H. FÖTTINGER.

HYDRAULIC DEVICE FOR TRANSMITTING POWER.

APPLICATION FILED JUNE 19, 1906.

1,199,359.

Patented Sept. 26, 1916.

2 SHEETS—SHEET 1.

Fig. 1.

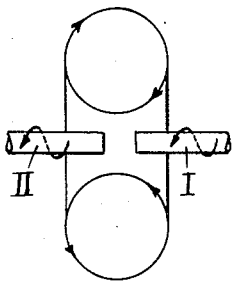


Fig. 2.

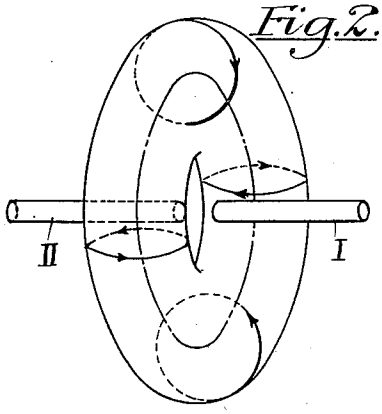


Fig. 3.

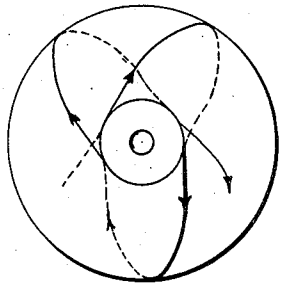


Fig. 4.

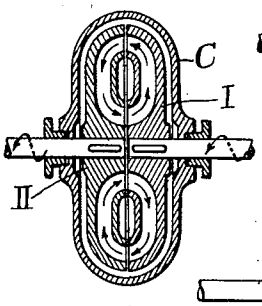


Fig. 5.

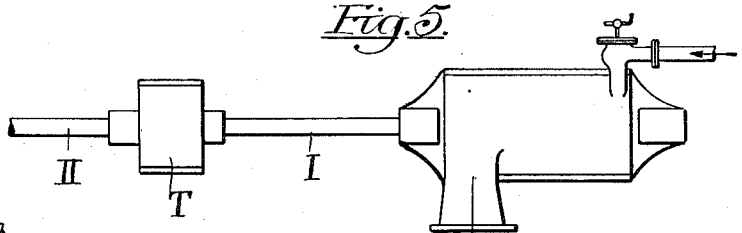


Fig. 6.

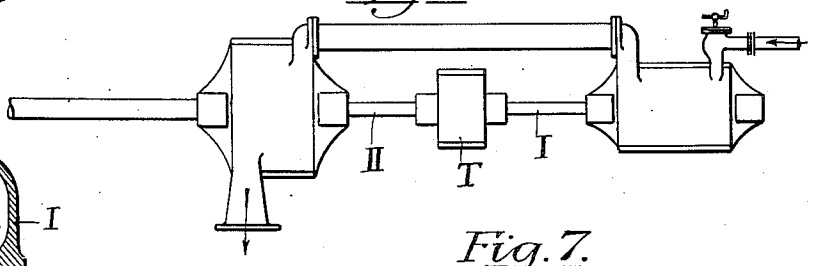


Fig. 3a.

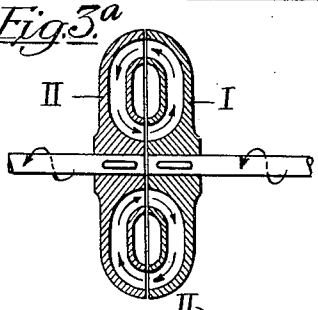


Fig. 3b.

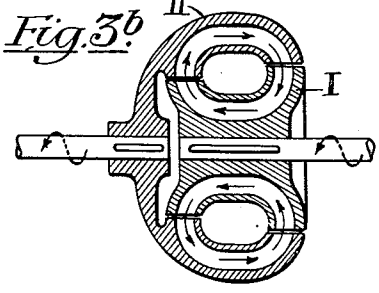
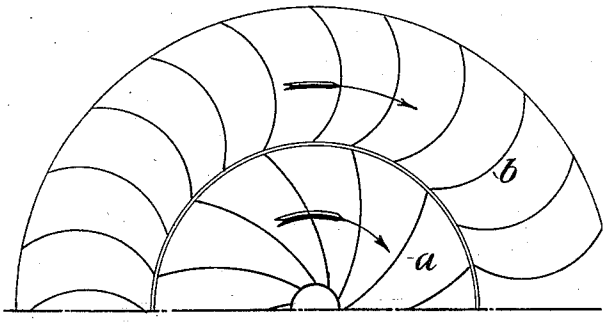


Fig. 7.



Inventor

Hermann Föttinger

By his Attorney.

E. O. Fairbanks

Witnesses

Titus H. Sons — A. M. Murray.

H. FÖTTINGER.

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2 SHEETS—SHEET 2.

Fig. 8.

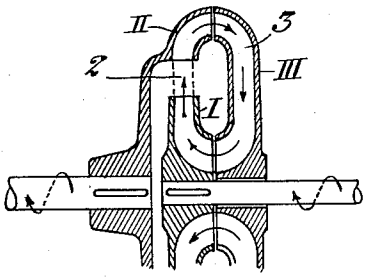


Fig. 9.

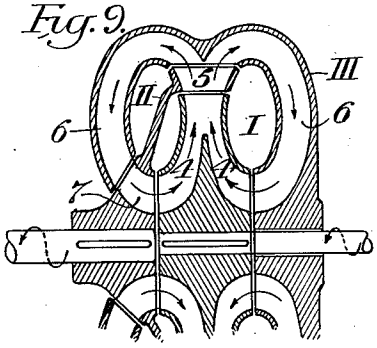


Fig. 10.

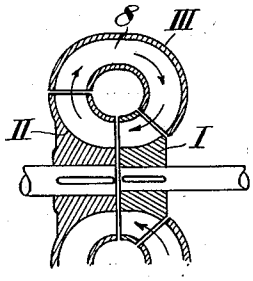


Fig. 12.

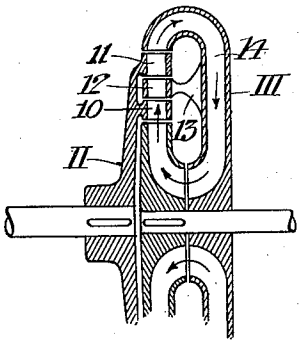


Fig. 11.

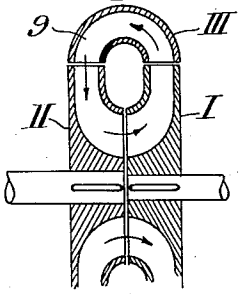


Fig. 13.

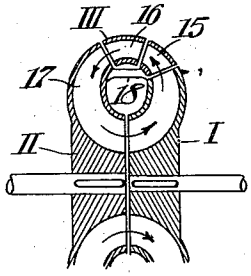


Fig. 14.

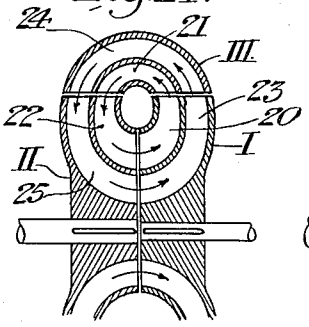


Fig. 15

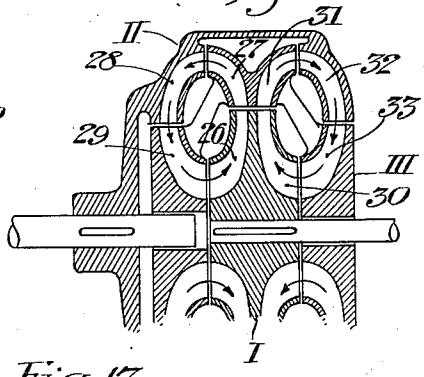


Fig. 16.

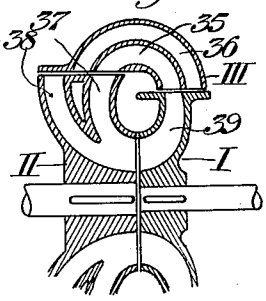
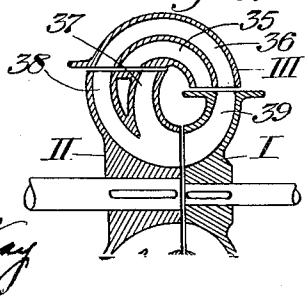


Fig. 17.



Witness:-

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HYDRAULIC DEVICE FOR TRANSMITTING POWER.

1,199,359. Specification of Letters Patent. Patented Sept. 26, 1916.

Application filed June 19, 1906. Serial No. 322,395.

To all whom it may concern:

Be it known that I, HERMANN FÖTTINGER, a subject of the King of Bavaria, residing at No. 4 Prutz street, Stettin, in Germany, have invented new and useful Improvements in Hydraulic Devices for Transmitting Power, of which the following is a specification.

This invention relates to apparatus adapted for transmitting or transforming power by means of a fluid which serves as the transmitting medium and which effects a rotation of the fluid-impelled member upon a rotation of the power driven, fluid-impelling member.

In one type of apparatus heretofore designed, fluid driving and fluid driven members have presented blades, vanes, baffles, or other obstructions, within a body of fluid so confined or inclosed that it would be given a bodily or mass movement around the axis of rotation by the rotation of the power driven member and this bodily movement of the liquid would drag along or otherwise cause the rotation of the liquid driven member. In another type, it has been proposed to pump the fluid by a rotary or other power driven member and deliver it under pressure through conduits, storage chambers, or the like to the rotary or other fluid driven member.

The main object of my invention is to utilize more directly and more efficiently the kinetic energy of the moving fluid than has been possible in devices heretofore designed and to thereby increase the amount of power transmitted, increase the efficiency and decrease the loss due to friction, slippage and other causes. To secure this main object, I so design the member which imparts energy to the fluid and the member in which the energy is utilized, and so position them in respect to each other, that the fluid is caused to circulate through passages in the liquid-impelling member and is delivered, by reason of the shape of the passages, with high kinetic energy, from an annular outlet across an annular space to an annular inlet of the independently rotatable member in which the energy is utilized and through which the liquid may flow before reëntering the liquid impeller at the annular intake of the latter. Thus the liquid travels not only around the axis of rotation of the members but also is being continuously forced away from the axis of rotation and returned toward said axis.

In designing an apparatus embodying my invention, the power-propelled and liquid-propelling part may be somewhat similar in construction and may operate in somewhat the same way as the rotor of a rotary or turbine pump, the liquid being received through an annular eye concentric with the axis of rotation and being discharged at high velocity and comparatively low pressure. The liquid-propelled member may be somewhat similar in construction and operation to a fluid-operated turbine in which the liquid impacts at its high velocity upon blades, buckets, or vanes, to cause the turbine to rotate the liquid being conducted through passages in the turbine to the discharge side thereof.

By the proper designing of the blades of the members and by the special construction of the path for the liquid, the primary or liquid-propelling part which imparts the velocity and kinetic energy to the liquid, and the secondary or liquid-propelled part, within which the energized liquid acts, may rotate in the same or in opposite directions and with various different reductions in the speed of the secondary below that of the primary. The curves or buckets of the said wheels may be of any appropriate form, as well known in rotary pumps and water or steam-turbines, and they may also be constructed so as to allow the fluid to act by its impulse or reaction.

Instead of converting the fluid velocity into pressure in a receiving chamber or conduit and then releasing the fluid so that it may escape at high velocity, to act on the blade of the turbine, I secure the main objects of my invention by so juxtaposing the primary or liquid-propelling turbine and the secondary or liquid-propelled turbine, that the velocity is entirely or substantially maintained without intermediate conversion into pressure, and the kinetic energy is immediately utilized for driving purposes. The fluid may pass directly from the liquid-impelled member, or through an annular, intermediate, guiding part which may change or control the direction of flow of the liquid

from one to the other without materially reducing the velocity or converting it into pressure. The said intermediate part may be made very short with a correspondingly small amount of surface frictionally retarding the flow of the liquid. In consequence of this direct utilization of the force, the total efficiency of the transmission which I have been able to secure is equal to, or even in excess of, that of the best turbines. The device is utilizable and suitable for the highest powers and the highest speeds of revolution, and owing to its flexibility it may readily be adapted to the most diverse working conditions. In addition to this, the apparatus is of small volume and weight and therefore, space and cost of construction are economized.

My invention may be embodied in various different forms within the scope of my invention as defined in the generic claims hereto appended. Specific claims for certain of these forms have been presented in my applications Serial No. 540,162, and Serial No. 540,163, filed January 26th, 1910, and Serial No. 842,409, filed June 2nd, 1914.

In my present application, I have retained the specific claims to those forms in which no intervening liquid guiding members are employed between the outlet of one member and the inlet of the other, so that the annular spaces, across which the liquid passes, may be reduced to a minimum and the two members comprise the whole circuit in which the fluid circulates.

The invention will be fully understood by referring to the accompanying drawings forming a part of this specification, in which—

Figures 1–3 are diagrams of the path of the transmitting fluid. Figs. 3^a and 3^b are sectional views diagrammatically illustrating two forms of an apparatus constructed on the principles disclosed by the foregoing figures. Fig. 4 is a sectional view of the apparatus, shown provided with a casing. Figs. 5 and 6 are diagrammatic elevations of the apparatus applied on propeller shafts. Fig. 7 is a diagrammatic development showing the vanes of the driving and driven members of the form shown in Fig. 3^a. Figs. 8 to 13 inclusive are sectional views diagrammatically illustrating other forms of apparatus embodying my broad invention; Figs. 14 and 15 are sectional views diagrammatically illustrating forms in which two separate liquid circuits are employed; Fig. 16 is a sectional view diagrammatically illustrating a form in which the liquid driven member has two sets of passages, to either of which the liquid may be guided, and showing the parts in one position, and Fig. 17 is a view of the form shown in Fig. 16 with the shiftable member in the opposite limiting position.

Similar reference numerals designate similar or equivalent parts throughout the several views of the drawings.

The apparatus in each and all of its forms, includes a primary turbine wheel mounted on the driving shaft and a secondary turbine wheel, the two being arranged in such relative positions that their passage systems merge one into the other, so that the continuity of all of them forms a closed circuit in the shape of a gyratory or vortex ring defined only by means which are actually operative to drive or direct the liquid and be driven by it, the connection thus being without any idle and losing conduits. In this restricted closed circuit the operative fluid continuously circulates, flowing alternately through the primary wheel I and the secondary wheel II, receiving energy in the former, transmitting it to the latter, and then returning to the primary wheel.

Losses due to liquid friction may be considerably minimized by selecting as operative media liquids with the smallest possible internal friction (such for example as alcohol, ether, petroleum, appropriate mixtures with water and so forth) and also by using them, (and water also, for example) in a hot condition.

When it is desired to keep the dimensions of the entire apparatus very small, it is preferable to employ liquids with a very high specific weight such as a mercury for example.

The primary and secondary shafts may be arranged in any desired relative positions, intersect at any angle, or run parallel. The most important arrangement is, however, the coaxial position, when the secondary shaft is in line with the primary. The flow of the liquid may, according to the present invention, be such that it forms a gyratory ring similar to a smoke ring (Figs. 1 and 2) passing around the common axis, and either wholly or partly closed with the difference, however, that here the displacement of the separate particles of liquid takes plate not in a plane intersecting the axis, but helically extended owing to the rotation of the turbine wheels (Fig. 3). The coaxial arrangement permits of the employment of the shortest path for the liquid between the primary and secondary wheels, and even under some conditions of direct transfer from the primary wheel to the concentrically mounted secondary wheel.

The drawing shows diagrammatically by way of example apparatus for carrying into practice the hydrodynamic transmission of power between coaxial shafts.

In the drawings I represents the primary wheel for transmitting velocity and pressure energy from the primary shaft to the liquid.

II represents the secondary wheel for utilizing this energy for the secondary shaft,

the parts being arranged immediately adjacent to each other.

In Fig. 3^a and 3^b are shown forms of the apparatus which merely consist of primary and secondary parts.

Both wheels I and II are provided with channels or passages subdivided through intermediate vanes more or less curved transversely as to the axis of the wheel and which have resemblance to the known curved vanes in the rotating and guide wheels of centrifugal pumps and turbines. The vanes of the wheels I and II are indicated by way of example, at *a b* in Fig. 7. The separate inlets and outlets of the annular row of passages between the vanes of each are arranged around the axis of rotation and collectively constitute the annular inlets and outlets of the members. The annular outlet of one member is opposite to and registers with the annular inlet of the other and is separated therefrom by a thin annular space across which the liquid is driven. The fluid passes over from the part I to the part II with high velocity, whereupon it is reconducted to part I with lower velocity, being deflected on its way so that the transmission of the power from the primary wheel to the fluid and from the fluid to the secondary wheel takes place gradually and continually in the circuit. The arrows in Figs. 3^a and 3^b indicate the direction of the movement of the liquid. Of course the curvature of the buckets or vanes and passages may be different from that shown in the drawing in order to obtain special results in the operation of the device, as the case may require.

Fig. 4 of the drawing shows the primary and secondary wheels inclosed in a casing C common to both wheels.

It will be obvious that the variations of reduction of the number of revolutions of the secondary part can be obtained either by the employment of a corresponding number of stages consisting of vane rims for the primary and secondary wheels or by appropriate dimensions of the wheels.

In Figs. 8, 9 and 10, I have shown forms embodying my invention, in which annular stationary members are included in the circuit to guide the liquid across the annular space from the annular discharge or outlet of the driven member to the annular eye or intake of the liquid-driving member.

In Fig. 8, a true dynamic transmission of power takes place. The liquid is discharged from the periphery of the driving member I without any pressure and merely possessed of high velocity. It passes the space 2 and enters the secondary or driven member which is caused to rotate more slowly than the primary or driving member. The residual velocity which it possesses on leaving the driven member enables it to return to the driving member through the channels or passages 3 of the stationary or liquid guiding wheel III.

Two substantially parallel circuits may be employed as shown in Fig. 9 instead of a single circuit. The driven member I has separate sets of passages 4 which counteract end thrust on said member and deliver to a common part 5 of the driven member II. The liquid is returned from the periphery of the latter by separate passages 6, 6, in the stationary liquid guiding member III. The hub of the driven member is here provided with suitable passages 7, to permit the return of the liquid to the left hand side of the driving member.

In Fig. 10, the driving member I discharges substantially axially and the driven member II corresponds in type to a radial discharge turbine with a flow or admission of fluid in axial direction. The return of the liquid is secured by an appropriately formed guide member III with passages 8.

In the construction shown in Fig. 11, the stationary liquid-guiding member, instead of acting to return liquid to the driving member from the driven member, is employed to direct or guide the liquid from the driving to the driven member. The outlet from the driving member and the inlet from the driven member are shown as being peripherally located so that the liquid in leaving the driving member first enters between guiding buckets or vanes in the passages 9 of the stationary member III and is directed inwardly to the driven member II which is constructed in the form of a Francis turbine. The curvature of the blades in the passages 9 in the stationary member may be such as to cause a rotation of the driven member in the same direction as the driving member, or in the opposite direction.

A device adapted to produce a considerable reduction of the number of revolutions is shown in Fig. 12. The driven part II includes two wheels or sets of radial turbine sections 10 and 11, between which is a stationary section 12 in the form of a row of curved guides. This section is held in place by means of ribs 13 attached to the main body of the stationary casing or section III, and said body portion contains passages 14 for the return of the liquid to the intake of the impeller. It is evident than any suitable number of subsequent bucket wheels and interposed guide wheels may be employed in order to decrease the rotative speed of the secondary shaft at will. The modification of this arrangement is illustrated in Fig. 13 where the first section 15 of the driven member II utilizes only a part of the velocity of the fluid. By curved guides 16 in the stationary part III, the fluid is given an appropriate direction so that it is able to act on the second section 17 of the driven member. The two sections may be

connected together by bolts 18 or the like. A similar subdivision of the primary wheel into sections may also be provided, if desired.

In Figs. 14 to 17 inclusive, I have illustrated devices in which the driven member may be rotated either in the same direction or in the opposite direction to that of the driving member. Separate circuits are employed which may be either one within the other as shown in Fig. 14, or side by side as shown in Fig. 15. In each of these forms, reversing is secured by admitting liquid to one circuit and simultaneously removing it from the other, or by shutting off the circuit which is idle at the time being, by means of annular slides inserted between the stationary section and the driving and driven parts as is well known in Francis turbines. The driving member I has separate driving sections 20, 23, the driven member II has separate sections 22, 25, while the stationary member III has separate sections 21, 24. The liquid may be caused to circulate either in the circuit 20, 21, 22, or in the circuit 23, 24, 25. While the primary member is rotating in one direction, the liquid, if in the circuit 20, 21, 22, may be guided against the vanes of the driven member at such an angle as to rotate the latter in one direction, while if the liquid be in the circuit 23, 24, 25, it will be directed against the blades of the driven member at such an angle as to rotate the latter in the opposite direction. The same results may be secured in the construction shown in Fig. 15 where the driving member I has sections 26, 30, the guiding member III has sections 27, 31, 29, 33, and the driven member II has sections 28, 32. One direction of rotation of the driven member is secured when the liquid circulates in the passages 26, 27, 28, 29, while the opposite rotation is secured if the liquid be in the circuit formed of the passages 30, 31, 32, 33.

In the forms shown in Figs. 16 and 17, reversing is secured by an axial displacement of the non-rotatable guide section III which constitutes a distributing member and which has an inner series of guiding buckets or passages 35 adapted to induce rotation of the secondary or driven wheel in the forward direction and an outer series of passages or buckets 36 for reverse rotation of the secondary wheel. In the first case, the guiding member is shifted to the position shown in Fig. 16 so that the liquid circulates from the passages 39 of the driving member through the guide passages 35 to a set of passages 37 in the driven member. At this time, the passages 36 of the guide member and the passages 38 of the driven member are out of operation and preferably emptied to avoid loss of power. When the guiding member is shifted to the position shown in Fig. 17, the guiding passages 36 are brought into operation as are also the passages 38 of the driven member.

The clefts between the different parts of any form of the device may be closed in any convenient manner, as for instance by stuffing or packing. Any one of the forms of apparatus shown may be inclosed in a casing. A suitable casing for the form shown in Fig. 3ª may be that illustrated in Fig. 4. A casing may be provided with cavities for the circulation of a cooling medium if desired, or the two rotary members may, themselves, be so constructed as to constitute the confines of the appliance.

From the foregoing explanations, it will be obvious that the variation or reduction of the number of revolutions of the secondary part can be obtained either by the employment of a corresponding number of bucket-rims for the secondary wheel or by appropriate dimensions of the two wheels; therefore a more special description of such arrangements may be dispensed with. Partial flow turbines may also be employed for the devices, as well as radial or parallel flow turbines, and inward or outward discharge wheels, of which some examples are shown in the drawings.

The principle of the present invention is in nowise altered, if, for example, the construction of the apparatus is such that in order to obtain special results, the primarily produced velocity is partially converted into pressure, and partially utilized directly.

The present device is especially adapted for the transmission of energy between adjacent shafts, for replacing belt, gear wheel or chain transmission, and so forth, and also particularly for reversing gears, all of which are not utilizable for the high powers and velocities. By appropriately selecting the dimensions and the construction of the primary and the secondary turbine wheels, it is possible to establish any desired transmission ratio between their speeds of revolutions; further any known method of regulation for turbines and centrifugal pumps may be utilized for the present device, provision being made if desired for varying this transmission ratio during running. It is also possible by providing appropriate checking devices, reversing valves and the like in combination with special liquid driven reversing turbine wheels to reverse the driven shaft.

For obtaining variations of the rotative speed of the secondary part, any suitable means hitherto practised in turbines may be employed, such as adjustable buckets or feathering paddles, in the stationary part, or on the rotary members, or shiftable devices for controlling the flow of the liquid.

One of the most important fields for the employment of the present invention is the reduction of the speed of revolution and the reversing of devices driven by steam turbines especially for ships and the like, in which case the hydraulic transformer T (Fig. 5) is interposed between the shaft I of the steam turbine and the propeller shaft II. The loss of energy arising from the intermediate transmission is far more than compensated for in the case of ships, for example, by the much more efficient operation of the steam turbines and of the propeller, the former at the increased and the latter at decreased number of revolutions, and by the elimination of idly running steam turbines for going astern. In place of the latter the incomparably more compact reversing wheel is employed; during forward running, this wheel preferably runs idly, that is to say uncharged or emptied.

Figs. 5 and 6 represent examples of the arrangement in which a hydraulic power transmitting device of the kind described is interposed between the engine and the propeller. The passage of the steam is indicated by the arrows.

Fig. 5 shows the general disposition with one steam turbine and one propeller shaft. The shaft I of the steam turbine rotating with high speed is coupled with the primary part of the transformer T, while the propeller shaft II attached to the secondary part receives the energy and rotates with lower speed.

Any axial thrust on the liquid driving and liquid driven wheels of the power transmitter may be balanced by the opposite pull of the ship's propeller, steam turbine, or the like. Instead of causing the whole steam turbine to run with an increased speed, a part of it may be mounted directly upon the propeller shaft II, and the power of the quickly rotating part may be transmitted in the manner described on to the propeller shaft by means of the apparatus T, as shown in Fig. 6.

Another application of the power transmitting device consists in transmitting onto one shaft the energy of the two oppositely rotating parts of counter running steam turbines.

In all these examples the transmitting apparatus T may also be one of those types which are capable of reversing rotation.

I have shown a number of constructional arrangements for purpose of examples, but evidently the device may be constructed in different ways without departing from the principle of my invention. I therefore do not wish to be limited to the said constructions, but

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

1. An apparatus for transmitting or transforming power, having a turbine adapted to transmit energy to a fluid, and a turbine capable of receiving power from an energized fluid, the two turbines both having curved passages and arranged with respect to each other in such a manner that they comprise the whole circuit in which the said fluid circulates.

2. An apparatus for transmitting or transforming power, having a turbine adapted to transmit energy to a fluid and a turbine capable of receiving power from an energized fluid, the two turbines both having curved passages merging the one into the other in such a manner that the circuit in which the said fluid circulates is comprised by their passage systems.

3. An apparatus for transmitting or transforming power, consisting of a turbine adapted to transmit energy to a fluid, and a turbine capable of receiving power from an energized fluid, the two turbines both having curved passages and arranged adjacent to each other so as to comprise the circuit in their passages in the form of a gyratory ring in which the said fluid circulates.

4. The combination with a steam turbine, of a power transmitting or transforming apparatus, consisting of power transmitting and receiving turbines both having curved passages, the said passages comprising a circuit in the shape of a gyratory ring in which a fluid is adapted to circulate, and a propeller shaft attached to the power receiving turbine.

5. An apparatus for the transmission of power between adjacent shafts, comprising a primary turbine wheel mounted on the driving shaft and adapted to transmit energy to a fluid, and a secondary turbine wheel on the driven shaft and capable of receiving power from said energized fluid, the passages of both of the said wheels being curved and merging into each other to form a circuit in which the said fluid circulates.

6. An apparatus for transmitting or transforming power, consisting of a rotating member having curved vanes adapted to transmit energy to a fluid, a rotating member having curved vanes capable of receiving energy from a fluid, the two members being arranged relatively to each other in such a manner that their vane rims comprise the entire circuit in which the said fluid is capable of circulating.

7. An apparatus for transmitting or transforming power, comprising two rotatable members oppositely arranged and having curved passages formed therein, in which a power transmitting medium is adapted to circulate, the said passage in one member having its discharge opposite to the inlet of the passage in the other member and vice versa.

8. An apparatus for transmitting or transforming power, having a turbine adapted to transmit energy to a fluid, a turbine capable of receiving power from the energized fluid, the two turbines both having curved passages, the turbines being so arranged with respect to each other that they comprise the whole circuit in which the said fluid circulates, and a casing inclosing both of said turbines.

9. A driving connection for rotary parts, having in combination a fluid-tight casing, two disks or heads arranged in said casing and one of said heads having radial passages with inlets and outlets in the face or side adjacent to the other, the outlets being constructed to deliver a liquid against the other disk or head in a direction at an angle to the plane of rotation of said heads.

10. A driving connection for rotary parts, having in combination a fluid-tight casing, two disks or heads arranged in said casing and having radial passages having outlets and inlets, the inlets and outlets in one disk being in line with the outlets and inlets of the other disk, the outlets in the driving disk being adapted to deliver liquid contained in said passages toward the other disk or head in a direction at an angle to the plane of rotation of said heads or disks.

11. In a hydraulic power transmitting apparatus, the combination with a driving member, of a driven member, a closed casing adapted for containing a liquid and inclosing said members, and means suited to move said liquid in said driving member centrifugally and in a direction which has a radial component and deliver the same from said driving member to said driven member, whereby the driven member is actuated.

12. The combination with a rotatable driving member, of a rotatable driven member, a closed casing adapted for containing a liquid and inclosing said members, and means on said driving member adapted to move said liquid in said driving member centrifugally and in a direction which has a radial component and deliver the same to said driven member at an angle to the plane of rotation of said members whereby said driven member is actuated.

13. In a hydraulic power transmitting apparatus, the combination with a centrifugally acting rotatable driving member, of a driven member adapted to rotate independently of said driving member, a casing inclosing said members and adapted to contain a liquid, a plurality of passages in said driving member and running in a direction which has a radial component, and a plurality of passages in said driven member, the passages of said driving member being adapted to deliver liquid across an annular space to the passages of said driven member, whereby the same is actuated.

14. In a hydraulic power transmitting apparatus, the combination with a centrifugally acting driving member, of a driven member, a closed casing inclosing said members and containing a liquid, and means on said driving member and adapted to gradually increase the velocity of said liquid toward the periphery and deliver the same across an annular space in a direction which has a radial component to said driven member, whereby the same is actuated.

15. In a hydraulic power transmitting apparatus, the combination with a centrifugally acting driving member, of a driven member, a closed casing adapted to contain a liquid and inclosing said members, means on said driving member and adapted to gradually increase the velocity of said liquid toward the outer periphery of the same and deliver the liquid in a direction which has a radial component and at an angle to the plane of rotation across an annular space to said driven member, and means on said driven member adapted to discharge said liquid gradually decreasing its velocity.

16. In a hydraulic power transmitting apparatus, the combination with a primary turbine wheel provided with passages running in a direction which has a radial component, of a secondary turbine wheel, a casing inclosing said wheels and containing a liquid, the outlets of the passages of the primary wheel fitting closely the inlets of the passages of the secondary wheel and the outlets of the passages of the secondary wheel fitting closely the inlets of the passages of the primary wheel whereby a closed circuit is formed in which the liquid circulates continuously.

17. In a hydraulic power transmitting apparatus, the combination with a primary turbine wheel provided with passages running in a direction which has a radial component, of a secondary turbine wheel, the outlets of the passages of the primary wheel fitting closely the inlets of the passages of the secondary wheel and the outlets of the passages of the secondary wheel fitting closely the inlets of the passages of the primary wheel whereby a closed circuit is formed in which the liquid circulates continuously.

18. In a hydraulic power transmitting apparatus, the combination with a driving member, of a driven member, a closed casing adapted for containing liquid and inclosing said members, and means suited to move said liquid in said driving member centrifugally in a direction which has a radial component and deliver the same across an annular space from said driving member to said driven member at an angle to the plane of rotation.

19. In a hydraulic power transmitting ap-

paratus, the combination with a rotatable driving member, of a driven member adapted to rotate independently of said driving member, a water-tight casing inclosing said members and adapted to contain a liquid, a plurality of radially located buckets on said driving member, a plurality of buckets on said driven member, the buckets of said driving member being adapted to deliver liquid in a direction which has a radial component to the buckets of said driven member.

20. In a hydraulic power transmitting apparatus, the combination with a rotatable driving member, of a driven member adapted to rotate independently of said driving member, a water-tight casing inclosing said members and adapted to contain a liquid, a plurality of radially located buckets on said driving member, a plurality of buckets on said driven member, the buckets of said driving member being adapted to deliver liquid across an annular space to the buckets of said driven member in a direction which has a radial component and at an angle to the plane of rotation of said member.

21. The combination with a closed casing containing a confined volume of liquid, of a turbine-wheel located therein, and a centrifugal pump impeller located within the said casing and adapted to direct said liquid to said turbine-wheel, whereby the same is actuated.

22. The combination with a closed casing containing a confined volume of liquid, of a shaft rotatably mounted therein, a centrifugal pump impeller fixedly secured to said shaft, and a turbine-wheel located in said casing, said impeller being adapted to direct liquid to said turbine-wheel, whereby the same is actuated.

23. A hydraulic power transmitter including a rotary pump impeller having an annular inlet, an annular outlet and a plurality of vanes or blades therebetween forming an annular series of passages and a turbine closely juxtaposed thereto and coaxial therewith and having an annular inlet, an annular outlet and a plurality of vanes or blades therebetween forming a series of passages, the inlet of one of said members being closely juxtaposed to the outlet of the other member and registering therewith.

24. In combination, a rotary pump impeller and a turbine coaxial therewith, each having an annular liquid inlet, an annular liquid outlet and a plurality of vanes or blades between the inlet and the outlet and forming an annular series of passages, and means for supporting said impeller and turbine coaxially in closely juxtaposed positions, whereby liquid may be delivered from said impeller across an annular intervening space to said turbine to actuate the latter by the kinetic energy imparted to the liquid by the impeller.

25. In combination, a rotary member for imparting kinetic energy to a liquid and including an annular series of vanes or blades between which the liquid may be caused to flow at high velocity upon the rotation of said member, and a rotatable energy receiving member coaxial therewith, independently rotatable in respect thereto and closely juxtaposed thereto, said second mentioned member having an annular series of vanes or blades against which the liquid may impact.

In testimony whereof I have signed my name to this specification in presence of two subscribing witnesses.

HERMANN FÖTTINGER.

Witnesses:

WILHELM SPANNHAKE,

HANS HILDEBRAND.