rises to a greater value, the force of the governor will exceed the

preliminary load on the regulator spring and the governor spindle 21 is thus able to displace and the regulator spring 59 is compressed whereby, through the floating lever 23, link member 24 and control lever 26, the control rod 11 is moved in a direction such as to suppress the fuel injection; the speed of rotation of the engine 2 thus becomes restricted to a maximum value.

With the engine 2 in idling condition, the regulator spring 59 is in the inoperative condition and the force of the idling spring 62 is balanced against the governor force; thus, as soon as the speed of rotation of the engine falls below a certain value the amount of fuel injected is immediately increased, while as soon as the speed of rotation exceeds a certain value on the other hand, the fuel injection is reduced. It will be readily understood that the idling spring 62 can be provided with a suitable spring constant enough to determine a selected idling speed mentioned above.

In practice, however, friction occurs in the link system comprising the control lever 26, link member 24 and floating lever 23, and in order to enable the spring 62 to operate and overcome the friction, the spring constant of the spring 62 should necessarily be of a sufficiently great value for this purpose. Otherwise, it will be difficult to obtain a governed idling condition as mentioned above, and this must be taken into consideration when determining the spring constant of the idling spring 62.

Also, it must be borne in mind that at idling speed of the engine, the governor force is extremely small, so

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that with the engine 2 in a stopped condition, that is, upon starting of the engine, the amount by which the idling spring 62 can contract indispensably tends to be relatively small and the fuel injection tends to be
5 insufficient at the starting of the engine. Taking this point into consideration, the idling spring 62 is connected in series with an auxiliary spring 66 through a hook 67 and an adjustor 68, this spring 66 being of a smaller spring constant than the idle spring 62 and
10 operating to increase the fuel injection at the starting of the engine.

The spring 66 is set at a load such that in the condition in which the adjustor 68 abuts against the
15 idling-spring mount 69, it is smaller than the sum of the governor force at the idling speed and the weight of the link system but greater than the weight of the link system.

20 Thus, in a condition where the internal combustion engine 2 rotates at a speed of rotation exceeding the idling speed, the adjustor 68 is brought into contact with the idling spring mount 69 and the spring 66 can no longer function as a spring; in this condition, this
25 spring can only exert its own spring constant.

Then, when the engine is stationary, the spring 66 compensates for the shortage in contraction of the idling spring 62 and urges the rod 11 in the direction
30 of the arrow H of Figure 6 for increasing the fuel injection, until the control rod 11 abuts against the idling spring mount 69, in which position of the control rod 11 a maximum fuel injection is obtained, whereby the

starting of the engine can be effected with certainty and rapidity.

The arrangement for displacing the control rod 11 through the idling-spring 62 to the position for maximum fuel injection when the engine 2 is stationary need not be limited only to the above-described arrangement, but may comprise any of a number of other arrangements. For example, as shown in Figure 9, an idling-spring chamber 70 may be formed in an upper portion of the cylinder head 9, above the control rod 11, with the idling-spring 62 housed in this chamber 70, whereby an extremely easy access to the idling-spring 62 can be obtained.

By applying such an idling-spring arrangement to an internal combustion engine having a floating-lever type governor, the operation of the governor can be stabilized. Since the idling-spring chamber is formed in an upper portion of the cylinder head, inspection, maintenance and adjustment of the fuel-injection control system can be effected with extreme ease.

When the idling-spring chamber is disposed in an upper portion of the cylinder head as above, it becomes feasible to provide a breather outlet above the idling-spring chamber. From such a high position, the blow-by gas can be discharged in a condition of being substantially free of oil residue, that is of comprising air alone, so that undesirable discharge of oil out of the engine can be effectively prevented from occurring.

As described in detail above, the present invention provides a governor in an internal combustion engine in

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which the motion of the governor spindle is transmitted through a floating lever and a link member to a control rod for controlling the fuel injection, and the regulator handle of the governor is operatively
5 associated with a twist grip of the steering handle of a ship or boat so that simply by operating the grip which requires no great force for operation, acceleration and deceleration can be controlled with ease and accuracy, whereby the efficiency of the engine operation can be
10 remarkably enhanced.

Further, the governor can be made lighter in weight and more compact in structure than comparable conventional devices, and this governor can be incorporated in an
15 internal combustion engine in a compact manner. Thus, the invention can enhance the efficiency of engine assembly and simplify the inspection and maintenance operations on the engine.

20 Finally, it is possible to let the fuel injection be automatically increased whilst starting the engine, whereby the engine starting efficiency can be improved.

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CLAIMS

1. A vertical-crankshaft type outboard-motor engine having a governor the movements of which are transmitted in use, via a floating lever and a link member to a control rod operable to control the amount of fuel injected into the engine, in which the governor is mounted to a cylinder head of the engine and a regulator handle for manually pivoting the floating lever is connected through link means to a twist grip of a steering handle.

2. A vertical-crankshaft outboard-motor engine as claimed in Claim 1, in which the governor is arranged so as to be driven by a timing belt mounted above the cylinder block for driving a camshaft.

3. A vertical-crankshaft type outboard-motor engine as claimed in Claim 1 or Claim 2, in which the governor and the regulator handle are pre-assembled on respective cover members prior to being mounted on the cylinder head.

4. A vertical-crankshaft type outboard-motor engine as claimed in Claim 1, in which a first lever is rockably supported in the vicinity of the governor, the said first lever having one end disposed between a governor spindle and the floating lever, and the other end facing a regulator spring.

5. A vertical-crankshaft type outboard-motor engine as claimed in Claim 4, in which the governor, comprising the governor weights and the governor



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spindle, is carried on a governor mount, and a shaft supporting the first lever operatively associated with the governor spindle, the regulator spring against which the said other end of the first lever abuts, and a
5 regulator-lever shaft variably supporting the fulcrum of the floating lever abutting against the said one end of the first lever, are all assembled on a governor cover member.

10 6. A vertical-crankshaft type outboard-motor engine as claimed in any preceding Claim, in which the control rod for controlling the amount of fuel to be injected into the engine is biased by an idling spring constantly urging the control rod in the direction for
15 increasing the fuel injection, the idling spring having a spring constant such that it is substantially balanced by the force of the governor when the engine is operating at the idling speed.

20 7. A vertical-crankshaft type outboard-motor engine as claimed in Claim 6, in which there is further provided an auxiliary spring for displacing the control rod via the idling spring to a position for maximum fuel injection only when the engine is stationary, whereby
25 when the governor force is small such as at the commencement of the engine start, the fuel injection is automatically increased to a maximum value.

30 8. A vertical-crankshaft type outboard-motor engine as claimed in Claim 7, in which the idling spring and the auxiliary spring are connected in series through a hook and an adjuster.



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9. A vertical-crankshaft type outboard-motor engine as claimed in Claim 7, or Claim 8, in which the idling spring is housed in a chamber in an upper portion of the cylinder head of the engine, above the control rod.

10. A vertical-crankshaft type outboard-motor engine as claimed in any preceding Claim, in which the governor is mounted to a cover member, which in turn is secured to an upper end face of the cylinder block.

11. A vertical-crankshaft type outboard-motor engine as claimed in any preceding Claim, in which the floating lever is mounted on a regulator-lever shaft through a regulator lever, the regulator-lever shaft being in turn supported by a regulator-handle support disposed at a side wall of said cylinder block.

12. A vertical-crankshaft type outboard-motor engine substantially as described with reference to and as shown in any of the accompanying drawings.
