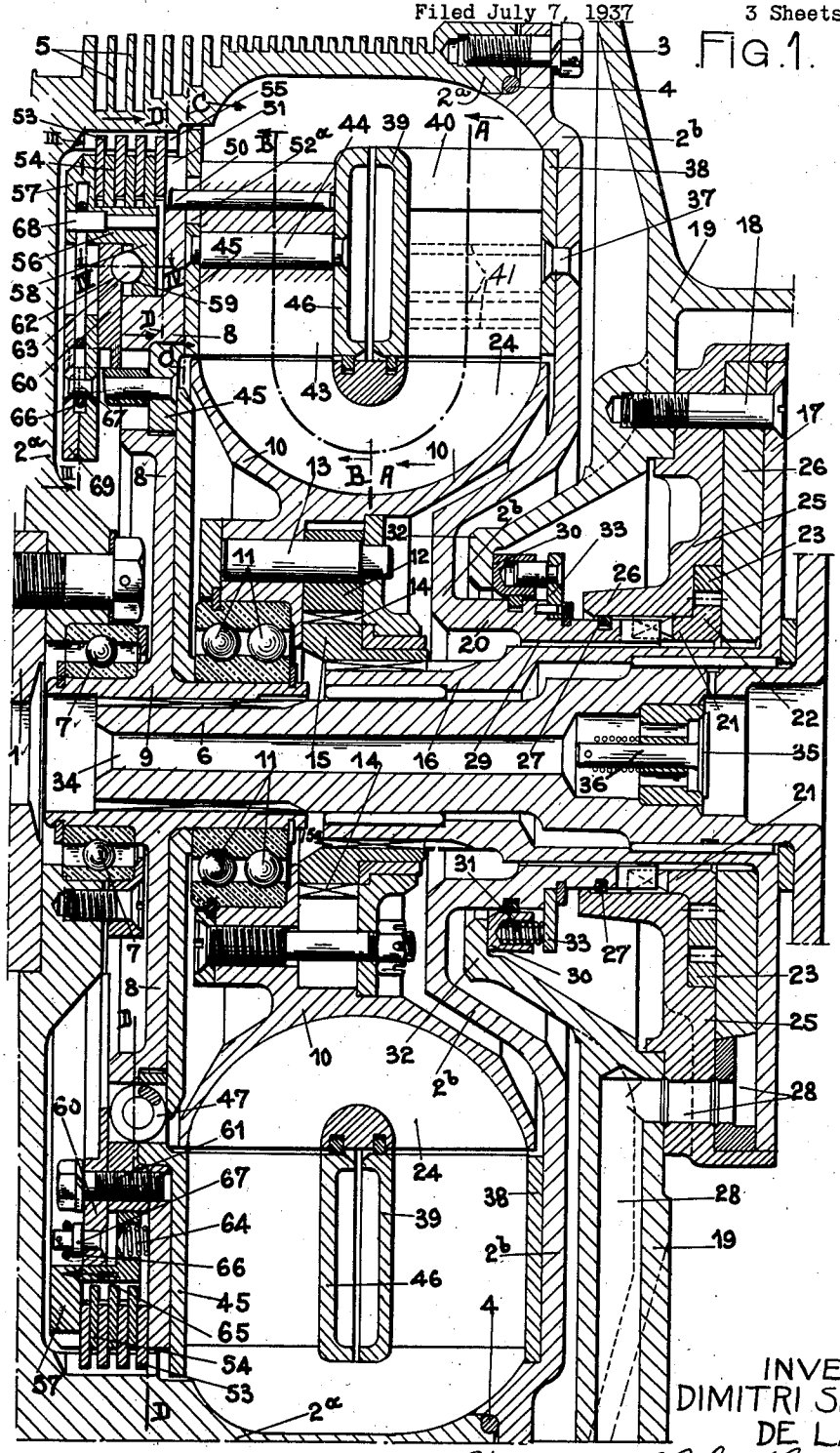
Aug. 8, 1939. D. SENSAUD DE LAVAUD 2,168,863

HYDRAULIC POWER-TRANSMITTING DEVICE

Filed July 7, 1937 3 Sheets-Sheet 1

Fig. 1.



INVENTOR:
DIMITRI SENSAUD
DE LAVAUD

BY Haseltine, Lake & Co. ATTORNEYS

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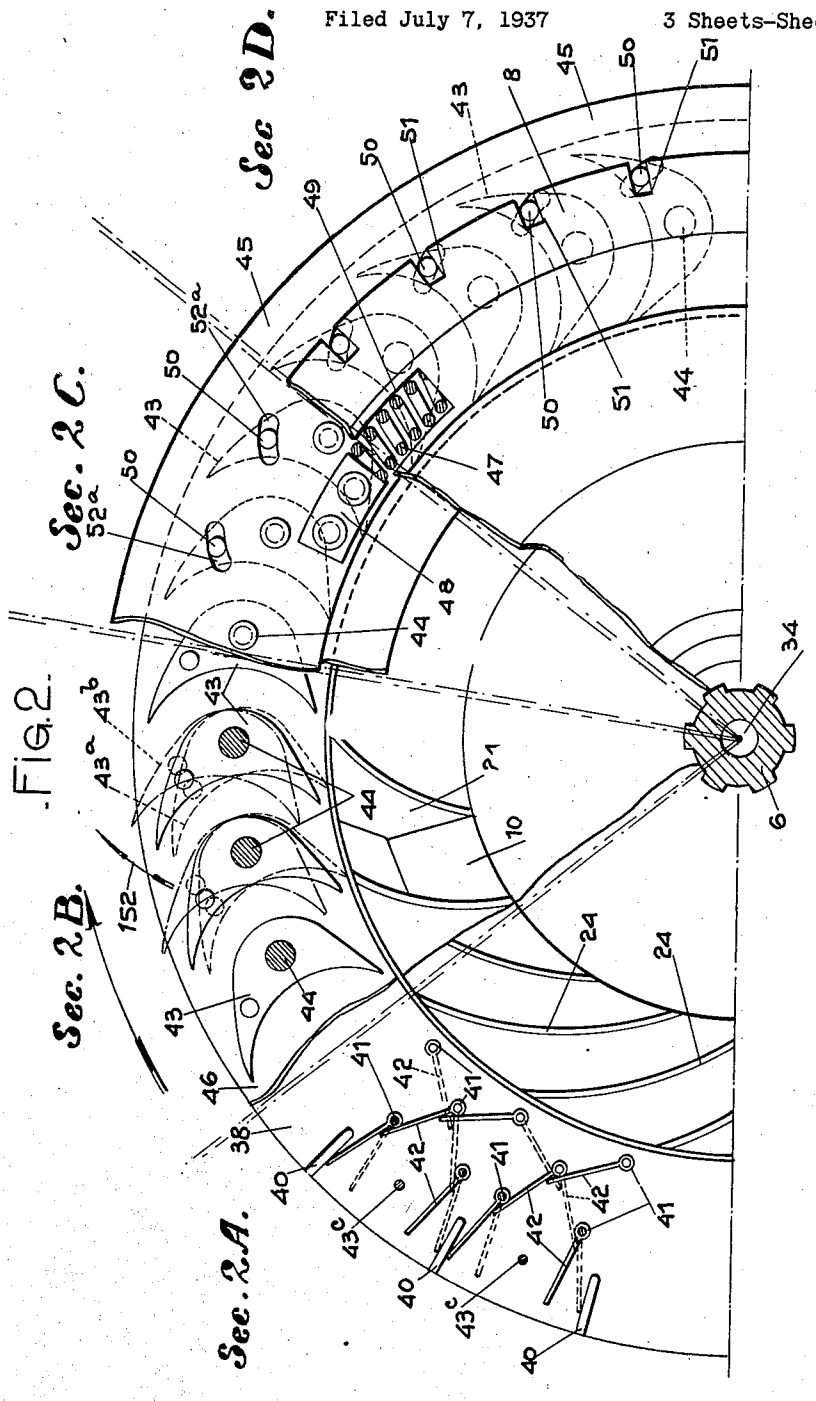
Filed July 7, 1937 3 Sheets-Sheet 2



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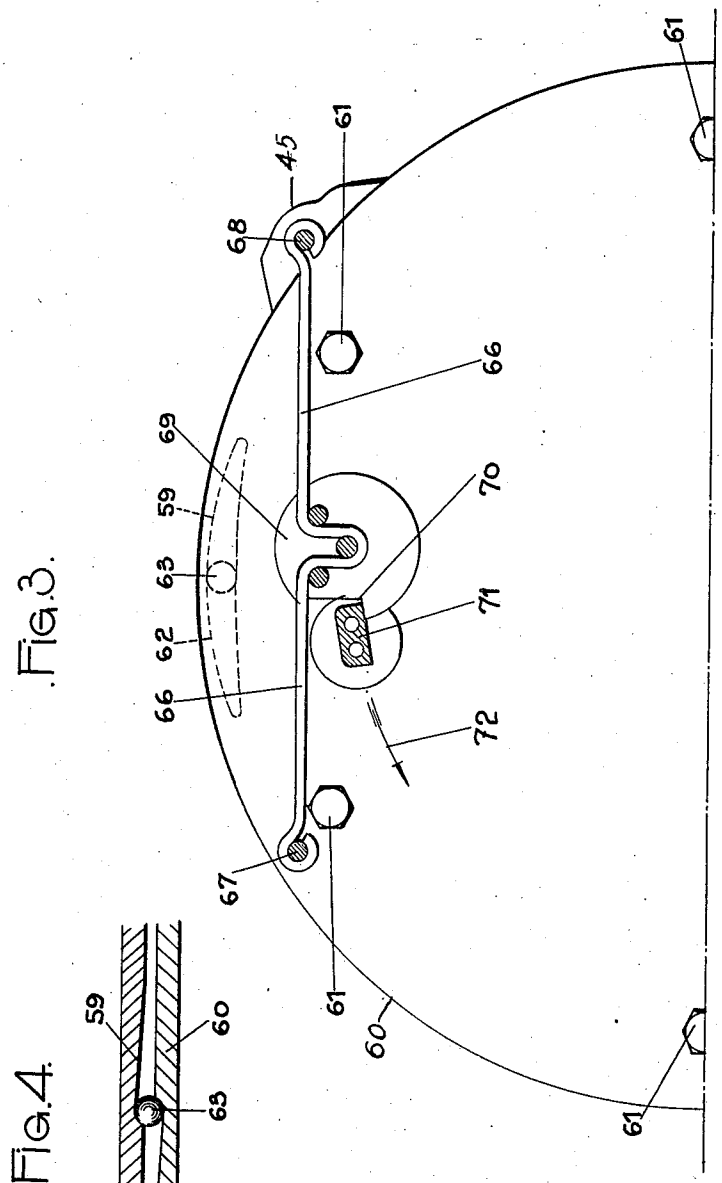

Fig. 3.

Fig. 4.

INVENTOR
DIMITRI SENSAUD DE LAVAUD
BY Haseltine, Lake & Co.
ATTORNEYS

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HYDRAULIC POWER-TRANSMITTING DEVICE

Dimitri Sensaud de Lavaud, Paris, France

Application July 7, 1937, Serial No. 152,292
In France December 19, 1936

7 Claims. (Cl. 60—54)

This invention relates to improvements in hydraulic power-transmitting devices in which, co-axially with a pump rigidly secured on a driving shaft, is arranged a turbine rigidly secured on a driven shaft co-axial with the driving shaft, and a ring provided with fixed guide blades arranged between the outlet of the turbine blades and the inlet of the pump blades, the said ring co-axial with the turbine and with the pump, being connected to the fixed frame of the device through the medium of a movement selecting device such that it prevents the rotation of said ring in a direction reverse to the rotation of the pump and turbine, but allows this rotation in the same direction as that of the pump and turbine when the latter rotate at the same speed, that is to say when the device operates under hydraulic coupling conditions.

The applicant has already described, in particular in his United States patent application filed on December 10, 1936, under Serial No. 115,087, for "Improvements in hydraulic power-transmitting devices", the construction of the pump blades, on the one hand, on the fluid outlet side, by rigid blades substantially arranged in diametral planes and, on the other hand, on the fluid inlet side, by vanes flexible throughout their length and each secured on the shell of the pump and on an inner cheek member by means of a rod secured to the inlet end of said blade; the length of this blade is such that its free end can bear, under the action of the thrust of the fluid, on one or the other of the rigid blades between which said flexible vane is fitted, the position of the rod, on which said flexible vane pivots, relatively to the adjacent rigid blades, being chosen according to the distortions it is desired to obtain for this flexible vane.

In this prior United States patent application filed on December 10, 1936, under Serial No. 115,087, for "Improvements in hydraulic power-transmitting devices", the applicant had, moreover, for obtaining a satisfactory efficiency of the hydraulic device at the various working speeds of the latter, used flexible blades for the turbine and, in a convenient form of construction, these blades were each formed by two elements lying adjacent at their inlet ends, and one of which constituting the concave dorsal portion of the blade was rigid, whilst the other, constituting the concave ventral portion of said blade, was flexible.

It will be seen that, by the use of such turbine blades, an automatic regulation of the angle according to which the fluid issues from said blades is obtained owing to the distortions of the ventral portion of the blades of this turbine. On the other hand, the fluid inlet angle of said blades remains constant. Now, in some cases, it may be necessary that this angle should vary according to working conditions. Moreover, with such blades having a rigid and fixed dorsal face, separations of the fluid jet occur which are prejudicious to the preservation of a satisfactory efficiency for all working conditions.

Moreover, a different flexible ventral face for the turbine blades is required for each different desired power output.

The present invention is adapted to remedy these various inconveniences and, for that purpose, the turbine blades are rigid and each pivoted about a pin secured on a disc movable relatively to the shell of said turbine, these blades each having a stud entering a substantially radial groove or slot provided in the shell of this turbine, the angular displacement of the disc relatively to the shell of said turbine taking place in antagonism to suitably calibrated resilient biasing means, so that when the fluid acts on the blades for causing them to pivot, this pivotal movement determines a relative angular displacement of the disc connected, by a groove and finger connection, to these blades in antagonism to said resilient biasing means.

The hydraulic power-transmitting device according to the invention also comprises the following features:

1. Each turbine blade has, on its dorsal face, a substantially parabolic shape so that the apex portion of said dorsal face is substantially circular, whilst its ventral face has substantially the shape of an arc of circle concentric with the apex portion of the dorsal face of the adjacent blade and which is substantially in the form of a circular arc.

2. Each blade is pivoted at a point distinct from its center of gravity, so that centrifugal force acting on this blade tends to cause it to pivot in a direction reverse to the action of the fluid on the latter.

3. The biasing means for restoring the disc in position, to which disc are secured the pivot pins of the various rocking blades of the turbine, include a number of suitably calibrated springs which bear, at their ends, on abutments respectively secured to the turbine shell and to the disc movable angularly relatively to the latter.

4. Each of the pump blades consists of a plurality of elements, one of which, located on the side the fluid issues from the pump, is substan-

tially rigid and directed according to a diametral plane, whilst the other elements are constituted by vanes pivoted, at their inlet end, about fixed pins and the lengths of which are so chosen that these vanes can bear on the inlet edge of the next element in the direction of flow of the fluid; these pivoted vanes can substantially assume two positions, according to the angle of entrance of the fluid in the pump.

5. A clutch device for rendering the shells of the pump and turbine rigid together, is put in and out of action by means of the centrifugal force exerted by the rotation of either the pump or turbine, operable in response to the position of the blades of said pump or turbine and, for instance, by the position of the blades of the turbine.

6. The clutch device provided between the shells of the pump and turbine for rendering them rigid together, includes a disc clutch operable in response to at least one centrifugal member subjected to the centrifugal force generated by the rotation of the turbine and which is rendered inoperative below a definite speed of the turbine, by a catch rigid with the disc on which the turbine blades are fitted, so that, when these blades move, under the action of centrifugal force and of the thrust of the fluid (which is then null or very small), to their so-called "direct drive" position by angularly moving the disc, the latter unlocks the centrifugal member which then moves so as to cause the actuation of the clutch and locking the shells of the pump and turbine rigid together.

The clutch used can be of any suitable type, but, in order to avoid any slipping between the pump shell and the turbine shell, this clutch is preferably of the type constituted by two series of friction discs, the discs of which are alternate and can be axially moved to bring them in contact with each other by means of a ball and incline device, one of the groups of inclines being provided on the cheek member of the turbine, whilst the other group is provided on a drum which can be angularly moved relatively to said cheek member through the medium of at least one centrifugal member, so as to move the friction discs in intimate contact, one of the series of said discs being secured to the pump shell, whilst the other series of discs is secured to said drum, when said centrifugal member radially moves outwardly after it has been released by the locking device controlled by the setting of the turbine blades.

The present invention further relates to a number of particular features which will appear from the following description with reference to the accompanying drawings, given by way of example only, in which:

Fig. 1 is a partial view in diametral section showing the arrangement of the various blades of the pump, of the turbine and of the guide ring or guide vane ring.

Fig. 2 is in its lower left-hand portion, a section 2A, made according to A—A of Fig. 1, in its upper left-hand portion, a section 2B, made according to line B—B of Fig. 1, in its upper right-hand portion, a section 2C, made according to line C—C of Fig. 1 and, finally, in its lower right-hand portion, a section 2D, made according to line D—D of Fig. 1.

Fig. 3 is a partial section made according to line III—III of Fig. 1, showing the centrifugal member controlling the clutch, the locking device of said centrifugal member in non-operative position, as well as the inclines actuating the disc clutch.

Fig. 4 is a partial developed section made according to line IV—IV of Fig. 1.

On the end of a driving shaft 1 is rigidly secured one of the shells 2^a of a pump 2, the other shell 2^b of which is connected to the first one by any suitable means, such as screws 3, a ring or the like 4, made of relatively plastic material, being interposed between the contact faces of the shells 2^a and 2^b for ensuring fluid-tightness between these shells. The periphery of the shell 2^a is preferably provided with ribs or the like 5 facilitating the cooling of the hydraulic device.

On the end of a driven shaft 6, co-axial with the driving shaft and which is journaled through the medium of a ball or like bearing 7 on the shell 2^a of the pump, is rigidly secured the hub 9 of the shell 8 of a turbine.

The shell 10 of the guide vane ring is journaled through the medium of a ball or like bearing 11, on the hub 9 of the turbine shell. This guide vane ring 10, provided with suitable fixed vanes 24, is connected to a stationary sleeve 16 through the medium of a one-way clutch device allowing free rotation of said guide vane ring 10 in the same direction as the turbine 8 and pump 2, but preventing rotation in the reverse direction. In the embodiment illustrated, this one-way clutch device is constituted by a pawl and ratchet device the pawl or pawls 12 of which are pivoted about pins 13 provided on the shell 10 of the guide vane ring. This pawl or pawls 12 are preferably balanced and normally engaged with the teeth 14 of a ratchet 15. This ratchet 15 is internally fluted for engaging with corresponding flutes 15^a provided at the end of the sleeve 16 co-axial with the driven shaft 6 and having, at its other end, a plate 17 secured by screws 18 on the fixed casing 19 of the device.

The central portion of the shell 2^b of the pump terminates in a cylindrical sleeve 20 notched at its end and engaging with notches formed in the corresponding end of the hub 21 of a toothed wheel 22 constituting one of the wheels of a pump having internal gears, the toothed crown wheel 23 of which is loosely mounted in a suitable housing of the body of the gear pump. This body is constituted by a member 25 also forming a cover and which fits on a disc 26, the whole being held assembled and on the fixed casing 19 of the device by means of the screws 18. The member 25 is provided with a tubular projection 26 in which the sleeve 20 enters, fluid-tightness being ensured between these two parts by means of a resilient packing ring 27. The suction of the gear pump takes place through a conduit 28 opening in a tank constituted by the casing 19. The delivery of the pump takes place through the central portion in an annular space 29 provided between the sleeve 20 rigid with the shell 2^b of the pump and the fixed sleeve 16 and which communicates with the interior of the hydraulic circuit. A sealing device, constituted by a ring 30 resiliently pressed by springs 31 on a bearing portion 32 provided on the fixed casing 19, is arranged between this casing 19 and a disc 33 mounted on the sleeve 20 of the shell 2^b of the pump 2 of the hydraulic device. For allowing this hydraulic device to be filled up, the driven shaft 6 is axially bored at 34 for allowing the escape of the air or gases initially contained in the hydraulic device. In order to limit the pressure of the liquid within this device once filled up, the axial passage 34 is closed, at its end open-

ing outside the transmission device, by a valve 35 resiliently pressed upon its seat by a suitably calibrated spring 36, so that, when the pressure of the liquid within the hydraulic device exceeds a predetermined value, the valve 35 lifts and restores the pressure to the predetermined value.

The vanes of the pump 2 are constituted as follows: on the shell 2^b is secured, by means of rivets 37 for instance, a crown 38 concentric with the driving and driven shafts. On this crown 38 and on an inner crown 39 are secured, on the one hand, rigid blades 40 arranged on the fluid outlet side of the pump 2, regularly spaced apart and substantially set according to diametral planes and, on the other hand, a number of rods or pins 41 on each of which is pivoted a vane 42. The arrangement of the pins 41 and the length of the vanes 42, which can be rigid or flexible, are such that these vanes abut, at their free end, either on the corresponding rigid blade 40, or on the journalled end of the adjacent vane, as shown in Fig. 2 of the drawings. The number of vanes 42 can be chosen in any suitable manner, and, in the example illustrated in which each blade of the pump comprises three pivoted elements, it will be seen that it is necessary to provide four vanes, so that the latter may occupy two distinct positions according to the angles of entrance of the fluid in the pump, as will be explained later on. The inoperative vane for one of the settings of the blades freely orientates itself in the fluid stream; a pin 43^c can however be provided for limiting the possible pivotal movement of said vane and thus preventing the latter from wedging against the other blades when the device is at rest.

The blades of the turbine are constituted by rigid vanes 43, the dorsal face of which has a substantially parabolic shape so that the apex portion of said dorsal face is substantially circular, whilst their ventral face is substantially circular and substantially concentric with the apex portion of the dorsal face of the adjacent blade and which is substantially in the shape of a circular arc. Each of these vanes 43 is pivoted about a pin 44 secured at its ends, by any suitable means, and, for instance, by rivets, on two circular crowns 45 and 46. The outer circular crown 45 can rotate relatively to the shell 8 of the turbine in antagonism to resilient biasing means, such as a number of suitably calibrated springs 47 each of which bears, on the one hand, on an abutment or finger 48 rigid with said crown 45 and, on the other hand, in the bottom of a recess 49 provided in the shell 8. Each of the blades 43 of the turbine has a finger 50 projecting laterally for entering substantially radial notches 51 provided in the periphery of the cheek member 8 constituting the turbine shell. These fingers 50 pass through the ring 45, through apertures 52^a of circular shape and respectively concentric with the pivot pins 44 of said blades 43. The center of gravity of each of these blades 43 is situated, relatively to the pivot pin 44, so that centrifugal force tends to cause this blade 43 to pivot in the direction of the arrow 152.

The various springs 47 act to rotate the ring 45 in a counterclockwise direction relative to the turbine shell 8 and consequently to pivot the blades 43 in the direction of the arrow 152, the fingers 50 abutting to the left side of the notches 51 (Fig. 2). The fluid entering the turbine from outside acts upon the concave face of the blades 43, below the pivot pins 44, for rotating the said blades in a direction opposed to the arrow 152.

The operation of the hydraulic device will be easily understood from the foregoing. Upon starting, the turbine 8 being assumed to be at rest, the pump 2, owing to its rotation, produces the circulation of the fluid within the hydraulic circuit and this circulation is then maximum; the vanes 42, forming a part of the pump blades, are in the position shown in dot and dash lines in Fig. 2, whilst the blades 43 of the turbine 8, on which the maximum thrust of the fluid is exerted, are in the position 43^a shown in dotted lines in Fig. 2 of the drawings, as the turbine 8 not yet rotating, no centrifugal force is exerted on the bldase 43 and, from this fact, the maximum thrust of the fluid is exerted solely in antagonism to the springs 47. In proportion as the speed of the turbine 8 increases, the thrust of the fluid on the blades 43 diminishes for a speed, assumed to be constant, of the pump 2, moreover centrifugal force is exerted on said blades 43 and the latter pivot in the direction of the arrow 152 for coming, upon direct drive, that is to say when the turbine 8 and pump 2 rotate at the same speed, in the position 43^b shown in dot and dash lines in Fig. 2. The pivoted blades 42 of the pump have then, when direct drive is nearly obtained, reached the position shown in dotted lines at the lower left in Fig. 2. It will therefore be seen that the blades 43 of turbine 8 assume, for each speed intermediate between the stalled condition and a speed corresponding to a direct drive a position intermediate of the two positions indicated at 43^a and 43^b in Fig. 2, the ring 45 angularly moving, owing to its groove and finger connection with said blades 43, relatively to the turbine shell 8.

A mechanical device for locking the shells of the pump 2 and turbine 8 rigid together is controlled by the position of the blades 43 of turbine 8 so as to be rendered operative when these blades 43 reach their direct drive position. This device comprises a disc clutch constituted by two series of alternate discs 53 and 54. The discs 53 are slotted at their peripheries and the slots engage into corresponding slots 55 provided in the pump shell 2^a so as to be rendered angularly rigid with this shell, but as to be able to move axially. The discs 54 are internally fluted so as to fit on flutes formed on a drum 56 having an outer cheek member 57 fitting against the outer one of said friction discs 53 and an inner cheek member 58. On this cheek member 58 and on its outer face are formed inclines 59. Opposite the latter and on a disc 60, rendered rigid by screws 61 or the like, with the turbine shell 8, are formed corresponding inclines 62 (see Fig. 4), balls 63 being interposed between the inclines 59 and 62 Springs 64 are arranged between the cheek member 58 and the turbine shell 8 for pushing back this cheek member 58 in the direction of the arrow 65.

The drum 56 is connected, moreover, to the shell 8 of the turbine by at least one device having a centrifugal action and which will now be described. Each of these devices is constituted by a wire link 66 which is resilient but invariable in length, made of piano wire for instance, and the ends of which are attached to pins 67 and 68 respectively secured with the turbine shell 8 and drum 56. To this wire link 66 or the like, and substantially at midway of its length, is attached, by any suitable means, a centrifugal member 69. The operation of the device rendering the shells of the pump and turbine rigid together and described above is as follows: under the action of

the centrifugal force exerted on the centrifugal member 69, the latter radially moves by distorting the wire link 66 according to an arc of circle, this effecting movement of the pin 68 by causing the drum 58 to rotate relatively to the shell 8 of the turbine. Owing to this angular displacement, the inclines 59 and 62 are moved relatively to each other and, owing to their arrangement and of the interposition of the balls 63, the cheek member 58, rigid with the drum 56 and cheek member 57, is pushed back, in antagonism to the springs 64, in reverse direction to the arrow 65, thus acting to bring the discs 53 and 54 in contact and to engage the device provided for rendering the shells of the pump and turbine rigid together.

When the speed of the unit thus rendered integral diminishes, the centrifugal members 69 are restored in position by the resiliency of the wire link 66, the drum 56 and cheek members 57 and 58 are angularly moved relatively to the shell 8 of the turbine in a direction reverse to the displacement indicated above, the springs 64 axially push back the member 56, 57, 58 in the direction of the arrow 65 and, consequently, the shells of the pump 2 and turbine 8 are disengaged from each other.

In order that this locking device should act only from a certain speed of rotation of the turbine 8, each of the centrifugal members 69 is provided with a notch 70 in which normally engages a suitable abutment 71 secured to the movable ring 45 on which are secured the pivot pins 44 of the blades 43 of the turbine 8. When the turbine 8 reaches a certain speed substantially equal to the working speed of the pump 2, that is to say when the secondary torque is substantially equal to the primary torque, it has been stated above that the blades 43 moved to the position 43^b by causing the ring 45 to rotate relatively to the shell 8 of the turbine in the direction of the arrow 72, this having for effect to release the abutment 71 from the notch 70 of the centrifugal member 69 which, being released, acts, under the action of centrifugal force, as indicated above, in order to render the shells of the pump 2 and turbine 8 rigid together.

When the speed of the turbine becomes smaller than that of the pump, that is to say after the speed of the unit, initially rendered integral by the disc clutch, has become such that this clutch has been rendered inoperative, as indicated above, in order that the device should operate under hydraulic speed reducing conditions, the blades 43 of turbine 8 automatically return, owing to the increase of the thrust of the fluid and to the reduction of the centrifugal force exerted on these blades 43, to an intermediate position by causing the ring 45 to rotate in a direction reverse to the arrow 72, this causing to lock again, through the medium of the abutments or fingers 71, the various centrifugal members 69.

What I claim as my invention and desire to secure by Letters Patent is:

1. In a hydraulic power transmitting device of the kind in which, coaxially with a pump rigidly secured on a driving shaft, a turbine is arranged rigidly secured on a driven shaft coaxial with the driving shaft, and a ring provided with fixed guide blades arranged between the outlet of the turbine blades and the inlet of the pump blades, a one way clutch device, said ring, coaxial with the turbine and with the pump, being connected to a fixed frame of the device by means of said one way clutch device in order to prevent the rotation of said ring in a direction reverse to the rotation of the pump and turbine, but allow this rotation in the same direction as that of pump and turbine when the latter rotate at the same speed and the device operates under hydraulic coupling conditions, in combination a disc movable relatively to the shell of said turbine, rigid turbine blades pivoted about pins secured on the said disc, said blades having, on their dorsal face, a substantially parabolic shape and, on their ventral face, a shape of an arc of circle concentric with the apex portion of the dorsal face of the adjacent blade, resilient biasing means and resilient returning devices in antagonism to which the blades pivot under the action of the thrust of the fluid.

2. In a hydraulic power transmitting device of the kind in which, coaxially with a pump rigidly secured on a driving shaft, a turbine is arranged rigidly secured on a driven shaft coaxial with the driving shaft, and a ring provided with fixed guide blades arranged between the outlet of the turbine blades and the inlet of the pump blades, a one way clutch device, said ring, coaxial with the turbine and with the pump, being connected to a fixed frame of the device by means of said one way clutch device in order to prevent the rotation of said ring in a direction reverse to the rotation of the pump and turbine, but allow this rotation in the same direction as that of pump and turbine when the latter rotate at the same speed and the device operates under hydraulic coupling conditions, in combination a disc movable relatively to the shell of said turbine, rigid turbine blades pivoted about pins secured on the said disc and a device provided between the shells of the pump and turbine for locking them rigid together, including a disc clutch operable in response to at least one centrifugal member subjected to the centrifugal force generated by the rotation of the turbine and which is rendered inoperative below a definite speed of the turbine by a catch rigid with the disc on which are fitted the turbine blades so that, when these blades move, under the action of centrifugal force and of the thrust of the fluid, which is then null or at most very small, to their so-called direct drive position by angularly moving the disc, the latter unlocks the centrifugal member which then moves so as to cause the actuation of the clutch and rendering the shells of the pump and turbine rigid together.

3. In a hydraulic power-transmitting device, a stationary casing, a driving shaft; a rotary pump comprising a shell secured on said driving shaft and an inner annular wall, fixed sets of blades radially arranged at the fluid outlet of said pump for connecting the inner annular wall and the shell, pivots symmetrically distributed in several circular series between the inner edges of said sets of blades and the fluid inlet of the pump, vanes pivoted on said pivots and each having respectively a length greater than the distance between each pivot and the pivots the nearest to the adjacent outer circular series; a driven shaft; a turbine comprising a shell secured on said driven shaft and an inner annular wall, pivots supported by said shell and said inner annular wall, rigid blades pivoted on said pivots, resilient means for restoring said blades to a position of rest; a guide vane ring interposed between the fluid outlet of the turbine and the fluid inlet of the pump, and a ratchet mechanism to lock said guide vane ring to said stationary casing against rotation in a direction reverse to the rotation of the pump and turbine.

4. In a hydraulic power-transmitting device, a stationary casing, a driving shaft; a rotary pump comprising a shell secured on said driving shaft and an inner annular wall, fixed, fixed sets of blades radially arranged at the fluid outlet of said pump for connecting the inner annular wall and the shell, pivots symmetrically distributed in several circular series between the inner edges of said sets of blades and the fluid inlet of the pump, vanes pivoted on said pivots and each having respectively a length greater than the distance between each pivot and the pivots the nearest to the adjacent outer circular series; a driven shaft; a turbine comprising a shell secured on said driven shaft and an inner annular wall, pivots supported by said shell and said inner annular wall, rigid blades pivoted on said pivots, kinematic connection means between said blades, in order that the movements of one of them should be transmitted to the others and reversely, resilient means for restoring said blades to a position of rest; a guide vane ring interposed between the fluid outlet of the turbine and the fluid inlet of the pump, and a ratchet mechanism to lock said guide vane ring to said stationary casing against rotation in a direction reverse to the rotation of the pump and turbine.

5. In a hydraulic power-transmitting device, a stationary casing, a driving shaft; a rotary pump comprising a shell secured on said driving shaft and an inner annular wall, fixed sets of blades radially arranged at the fluid outlet of said pump for connecting the inner annular wall and the shell, pivots symmetrically distributed in several circular series between the inner edges of said sets of blades and the fluid inlet of the pump, vanes pivoted on said pivots and each having respectively a length greater than the distance between each pivot and the pivots the nearest to the adjacent outer circular series; a driven shaft; a turbine comprising a shell secured on said driven shaft, a lateral cheek member adjacent to said shell and an inner annular wall, pivots supported by said cheek member and said inner annular wall, rigid blades pivoted on said pivots and each provided with a lateral projection, each projection passing through the lateral cheek member through an opening in the form of an arc of circle and entering a radial notch formed in the shell, resilient means interposed between the cheek member and the shell for restoring said blades to a position of rest; a guide vane ring interposed between the fluid outlet of the turbine and the fluid inlet of the pump, and a ratchet mechanism to lock said guide vane ring to said stationary casing against rotation in a direction reverse to the rotation of the pump and turbine.

6. In a hydraulic power-transmitting device, a stationary casing, a driving shaft; a rotary pump comprising a shell sets of blades radially arranged at the fluid outlet of said pump for connecting the inner annular wall and the shell, pivots symmetrically distributed in several circular series between the inner edges of said sets of blades and the fluid inlet of the pump, vanes pivoted on said pivots and each having respectively a length greater than the distance between each pivot and the pivots the nearest to the adjacent outer circular series; a driven shaft; a turbine comprising a shell secured on said driven shaft and an inner annular wall, pivots supported by said shell and said inner annular wall, rigid blades pivoted on said pivots, and having a dorsal face of parabolic cross section and a ventral face of circular cross section, resilient means for restoring said blades to a position of rest; a guide vane ring interposed between the fluid outlet of the turbine and the fluid inlet of the pump, and a ratchet mechanism to lock said guide vane ring to said stationary casing against rotation in a direction reverse to the rotation of the pump and turbine.

7. In a hydraulic power-transmitting device, a stationary casing, a driving shaft; a rotary pump comprising a shell secured on said driving shaft and an inner annular wall, fixed sets of blades radially arranged at the fluid outlet of said pump for connecting the inner annular wall and the shell, pivots symmetrically distributed in several circular series between the inner edges of said sets of blades and the fluid inlet of the pump, vanes pivoted on said pivots and each having respectively a length greater than the distance between each pivot and the pivots the nearest to the adjacent outer circular series; a driven shaft; a turbine comprising a shell secured on said driven shaft and an inner annular wall, pivots supported by said shell and said inner annular wall, rigid blades pivoted on said pivots at a point different from their center of gravity, in order that centrifugal force should exert on said blades a torque opposed to that produced by the thrust of the fluid, said blades having a dorsal face of parabolic cross section and a ventral face of circular cross section, resilient means for restoring said blades to a position of rest; a guide vane ring interposed between the fluid outlet of the turbine and the fluid inlet of the pump, and a ratchet mechanism to lock said guide vane ring to said stationary casing against rotation in a direction reverse to the rotation of the pump and turbine.

DIMITRI SENSAUD DE LAVAUD.