June 3, 1958 J. THORPE 2,837,062

HYDRAULIC POWER UNIT

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FIG. 1.

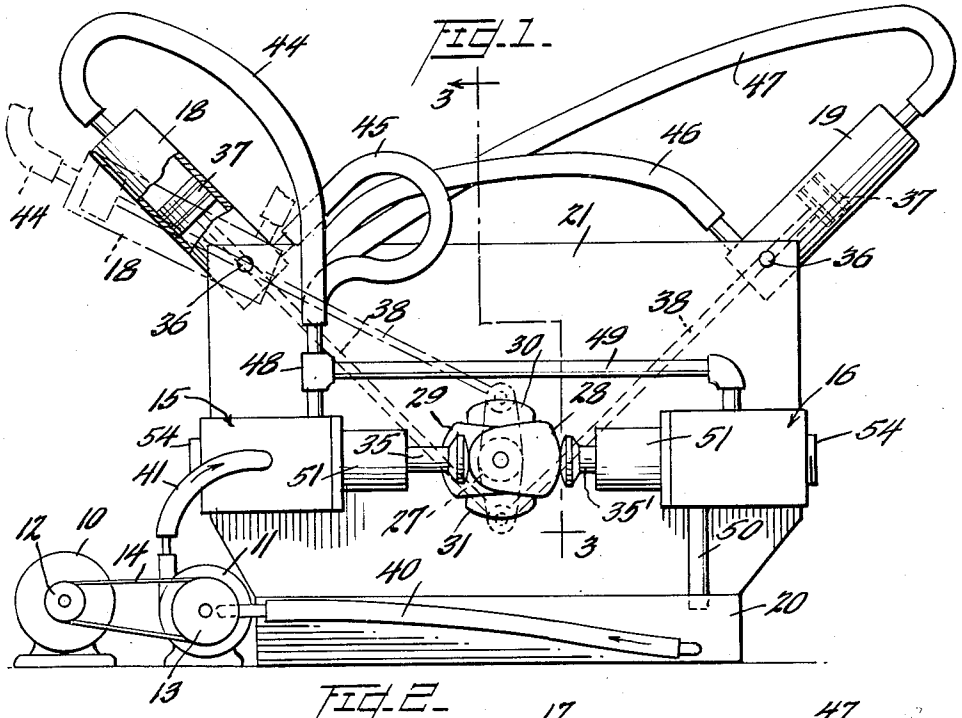
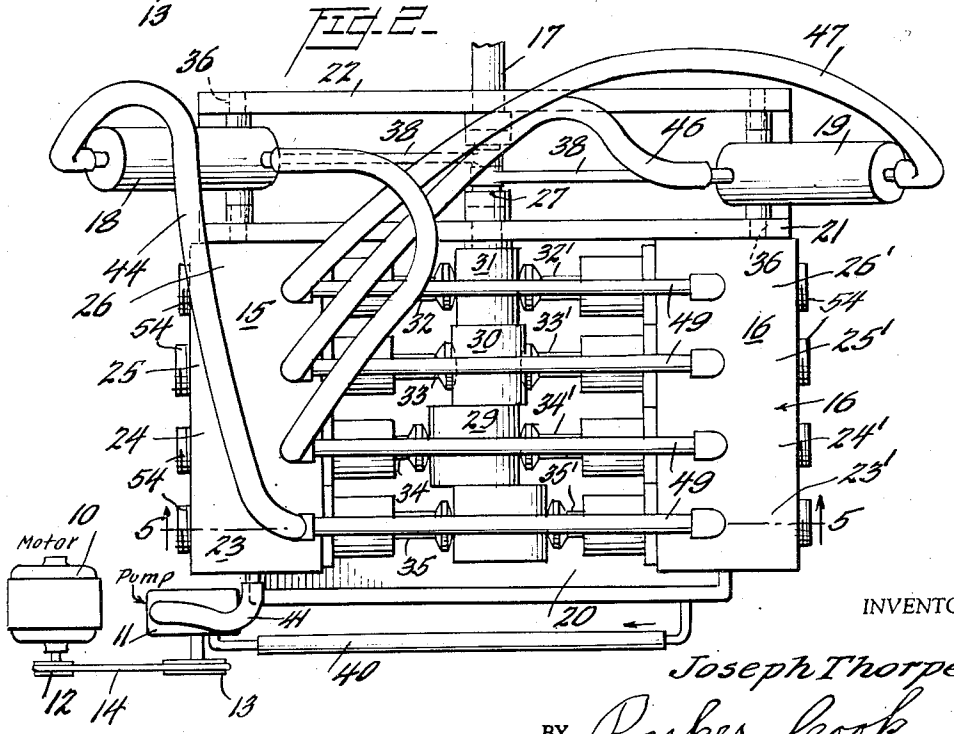


FIG. 2.



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FIG. 3.

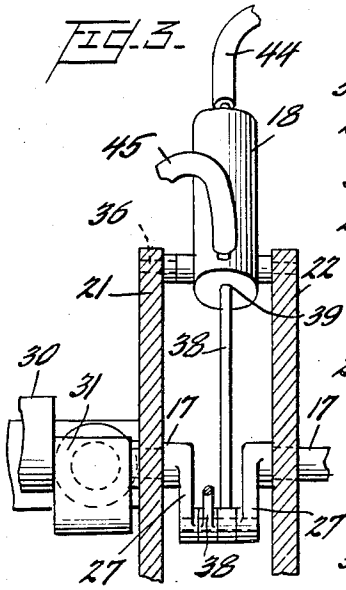


FIG. 4.

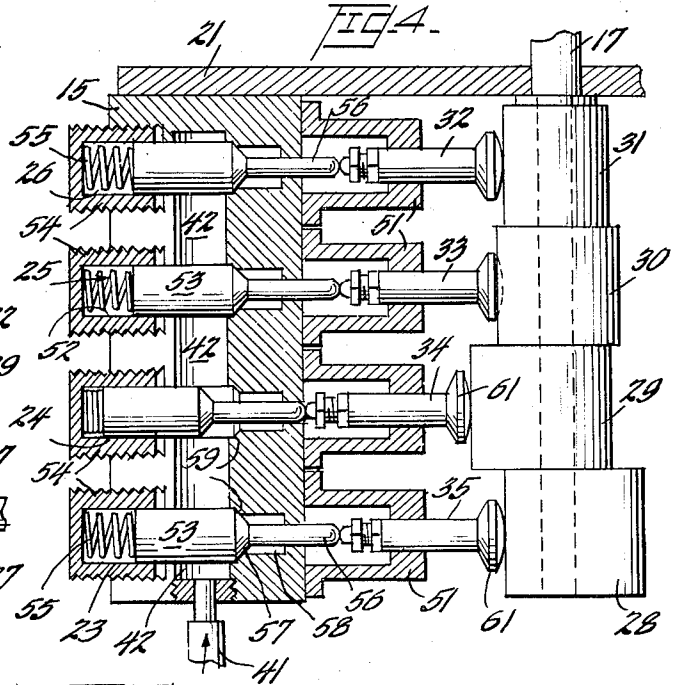


FIG. 5.

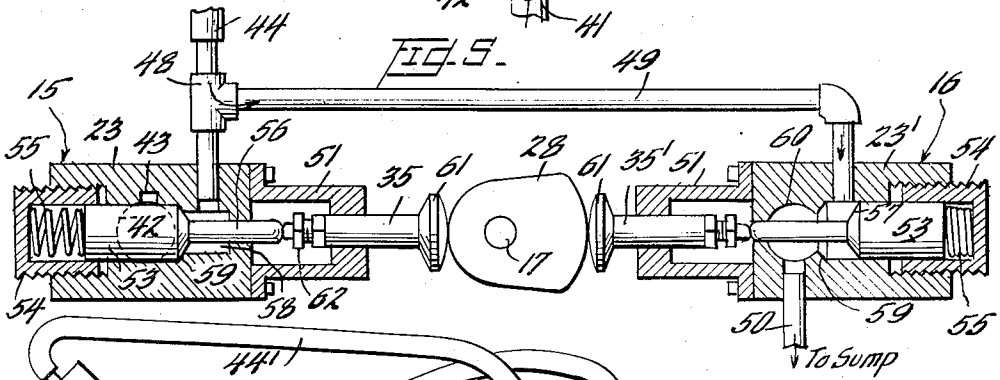
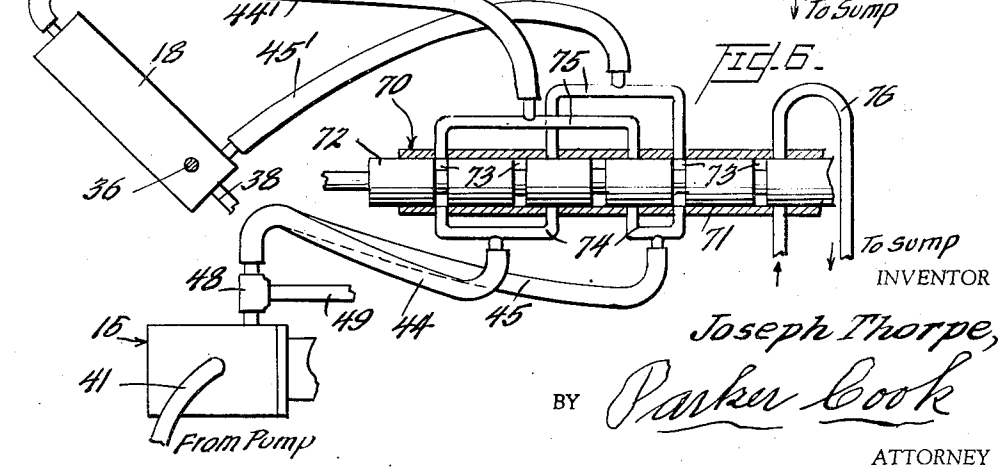


FIG. 6.



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2,837,062

Patented June 3, 1958

2,837,062

HYDRAULIC POWER UNIT

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Application March 28, 1957, Serial No. 649,175

7 Claims. (Cl. 121—63)

My invention relates to an hydraulic power unit for converting a high speed power source into a low speed power supply of greater torque.

In accordance with the invention, a high speed internal combustion engine, if the power unit is to be used on a boat or on a mobile unit, or an electric motor, if it is to be used where there is electric current, is employed to drive a pump which supplies an hydraulic fluid under pressure.

The hydraulic fluid is sequentially supplied to a plurality of pivotally mounted cylinders to reciprocate double-acting pistons operating within the cylinders and thereby to rotate, by means of connecting rods and a crank, a drive shaft at low speed with great torque.

An object of the invention is to provide a power unit that is especially adapted for use in boats where a large screw or propeller is used to be driven at a low rate, say 100 to 150 R. P. M.'s, thus to give great driving torque to the screw, rather than attempting to drive a smaller screw at a high rate of speed.

Another object of the invention is to produce a power unit that will have the drive shaft turn with great torque at a minimum number of R. P. M.'s, and at the same time not require any reduction gears.

An hydraulic pump driven by an internal combustion engine may be mounted in any part of the boat with a pipe line running to the power unit at the stern, or the engine and driven unit may be closely associated, if so desired.

Another object of the invention is to provide a power unit that may be used, for instance, on a boat, a bulldozer, a crane, or in a shop, where a slow rate of R. P. M.'s is essential, but with greater torque than that produced where there is a high rate of R. P. M.'s of the crank shaft.

With these and other objects in view, the invention consists in certain new and novel construction and combination of parts, as will be hereinafter more fully pointed out and described in the accompanying drawings, in which:

Fig. 1 is a front elevation of an illustrative apparatus constructed in accordance with the invention,

Fig. 2 is a top plan view of the apparatus shown in Fig. 1,

Fig. 3 is a cross-section taken on line 3—3 of Fig. 2, and showing the mounting of the cylinders and the operation of the cam-carrying drive shaft,

Fig. 4 is a partial horizontal cross-section through the inlet valve block, showing the valves and the manner in which these valves are actuated in time relation by means of the cams carried by the drive shaft,

Fig. 5 is a cross-section taken on line 5—5 of Fig. 2 and showing the movement of hydraulic fluid through the power unit, and

Fig. 6 illustrates a refinement of the invention which permits the drive shaft to be selectively powered in either direction and which also permits the apparatus to "idle,"

e. g., to remain at rest despite the continued operation of the high speed power source.

Referring more particularly to the drawings, and with particular reference to Figs. 1 and 2, the numeral 10 designates an electric motor which constitutes the high speed power source. The motor 10 drives a pump 11 by means of the pulleys 12 and 13 and the belt 14.

The power unit illustratively shown in the drawings includes an inlet block 15, an outlet block 16, a drive shaft 17, hydraulically operated double-acting cylinders 18 and 19, and a sump 20. These various items are supported by a pair of upright plates 21 and 22 between which the cylinders 18 and 19 are mounted for pivotal movement.

More particularly, the motor 10, the pump 11, and the sump 20 can be secured to any suitable supporting surface by means not shown; and the upright plates 21 and 22 are also secured to the supporting surface to position the plates 21 and 22 in substantially parallel spaced-apart planes.

The plate 21 carries the inlet block 15 and the outlet block 16, which may be welded or bolted or otherwise fixedly secured in place. The blocks 15 and 16 each provides a plurality of juxtaposed valves. The valves of the inlet block 15 are designated 23, 24, 25 and 26; and the corresponding juxtaposed valves of the outlet block are designated 23', 24', 25' and 26'. The drive shaft 17 is supported in bearings in the plates 21 and 22 and projects from between the plates 21 and 22 to extend between the blocks 15 and 16 intermediate the valves 23, 23', etc.

The portion of the draft shaft 17 which lies between the plates 21 and 22 is V-shaped to provide a crank 27. The portion of the drive shaft 17 which extends between the blocks 15 and 16 carries a plurality of valve actuating cams, one for each of the juxtaposed pairs of valves, 23, 23', etc. The valve actuating cams are designated 28, 29, 30 and 31, and these bear against followers 32, 33, 34 and 35 in the blocks 15, and followers 32', 33', 34' and 35' in the block 16.

As will be evident, the cams 28, 29, 30 and 31 operate the followers in opposite directions so that when one of the valves 23—26 is open, the juxtaposed valve of the group of valves 23'—26' is closed, and vice versa.

The cylinders 18 and 19 are each mounted for pivotal movement in the plane of the plates 21 and 22 by means of shafts 36, which are suitably supported in bearings in the plates 21 and 22. These cylinders 18 and 19 are double-acting so that both strokes of the piston in each piston cycle is positively powered.

Each cylinder is provided with a piston 37, which is slidingly mounted for reciprocating movement along the longitudinal axis of the cylinder. The pistons 37 are fixedly secured to connecting rods 38 which are pivotally secured to the crank 27 of the drive shaft 17. The cylinders 18 and 19 are offset from each other along the length of the shaft 17 so that the connecting rods 38 can simultaneously drive the crank 27.

As the crank 27 rotates, the lower end of connecting rods 38 rotate with it; and the cylinders 18 and 19 are pivoted so that the lower end of the cylinders are sealed, permitting the pistons to be double-acting.

The movement of the cylinder 18 is illustrated in Fig. 1, where the furthest upwardly tilted position of the cylinder 18 is shown in full lines, and the furthest downwardly tilted position is shown in dotted line.

In Fig. 3, it can be seen that the connecting rod 38 emerges from the lower extremity of the cylinder 18 through a tightly fitted orifice 39, which is packed to provide a fluid-tight seal between the orifice 39 and the connecting rod 38.

Referring again to Figs. 1 and 2, and with particular reference to Fig. 2, the path of hydraulic fluid from the

sump 20 through the cylinders 18 and 19 and then back again to the sump 20 can be seen clearly.

The hydraulic fluid, e. g., oil, is pumped from the sump 20 through the line 40 to the pump 11, and is forced from this pump 11 through line 41 into the inlet valve block 15. A common inlet may be used for all of the inlet valves 23, 24, 25 and 26; or, the line 41 may be provided with branches, one for each of the inlet valves.

In the form illustrated, the hydraulic fluid is supplied to all of the inlet valves via the common line 41, the bores 42, and the recessed channels 43. (See Figs. 4 and 5.)

As can be seen in Fig. 2, line 44 interconnects valve 23 with the upper end of cylinder 18; and line 45 interconnects valve 24 with the lower end of cylinder 18. Lines 46 and 47 interconnect the valves 25 and 26 with the lower and upper ends respectively of the cylinder 19. Each of the lines 44, 45, 46 and 47 is provided with a T connection 48 to which is connected a drain line 49 which leads to the juxtaposed outlet valve in the block 16.

The operation of the inlet and outlet valves is timed so that when the inlet valve is open, the corresponding juxtaposed outlet valve is closed and vice versa. Since the inlet and outlet valves are connected together through the T connection 48 and the drain line 49, when the inlet valve is open fluid can move through the inlet valve to the cylinder, and this fluid cannot go directly to the sump because the outlet valve is closed.

When the outlet valve is open, the inlet valve is closed. As a result, when fluid is discharged from the cylinder, the inlet valve is closed and the discharged fluid is directed to the open outlet valve through T connection 48 and drain line 49 and thence to the sump 20 for further use. To avoid splashing of oil, downspouts 50 are provided to direct fluid discharged from the outlet block 16 to the sump 20 beneath the level of the hydraulic fluid therein.

The positioning of the cams 28, 29, 30 and 31 is clearly shown in the drawings where each cam is mounted for valve actuation 90° apart. The sequential action of the valves 23, 24, 25 and 26 of inlet block 15 is as follows: first, valve 23 opens; second, valve 25 opens; third, valve 24 opens; and fourth, valve 26 opens. As will be obvious, each of valves 23, 24, 25 and 26 is forced to close 180° after opening. The degrees referred to are degrees of rotation of the drive shaft 17. The action of the juxtaposed valves 23', 24', 25' and 26' is exactly the opposite of the valves 23, 24, 25 and 26, as has been previously explained, and as is best seen in Fig. 5. The timing of the valves 23, 24, 25 and 26 is best seen in Fig. 4.

The structure of valves 23, 24, 25 and 26 is clearly shown in Figs. 4 and 5, where it will be seen that the followers 32, etc., are slidingly mounted for longitudinal reciprocation in yokes 51 which are secured to the blocks 15 and 16. The valve in each block is bored to provide a large diameter valve element receiving cylindrical chamber 52 within which the valve element 53 is mounted.

The valve element 53 is trapped within the chamber 52 by a cap 54 threaded to the blocks 15 and 16, as shown. Within the cap 54 springs 55 bias elements 53 towards the followers and the cams 28, etc. Each element 53 is provided with a small diameter projection 56 and a shoulder 57 and the chamber 52 leads to a small diameter base 58 which provides a seat 59 against which shoulder 57 bears to prevent fluid from reaching the lines 44, etc., to thereby close the valve. As will be understood, in the absence of cam actuation, springs 55 bias elements 52 into closing position, and the action of the cams 28, etc., overcomes the springs 55 to open the valves.

As will now be evident, the operation of the power unit is as follows: first, valve 23 opens (23' closed) and fluid enters the top of cylinder 18 to force piston 37 down; second, valve 25 opens (25' closed) and fluid enters the bottom of cylinder 19 to force its piston up; third, valve 24 opens (24' closed) and fluid enters the bottom of cylinder 18, forcing the piston of cylinder 18 up and ejecting fluid through lines 44 and 49 to the now open valve 23' (23 closed); fourth, valve 26 opens (26' closed) and fluid enters the top of cylinder 19 forcing the piston of cylinder 19 down and ejecting fluid through lines 46 and 49 to the now open valve 25' (25 closed) and so on.

In the preferred embodiment illustrated, the cylinders 18 and 19 are mounted at an angle of about 90° with respect to one another in V-fashion with respect to the crank 27.

The outlet valves 23' etc., are similar to the inlet valves. As can be seen at the right hand portion of Fig. 5, the downspouts 50 communicate with a chamber 60 positioned in advance of the shoulder 59 so that the valve is open whenever the cams 28, etc., overcome the pressure of springs 55 in the outlet valves.

As an indication of preferred structural detail, the followers 35, 35', etc., are provided with arcuate heads 61 and also with threaded adjustable members 62 at the ends of the followers which engage the projections 56 so that the valve action can be precisely adjusted.

The modification of Fig. 6 interposes a reversing valve broadly designated 70 in the various lines 44, 45, 46, and 47 in the construction previously shown. Thus, instead of lines 44 and 45 leading directly to the cylinder 18, these lines, in the form shown in Fig. 6, lead to the valve 70, and lines 44' and 45' lead from the valve 70 to the cylinder 18.

As will be evident, adjustment of valve 70 can function to switch the connections so that line 44 will supply line 45' and hence the lower end of cylinder 18. This serves to reverse the timing and the direction of rotation of drive shaft 17.

Specifically, reversing valve 70 is constituted by a cylinder 71 having a rod 72 fitted therewithin. The rod 72 is formed with circumferential recesses 73. The inlet lines 44, 45, etc., are branched as indicated at 74, and the lines 44', 45', etc., are also branched as indicated at 75.

The branches span a distance which is different from the distance between adjacent recesses 73 on the rod 72, so that only one end of the branches 74 and 75 is interconnected at any position of rod 72.

In the position shown in Fig. 6, the shaft 17 will rotate in the same direction as with the construction shown in Figs. 1–5. However, if rod 72 is moved to the right a distance of half the span between adjacent recesses 72, then the direction of rotation is reversed.

Rod 72 can also be moved to an intermediate position at which the recesses 72 do not link together any of the branches 74 and 75. When this happens the pump 11 and hence the motor 10 may be unduly burdened by the pumping of fluid into a blind passageway. To avoid this, this intermediate position is utilized as shown at the right hand portion of Fig. 6 to connect a line 76 leading directly to the sump 20.

It will be understood that the invention has been illustratively described and many structural variations can be made without departing from the invention, the scope of which is defined in the claims which follow.

I claim:

1. A power unit comprising a plurality of pivotally mounted cylinders, double-acting pistons mounted for longitudinal reciprocation within said cylinders, a drive shaft including a crank portion, connecting rods fixed to said pistons and connected with said crank portion, said connecting rods extending through the closed lower end of said cylinders and being slideably mounted with respect to said cylinders in fluid-tight manner, means for supplying fluid under pressure, an inlet valve block communicating with said fluid supply and comprising a plurality of valves, one for each end of said cylinders, an outlet valve block comprising a plurality of valves, one for each end of said cylinders, conduit means separately intercon-

necting each of said valves of said inlet valve block with one of the upper and lower ends of said cylinders, conduit means separately interconnecting each of said valves of said outlet valve block with one of the upper and lower ends of said cylinders, means to actuate said valves of said inlet valve block in timed sequential relation, and means to oppositely actuate the valve of said outlet valve block which is connected with the same end of the same cylinder.

2. A power unit as recited in claim 1 in which said inlet valve block and said outlet valve block are laterally juxtaposed with respect to each other and said drive shaft extends between said valve blocks and provides cams for actuating the valves of both of said valve blocks.

3. A power unit as recited in claim 2 in which said oppositely actuated valves are laterally juxtaposed with respect to each other and are actuated simultaneously by the same cam on said drive shaft.

4. A power unit as recited in claim 3 in which said valves are spring-biased toward the cams on said drive shaft.

5. A power unit as recited in claim 1 in which said first-named conduit means includes a T connection and said second-named conduit means is secured to said T connection.

6. A power unit as recited in claim 1 in which said first-named conduit means is constituted by first and second conduits having a pair of branches communicating with a valve cylinder, said first conduits communicating with said inlet valves and said second conduits communicating with said pivotally mounted cylinders, a valve rod movably mounted within said valve cylinder, said valve rod having means for intercommunicating one branch of said first conduits with one branch of said second conduits, said branches being positioned so that in one position of said rod said conduits are connected to operate said drive shaft in one direction, and in another position of said rod said conduits are connected to operate said drive shaft in the opposite direction.

7. A power unit as recited in claim 6 in which said valve rod is provided with longitudinally spaced circumferential recesses for intercommunicating one branch of said first conduits with one branch of said second conduits, and said valve rod is mounted within said cylinder for sliding movement along the length thereof.

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