

R. ABELL.
LIQUID FUEL MOTOR.
APPLICATION FILED APR. 25, 1916.

1,424,705.

Patented Aug. 1, 1922.

2 SHEETS—SHEET 1.

FIG. 1.

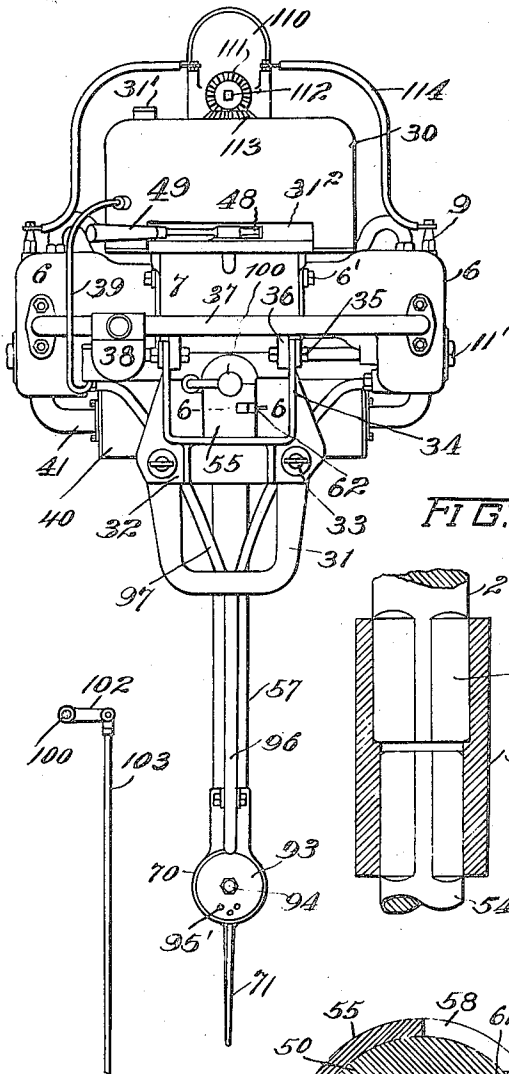


FIG. 2.

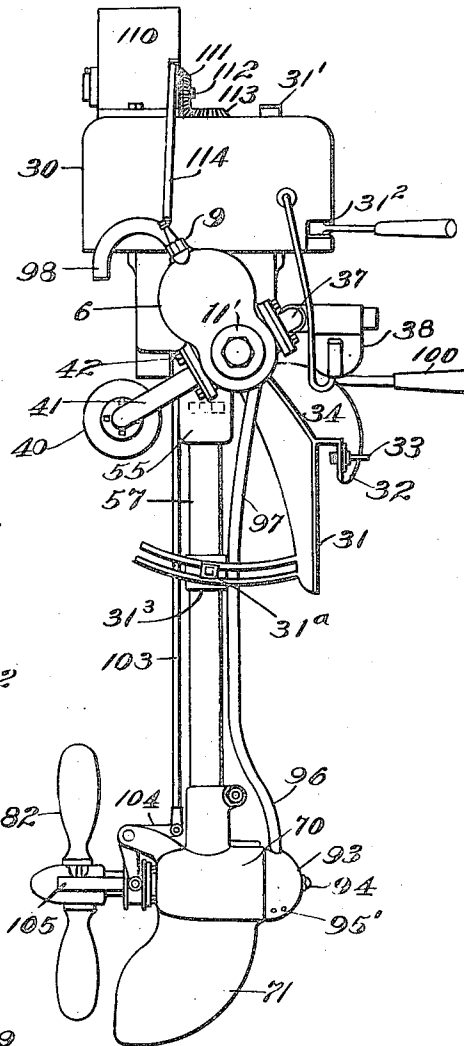


FIG. 9.

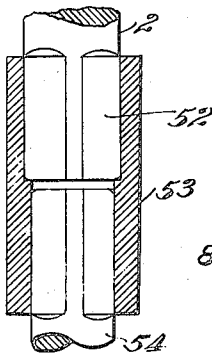


FIG. 3.

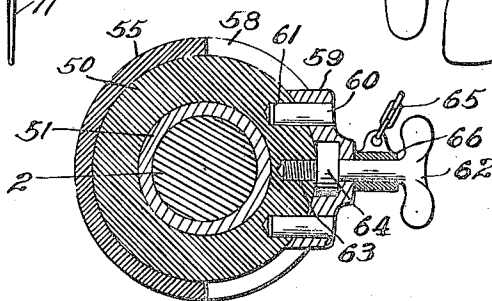


FIG. 6.

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2 SHEETS—SHEET 2.

FIG. 4.

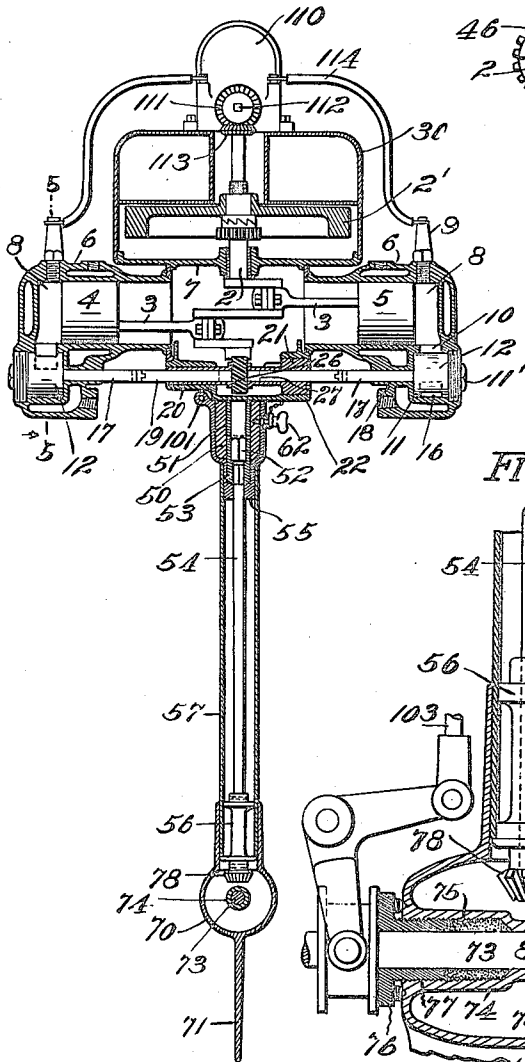


FIG. 11.

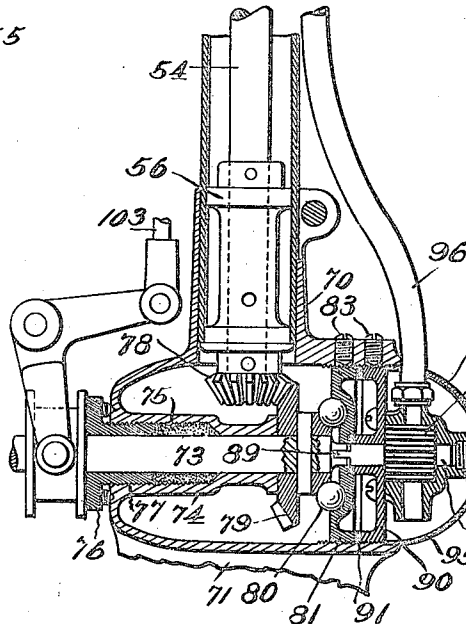


FIG. 7.

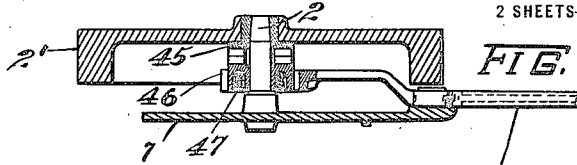


FIG. 8.

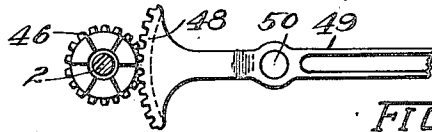


FIG. 5.

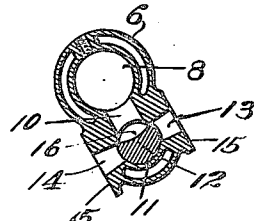


FIG. 12.

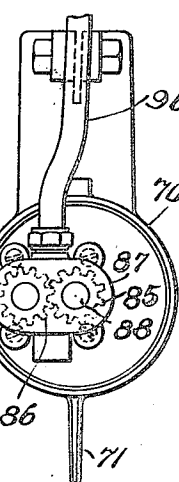
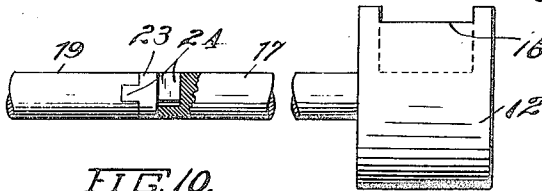


FIG. 10.



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ROLLIN ABELL, OF MILTON, MASSACHUSETTS.

LIQUID-FUEL MOTOR.

1,424,705.

Specification of Letters Patent.

Patented Aug. 1, 1922.

Application filed April 25, 1916. Serial No. 93,548.

To all whom it may concern:

Be it known that I, ROLLIN ABELL, a citizen of the United States, residing at Milton, county of Norfolk, Commonwealth of Massachusetts, have invented certain new and useful Improvements in Liquid-Fuel Motors, of which the following is a specification.

This invention relates to hydro-carbon motors, and more particularly to a liquid fuel motor of a type designed for attachment to and the propulsion of boats.

Heretofore, so-called outboard motors constituting a part of propelling apparatus for ready attachment to small boats, have been of the two-cycle type and are objectionable because of the vibrations set up during operation, and when of the single cylinder form are deficient in power. Larger units or multiple cylinders may be employed, but at a consequent increase in weight to such an extent as to make the apparatus unwieldy.

While four-cycle engines may be used in detachable boat propelling apparatus, an objection to the usual form of the latter type is the number of valves and operating parts therefor when the valves are of the poppet-type, which not only add to weight but increase the complexity of the engine and cost of up-keep and operation, and require careful attention and adjustment.

It is one of the objects of the present invention to provide a simplified internal combustion or hydro-carbon motor in which the pistons are opposed, and which involves the novel arrangement of valves of such a type as to eliminate as far as possible the number of pieces ordinarily required in motors utilizing poppet-valves. Therefore, one of the features of the present invention contemplates a motor having opposed cylinders and pistons operable therein, and having a set of rotary cylindrical valves, one for each of the cylinders, and with a novel and simple actuating means for said valves to operate them in proper time, requisite for the operation of the pistons on the four-cycle explosion principle. In this connection a feature of the invention resides in a motor in which the cylinder casings are substantially duplicate in form and construction, and are detachable and interchangeable relatively, so as to be readily adjustable in predetermined position with respect to the crank-shaft mounting or support, thus sim-

plifying the construction of the engine. The cylinder or piston casings are each provided with symmetrical and oppositely disposed transverse ports which are adaptable for communication with either a fuel supply connection at one side of the motor, or for connection to a gas discharge or muffler disposed on the opposite side of the engine, the arrangement and formation of the transverse ports providing for the ready connection of the cylinder casings to the inlet or exhaust connections when the casings are mounted in proper position on either side of the crank-shaft.

It is a further object of the invention to provide a motor in which the valves controlling the admission of fuel and gases to and from the piston chambers are so constructed, arranged and disposed with relation to the gas ports of the piston-casings that the temperature of the valve when in operation, during the running of the engine, may be controlled by subjecting the valve to the cooling action of the incoming fresh fuel from the carburetor, the effect of which will be to remove a portion of the heat that is transmitted to the valve during the explosion of charges of gas in the engine-casing and by the outflow of hot exhaust gases. To that end a feature of the invention comprises a valve which at once serves the dual functions of controlling the inlet of cool, fresh vapor fuel to the explosion chamber of the respective piston-casing, and also controls the discharge of the hot exhaust gases through an exhaust port. The valve as contemplated in this invention is of the rotary type and of cylindrical form, and has a transverse passage or portway which is adapted during the operation of the motor and movement of the valve to pass alternately from an intake port in the piston cylinder to a discharge port. The said passageway, when registering with either of said ports, serves to open communication therewith to the combustion chamber in the piston casing. This alternate exposure of the valve to an incoming and cool gaseous vapor after exposure to an outgoing or exhausting hot gas, measurably lowers the temperature of the valve over that form of a valve which is subjected in its operation to contact with hot gases alone. An advantage of the provision of a valve of this type which is subjected to the cooling action of an in-

coming low temperature gas is that the valve will not be so liable to expand and bind or stick in its casing, and will be more easily kept lubricated.

5 It is a further object of the present invention to provide an outboard boat-propelling motor which is substantially self-contained in its construction and yet which provides for the ready assembling of the
10 propeller and its gearing with the power plant or motor or their disconnection with ease and facility so as to permit these detached elements to be more readily ported or packed for shipment in a compact arrangement. To accomplish this desirable feature
15 a characteristic of the invention consists in a motor or power plant to which there is detachably connectible a structure which consists of a propeller and associated driving
20 gears with a support having a member adapted to be detachably connected to a complementary part of the motor. In the present instance the detachable propeller supporting structure is further utilized as a tubular post upon which is supported a steering
25 blade or rudder; the manner of connecting the rudder-post or tube to the motor proper providing for the swivelling of these parts relatively to permit of the steering of the boat to which the motor may be applied.

30 For the further simplification of propelling apparatus of the type including a motor adapted to be detachably connected to a portion of the boat to be driven, it is an object of the invention to provide for the
35 steering of the boat and for the control of the direction of propulsion thereof through a single, manually operable tiller or control lever. To that end, one of the features of
40 the invention involves the steering tiller or lever by which the rudder is turned, and which is connected to a reversible propeller in such a manner that the one lever may be used to turn the rudder and to actuate a
45 mechanism which will effect a reversal of the position of blades of the propeller, when the latter is of the reversible-blade type.

It is advantageous in boat-propelling apparatus to dispose the motor elements so
50 that they will be protected both from the spray and against liability of injury from the occupants or cargo of the boat, and to dispose of them in such a manner that they may be readily reached when it is necessary
55 to make adjustments as occasion requires. It is therefore a further object of the invention to provide a self-contained power or propelling apparatus for boats in which the carburetor, the muffler, and the magneto,
60 when one is employed, are disposed in the most convenient positions, and in which they will be least liable to injury. In the present apparatus, the carburetor is connected to a manifold which is disposed transversely across the engine and is connected to

reversible or interchangeable piston-casings, and the muffler is disposed below the motor proper and transversely as to one side thereof, the magneto being preferably mounted
70 upon the upper portion of the apparatus where it is operatively connected to a driving means upon the upper end of the crank-shaft, and in which position it is most remote from the spray.

In further carrying out the provision for
75 the compact arrangement of the elements of the apparatus, it is desirable to provide a starting device which is connected to the engine-shaft at a position intermediate the motor body, and a superimposed fuel tank
80 which may be utilized, as here disclosed, as a support for the magneto.

With these and other objects in view, as will be more clearly set forth in the accompanying specification, the invention consists
85 of a power plant or motor consisting of various improvements in the arrangement, construction, and combination of parts, hereinafter set forth, and illustrated in one of its embodiments in the accompanying drawings, in which

Fig. 1 is a front elevational view of the apparatus as ready to be applied to a boat to be propelled.

Fig. 2 is a side elevation looking toward
95 the left end of Fig. 1.

Fig. 3 is a detail of a portion of the connecting means between the steering lever and the reversible propeller.

Fig. 4 is a vertical section taken on an
100 irregular line substantially in the plane of the axis of the crank-shaft and the axis of the pistons and through the bearing of the valve coupler.

Fig. 5 is a vertical section on line 5—5 of
105 Fig. 4, omitting the spark plug.

Fig. 6 is a horizontal cross-section on line 6—6 of Fig. 1 on an enlarged scale showing in detail the swivel locking connection between the tubular rudder post and the motor
110 body.

Fig. 7 is an enlarged detail, in side elevation, of the starting device, and

Fig. 8 is a plan view of the same showing the crank-shaft in cross section.

Fig. 9 is an enlarged detail view of the coupling socket for detachably connecting the crank-shaft with the extension-shaft.

Fig. 10 is an enlarged detail view, showing the flexible coupling between a valve
120 stem and the coupler for driving the same, and

Figs. 11 and 12 are detail sectional views showing the pump arranged in the propeller-shaft housing at the foot of the rudder post.

In the form of the motor here illustrated, piston-casings are disposed in diametrically opposite positions as to a crank-shaft which is mounted in a suitable support or bearing structure, the casings being each provided
130

with chambers or pockets in each of which there is rotatably mounted a substantially cylindrical valve having at a suitable location in its circumference a passage or port-way which is adapted to be alternately presented to inlet and outlet ports formed in each piston-casing. The rotary valves of the piston-casing are adapted to be actuated by a form of driving connections deriving power from the crank-shaft. In the present embodiment of the invention, the motor includes a crank-shaft 2 having a plurality of oppositely disposed cranks connected by respective connecting rods 3 to pistons 4 and 5 which in the present arrangement are shown as oppositely disposed and co-axially arranged in respective and substantially duplicate piston-casings 6—6. The inner ends of the casings 6—6 are adapted to be suitably connected, as by bolts or screws, to an intermediate support or bearing structure 7 in which the crank-shaft 2 is appropriately journaled, the support 7 preferably enclosing the cranks and connecting rod. The piston-casings 6, being substantially duplicate in construction are preferably so designed as to be interchangeable in position upon the crank case 7 and are provided, each with a symmetrical arrangement of ports, so that the casings may be readily connected, when in position on opposite sides of the crank case 7, to the gas or vapor supplying means, or the gas discharge means.

In carrying out and practising the present invention, an engine has been constructed and successfully operated in which each of the piston-casings is provided with a rotary valve disposed between opposite ports, the valve being arranged to be driven in proper time through suitable connections with the crank-shaft 2. The driving connections and valves obviously are capable of various constructions, as may be required in practice. Each casing 6 is provided with a central longitudinal bore in which its piston 4 or 5, as the case may be, may reciprocate, one end of the casing being provided with a clearance or combustion chamber 8 in which a firing of a charge of gas may be accomplished by an electric spark plug 9 or other suitable means. Leading from one side of the combustion chamber 8 is a port-way or passage 10 adapted to communicate with a chamber 11 in which there is turnably fitted a cylindrical valve 12, insertable into its respective chamber 11 through an opening at one side of its casing 6, and which is adapted to be closed by a cap 11¹ Fig. 4.

Disposed at right angles to the port 10 of the casing 6 and communicating with the valve chamber 11, Fig. 5, are diametrically opposite ports 13 and 14 terminating in parallel opposite faces 15 of the cylinder 6 and to which faces are adapted to be connected suitable gas or fuel supply and gas

exhaust means. By this arrangement of diametrically opposite inlet and outlet ports it is possible to use a single valve 12 to control the inflow of a fresh charge of gas, for instance through the port 13 to the intermediate port 10 leading into the explosion chamber 8 of the cylinder 6, and by the same valve control the exhaust of the burnt gases from the explosion chamber 8 and out through the port 14. This is accomplished by forming a transverse duct, passage or port-way 16 in the valve 12 and intermediate its ends, the port-way 16 being of such length that it will during its rotation open communication for a period of time between ports 10 and 13 to permit ingress of a charge during the suction stroke of the piston 5 and thereafter cut off the flow between the said ports and cover the port 10 during the compression and explosion period and subsequently during the exhaust stroke of the piston 5 open communication between the common port 10 and the exhaust port 14; the relative angular velocity or rate of rotation of the valve 12 being one-half that of the crank-shaft 2 and effect explosions of a charge in the cylinder 6 on the four-cycle principle. The port-way 16 is here shown as being circumferentially disposed about the surface of the valve body.

One of the novel features of the present invention resides in the arrangement and construction of the rotary valves 12 and in their disposition with relation to the engine-pistons and the crank-shaft, and in the driving means whereby the valves are operatively connected to the crank-shaft. In the present disclosure the piston-valves 12 are shown as arranged with their axes substantially parallel with the axes of their respective pistons, although in practice the valves may be otherwise arranged and disposed in the construction of an engine. The valves are here shown as arranged also with their respective axes co-axial and parallel with the axes of the pistons, the plane of the axes of the valves being parallel to the axis of the crank-shaft, but the axes disposed at right angles thereto, in such a manner that the axes of the valves is normal to the axis of the crank-shaft and laterally offset to the crank-shaft so as to provide for the utilization of a very simple and direct driving means for co-operatively connecting the crank-shaft and the axially alined valves. To achieve the axial alinement of the valves in a plane parallel to the plane of the axes of the pistons and crank-shaft and in a line transverse or normal to the crank-shaft in a relatively offset relation, the cylinder-casings 6—6 are secured by their fastening screws 6¹, Fig. 1, in a substantially diagonal or oblique position to the crank case, so that while the axes of the piston-casings intersect the axis of the crank-shaft, the axes of the

valves are alined in a plane slightly offset from the plane of the crank-shaft, the angular relation of the casing 6 being clearly indicated in Figs. 2 and 5. An advantage 5 obtained by the duplicate construction of the piston-casings 6 is that they are readily interchangeable and usable reversibly on either side of the crank-case 7, and by reason of the provision of the symmetrically arranged inlet and outlet ports 13—14 respectively, these may be reversibly utilized in 10 function and are adapted to be readily connected to either the gas supply connections at one side of the motor, or to the exhaust connections at the opposite side thereof.

The valves 12 are preferably so relatively disposed in their respective casings as to provide for the alternate introduction of combustible vapor into their respective explosion chambers 8 of the motor, so that 20 explosions occur alternately in the casings during the operation of the motor, one explosion taking place at each revolution of the shaft. The simultaneous operation of the rotary valves 12 is accomplished in such 25 manner as to bring their respective gas ducts 16 in proper sequence to communicate with the respective ports in the valve head by a driving means actuated by the crank-shaft. A simple and practical form of valve driving mechanism is here incorporated as comprising a coupling adapted to be connected with each of the rotary 30 valves 12 and to be operatively connected to the crank-shaft. As before stated, the valves 12 are arranged co-axially, and each is provided with an inwardly directed stem 17 working in appropriate bearings 18, and the inner ends of the stems 17 are connected 40 for positive rotary engagement with a co-axial driving rod or shaft 19 which is removably mounted in oppositely disposed bushings 20 and 21, the latter preferably being threaded in a complementary portion 45 22 of the crank case 7. It is desirable to so couple the valve stems 17 and the driving spindle or shaft 19 as to secure a positive rotary action and yet provide for a reasonable amount of play as between the connecting spindle 19 and the valves, to allow for 50 such axial disalinement or eccentricity as may occur in construction and by the movement of the respective parts in their journals; this coupling may be effected in various ways. A simple means providing for 55 this flexible and yet positive rotary connection consists of a coupling disk or member 23, Fig. 10, having on its opposite sides tongues 24 adapted to engage complementary recesses formed for their reception in 60 the adjacent ends of a valve stem 17 and the valve driving rod 19. By arranging the diametrical tongues 24 of the disk 23 at right angles to each other they will automatically lock against displacement between

the adjacent ends of a valve stem 17 and the operating rod 19 when these members are axially abutted against the coupling disks 23. Obviously there is such a flexible connection as 23 between each of the rotary 70 valves 12 and the operating rod 19.

To insure that the valves 12 will be properly assembled in the respective positions, either during the assembling of the engine or when they are being replaced after removal for inspection, the means for coupling 75 the valves and the valve rod 19 are preferably so designed that it is possible to connect them in the proper positions only. This may be accomplished by an eccentric or dogging relation of the parts as, for instance, by extending the tongues 24 and their respective slots but part way across the end faces of the coupling connection, as 80 shown in Fig. 10. Hence, the parts will go together in one relation only, and moreover permits the valves to be interchangeable. The valves 12 are so relatively positioned 85 as to obtain explosions alternately in the cylinders.

While the requisite rotary motion may be imparted to the valves 12 in diverse manners, by connecting them to the co-axial rod 19 and mounting upon this a driving device 90 the valves will be positively and simultaneously operated in a very simple and direct fashion. The driving device here contemplated includes a spiral gear 26 formed or mounted upon the central portion of the driving rod 19 and engaged and driven by 100 a complementary spiral gear 27 which is secured upon the crank-shaft 2 in the plane of the axis of the valve driving rod 19. This simple and direct connection of the crank-shaft through the gear-set 26, 27 is 105 efficient, practicable, and reliable, and the timing of the valve speed with relation to the speed of the shaft is accomplished by the predetermined ratio of the gears 26, 27; the rod or coupler being adapted to be 110 driven at one-half of the speed of the crank-shaft 2. To take up wear of the gears, and carry the end thrust of the driven gear 26, the bushing 21 is adjustable, axially in its bearing, as may be requisite to bear against 115 the adjacent side of the driven gear 26.

From the foregoing, it will be seen that I have devised and provided a motor of the double-opposed piston type, incorporating rotary valves for each cylinder, these valves 120 preferably being disposed with their axes parallel to the cylinder, and also respectively co-axial in their own arrangement, and have provided a simple driving connection connecting the valves for simultaneous 125 operation by a driving connection with the crank-shaft of the engine. It is understood that various structural modifications and arrangements may be resorted to within the skill of those advised in the art.

While an engine of this type may be utilized in a variety of adaptations, it is here illustrated as arranged and designed for use as a part of a boat propelling apparatus capable of being readily connected to or disconnected from small boats without the requirement of any substantial alteration of the construction of the boat. In such an arrangement the crank-shaft 2 is usually disposed in a substantially vertical position and is projected upwardly and is provided with a suitable fly wheel 2¹, which preferably is covered and protected by a superposed fuel tank 30, having a filling cap 31¹ and connected to the upper side of the crank-case 7. To provide for the ready connection and disconnection of the motor to a row boat or other vessel to be propelled, there is detachably connectable to the motor a suitably shaped bracket 31 having a forwardly overhanging transverse flange 32 provided with suitable clamp screws 33 by which the bracket 31, when hung upon the stern of the boat, may be detachably secured thereon. Upwardly extending arms 34 of the bracket 31 are detachably and pivotally connected by bolts or other suitable means 35 to lugs 36 on the front side of the crank case 7, Fig. 1, and by means of this pivotal connection 35 the angle of the vertical shaft with relation to the position of the bracket 31 may be readily obtained to provide for the proper disposition of a propelling apparatus hereinafter described, and which is connectable, detachably, to the motor casing.

In the present arrangement of the motor, the intake ports 13 of the valve chambers in the casing 6 are presented to the forward and upper side of the motor, and are connected to a transversely disposed manifold 37 by cap screws there being connected to the manifold 37 a suitable type of carburetor or generator 38, this being disposed above the motor supporting bracket 31 so that when the apparatus is mounted upon the boat the carburetor 38 is within convenient reach of the operator of the boat. The carburetor 38 is connected to the fuel tank 30 by feed pipe 39, Figs. 1 and 2, The exhaust from the engine is discharged through the lower and opposite ports 14 of the piston-casings 6 into a muffler or other exhaust device 40. In the present arrangement, the ends of the carburetor are connected by exhaust pipes 41 which are fastened by screws 42 to the faces of the exhaust ports 14 at the rear of the engine and below the case 7. By this disposition of the muffler 40 it is sustained below the general structure of the motor in an out-of-the-way position and most remote from the occupants of the boat.

When the fly wheel 2¹ is substantially covered and concealed by the fuel tank 30 mounted thereabove, it is desirable that a

simple, practicable and safe means be provided to manually turn the crank-shaft a sufficient number of revolutions to start the engine, and while this may be accomplished in practice in a variety of ways, I provide a simple starting device which preferably is disposed in a concealed position where it is not only out-of-the-way, but also lends to the compactness of the apparatus. The starting device, in one form, comprises as shown in Figs. 7 and 8, a ratchet wheel 45 secured on the shaft 2 and having in one of its side faces teeth which are adapted to engage with a driving pinion 46 slidably and rotatably mounted on the shaft 2 and normally projected by a spring 47 so as to mesh, when driven in one direction, with the teeth of the ratchet wheel 45 on the shaft 2. The slidable pinion 46 has circumferential teeth which are adapted to mesh with the teeth of a sector 48 formed on one end of a lever arm 49 which is pivoted at 50 at a position on a portion of the crank case 7 from which the longer and operating arm of the lever 49 may project forwardly to be readily accessible to the operator of the boat; the base of the tank 30 being provided with a slot 30² in which the operating lever 49 may play. To start the engine, the operator grasps the projecting handle or arm of the starting lever 49 and swinging it in one direction will cause the ratchet gear 46 to automatically yield longitudinally on the shaft 2 and ratchet across the teeth of the ratchet wheel 45 whereupon by throwing the lever 49 in the opposite direction the complementary ratchet teeth of the wheel 45 and the gear 46 will be interlocked by the action of the spring 47, and when sufficient power is applied to the starting lever 49 the crank-shaft will be rotated and produce a compression of a charge of fuel in one of the engine cylinders, which charge will be ignited in the usual manner when the ignition circuit is closed. For safety, in event of a back-fire, the pinion 46 will automatically run out of mesh with the short sector 48 as this is swung around, and clears the pinion.

It is one of the features of the present invention to provide a boat propelling apparatus of the outboard motor type in which the motor and the propeller and its mechanism connecting it to the motor may be readily connected to be utilized and easily disconnected, so that the two separate or main elements, that is, the motor, and the propeller, and its connecting mechanism, may be separated to permit the apparatus to be closely arranged for packing and transportation, and to permit of the separated structures being more easily handled during portage and assembly. To that end I have shown a structure in which the crank-shaft mounting or support is extended down-

wardly in an elongated hub or tubular portion 50, in line with the crank-shaft and having an internal bushing 51 terminating at a point somewhat within the lower end of the hub 50. The exterior of the hub 50 is turned cylindrically true, and the lower end of the crank-shaft 2 in the hub 50 is given polygonal form as at 52 to slidably receive the upper end of a tubular socket member 53 which has an internal contour fitting the polygonal end 52 of the shaft 2 so that the coupling member may be positively rotated by and with the shaft. The socket member 53 has at its opposite end a polygonal socket to receive a complementary polygonal end of an extension shaft 54 which is supported at its upper end in a bushing 55 and in its lower end in a bushing 56, each of which are appropriately secured in a tube 57. The upper bushing or head 55 has its upper end enlarged and turnably fitted upon the hub 50 of the motor casing or mounting, and is adapted for a limited turning or rotative movement thereon, but is held against axial movement when connected to the hub 50 by a supporting and locking means of suitable type. As shown in Fig. 6, the swivelling head or bushing 55, which is secured to the tube 57, is provided with a circumferential slot 58 of suitable length and width, and when the swivel head has been slipped upon the hub 50, it is turnably locked thereto by a detachable key or plate 59 of suitable length and the width of which is approximately equal to the width of the slot or way 58 in the head 55, and carries suitable dowel pins or projections 60 adapted to be inserted into respective pin pockets 61 formed to receive the same in the pendant hub 50, the pins serving to support the weight superimposed on the plate 59. The supporting plate or key 59 is adapted to be detachably connected to the bearing 50 when the head 55 is mounted thereon by a suitable fastening device here shown as consisting of a thumb screw 62 turnably fitting the plate 59 and engageable with a threaded aperture 63 in the hub 50, and also as having an annular shoulder 64 engaging on one side with a counter-sunk space of the plate 59. To prevent accidental loss or displacement of the head supporting or locking plate 59, it is preferably permanently connected to the motor by a suitable means, consisting in one form of a chain 65, having one of its ends attached by a swivel ring 66 to the shank of the thumb screw 62 where it projects through the locking plate 59.

Thus the tube 57 is turnably connectible to the crank-support or mounting and held against longitudinal movement by the detachable locking key or member 59 which can be quickly inserted into the circumferential slot 58 of the tubular head 55 and

fastened in position by turning the screw 62 into the projecting hub 50.

The depending tubular member 57 serves not only as an enclosure for the shaft extension 54, but further has the function of supporting and turning a rudder by which the boat, to which the motor is connected, is controllable. Upon the lower end of the tube 57 there is detachably mounted a housing or box 70 projecting downwardly from which is a rudder or fin 71 which may be integrally formed with housing 70, this latter comprising a tubular chamber, the axis of which is disposed at right angles to the axis of the tube 57, and incloses a propeller-shaft 73 which is supported in a bearing 74 arranged in the plane of the projected axis of the extension-shaft 54. The bearing is formed with a packing chamber 75 to receive a suitable packing medium which may be compressed by an adjustable gland 76 threaded at 77 into the chamber 75 of the bearing portion 74. Power is transmitted from the shaft 54 when the engine is operating through a set of bevel gears 78—79, one of which is secured upon the lower end of the shaft 54 and another of which is secured on the inner end of the propeller shaft 73. The hub of the gear 79 which is mounted on the shaft 73 provides a ball race to support a set of balls 80 which are adjustably forced against the hub of the gear 79 by a thrust disk 81, circumferentially threaded into the housing 70 and having a race-way in which the balls 80 operate. In this manner the end thrust of a propeller 82, secured on the shaft 73 is taken on an anti-friction bearing in which the member 81 is adjustable to take up the wear of the parts, and the race member 81 may be locked in its desired position by a set-screw or other suitable device 83.

The motor here shown is of the water cooled type and a supply of water is circulated to the motor through a means consisting of a pump which in the present case is mounted upon the housing 70 and is preferably of such an arrangement and construction as to be readily detachable bodily to permit inspection and renewal of parts as may be necessary without requiring the dismantling or change of position of the propeller driving mechanism contained within the housing 70. The pump here illustrated is of the rotary gear form in which gears 85 and 86 are intermeshed in parallel position and inclosed in a small casing 87 in which parallel shafts 88 are journaled and operatively connected to the shaft 73 in suitable manner. One of these shafts is shown provided with a transverse or diametrical lug or projection 89 flexibly but positively engaging with the adjacent end of the propeller-shaft 73 so as to be driven thereby. The

flexible connection 89 between the co-axial shafts 73 and 88 provides for relative independent axial and transverse play incident to the operation of these members, without causing them to bind in their bearings. The pump casing 87 is fastened at one side to a disk or head 90, which serves as a cover plate and is concentric with the centre of the shaft 88 which is coupled to the propeller-shaft 73, and the disk or head 90 is circumferentially threaded to permit of its being screwed into the housing 80 and adjacent to the stationary race-disk 81. There may be placed between the pump head 90 and the race-disk 81 a packing ring 91 against which the adjacent annular shoulders of the respective members may bear when the pump head 90 is screwed firmly into place, and in which position it may be locked by a set screw 83. The pump casing 87 and the pump head 90 are separably connected by a set of fastening screws 92. The pump casing 87 is adapted to be covered after it has been assembled upon the box or housing 70 by a hemispherical forwardly projecting cover or cap 93, the diametrical edge of which is adapted to telescope in the bore of the open end of the housing 80 and may be fastened securely in position by a cap screw 94 fitting a threaded extension 95 of the pump casing 87. The cap 93 may be provided with a plurality of apertures 95¹ for the inlet of water to the suction point of the pump, and in operation water is discharged by the rotating gears 85 through a pipe or other suitable conductor 96, Figs. 1, 2, and 11, which extends upwardly along the front of the tube 57 and is connected by flexible branch tubes or hose 97 which in turn are connected to lower inlet ports of the water chambers, surrounding the respective piston-casings 6—6, the water circulating through the water jackets of the engine and being discharged through suitable tubes 98.

When in use, the motor is suspended upon the stern of a boat to be propelled through means of the bracket 31, the tubular member 57 depending from the motor and being maintained in a suitable angular position with relation to the boat and the bracket 31 by means of a collar 31 which turnably fits the tube 57 and has transversely projecting studs which engage slidable clamps 31^a which are adjustably movable in rearwardly extending parallel slotted guide ways projecting from the lower arms of the bracket 31. The tube supporting the propeller-shaft and rudder 71 is adapted to be turned angularly on the hub 50 so as to accomplish the desired change of angle of the rudder for the purpose of steering the boat, by means of a horizontally projecting lever 100, Figs. 1 and 2, which projects forwardly from and

is turnably mounted in a bearing 101, Figs. 65 1 and 4, formed at the upper portion of the swivelling head 55. Thus, by grasping the steering lever or tiller 100 and turning it either to the right or to the left, the steering tube 57 is swung to turn the rudder 71 to the desired angular position, during which movement the tube 57 is permitted to rotate in its collar 31 by which it is held in a substantially vertical position when adjusted upon a boat.

For the further simplification of apparatus of this type, it is one of the objects of the present invention to utilize the steering lever 100 as a means whereby the propeller 82, when this is of the reversible type, may be operated as conditions require to check the speed of and stop or reverse the direction of travel of the boat. In the present instance, the propeller 82 shown, is of a type involving reversible blades, which, when their angle of pitch is changed or reversed, thereby changes the speed or reverses the direction of travel of the boat. When this type of propeller is utilized, the steering lever 100 is preferably rotatably mounted in its bearing 101, and is provided on its rear end, Fig. 3, with a lever 102 to which is connected the upper end of a link 103, Figs. 2 and 3, and the lower end of the link 103 is connected to a bell crank 104 which is pivoted upon the propeller-shaft housing 70; one end of the bell crank 104 engaging and being adapted to operate a sliding device 105 having operating connection with the blades of the propeller 82 in such a manner that when the bell crank 104 stands in one position, the propeller blades will operate to propel the boat forwardly and when by a rotative movement about its axis of the steering lever 100, the crank arm 102 will shift the link 103 downwardly and rock the bell crank 104 to shift the position of the slide 105 and effect a change of the angular position of the blades of the propeller 82 so that the latter will then operate with a reversing action on the boat. Thus it will be seen, that I have provided a means whereby the rudder may be manipulated to control the angular direction of travel of the boat, and by which also a reversible propelling mechanism may be actuated to control the speed of or reverse the motion of the boat.

In motors, especially of a type which are to be used for marine propulsion purposes, it is desirable to arrange all of the parts as compactly as possible so that they will not only require little space, but which will be so disposed as to be protected from injury by contact with surrounding bodies, but which will also be protected as much as possible against the action of the spray. It is therefore one of the features of the present invention to so dispose the magneto genera-

tor when used to supply current for the engine in such a position as to be directly connected to the engine shaft, and at the same time be accessible and protected from the spray, and in this embodiment of the invention, a magneto 110 is shown as mounted upon the top of the fuel tank 30 where it is most remote from the water, and is driven by a beveled gear 111 secured on its shaft 112, the gear 111 meshing with and being driven by a pinion 113 secured upon the upper end of the crank-shaft 2 where it projects through a central chamber formed therefor in the centre of the fuel tank 30. From the magneto 110 are extended lead wires 114 which connect the spark plugs 95 preferably mounted on the piston casings 6—6 to provide for the ignition of the fuel in the combustion chambers of the engine.

Various modifications in the form and construction of my invention may obviously be resorted to, if within the limit of the appended claims.

What I therefore claim and desire to secure by Letters Patent is:

1. In a motor, a crank-shaft, a support therefor, interchangeable piston-cylinders detachably connectible with the opposite sides of the said support, said cylinders having each a valve chamber with opposite ports for communication with either inlet or outlet connections, and rotary valves mounted

in said chambers and having each a port-way for alternate presentation respectively to said ports and controlling communication with the piston-cylinders.

2. In a liquid-fuel motor, a crank-shaft and its support, a fuel-tank superimposed upon the said support, the said crank-shaft extending through the said tank and an electric current generator, mounted above the tank and connected to the crank shaft.

3. In a liquid fuel motor, a crank-shaft and its support, a fuel tank superimposed upon the crank-shaft support, and a starting device operatively connected to the said crank-shaft and interposed between the said fuel-tank and the crank-shaft support.

4. A liquid fuel motor having a vertically disposed crank-shaft, a support therefor, a fuel tank superimposed on the motor, a ratcheting device arranged on the shaft below the said tank, and a manually operable starting lever projecting from below the tank between said tank and the crank-shaft support and disconnectibly engageable with the said device, whereby the motor may be started.

In testimony whereof I affix my signature in presence of two witnesses.

ROLLIN ABELL.

Witnesses:

JOHN H. ANDERSON,
WARREN A. ANDERSON.