

Nov. 7, 1939.

O. GRUENBERGER

2,179,149

POWER TRANSMITTING MEANS

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2 Sheets-Sheet 1

Fig. 1

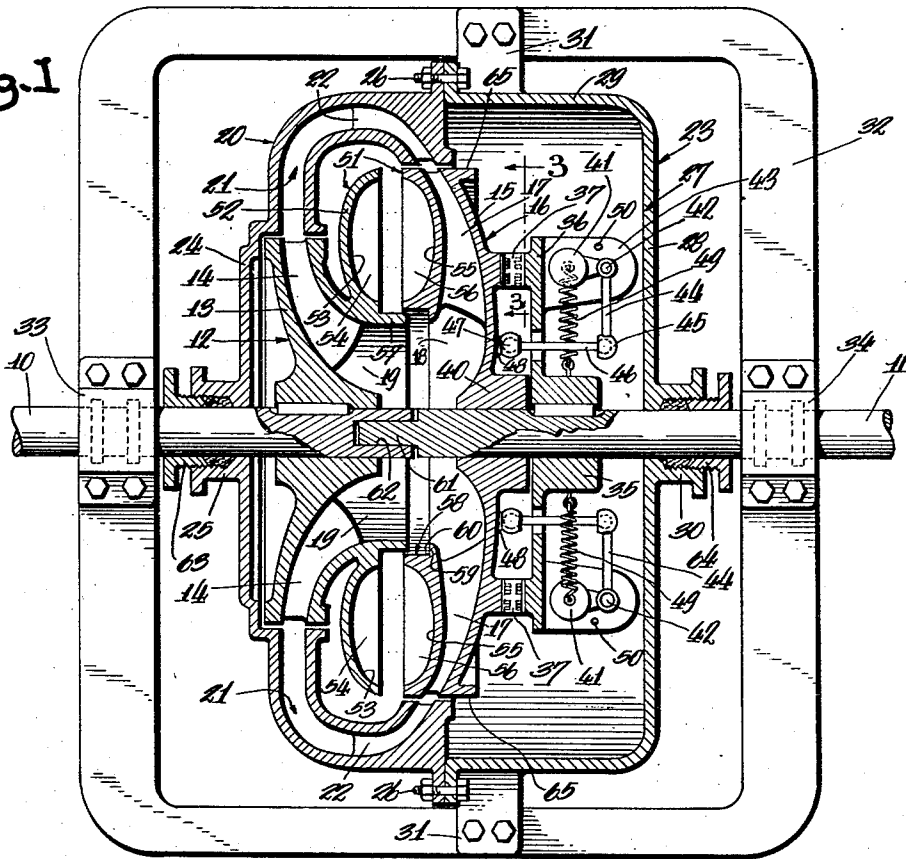
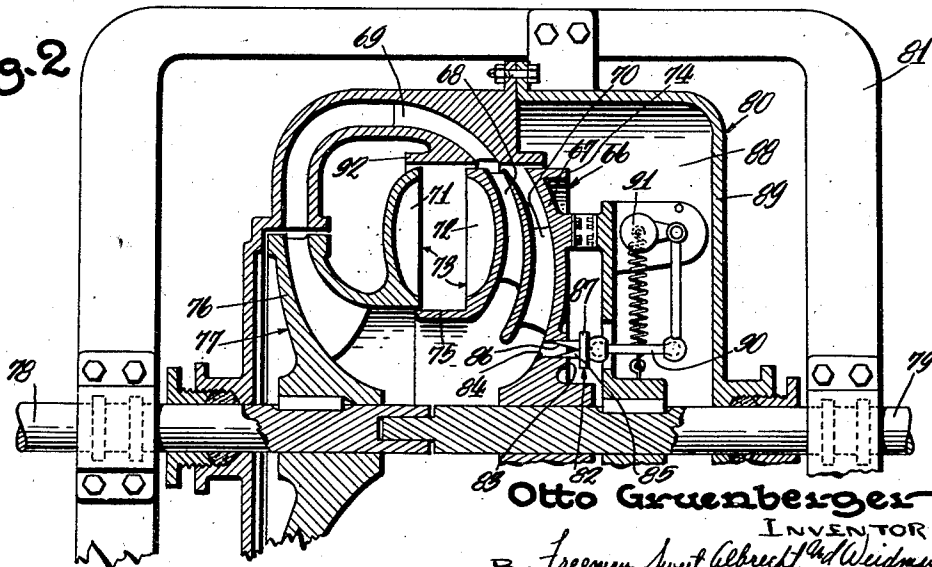


Fig. 2



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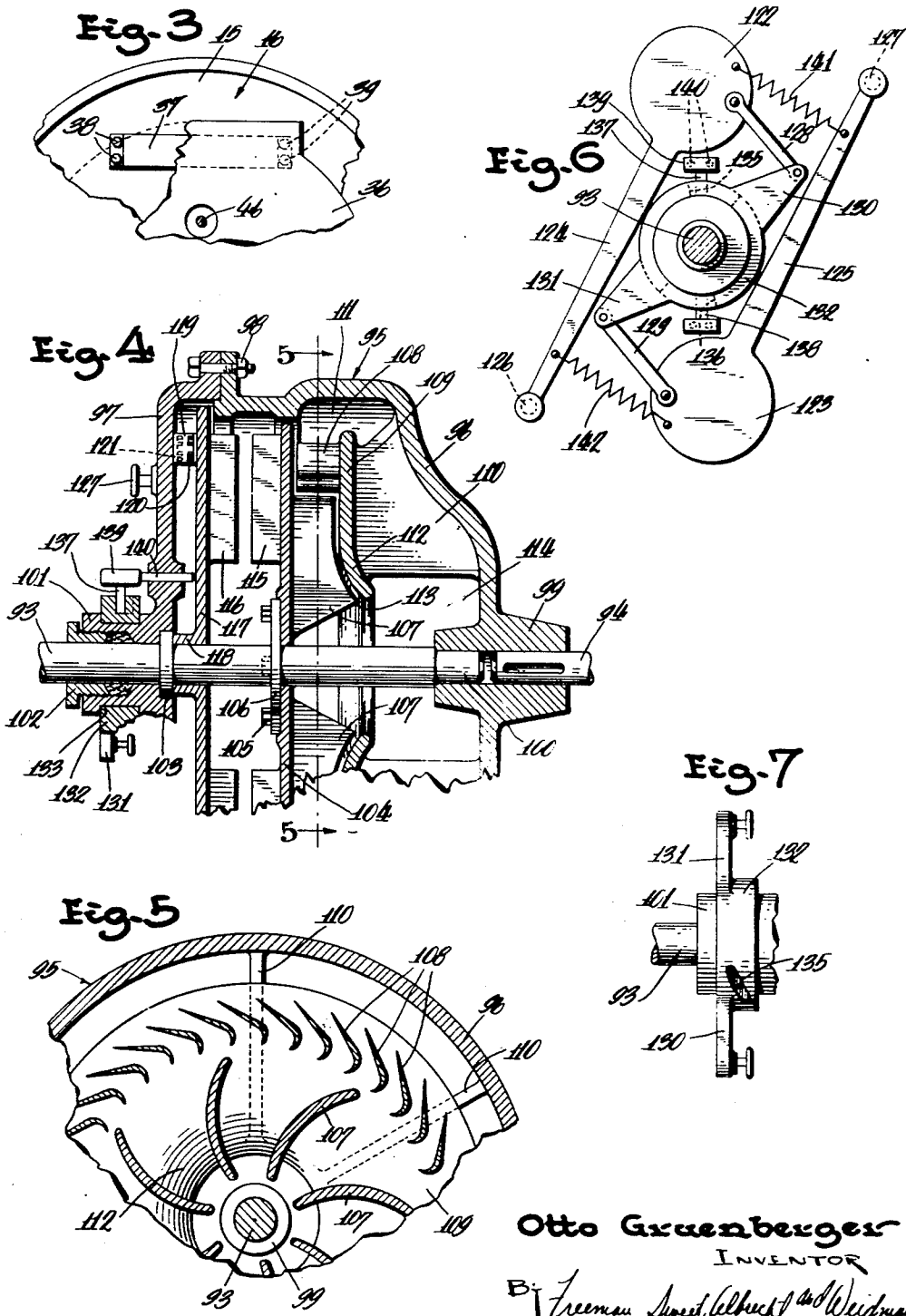
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2 Sheets-Sheet 2



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POWER TRANSMITTING MEANS

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Application June 20, 1935, Serial No. 27,533

37 Claims. (Cl. 60—54)

This invention relates to hydraulic power transmitting means, and has for its principal object the improvement of such power transmitting means.

Another object of the invention is to provide a purely hydraulic power transmitting means in which the driven shaft may be started and speeded up by a torque multiplying element, and wherein at a predetermined relative speed of driving and driven shafts said shafts will be hydraulically coupled together. A more specific object is to provide hydraulic power transmitting means involving a hydraulic turbine and a hydraulic clutch whereby during the starting from rest of the driven means power is transmitted from the driving to the driven means substantially entirely through the turbine and then as the speed of the driven means increases above a predetermined value the transmission of power is gradually transferred automatically from through said turbine to through said hydraulic clutch.

A further object is to provide means for adjusting the power transmitting means to predetermined conditions of operation, and more specifically to provide hydraulic means for that purpose.

Other objects will appear hereinafter as the description of the invention proceeds.

The novel features of the invention will appear from this specification and the accompanying drawings, showing several embodiments of the invention, and forming a part thereof, and all these novel features are intended to be pointed out in the claims. This application is a continuation in part of my application Serial Number 672,941, filed May 26, 1933, said application, Serial Number 672,941, having been permitted to become abandoned, in favor of the present application, without, however, in any way abandoning the inventions, or any of them, disclosed in said application Serial Number 672,941.

In the drawings Figure 1 is a longitudinal section of one embodiment of my invention;

Figure 2 is a fragmentary longitudinal section of another embodiment of my invention;

Figure 3 is a fragmentary view taken along the line 3—3 of Figure 1, parts being broken away;

Figure 4 is a fragmentary longitudinal section of another embodiment of my invention, with a detail omitted for the sake of clearness;

Figure 5 is a fragmentary section taken on the line 5—5 of Figure 4;

Figure 6 is an end view of the detail omitted from Figure 4; and

Figure 7 is a side elevation of a detail.

Referring to Figure 1 of the drawings, a driving shaft 10 is adapted to hydraulically drive a driven shaft 11 through means which will now be described. The shaft 10 has keyed thereto a rotor 12 including a pump impeller 13, of the centrifugal type provided with impeller vanes 14, of any desired number and conformation. The pump 13 is adapted to supply with operating fluid a turbine runner 15 forming part of a rotor 16. The turbine runner 15 is provided with turbine blades 17, desirably of the reaction type and of any desired number. The blades 17, in the embodiment of Figure 1, extend from the outer periphery of the turbine runner 15 in a generally radially inward direction to near the inner periphery thereof, leaving a vane-free space 18, through which fluid is adapted to flow into a vane-free entrance space 19 of the pump impeller 13.

Fluid may be conducted from the discharge side of the pump impeller 13 to the turbine runner 15 through a generally annular guide element 20 provided with a generally annular passage 21 which extends radially outwardly from the discharge side of the pump impeller 13, then turns axially and then radially inwardly toward the outer periphery of the turbine runner 15. In the passage 21 are provided a plurality of guide vanes 22 of desired number and form. The guide vanes 22 desirably extend from the discharge side of the guide member 20, at the periphery of the turbine runner 15, toward the intake side of the guide element 20, leaving a vane-free space between the guide vanes 22 and the intake opening of the passage 21.

The guide element 20 may be supported by or form a part of a housing 23 which generally surrounds the pump and turbine elements. In this case, one side of the guide element 20 is shown as integral with an end wall 24 forming a flange on a bearing element 25 in which the shaft 10 is freely rotatable. The other side of the guide element 20 is here shown as bolted, by bolts 26, to an end bell 27 having an end wall 28 and a peripheral wall 29, the end wall 28 being shown as forming a flange extension on a bearing 30 in which the shaft 11 is freely rotatable.

The housing 23 formed by the guide element 20 and its hereinbefore described supports may be held relatively stationary by one or more lugs 31 which may be bolted to a frame or housing 32. The frame or housing 32 need not be closed, and may be mounted on any suitable support. As here shown the frame 32 serves to support a pair of bearings 33, 34 for rotatably supporting the

shafts 10, 11, respectively. The bearings and shaft journals are desirably of any suitable type which will prevent axial movement of the shafts 10, 11.

The shaft 11 may be provided with a hub 35, keyed thereto, the hub 35 being here shown as provided with a flange extension 36. The turbine runner 15 may drive the shaft 11 and to this end the turbine runner 15 may be drivingly associated with the flange 36 by means of leaf springs 37, which extend in a generally circumferential direction, one end of each spring being fastened, as by bolts 38, 39, to the turbine runner 15 and to the flange 36, respectively. One of the springs 37, with its associated parts shown fragmentarily, is shown in Figure 3.

While the turbine runner 15 is thus adapted to drive the shaft 11, a hub 40 of the rotor 16 of which the runner 15 forms a part, is not keyed to the shaft 11, but is slidable thereon. The turbine runner 15 is adapted to have its position along the axis of the shaft 11 adjusted in accordance with predetermined conditions, in this case the speed of the shaft 11. To this end a desired number of fly balls 41 is provided, responsive to the speed of the shaft 11. In this instance each fly ball 41 is provided at the end of a crank pivoted at 42 to a bracket 43 carried by the flange 36. Operative in unison with each fly ball 41 is a crank 44 which is connected by means of a ball joint 45 to a link 46, in turn connected to a ball joint 47. One of the elements of the joint 47 is carried by a lug 48 on the turbine runner 15. The fly balls 41, and hence the turbine runner 15, are biased to the position shown in Figure 1 by means of springs 49, each having an end connected to a fly ball 41 and the other end to the hub 35. A stop 50 may be provided on the bracket 43 to limit the outward movement of the fly ball 41.

The embodiment illustrated in Figure 1 is shown as including a hydraulic clutch 51 having two elements, one of which is functionally integral with the pump impeller 13, and another of which is functionally integral with the turbine runner 15. To this end the pump impeller 13 is here shown as provided on the side nearest the turbine runner 15 with an annular extension 52 provided with a generally annular recess 53 (here shown as curved) this recess being divided by the provision of a desired number of radially extending ribs or vanes 54. To the same end, the turbine runner 15 is here shown as provided on its lateral face nearest the impeller 13, with a generally annular recess 55 (here shown as curved) which is similarly provided with a desired number of radially extending ribs or vanes 56, adapted to cooperate with the ribs or vanes 54. When the shaft 11 is at rest the opposed straight radial edges of the ribs 54, 56 are disposed a desired distance apart, in parallel planes perpendicular to the axis of the shafts 10, 11.

In order to assist in better guiding the fluid discharged by the turbine blades 17 into the intake of the pump impeller 13, an annular flange 57, concentric with the shafts 10, 11, may be provided, this being here shown as formed on the pump impeller 13 and serving as the outer periphery of the intake side of the pump impeller. The annular flange 57 is adapted to cooperate with a generally annular recess 58 in the adjacent lateral face of the turbine runner 15, this annular recess 58 having a peripheral portion 59 adapted to have a working fit with the outer periphery of the flange 57, and having a bottom

60, which is here shown in a plane perpendicular to the axis of the shaft 11.

The shaft 11 may have its left end, as viewed in Figure 1, of reduced section 61 and adapted to be rotatably fitted in a bore 62 in the right hand end of the shaft 10.

The power transmission means may have its housing 23 filled or partially filled with a suitable fluid, such as oil, and in order to retain this oil in the housing the bearings 25, 30 may be provided with suitable glands 63, 64 respectively.

The operation of the device illustrated in Figure 1 is as follows. If the shaft 11 is at rest, and connected to a load, and the shaft 10 has power applied thereto to rotate the pump impeller 13, the vanes 14 act to throw fluid radially outwardly by centrifugal force, thereby pumping fluid into the passage 21 of the guiding element 20, through which passage fluid is conducted to the guide vanes 22, which serve to properly direct the fluid into the entrance of the turbine runner 15 at the periphery thereof, the fluid then flowing between and against the turbine blades 17 to thereby generate a torque tending to rotate the turbine runner 15. After the fluid has passed in a generally radially inward direction through the turbine runner 15 it is discharged from the inner periphery of the turbine blades 17 from whence it passes through the vane-free spaces 18, 19 between the blades 17 and the pump impeller vanes 14, where it is again thrown out by centrifugal force, to proceed as hereinbefore described. By reason of this arrangement a torque is applied to the turbine runner 15 which is higher than that available on the shaft 10.

If, for example, the shaft 11 is connected to the driving wheels of an automotive vehicle, and the shaft 10 is connected to a gasoline engine, the engine may be run at any desired speed, including its highest rate of speed, thereby producing a high centrifugal force and a powerful pumping action by means of the pump impeller 13. The high velocity energy of the fluid thus pumped is converted as between the guide vanes 22 and the turbine runner 15 into energy at lower speed and high torque, thereby effectively starting the automotive vehicle from rest, without the necessity of the interposition of a mechanical clutch and reduction gears.

The turbine runner 15 (and therefore the shaft 11) cannot be brought up to the speed of the driving shaft 10 by the pump 13 and turbine 15 alone, and furthermore, as the speed of the turbine 15 increases above a predetermined value, the turbine operates less and less efficiently, a large circulation of fluid occurring with loss in power and consequent loss in torque production on the driven shaft, until, at a predetermined relative speed of the shafts 10, 11, the torque produced on the shaft 11 would be at best no greater than the torque of the shaft 10. However, in accordance with the present invention, as the speed of the shaft 11 rises and reaches a predetermined value, the fly balls 41 tend to move outwardly, and when they move outwardly they cause the turbine runner 15 to be moved toward the left, as viewed in Figure 1, so that the clutch ribs 56 are caused to approach the clutch ribs 54. At the same time, the peripheral ends of the turbine blades 17 are moved axially out of alignment with the discharge ends of the guide vanes 22, thereby reducing the circulation of fluid through the pump 13 and turbine 15. As the clutch ribs 54, 56 approach each other, they be-

come more and more effective to transmit torque from the driving shaft 10 to the driven shaft 11. This will be evident when it is considered that the clutch ribs 54, 56 tend to propel the fluid between the ribs radially outwardly, thereby putting the fluid between the ribs under considerable pressure and as the ribs approach each other, there is less and less opportunity for the fluid between the ribs to assume a rotational movement different from that of either the ribs 54 or 56. Consequently, when the fly balls 41 have moved the runner 15 to the limit of motion toward the left, at which time the edges of the ribs 54, 56 are as close together as possible, with running clearance, the pump impeller 13 and turbine runner 15 are effectively hydraulically clutched together.

When the ribs 54, 56 are in close cooperative relation as hereinbefore described, a peripheral annular flange 65 on the turbine runner 15 has been moved to cut off communication between the discharge side of the vanes 22 and the turbine blades 17. Losses due to circulation of fluid from the pump impeller 13 through the turbine runner 15 are therefore prevented. There are therefore no such losses as would impair the efficiency of the clutch 51. There is of course running clearance between the flange 65, and, in general, between the radially outer periphery of the rotor 16, on the one hand, and the adjacent inner periphery of the guide member 20, on the other hand.

It will be evident that inasmuch as the clutch ribs 54, 56 are a considerable distance apart when the shaft 11 is at rest, or has reached a predetermined low speed, losses which would occur if the ribs 54, 56 were close together under these circumstances, are avoided. It may be stated that in hydraulic clutches of the type herein described, if the ribs 54, 56 are close together when there is a considerable difference in speed between such ribs, the losses are so high that not enough power would be left to obtain any beneficial effect from the pump and turbine combination. On the other hand, if the difference in speed between the shafts 10 and 11 is first decreased by the pump-turbine combination to a predetermined amount and then the ribs 54, 56 brought into close proximity, the conditions are then such that the clutch 51 can operate at its maximum efficiency and is enabled to still further reduce the difference in speed between the shafts 10, 11, in fact the driven shaft 11 will rotate at virtually the same speed as the driving shaft 10, the "slip" amounting to only three or four per cent.

If, after a certain stable condition has been reached with virtually the same speed at shaft 11 as at 10, the load on the shaft 11 is increased, as by an automotive vehicle going up a hill, sufficiently to reduce the speed of the shaft 11 enough to cause the fly balls 41 to move radially inwardly, the clutch ribs 54, 56 will be separated a predetermined distance, depending on the reduction in speed, and at the same time the turbine runner 15 will be moved to the right, as viewed in Figure 1, thereby reestablishing circulation of fluid through the runner 15, as will be evident. The torque multiplying effect of the pump and turbine combination will consequently again come into action to take care of the increased torque required at the shaft 11. Thus with my invention an automotive vehicle may not only be started from rest, without the necessity of the interposition of a mechanical clutch and

reduction gears, but no declutching, shifting of gears, and re-clutching are necessary to take care of various changing load conditions, all that being taken care of automatically, and in a manner such that the parts are not subjected to violent changes in stress. The latter objectionable condition is avoided by a gradual and smooth transfer of power transmission from through the pump-turbine combination to through the hydraulic clutch and vice versa, automatically dependent on the conditions of operation.

Referring to Figure 2, this illustrates another embodiment of my invention, and it will be understood that the lower, chiefly omitted, half of the section is the same as the upper half. In the embodiment of Figure 2 a rotor 66 includes a turbine runner 67 which may be provided with more than one set of turbine blades, these being disposed in separate, generally radially extending passages of the runner. The runner 67, may, for example, be provided with a set of blades 68 adapted to cooperate with the discharge from guide vanes 69 when a shaft 79 is at rest, or has not reached a predetermined speed. The guide vanes 69 correspond to the vanes 22 of Figure 1. As the speed of the shaft 79 is increased by the effect of fluid passing between and against the blades 68, means is provided to shift the turbine runner 67 to the left, as viewed in Figure 3, thereby gradually bringing another set of turbine blades 70 into cooperation with the fluid discharged from the guide vanes 69, and at the same time gradually removing the turbine blades 68 from the depth of that discharge. The turbine blades 70 are desirably so constructed and disposed that the effective average radius thereof is less than that of the blades 68, and the blades 70 are otherwise designed as to curvature in their general plane to operate more efficiently at a speed higher than that at which the blades 68 operate most efficiently.

As in the case of the embodiment in Figure 1, when the turbine runner 67 has been moved to the left to its maximum distance, at which time clutch ribs 71, 72 of a hydraulic clutch 73, similar to the clutch 51 of Figure 1, are in close cooperative relation, a flange 74, similar to the flange 65, closes the discharge side of the guide vanes 69 and the runner 67.

In the embodiment of Figure 2 the space between the clutch ribs 71, 72 is closed at its inner periphery by means of an annular flange 75, analogous to the flange 57 of Figure 1, but in this instance provided on the turbine runner 67 and on the side thereof nearest to the intake side of a pump impeller 76, forming part of the rotor 77 corresponding to the pump impeller 13 and rotor 12 of Figure 1.

The rotors 66 and 77 are related to shafts 79, 78 in a manner similar to that described in connection with the rotors 12, 16 and shafts 10, 11 of Figure 1, and a housing 80 and frame 81 correspond to the housing 23 and frame 32.

In the embodiment of Figure 2 the means for causing movement of the turbine runner 67 in response to speed conditions of the shaft 79 includes a valve 82 cooperable with a valve seat 83 which surrounds an opening 84 through the turbine runner 67, into the space radially within the blades 70. The valve 82 in this instance is provided with a guide 85 slidable in the opening 84, the guide 85 being provided with one or more slots 86, which may be of V-shape, tapering toward a collar portion 87 of the movable valve member 82. Fluid is adapted to pass from a

space, 88, outside of the turbine runner, enclosed by an end bell portion 89 of the housing 80, through such portion of the slot 86 as may not be covered by the margins of the valve seat 83.

5 The valve 82 may be operated by means of a link 90, operable by fly balls 91 mounted and connected similarly to the fly balls 41 of Figure 1.

The operation of the embodiment of Figure 2 is similar to that already described in connection 10 with the embodiment of Figure 1, with exceptions to be pointed out. When the speed of the shaft 79 increases to a predetermined amount, the port formed by the V-shaped slot 86 will gradually close, thereby building up fluid pressure in the space 88 on the outside of the rotor 66. When the pressure in the space 88 has been 15 built up sufficiently high, either by partial closure of the slot 86 or complete closure by seating of the valve collar 87 of the valve member 82 on the seat 83, the rotor 66 will be moved toward the left, as viewed in Figure 2, by the fluid pressure thus built up.

When the rotor 66 moves, in response to closure or partial closure of the valve 82 by movement 25 of the fly ball 91, as hereinbefore described, such movement of the rotor 66 will cause re-opening of the valve 82 to thereby decrease the pressure in the space 88, thereby stopping axial movement of the rotor 66. The result is that the rotor 66 will 30 be positioned in accordance with the position of the fly ball 91 and it will not be necessary for the fly ball 91 to act directly on the rotor 66 as the speed rises, as is the case in the embodiment of Figure 1, although the fly ball 91 may also act 35 directly on the rotor 66 by engagement of the valve collar 87 with the valve seat 82. It will of course be obvious that the valve 82 as described in connection with Figure 2 may also be applied in the embodiment shown in Figure 1.

40 As the rotor 66 is moved toward the left in response to predetermined speed conditions of the shaft 79 the turbine blades 68 of the turbine runner 67 are gradually cut out of operation and the turbine blades 70 are gradually cut into operation, and at the same time, as in the case of 45 the embodiment of Figure 1, when the speed of the shaft 79 is such that the turbine blades 70 are operating at a speed at which torque production is no longer as efficient as at predetermined lower speeds, then the turbine blades 70 50 will gradually be cut out of operation entirely and the clutch ribs 71, 72 gradually brought into close proximity, so that the shafts 78, 79 are hydraulically clutched as hereinbefore described in connection with Figure 1. The clutch 73 is shown 55 in Figure 2 surrounded, with running clearance, by an annular flange 92 provided on the discharge end of the guide member in which the guide vanes 69 are disposed. Such a flange 92 may of course 60 also be provided if desired on the guide member 20 of Figure 1.

It will of course be apparent that the fly ball 91, in conjunction with the valve 82, will act to cause movement of the rotor in a direction toward 65 the right, as viewed in Figure 2, when there is a decrease in speed of the shaft 79.

Referring to Figure 4 of the drawings, this illustrates another embodiment of my invention, and the apparatus here shown includes a driving 70 shaft 93 and a driven shaft 94. The hydraulic transmission proper, for transmitting power from the shaft 93 to the shaft 94 is shown as enclosed in a divided housing 95 having generally the parts 96, 97, here shown as fastened together by 75 any suitable number of bolts 98. The housing

part 96 is provided with a hub 99 which is keyed to the shaft 94, and the hub 99 also serves as a journal bearing for a reduced end 100 of the shaft 93.

The housing part 97 is provided with a hub 5 or boss 101 which is freely rotatable with respect to the shaft 93, and in order to retain liquid within the housing 95 a suitable gland 102, with packing, is provided. The shaft 93 is here shown as provided with a collar 103 which serves as an abutment between it and the hub 101, to limit 10 the relative axial movement of the parts. The shaft 93 further has drivingly associated therewith a disc 104 which is here shown as fastened, as by screws 105, to a flange 106 drivingly associated with the shaft 93. The disc 104 extends 15 to within running clearance of the housing part 96, thus dividing the housing 95 into two chambers.

The disc 104 carries vanes 107, which may be 20 integral with the disc 104. The vanes 107 constitute the impeller vanes of a pump, and these vanes may be desirably curved as shown in Figure 5, the concave side being toward the direction of the rotation.

In the embodiment of Figure 4 the peripheral 25 outer ends of the impeller vanes 107 are disposed, with running clearance, adjacent and within the radially inner edges of a plurality of turbine blades 108. The turbine blades 108 are curved 30 generally in the opposite direction from the curvature of the vanes 107 and are desirably, for the best results, shaped to constitute the blades of a radially outward flow reaction turbine. The turbine blades 108 are drivingly associated with 35 a base ring 109, with which the blades 108 may be integral. The base ring 109 is drivingly associated with the housing part 96 by means of any suitable number of ribs or vanes 110, which in the embodiment shown, and as may be more 40 clearly seen in Figure 5, extend in a generally radial direction.

The space radially outside of the turbine blades 108 and confined by the disc 104 and by the inside 45 of the housing part 96 constitutes a discharge chamber proper, 111, for liquid flowing in a generally radial direction out from between the turbine blades 108. This chamber 111 along with the spaces between the ribs 110 constitute a discharge passage or passages for the turbine. In 50 the embodiment shown the base ring 109 extends in a generally radial inward direction forming a portion 112 which serves as a wall separating the aforesaid passage from the pump impeller.

In the embodiment shown in Figure 4 the 55 pump impeller vanes 107 extend radially inward, along the wall 112, with running clearance between the vanes 107 and the wall 112, to a point 113 which may be at a place substantially the same radial distance from the periphery of the 60 shaft 93 as is the radial inner edge of the wall 112. From the point 113 the edges of the vanes 107 may extend in a general axial direction and may also extend radially inward to substantially the periphery of the shaft 93. It is evident 65 that, with the arrangement of parts shown, a vane-free space 114 is provided at the inlet to the pump vanes 107 and at the terminus of the discharge passage from the turbine. While the discharge chamber 111, the discharge passage between the ribs 110, and the vane free 70 space 114 have been thus named for convenience of description, it will of course be obvious that no definite distinction can be made or limits assigned as between what may be considered the 75

discharge passage for the turbine and the inlet passage for the pump.

In the embodiment shown, the pump vanes 107 are axially wider at their inlet edges, than they are at their radial outer edges, which is desirable but not essential, and the wall 109 is correspondingly formed to accommodate running clearance between it and the vanes 107. It is evident that even if the vanes 107 are otherwise unshrouded on the sides facing the wall 109, the said wall will serve as a shroud for the vanes 107.

The disc 104 is here shown as also carrying vanes or ribs 115, on the side of said disc opposite from that of the pump vanes 107. The vanes 115 are of any desired number and, when provided, they are disposed in operative relation to another set of vanes 116, carried by a disc 117. The disc 117 is provided with a hub 118 which is freely slidable on the shaft 93. The disc 117 is here shown as biased towards the position shown in Figure 1 by means of a desired number of leaf springs 119. The ends of each spring are fastened respectively to the disc 117 and to the end wall of the housing part 97, as by means of screws 120, 121 respectively.

In order to regulate and adjust the distance between the axially opposed edges of the vanes 115, 116, in accordance with the speed of the driven shaft 94, the end wall of the housing part 97 carries, in this instance, inertia type fly balls 122, 123, not shown in Figure 4 but shown in end elevation in Figure 6. The fly balls 122, 123 are carried by levers 124, 125 which are adapted to be pivoted to pivots 126, 127 carried by the housing portion 97. As will be evident the fly balls 122, 123 and the pivoted levers 124, 125 to which they are attached are movable in a plane transverse to the driving shaft 93. The fly balls 122, 123 are suitably connected by pivoted links 128, 129 to arms 130, 131 carried by a ring 132 freely rotatable in a groove 133 in the hub 101 of the housing portion 97. The ring 132, as clearly shown in Figure 7, is provided with skewed slots 135, 136 into which pins 137, 138 are adapted to extend. The pin 137 is here shown as carried by a block 139 having axially extending operating pins 140 associated therewith. The pins 140 are here shown as extending through holes in the housing portion 97 and are operable against the disc 117. Two pins 140 are provided merely as one way of preventing the pin 137 from binding in the slot 135. The pin 138 is similarly carried by a block provided with pins acting on the disc 117.

The fly balls 122, 123 may be biased to the position shown in Figure 6 by springs 141, 142 having their ends connected to the fly balls and to the levers 124, 125 respectively.

When the driven shaft 94 and consequently the housing 95 are at rest or at a speed insufficient to overcome the bias of the springs 141, 142 and 119, the fly balls 122, 123 will be in the position shown in Figure 6, and the pins 137, 138 will be in the position shown in Figures 6 and 4. The clutch vanes 115, 116 will be in the position shown in Figure 4. When the speed of the housing 95 increases to a predetermined extent, the fly balls 122, 123 will be moved outwardly, thus turning the ring 132 in a counter-clockwise direction as viewed in Figure 6. The turning of the ring 132 will cause the pins 137, 138 and consequently the pin 140, to move toward the right as viewed in Figure 4, by reason of the cam action of the slots 135, 136 on the pins 137, 138, and consequently the disc 117 and

the vanes 116 carried thereby will be moved toward the vanes 115 a predetermined amount.

The housing 95 is preferably filled with a liquid such as oil, either fully or to a predetermined extent. If the housing is completely filled with liquid suitable means (not shown) must be provided to permit expansion of the liquid when heated, which applies also in the case of the embodiments of Figures 1 and 2.

The operation of the embodiment of the invention shown in Figures 4 through 7 is as follows.

If it be assumed that the driven shaft 94 is at rest and the driving shaft 93 is in rotation, the pump impeller, through rotation of its vanes 107, will take oil from the chamber 114 and drive it in a generally radial outward direction by centrifugal force, this oil impinging at the proper angle and having its direction of flow changed by the reaction turbine blades 108, and then discharged from the blades 108 at greatly reduced velocity into the discharge passage of the turbine. This produces a high torque tending to rotate the turbine and therefore the housing 95 and the driven shaft 94, in the same direction as the shaft 93. The oil discharged from the turbine runner passes first into the discharge space 111 and then turns radially inwards between the ribs 110 into the vane free space 114 and thence back to the inlet of the pump vanes 107. While the rotation of the shaft 94 is being begun and before it has attained any considerable speed, the ribs 110 act simply as supports for the base ring 109. However, as the speed of the shaft 94 is increased the ribs 110 begin to effectively tend to whirl the oil confined between said ribs, and therefore said oil tends to move in a general radial outward direction. The result is that when the shaft 94 thus increases in speed a greater and greater back pressure is put on the liquid in the discharge chamber 111. The consequence is that as the speed of the driven shaft 94 approaches that of the driving shaft 93 the circulation of liquid through the pump and turbine combination substantially or entirely ceases or is reduced to a predetermined extent, as may be desired.

The liquid between the vanes 107 and the turbine blades 108 is under considerable pressure when the ribs 110 come into effective action to produce a substantial centrifugal force, and therefore relative motion as between the vanes 107 and blades 108 is rendered more difficult and hence slip is reduced. The pump-turbine combination thus tends to act like a clutch when a predetermined speed is reached.

It will be evident that the pump and turbine combination whose operation has just been described is per se an improved hydraulic power transmitting means.

During the time that the foregoing actions of the pump and turbine combination are going on, the hydraulic clutch vanes 115, 116 are at first widely spaced as shown in Figure 4. There is therefore little churning, turbulence, and hydraulic friction when the shaft 94 is at a standstill and the vanes 115 are rotating at a comparatively high speed. Substantially all the power that may be delivered to the shaft 94, is therefore available for use in the pump and turbine. As the speed of the driven shaft 94 increases, by reason of the action of the pump and turbine, to an extent sufficient to overcome the predetermined force of the springs 141, 142, the fly balls 122, 123 will act to move the vanes

116 axially toward the vanes 115 a predetermined extent dependent upon the increase in speed of the shaft 94. The hydraulic clutch effect as between the vanes 115, 116 will therefore increase and reach a maximum when the vanes 116 have been moved toward the vanes 115 as close as running clearance between said sets of vanes will permit. The degree of approach of the vanes 116 to the vanes 115 may be limited, for example, by the abutting of the disc 117 against a portion of the housing 95.

It is of course obvious that if the load on the driven shaft 94 increases further, the fly balls 122, 123 will again permit more or less separation of the vanes 115, 116, and at the same time, since the ribs 110 are operating at a lower speed the back pressure produced in the chamber 111 will be lower and hence the turbine 108 will again be permitted to come into action, as a turbine, to an extent dependent upon the relative speeds of the shafts 93, 94, thus producing a high torque, or a sufficient torque on the shaft 94, to take the load.

While the embodiments of Figures 1 and 2 show turbine runners of the radial inward flow type and the embodiment of Figure 4 shows a runner of the radial outward flow type, it will be apparent to those skilled in the art that the turbine runner may be types other than of radial outward flow.

From the foregoing it will be apparent to those skilled in the art that the illustrated embodiments of my invention provide new and improved power transmitting means, and accordingly, each accomplishes at least the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiments of my invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combinations than those illustrated, without departing from the spirit of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

I claim:

1. Power transmitting means, comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby during the starting from rest of said driven means the power available from said driving means is transmitted from said driving to said driven means substantially entirely through said hydraulic torque multiplying means and then as the speed of said driven means increases above a predetermined value the transmission of power is gradually automatically transferred from through said hydraulic torque multiplying means to through said hydraulic clutch said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase.

2. Power transmitting means comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said hydraulic torque mul-

tiplying means and said clutch in relative amounts dependent upon the speed of said driven means in said range.

3. Power transmitting means comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said hydraulic torque multiplying means and said clutch in relative amounts dependent upon the speed of said driven means, predetermined increments in speed causing predetermined increase and decrease respectively in powers transmitted through said clutch and hydraulic torque multiplying means respectively, and predetermined decrements in speed causing predetermined decrease and increase respectively in powers transmitted through said clutch and hydraulic torque multiplying means respectively.

4. Power transmitting means comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby during the starting from rest of said driven means the power available from said driving means is transmitted from the driving to the driven means substantially entirely through said hydraulic torque multiplying means and then as the speed of said driven means increases above a predetermined value the transmission of power is gradually automatically transferred from through said hydraulic torque multiplying means to through said hydraulic clutch said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase, and upon decrease in speed said gradual automatic transfer is reversed.

5. Power transmitting means comprising: driving and driven means; a hydraulic turbine, drivingly associated with said driven means; means drivingly associated with said driving means for causing said turbine to rotate; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said turbine and said clutch in relative amounts dependent upon the speed of said driven means.

6. Power transmitting means comprising: driving and driven means; a hydraulic turbine, drivingly associated with said driven means; means drivingly associated with said driving means for causing said turbine to rotate; a hydraulic clutch including elements associated with said driving and driven means respectively; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said turbine and said clutch in relative amounts dependent upon the speed of said driven means, predetermined increments in speed causing predetermined increase and decrease respectively in powers transmitted through said clutch and turbine respectively, and predetermined decrements in speed causing predetermined decrease and in-

crease respectively in powers transmitted through said clutch and turbine respectively.

7. Power transmitting means comprising: driving and driven means; a hydraulic turbine, 5 drivingly associated with said driven means; means drivingly associated with said driving means for causing said turbine to rotate; a hydraulic clutch including elements associated with said driving and driven means respectively; and 10 means whereby during the starting from rest of said driven means power is transmitted from the driving to the driven means substantially entirely through said turbine and then as the speed of said driven means increases above a 15 predetermined value the transmission of power is gradually automatically transferred from through said turbine to through said hydraulic clutch said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase, and upon 20 decrease in speed said gradual automatic transfer is reversed.

8. Power transmitting means comprising: driving and driven means; means for starting 25 said driven means from rest including hydraulic torque multiplying means for transmitting power from said driving to said driven means; hydraulic clutch means having elements associated respectively with said driving and driven means; 30 means for reducing the absorption of power by said clutch means during said starting; and means for gradually reducing the circulation of liquid through said hydraulic torque multiplying means in response to predetermined speed 35 of said driven means, said gradual reduction of circulation varying as said speed so that the amount of reduction is dependent upon the amount of speed increase.

9. Power transmitting means comprising: 40 driving and driven means; means for starting said driven means from rest including a hydraulic turbine drivingly associated with said driven means; hydraulic clutch means having elements associated respectively with said driving and 45 driven means; means for reducing the absorption of power by said clutch means during said starting; and means for gradually reducing the circulation of liquid through said turbine in response to predetermined speed of said driven 50 means, said gradual reduction of circulation varying as said speed so that the amount of reduction is dependent upon the amount of speed increase.

10. Power transmitting means comprising: 55 driving and driven means; a rotor drivingly associated with said driving means; said rotor including centrifugal pump impeller vanes and a set of hydraulic clutch vanes unitary with said pump impeller vanes; a turbine having a runner 60 disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said first named set; and means whereby said second set of hydraulic clutch vanes and said turbine runner 65 are drivingly associated with said driven means.

11. Power transmitting means comprising: driving and driven means; a rotor drivingly associated with said driving means; said rotor including centrifugal pump impeller vanes and a 70 set of hydraulic clutch vanes; a turbine having a runner disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said 75 first named set; means whereby said second set

of hydraulic clutch vanes and said turbine runner are drivingly associated with said driven means; means for mounting said second set of hydraulic clutch vanes for axial movement; and means for causing said second set of vanes to 5 assume an axial position dependent upon the speed of said driven means.

12. Power transmitting means comprising: driving and driven means; a rotor drivingly associated with said driving means; said rotor including centrifugal pump impeller vanes and a 10 set of hydraulic clutch vanes; a turbine having a runner disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said 15 first named set; means whereby said second set of hydraulic clutch vanes and said turbine runner are drivingly associated with said driven means; means for mounting said second set of hydraulic clutch vanes and said turbine runner 20 for axial movement; and means for causing said second set of vanes and said turbine runner to assume an axial position dependent upon the speed of said driven means.

13. Power transmitting means comprising: 25 driving and driven means; a housing; a rotor drivingly associated with said driven means, a housing; a rotor drivingly associated with said driven means, said rotor having a wall dividing said housing into a first and second chamber 30 with running clearance between the periphery of said wall and said housing; a set of hydraulic clutch vanes carried by said rotor in said first chamber; a turbine runner carried by said rotor in said second chamber; and a centrif- 35 ugal pump impeller and a set of hydraulic clutch vanes, disposed in said first chamber, drivingly associated with said driving means, cooperating respectively with said turbine runner and said first named set of hydraulic clutch vanes. 40

14. Power transmitting means comprising: driving and driven means; a housing drivingly associated with said driven means; a disc drivingly associated with said driving means, said disc dividing said housing into two chambers 45 with running clearance between the periphery of said disc and said housing; a set of hydraulic clutch vanes carried by said housing in one of said chambers; a turbine runner carried by said housing in the other of said chambers; and a 50 centrifugal pump impeller and a set of hydraulic clutch vanes carried by and on opposite sides of said disc and cooperating respectively with said first turbine runner and said first named set of hydraulic clutch vanes. 55

15. Power transmitting means comprising: driving and driven means; a disc drivingly associated with said driving means; centrifugal pump 60 impeller vanes carried on one side of said disc; a set of hydraulic clutch vanes carried by the other side of said disc; a turbine having a runner disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said 65 first named set; means whereby said second set of hydraulic clutch vanes and said turbine runner are drivingly associated with said driven means; means for mounting said second set of hydraulic clutch vanes for axial movement; and means for causing said second set of vanes to 70 assume an axial position dependent upon the speed of said driven means.

16. Power transmitting means comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from 75

said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; said clutch containing a predetermined amount of liquid; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said hydraulic torque multiplying means and said clutch in relative amounts dependent upon the speed of said driven means, predetermined increments in speed causing predetermined increase and decrease respectively in powers transmitted through said clutch and hydraulic torque multiplying means respectively, and predetermined decrements in speed causing predetermined decrease and increase respectively in powers transmitted through said clutch and hydraulic torque multiplying means respectively, said predetermined amount of liquid remaining substantially the same while said speed so changes.

17. Power transmitting means comprising: driving and driven means; a hydraulic turbine, drivably associated with said driven means; means drivably associated with said driving means for causing said turbine to rotate; a hydraulic clutch including elements associated with said driving and driven means respectively; said clutch containing a predetermined amount of liquid; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said turbine and said clutch in relative amounts dependent upon the speed of said driven means, predetermined increments in speed causing predetermined increase and decrease respectively in powers transmitted through said clutch and turbine respectively, and predetermined decrements in speed causing predetermined decrease and increase respectively in powers transmitted through said clutch and turbine respectively; said predetermined amount of liquid remaining substantially the same while said speed changes.

18. Power transmitting means comprising: driving and driven means; hydraulic torque multiplying means for transmitting power from said driving to said driven means; a hydraulic clutch including elements associated with said driving and driven means respectively; said clutch containing a predetermined amount of liquid; and means whereby during the starting from rest of said driven means the power available from said driving means is transmitted from the driving to the driven means substantially entirely through said hydraulic torque multiplying means and then as the speed of said driven means increases above a predetermined value the transmission of power is gradually automatically transferred from through said hydraulic torque multiplying means to through said hydraulic clutch said gradual transfer varying as said speed so that that the amount of transfer is dependent upon the amount of speed increase; said predetermined amount of liquid remaining substantially the same while said speed so changes.

19. Power transmitting means comprising: driving and driven means; a hydraulic turbine, drivably associated with said driven means; means drivably associated with said driving means for causing said turbine to rotate; a hydraulic clutch including elements associated with said driving and driven means respectively; said clutch containing a predetermined amount of

liquid; and means whereby during the starting from rest of said driven means power is transmitted from the driving to the driven means substantially entirely through said turbine and then as the speed of said driven means increases above a predetermined value the transmission of power is gradually automatically transferred from through said turbine to through said hydraulic clutch said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase; said predetermined amount of liquid remaining substantially the same while said speed so changes.

20. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers, and including rotatable elements drivably associated with said driving and driven means, a first of said elements including a pump disposed in one of said chambers, and a second of said elements being disposed in the other of said chambers; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move at least one of said first and second elements out of one chamber toward the other; and means, including an adjustable valve, so constructed and arranged that said difference in hydrostatic pressures may be controlled by said valve.

21. Power transmitting means comprising: driving and driven means; rotatable means drivably associated with said driving means; said rotatable means including centrifugal pump impeller vanes and a set of hydraulic clutch vanes; a turbine having a runner disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said first named set; means whereby said second set of hydraulic clutch vanes and said turbine runner are drivably associated with said driven means; and means mounting at least one of said sets of hydraulic clutch vanes for axial movement.

22. Power transmitting means comprising: driving and driven means; rotatable means drivably associated with said driving means; said rotatable means including centrifugal pump impeller vanes and a set of hydraulic clutch vanes; a turbine having a runner disposed in operative relation to the discharge from said pump impeller; a second set of hydraulic clutch vanes disposed adjacent said first named set; means whereby said second set of hydraulic clutch vanes and said turbine runner are drivably associated with said driven means; and means mounting said turbine runner for axial movement.

23. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including rotatable elements drivably associated with said driving and driven means respectively, said elements being so constructed and arranged that they cooperate hydraulically to transmit power and are axially relatively movable to vary the hydraulic interaction of said elements; and inertia responsive means including connections controlling the relative axial position of said rotatable elements, so constructed and arranged that at a substantially constant relative speed as between said driving and driven means said elements remain in substantially the same relative position and upon a sudden change of speed causing a tem-

porary change in relative angular relation of said driving and driven means said elements are caused to change their relative axial position.

24. Power transmitting means comprising:
 5 driving and driven means; a hydraulic turbine, drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; hydraulic clutch means having elements associated with said driving and driven means respectively; said hydraulic clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined amount of liquid and when
 10 the speeds of said driving and driven means are least different; said clutch elements being so constructed and arranged that during the starting from rest of said driven means absorption of power by said hydraulic clutch is reduced though said clutch elements are supplied with said
 20 amount of liquid, thereby to render said otherwise absorbed power available for transmission through said turbine to said driven means; and means, responsive to increase of speed of said driven means above a predetermined amount substantially less than maximum, so constructed and arranged that the transmission of power is gradually automatically transferred from through said turbine to through said hydraulic
 25 clutch means said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase.

25. Power transmitting means comprising:
 35 driving and driven means; a hydraulic turbine, drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; hydraulic clutch means having elements associated with said driving and driven means respectively; said hydraulic clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined amount of liquid and when the speeds of said driving and driven means are
 40 least different; said clutch elements being so constructed and arranged that during the starting from rest of said driven means absorption of power by said clutch is reduced though said clutch elements are supplied with said amount
 50 of liquid, thereby to render said otherwise absorbed power available for transmission through said turbine to said driven means; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said turbine and said clutch means in relative amounts dependent upon the speed of said driven means in said range.

26. Power transmitting means comprising:
 60 driving and driven means; a hydraulic turbine, drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; hydraulic clutch means having elements associated with said driving and driven means respectively; said hydraulic clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined amount of liquid and when
 70 the speeds of said driving and driven means are least different; said clutch elements being so constructed and arranged that they are relatively movable toward and away from each other and during the starting from rest of said driven means are positioned away from each other so

that absorption of power by said hydraulic clutch is reduced though said clutch elements are supplied with said amount of liquid, thereby to render said otherwise absorbed power available for transmission through said turbine to said driven means; and means, responsive to increase of speed of said driven means above a predetermined amount substantially less than maximum, so constructed and arranged that the transmission of power is gradually automatically transferred from through said turbine to through said hydraulic clutch means said gradual transfer varying as said speed so that the amount of transfer is dependent upon the amount of speed increase.

27. Power transmitting means comprising:
 driving and driven means; a hydraulic turbine, drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; hydraulic clutch means having elements associated with said driving and driven means respectively; said hydraulic clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined amount of liquid and when the speeds of said driving and driven means are least different; said clutch elements being so constructed and arranged that they are relatively movable toward and away from each other and during the starting from rest of said driven means are positioned away from each other so that absorption of power by said clutch is reduced though said clutch elements are supplied with said amount of liquid thereby to render said otherwise absorbed power available for transmission through said turbine to said driven means; and means whereby for speeds of said driven means in a range from substantially less than maximum to maximum, power is transmitted to said driven means through both said turbine and said clutch means in relative amounts dependent upon the speed of said driven means in said range.

28. Power transmitting means comprising:
 45 driving and driven means; a hydraulic turbine drivingly associated with said driven means; means drivingly associated with said driving means for causing said turbine to rotate to start said driven means from rest; said turbine including housing means containing a predetermined amount of liquid; hydraulic clutch means having elements associated respectively with said driving and driven means; means for reducing the absorption of power by said clutch means during said starting; and means for gradually reducing the circulation of liquid through said turbine in response to predetermined speed of said driven means while leaving said amount of liquid substantially the same, said gradual reduction varying as said speed so that the amount of reduction of circulation is dependent upon the amount of speed increase.

29. Power transmitting means comprising:
 65 driving and driven means; a hydraulic turbine drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; said turbine including housing means containing a predetermined amount of liquid; hydraulic clutch means having elements associated respectively with said driving and driven means; said clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined

amount of liquid and when the speeds of said driving and driven means are least different; said clutch elements being so constructed and arranged that during the starting from rest of
 5 said driven means absorption of power by said hydraulic clutch means is reduced though said clutch elements are supplied with said amount of clutch liquid, thereby to render said otherwise absorbed power available for transmission
 10 through said turbine to said driven means; and means for gradually reducing the circulation of liquid through said turbine in response to predetermined speed of said driven means while leaving said amount of turbine liquid substantially the same, said gradual reduction varying
 15 as said speed so that the amount of reduction of circulation is dependent upon the degree of speed increase.

30. Power transmitting means comprising:
 20 driving and driven means; a hydraulic turbine drivingly associated with said driven means; hydraulic means drivingly associated with said driving means for causing said turbine to rotate; said turbine including housing means containing
 25 a predetermined amount of liquid; hydraulic clutch means having elements associated respectively with said driving and driven means; said clutch means being adapted to operate with maximum clutching effect when said clutch elements are cooperating in a predetermined amount
 30 of liquid and when the speeds of said driving and driven means are least different; said clutch elements being so constructed and arranged that they are relatively movable toward and away from
 35 each other and during the starting from rest of said driven means are positioned away from each other so that absorption of power by said hydraulic clutch means is reduced though said clutch elements are supplied with said amount of clutch
 40 liquid, thereby to render said otherwise absorbed power available for transmission through said turbine to said driven means; and means for gradually reducing the circulation of liquid through said turbine in response to predetermined
 45 speed of said driven means while leaving said amount of turbine liquid substantially the same, said gradual reduction varying as said speed so that the amount of reduction of circulation is dependent upon the amount of speed
 50 increase.

31. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers,
 55 and including rotatable elements drivingly associated with said driving and driven means, one of said elements including a pump disposed in one of said chambers, said rotatable elements including also hydraulic clutch elements relatively
 60 movable axially and drivingly associated with said driving and driven means respectively; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move at least said clutch elements axially relatively toward each other; and means for rendering
 65 said difference in hydrostatic pressures effective to position at least said clutch elements axially relatively to each other.

32. Power transmitting means, comprising:
 70 driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers, and including rotatable elements, said elements including a pump disposed in one of said chambers and a turbine constructed and arranged to

receive the discharge from said pump, said pump and said turbine being relatively movable axially and drivingly associated with said driving and driven means respectively, said rotatable elements including also hydraulic clutch elements relatively
 5 movable axially and drivingly associated with said driving and driven means respectively; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move
 10 said clutch elements axially relatively toward each other and tending to move said pump and said turbine relatively to each other; and means for rendering said difference in hydrostatic pressures effective to position said clutch elements axially
 15 relatively to each other and to position said pump and said turbine axially relatively to each other.

33. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including rotatable elements respectively associated with said driving and driven means, said driving element including a pump,
 20 and said driven element including a turbine; means for so mounting said elements that they are at all times drivingly associated with said driving and driven means so as to rotate in unison with said driving and driven means respectively and so that said turbine is movable axially toward and away from said pump; means whereby
 25 said pump develops fluid pressure tending to move said turbine axially toward said pump; and means for rendering said fluid pressure effective to position said turbine axially with respect to said pump.

34. Power transmitting means, comprising:
 35 driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers, and including rotatable elements drivingly associated with said driving and driven means, a first
 40 of said elements including a pump disposed in one of said chambers, and a second of said elements including a turbine disposed in the other of said chambers; said turbine being so constructed and arranged that it is movable axially
 45 toward and away from said pump; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move said turbine out of said other chamber toward said pump; and means, including an adjustable
 50 valve, so constructed and arranged that said difference in hydrostatic pressures may be controlled by said valve.

35. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers,
 55 and including rotatable elements drivingly associated with said driving and driven means, one of said elements including a pump disposed in one of said chambers and a second of said elements including a turbine disposed in the other of said chambers; said turbine being so constructed and arranged that it is movable axially
 60 toward and away from said pump; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move said turbine out of said other chamber toward said pump; and means for rendering said difference in hydrostatic pressures effective to position said
 65 turbine axially with respect to said pump.

36. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers, 75

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and including rotatable elements drivingly associated with said driving and driven means, one of said elements including a pump disposed in one of said chambers, and a second of said elements including a turbine disposed in the other of said chambers, said rotatable elements including also hydraulic clutch elements so constructed and arranged that they are drivingly associated with said driving and driven means respectively and so that said driven clutch element is movable axially toward and away from said driving clutch element; means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move at least the clutch element associated with said driven means axially toward the clutch element associated with said driving means; and means for rendering said difference in hydrostatic pressures effective to position said driven clutch element axially with respect to said driving clutch element.

37. Power transmitting means, comprising: driving and driven means; hydraulic means for transmitting power from said driving to said driven means, including two principal chambers, and including rotatable elements, said elements

including a pump disposed in one of said chambers, and a turbine, disposed in the other of said chambers, and constructed and arranged to receive the discharge from said pump, said pump and said turbine being so constructed and arranged that they are drivingly associated with said driving and driven means respectively and so that said turbine is movable axially toward and away from said pump, said rotatable elements including also hydraulic clutch elements drivingly associated with said driving and driven means respectively and so constructed and arranged that said driven clutch element is movable toward and away from said driving means whereby said pump develops a difference in hydrostatic pressures in said chambers tending to move the clutch element associated with said driven means axially toward the clutch element associated with said driving means, and tending to move said turbine axially toward said pump; and means for rendering said difference in hydrostatic pressures effective to position said driven clutch element axially with respect to said driving clutch element and to position said turbine axially with respect to said pump.

OTTO GRUENBERGER.

CERTIFICATE OF CORRECTION.

Patent No. 2,179,149.

November 7, 1939.

OTTO GRUENBERGER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 34, for the word "depth" read path; page 7, second column, lines 27, 28 and 29, claim 13, strike out the words and comma "a housing; a rotor drivingly associated with said driven means," page 8, first column, line 63, claim 18, strike out "that" second occurrence; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of December, A. D. 1939.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.