April 22, 1958 N. A. WOLF ET AL 2,831,345

OUTBOARD ENGINE ANALYZER

Filed Aug. 31, 1956 3 Sheets-Sheet 1

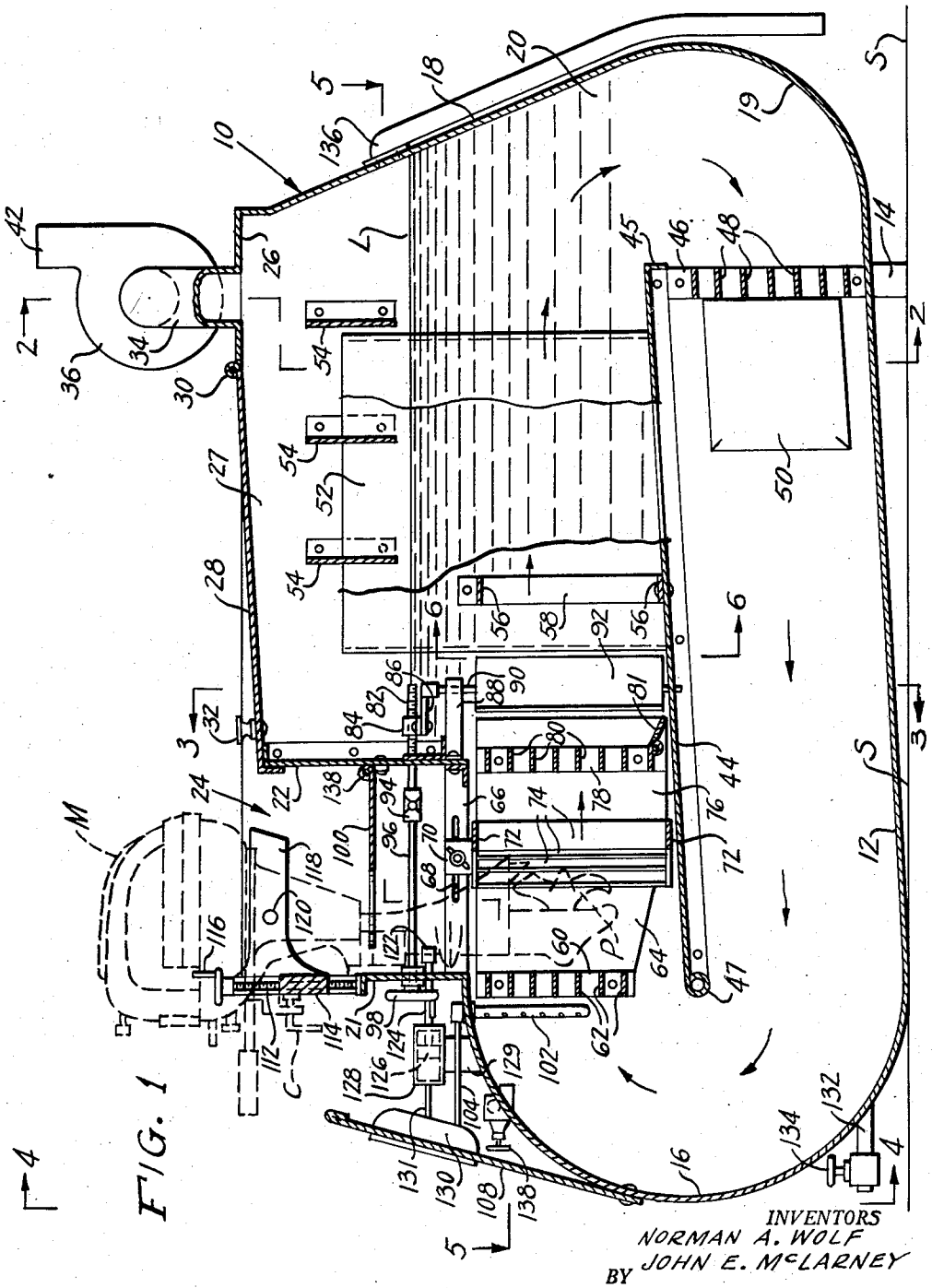


FIG. 1

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FIG. 2

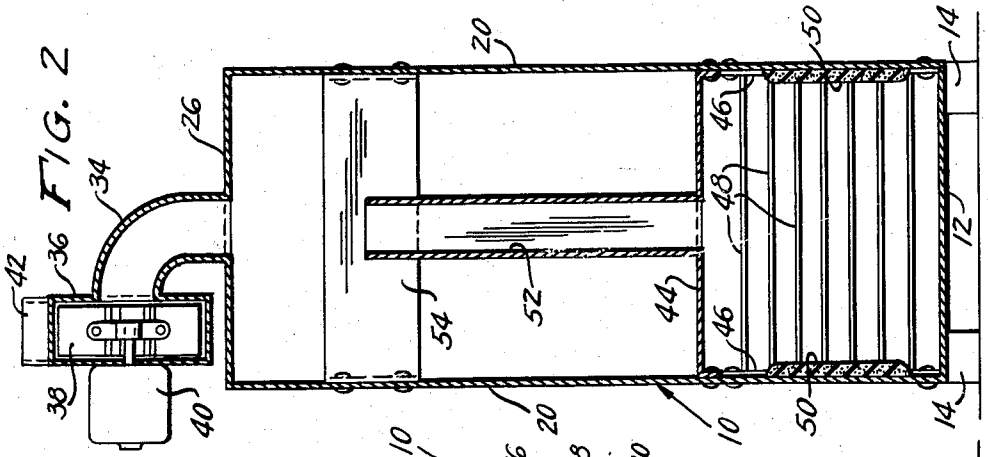


FIG. 3

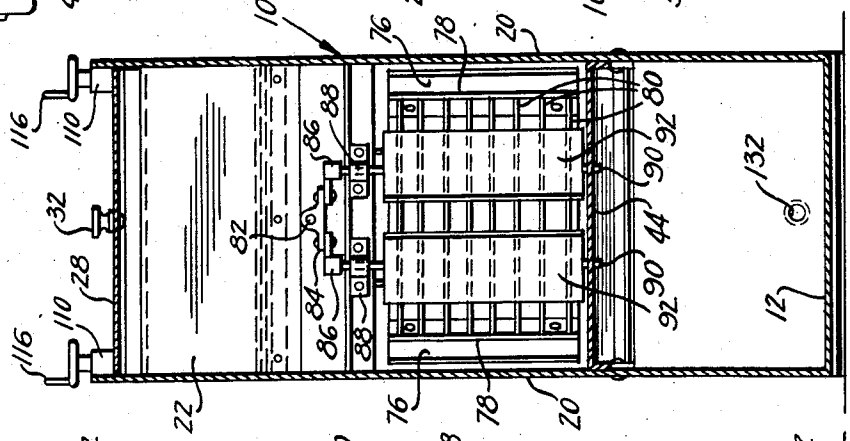
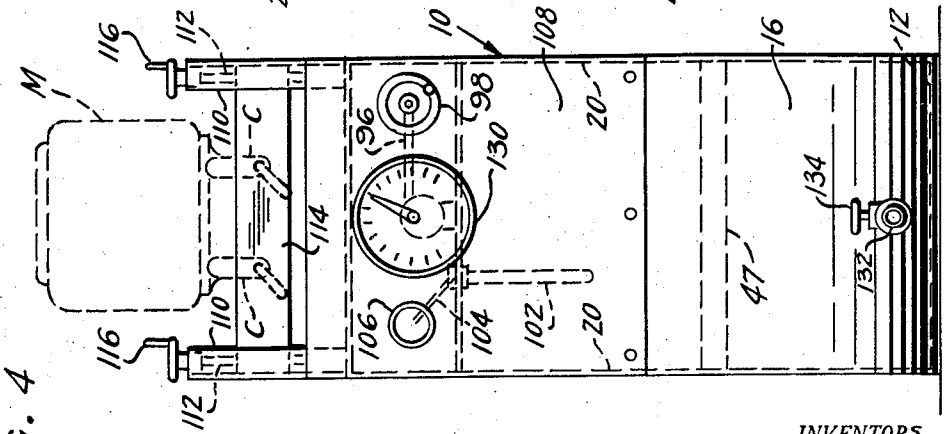


FIG. 4



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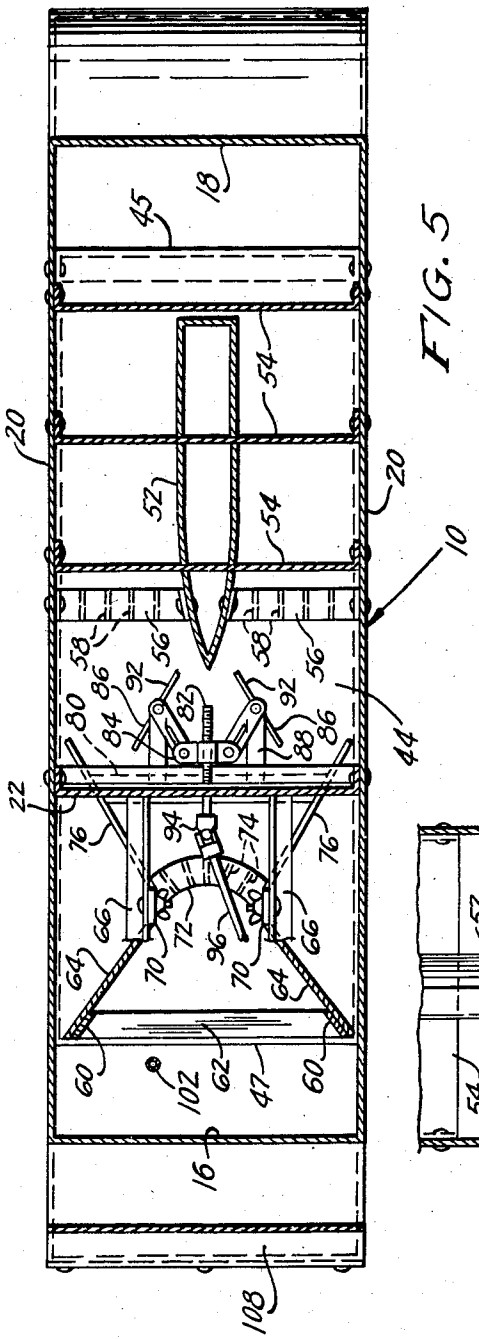


FIG. 5

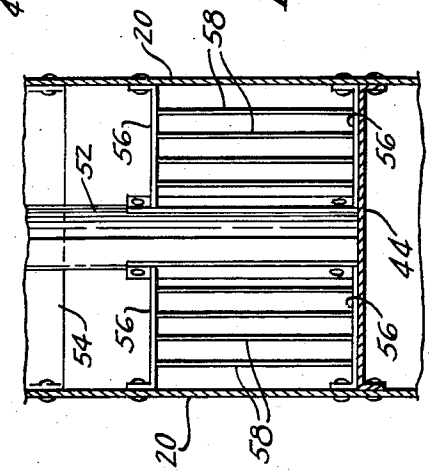


FIG. 6

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OUTBOARD ENGINE ANALYZER

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Application August 31, 1956, Serial No. 607,304

4 Claims. (Cl. 73—116)

The present invention relates to a device for bench testing an outboard engine.

Heretofore, the testing and analysis of the operational characteristics of an outboard engine has been achieved in a comparatively haphazard, inefficient manner, and proper information as to the characteristics of the engine under actual operating conditions has not been readily obtainable within the manufacturing plant, repair shop, or similar establishment.

It has been proposed to provide test tanks for outboard engines, capable of being set up within a manufacturing plant or shop, but so far as is known, said tanks have merely been adapted for supporting an outboard engine in position extending into the tank, to visually observe the operation of the engine. It has not been proposed to associate, with a tank of this nature, instrumentalities that will record, on gauges and equivalent devices disposed exteriorly of the tank, the exact operational characteristics of the engine.

The main object of the present invention is to provide an outboard engine testing and analysis apparatus that will be particularly designed to achieve the above stated desirable results, and to this end, we have designed apparatus of the character stated which may be summarized briefly as follows:

A tank is provided, having a novel shape designed, when an outboard engine is mounted upon support means provided within the tank, to permit operation of the engine under conditions that will duplicate actual operating conditions such as are encountered when the engine is in use upon a boat. The tank is designed with an ovally shaped lower portion, causing continuous cycling of the water in an oval path responsive to operation of the engine, with the water traveling during one portion of the cycle above the water traveling through the other, return portion of the cycle.

Above the oval portion of the tank there is provided a tank extension, in which the support means for the motor is provided, said support means being in the form of an adjustable transom, which when vertically adjusted permits selective disposition of the propeller of the motor within the part of the tank in which the water is cycled. Suitable venting means is associated with the tank, and an important component of the invention resides in the provision, in the path of the cycling water, of an adjustable propeller-orifice-providing means in the form of pivoted baffles conjointly adjustable toward and away from one another, responsive to rotation of a threaded rod from a location exteriorly of the tank.

Means is provided in association with the adjustable orifice-defining means for detecting the water speed immediately in front of the propeller, and gauge means is associated with the speed-detecting means for taking a reading of the water speed. In combination with the water speed pick-up and gauge means, there is provided a load-detecting assembly with which is associated a second gauge means from which a reading can be taken.

Among important objects of the invention are the following:

First, to permit bench testing and setting of an outboard engine for operation thereof at peak efficiency, it being important to note in this regard that the output of an engine is measured by its R. P. M. and thrust;

Second, to perform trouble-shooting operations on engines that are malfunctioning, the device being adapted to show up any malfunctioning of the engine upon one or more of the test stand instruments;

Third, to determine the propeller efficiency which would be, as is already known, a product of the R. P. M., thrust, and water flow;

Fourth, to conduct experimental operations on new or improved engine designs;

Fifth, to permit the tuning-up of engines to be used in competition; and

Sixth, to lower, as necessary, unit efficiency of outboard engines.

Other objects will appear from the following description, the claims appended thereto, and from the annexed drawing, in which like reference characters designate like parts throughout the several views, and wherein:

Figure 1 is a longitudinal section through an outboard engine test stand or analyzing apparatus formed according to the present invention, the engine being shown in dotted lines;

Figure 2 is a transverse section on line 2—2 of Figure 1, through the rear portion of the test stand;

Figure 3 is a transverse section substantially on line 3—3 of Figure 1 through the intermediate portion of the test stand, showing the propeller orifice-forming assembly;

Figure 4 is a front end elevational view of the apparatus as seen from the line 4—4 of Figure 1;

Figure 5 is a horizontal section through the apparatus on line 5—5 of Figure 1; and

Figure 6 is a transverse section on line 6—6 of Figure 1.

Referring to the drawings in detail, the apparatus constituting the present invention includes a tank generally designated by the reference numeral **10**. The tank can be suitably braced and reinforced in any desired manner. It is mainly important to note, for the purposes of the present application, that the tank is of a horizontally elongated formation, having a generally oval lower or main portion merging at its top into an upwardly projecting, motor-receiving extension.

The tank, as shown in Figure 1, includes a flat bottom wall **12** inclined slightly from the horizontal, and supported at its rear end upon a transversely extending support or base bar **14**. The front end of the bottom wall is supported directly upon a supporting surface S, so as to locate the bottom wall at the desired angle of inclination.

At its front end, bottom wall **12** merges into a front end wall **16**, and is curved about a horizontal, transversely extending axis through substantially 180 degrees. A rear wall **18** has a lower portion **19** into which the rear extremity of bottom wall **12** merges. Lower portion **19** is curved through substantially 90 degrees and merges into a flat, vertically elongated upper portion of the rear end wall, inclined forwardly in the direction of its upper end, and rising to a height substantially above the upper end of the front end wall **16**.

The tank is further formed with vertically disposed side walls **20**, which completely close the tank at its sides, said side walls projecting above the oval lower portion of the tank to also close the upper extension of the tank at the sides thereof.

A vertical front end plate **21** is fixedly secured at its lower end to the front end wall **16**, and may be integral

with the front end wall. Spaced rearwardly from plate 21 is a transversely disposed, vertically positioned intermediate plate 22, cooperating with the end plate 21 in defining an upwardly opening well 24 in which the motor M to be tested is disposed.

Integral with the upper end of the rear end wall 18 is a forwardly projecting top wall 26 in a horizontal plane, terminating a substantial distance rearwardly from plate 22. An access door 28 is hinged at its rear end as at 30 to the forward end of the top wall 26, and is provided with a handle 32.

Projecting upwardly from top wall 26 and communicating with the tank extension 27 through said top wall is a conduit 34 opening laterally at its upper end into a blower or fan housing 36 in which is journalled a suction fan 38 driven by a motor 40 mounted on the side of the housing. The blower outlet 42 of the housing 36 is connectable to a suitable exhaust conduit, not shown, whereby exhaust fumes collecting within the tank extension responsive to operation of the motor may be exhausted to a location outside the building structure in which the test stand is installed. In this connection, the tank is filled with water to a level L shown in Figure 1, so that the oval lower portion of the tank is completely filled, with the water rising within the tank extension to a location well below the top wall 26, said water also rising to a corresponding extent, of course, within the well 24, in view of the fact that the well is in full communication at its lower end with the interior of the tank.

Water cycles within the oval lower portion of the tank in the direction of the arrows in Figure 1, the curvature of the front and rear end walls being adapted to cooperate with an elongated partition, disposed within the tank for the purpose of causing the water to flow through a closed cycle in a generally oval path, when the motor M is operated.

To reduce turbulence in the water, there is provided adjacent the rear end of the tank a baffle assembly comprising vertically disposed side members 46 fixedly secured to the inner surfaces of the side walls 20 of the tank.

Connected between the members 46 are vertically spaced, transversely extending baffle plates 48. These are straight from end to end, and are disposed in parallel relation, the baffle plates being pitched slightly out of a horizontal plane as shown in Figure 1, so as to be disposed in planes parallel to that of bottom wall 12.

The baffle assembly is disposed below and at the rear end of a partition 44. Partition 44 is of planiform construction, and is fixedly connected between side walls 20 (see Figure 3), with the partition being flanged at it opposite sides to facilitate its connection to the side walls. The partition 44 is inclined into parallelism with bottom wall 12, has a dependnig transversely extending end lip 45 at its rear end, and has a rolled flange 47 at its front end.

Due to this arrangement, it will be seen that when the propeller P of motor M rotates during testing of the motor, it will force water above the partition 44 in a direction toward the right in Figure 1. As the water reaches the rear end of the tank, it will be deflected downwardly in a curving path by wall portion 19, through the baffle assembly previously described. It will then flow forwardly as shown by the arrows in Figure 1, below partition 44 and at the front end of the tank will be deflected upwardly in a curving path back into the suction side of the propeller P.

The provision of the depending lip 45 and rolled flange 47 defines a trap below the partition 44 for air that may be forced into the water during testing of the motor M. It is of course desirable that the flow of the water be smooth as possible, with turbulence, sloshing, water surge, and aeration held to a minimum.

So far as the water surge is concerned, it is desirable to mount upon the respective side walls 20 relatively large, flat rubber pads 50. These are disposed immediately forwardly of the baffle assembly 46, 48 and serve to minimize surge, with the baffle assembly of course acting to reduce turbulence within the water.

De-aeration of the water, meanwhile, is effected through an air removal conduit 52. This, as shown to best advantage in Figures 1, 2, and 5, is in communication at its lower end with the area below the partition 44, so that air trapped under the partition between the depending lips 45, 47 is released and flows upwardly through the conduit 52, to be exhausted through conduit 34. Conduit 52 is elongated in a fore-and-aft direction, tapering toward its forward end as shown in Figure 5 with a view to streamlining the same so that water may flow thereby smoothly.

It is also desirable to reduce to a minimum sloshing of the water within the tank extension. To this end, we provide a plurality of transversely extending splash guards 54 (Figures 1 and 2), fixedly connected between side walls 20 within the tank extension and uniformly spaced apart longitudinally of the tank, in vertical planes. The splash guards are disposed at or just above the water level L, and water tending to slosh upwardly within the tank extension is immediately thrown against one or more of the splash guards, to reduce the water splash within the tank extension to a minimum.

Adjacent the front end of conduit 52 (see Figure 5) is one of a plurality of baffle assemblies provided at spaced locations in the closed path or cycle of the water. This includes horizontally disposed support bars 56 connected between the side walls of conduit 52 and the respective side walls 20. Connected between the vertically spaced, horizontal bars 56 are vertically extending, uniformly spaced baffles 58, said baffles 58 being spaced apart the full distance between the respective sides of the conduit 52 and the adjacent side walls 20.

Forwardly of the propeller P of the motor, that is, at what might appropriately be termed the intake side of the propeller, guide baffles are also provided. Vertical support bars 60 are secured to the respective side walls 20, and fixedly connected therebetween are horizontally extending, uniformly spaced baffles 62. These serve to straighten the flow of water immediately prior to passage of the water into the propeller area.

Referring to Figure 5, as soon as the water passes through the baffle assembly 60, 62, it is guided through the propeller due to the provision of guide walls 64 converging in a direction rearwardly from the baffles 62. Guide walls 64 are fixedly secured at their divergent ends to the vertical support bars 60, and terminate at their convergent ends substantially in the plane in which the propeller P rotates.

Above guide walls 64 there are mounted, in the lower open end of the motor well 24, parallel, straight angle iron support members 66. These extend in a fore-and-aft direction, and are formed with longitudinally extending slots 68.

Mounted for sliding adjustment along the lengths of the members 66 are support brackets 70, through which extend bolts passing through the slots and equipped with wing nuts. The brackets 70 can thus be adjusted in a fore-and-aft direction by loosening of the wing nuts.

The brackets support an adjustable baffle assembly which includes upper and lower support bars 72 lying in horizontal planes. Bars 72 as shown in Figure 5 are curved longitudinally, being bowed rearwardly and being curved about a center lying in the area in which the propeller P is rotated.

Fixedly connected between the bars 72 are vertically disposed baffles 74, lying in planes extending radially from the center about which the bars 72 are curved. The baffles 74, thus, cause water leaving the propeller to be smoothed out and dispersed in a rearwardly flaring or fan-shaped wake.

Fixedly connected to the bars 72, at the ends of said bars, are rearwardly flaring guide walls 76, limiting the

fanning out of the water after it leaves the propeller. The plates or walls **76** are rigid with the bars **72**, and fixedly connected between the divergent portions of the walls **76** are horizontally extending baffles. To mount the baffles, there are provided vertical bars **78** secured to the inner surfaces of the plates **76** (see Figure 1) and fixedly connected between the bars **78** are baffles **80** disposed in horizontal planes. The lowermost baffle **80** has hingedly connected thereto a flap **81**, for the purpose of preventing reverse flow of water from reaching the propeller when an engine with a small diameter propeller is being tested.

It will be apparent that the baffle assembly comprising the radially disposed baffles **74**, the baffle assembly comprising the horizontal baffles **80**, and the guide walls **76** are all moved toward or away from the propeller P conjointly, by adjusting the brackets **70** in the manner previously described herein.

Immediately aft of the adjustable baffle and guide unit, means is provided for adjusting the sides of the orifice through which water leaving the propeller must pass. The purpose of an adjustable orifice through which the water must pass after leaving the propeller is to permit adjustment of the size of said orifice until the engine R. P. M. can be brought to the manufacturer's specifications, R. P. M. being read upon a tachometer or other conventional device, not shown, during this stage of the operation.

In any event, the adjustment of the size of the orifice is effected through the medium of identically but oppositely arranged plates, and to permit adjustment of said plates, there is provided a horizontally disposed screw **82** (Figures 1 and 3) with which is threadedly engaged a follower **84** to the underside of which are pivotally connected rearwardly divergent arms **86** having at their divergent ends downwardly opening sockets within which are fixedly engaged the upper ends of shafts **90** the lower ends of which are journalled in the partition **44**. Fixedly secured to the shafts are vertically elongated plates **92**.

The arms **86** are slotted to receive the pivotal connections whereby the same are attached to the follower **84** (see Figure 5).

A universal connection **94** at the front end of the screw **82** connects said screw to a shaft **96** which projects through and is journalled in a bearing mounted in the wall **21**. Forwardly of the wall **21** the shaft has a hand wheel **98**.

It will be seen that by rotating the hand wheel in one direction, the follower **84** is shifted rearwardly along the length of screw **82**, which screw is journalled in the rear wall **22** of the motor well **24**. As a result, the arms **86** are swung conjointly, to rotate the shafts **90** in opposite directions, thus correspondingly turning the plates **92** in opposite directions, whereby to increase or reduce the space between the plates and hence adjust the size of the orifice, which orifice is defined by said space between the plates.

To minimize splashing of the water upwardly within the motor well, there is provided a hinged baffle **100**. This keeps down spray that might otherwise tend to be thrown upwardly out of the well, and is projected forwardly within the well to a substantial degree, with the baffle being recessed at its forward end to receive the adjacent portion of the motor M, thus to serve not only in holding down the spray, but also to hold the motor to prevent side movement thereof.

Immediately forwardly of the baffle assembly **60, 62** there is provided a water pick-up tube **102**, perforated throughout its length. Tube **102** is fixedly secured at its upper end to the upper extremity of the front end wall **16** of the tank, and is a device conventional per se, being designed to provide a reading at a remote location of the speed of water passing by the same.

Connected with the upper end of the tube **102** is a length of tubing **104**, extending to the water speed gauge **106** (see Figure 4). The gauge is also a device conventional per se and hence need not be described in detail herein.

Fixedly secured to the front end wall **16**, and projecting upwardly therefrom, is a gauge support plate **108**, on which the gauge **106** will be mounted.

The means for supporting the motor M within the well will now be described. Referring to Figure 4, at opposite sides of the well there are provided sleeves **110**, and rotatably mounted within said sleeves are vertically disposed screws **112**. A transom **114** has vertical openings at its opposite ends receiving the screws and threaded complementarily to the threads of the screws. By rotation of hand cranks **116** secured to the upper ends of the screws, the transom is raised or lowered, thus to correspondingly raise or lower a conventional outboard motor M having clamps C secured to the transom. The motor may thus be positioned in a selected position of vertical adjustment within the well **24**.

Fixedly secured to and projecting rearwardly from the respective sleeves **110** are support plates **118** (see Figure 1). Medially between their ends, plates **118** are provided with ball bearings **120** connected to the side walls, so that the arms **118** are in effect freely pivoted upon the respective side walls. The purpose of this arrangement is to provide a balanced support for the motor, due to the fact that the ball bearings are disposed at the center of gravity thereof. Said support will maintain the motor in a state of proper balance while still not holding the same with such rigidity as would transmit an excessive vibratory motion to the apparatus.

The apparatus also includes means for providing an indication, readable upon a gauge, of the load under which the motor is operating. To this end, a foot **122**, which may be arcuately shaped to engage the front edge of the motor, is secured to the rear end of a horizontally disposed piston rod **124** slidable in the end wall **21**. At its front end, rod **124** is provided with a piston **126** working in a hydraulic cylinder **128**, from the front end of which extends a tube **131** leading to a load gauge **130**. Suitable means is provided within the gauge **130**, and is known in the gauge art, whereby the index arm of the gauge is rotated to traverse a calibrated scale (Figure 4) responsive to and in direct proportion to the pressure of hydraulic fluid within tubing **131**.

In other words, the load under which the motor is operating causes movement of the lower portion of the motor to the left in Figure 1, exerting pressure against foot **122** which pressure in turn causes movement of the piston **125** forwardly within cylinder **128**. This forces fluid through tubing **131** to gauge **130**, and the index arm is turned proportionally to the load, to provide a reading of the load under which the motor is operating.

The cylinder **123** is supported upon a suitable bracket **129** fixedly secured to and projecting upwardly from end wall **16**.

For the purpose of emptying the tank of water, there is provided a drain **132** projecting forwardly from the lower portion of the tank as shown in Figure 1, and equipped with a drain cock **134**.

Further, to fill the tank, or to permit water to be directed thereinto for the purpose of maintaining a fresh supply during testing of a motor M, there is provided an inlet valve **138** which would be connected with a suitable source of water under pressure.

It is also desirable, in connection with the replenishment of water or the changing of water during operation of the apparatus, to provide an overflow pipe **136**. This, as shown in Figure 1, is connected to the back wall **18**, and prevents the water from rising above a predetermined level L. One may, if desired, change the water during operation of the motor by opening the valve **138**, with the water that is being changed flowing out of the tank through pipe **136**.

In use of the apparatus, the baffle **100** would be swung upwardly about a hinge **138** on which it is mounted. A motor would be inserted in the well, and clamped to the transom. The baffle and guide unit comprising baffles **74**, baffles **80**, and plates **76** is adjusted forwardly or rearwardly as desired relative to the propeller, in the manner previously described. This is desirable in view of the fact that some motors have longer cavitation plates than others, requiring that the baffle unit be adjusted rearwardly to make room for the longer cavitation plates.

The motor is then started, and the orifice defined between plates **92** is adjusted as necessary, that is, the R. P. M. of the motor is controlled by the engine throttle, read on a tachometer, and the restricted orifice or passage defined between plates **92** adjusted as to size by the rotation of the hand wheel **98** until the engine R. P. M. is brought to the manufacturer's specifications.

Operation of the propeller will of course begin the cycling of water within the oval lower portion of the tank, and the turbulence, surging, and aeration of the water is continuously kept under control by the baffle means, surge pads **50**, and conduit **52** in the manner previously described.

The actual engine thrust may now be read upon the load scale **130**, to determine if the engine is performing according to the manufacturer's specifications.

In this connection, propeller efficiency is measured by the following factors: R. P. M. (read on a tachometer); thrust (read on a load scale); and water speed, read upon the water speed indicator gauge **106**. It will thus be seen that a proper reading can readily be taken, and efficient testing and analysis of the outboard motor effected in this manner.

It should be noted, in this connection, that although a hydraulic cylinder means **126**, **128** has been illustrated as a load pick-up or detection assembly there could be employed, instead, a mechanical linkage such as a lever fulcrumed intermediate its ends and adapted to be rocked about its fulcrum by a link extending from one end of the lever to the motor in the same manner as the piston rod **124** extends in the illustrated example. The lever at its other end could be connected to a cable, in turn connected to an arm at the gauge **130**.

It will also be noted that although the apparatus has been illustrated in association with a conventional outboard motor of present design, the invention is intended to and is adapted to operate efficiently in the analysis of outboard motors of the jet action, rather than the reciprocating engine type, this being a type of outboard motor which is currently being developed.

It is believed apparent that the invention is not necessarily confined to the specific use or uses thereof described above, since it may be utilized for any purpose to which it may be suited. Nor is the invention to be necessarily limited to the specific construction illustrated and described, since such construction is only intended to be illustrative of the principles, it being considered that the invention comprehends any minor change in construction that may be permitted within the scope of the appended claims.

What is claimed is:

1. An outboard motor test apparatus comprising: a tank proportioned for cycling of water therein responsive to operation of an outboard motor extending into the tank, said tank including a lower, main portion of generally oval formation, said main portion including a horizontal partition terminating short of opposite ends of the main portion about which the path of cycled water extends, the tank further including an upper portion projecting upwardly from and communicating with the main portion for receiving an outboard motor; means within the tank for detecting the speed of water cycled within said path; means cooperating with said motor for detecting the load under which the motor is operated; gauge means mounted exteriorly of the tank and connected respectively to said water speed detection means and load detection means to provide a visual indication; and a plurality of baffle assemblies spaced apart within said path of the cycled water for reducing turbulence of the water.

2. An outboard motor test apparatus comprising: a tank proportioned for cycling of water therein responsive to operation of an outboard motor extending into the tank, said tank including a lower, main portion of generally oval formation, said main portion including a horizontal partition terminating short of opposite ends of the main portion about which the path of cycled water extends, the tank further including an upper portion projecting upwardly from and communicating with the main portion for receiving an outboard motor; means within the tank for detecting the speed of water cycled within said path; means cooperating with said motor for detecting the load under which the motor is operated; gauge means mounted exteriorly of the tank and connected respectively to said water speed detection means and load detection means to provide a visual indication; a plurality of baffle assemblies spaced apart within said path of the cycled water for reducing turbulence of the water; and means for continuously de-aerating water cycled within the tank comprising a conduit projecting upwardly from said horizontal partition, the conduit opening into the area below the partition at the lower end of the conduit, said conduit at its upper end opening into the upper portion of the tank.

3. An outboard motor test apparatus comprising: a tank including an elongated, generally oval lower portion proportioned for cycling of water therein, said tank including a partition within the lower portion about which the path of the cycled water extends, the tank further including an upper portion projecting upwardly from the lower portion to confine exhaust fumes resulting from operation of an outboard motor extended into the lower portion, the tank being formed with an upwardly opening well for receiving said motor, said well communicating at its lower end with the lower portion of the tank for extension of the motor into said lower portion, the well being disposed forwardly of the upper portion of the tank; means within the tank for detecting the speed of water cycled within said path; means cooperating with said motor for detecting the load under which the motor is operated; gauge means mounted exteriorly of the tank and connected respectively to said water speed detection means and load detection means to provide a visual indication; a plurality of baffle assemblies spaced apart within said path of the cycled water, said baffle assemblies being adapted for reducing turbulence of the water; means within the path of the cycled water disposed rearwardly of said well including a pair of plates mounted for adjustment toward and away from each other, thus to provide for an adjusted space between the plates to form a restricted orifice through which the water is forced during its movement into said path; and transom means mounted upon the tank within the well adapted for supporting the motor.

4. An outboard motor test apparatus comprising: a tank including an elongated, generally oval lower portion proportioned for cycling of water therein, said tank including a partition within the lower portion about which the path of the cycled water extends, the tank further including an upper portion projecting upwardly from the lower portion to confine exhaust fumes resulting from operation of an outboard motor extended into the lower portion, the tank being formed with an upwardly opening well for receiving said motor, said well communicating at its lower end with the lower portion of the tank for extension of the motor into said lower portion, the well being disposed forwardly of the upper portion of the tank; means within the tank for detecting the speed of water cycled within said path; means co-

operating with said motor for detecting the load under which the motor is operated; gauge means mounted exteriorly of the tank and connected respectively to said water speed detection means and load detection means to provide a visual indication; a plurality of baffle assemblies spaced apart within said path of the cycled water, said baffle assemblies being adapted for reducing turbulence of the water; means within the path of the cycled water disposed rearwardly of said well including a pair of plates mounted for adjustment toward and away from each other, thus to provide for an adjusted space between the plates to form a restricted orifice through which the water is forced during its movement into said path; and transom means mounted upon the tank within the well adapted for supporting the motor, including a transom

mounted within the well for vertical adjustment to correspondingly adjust in a vertical direction a supported motor; and support arms for the transom mounted within the well for pivotal movement about a horizontal axis extending transversely of said well, to absorb vibration resulting during operation of the motor.

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