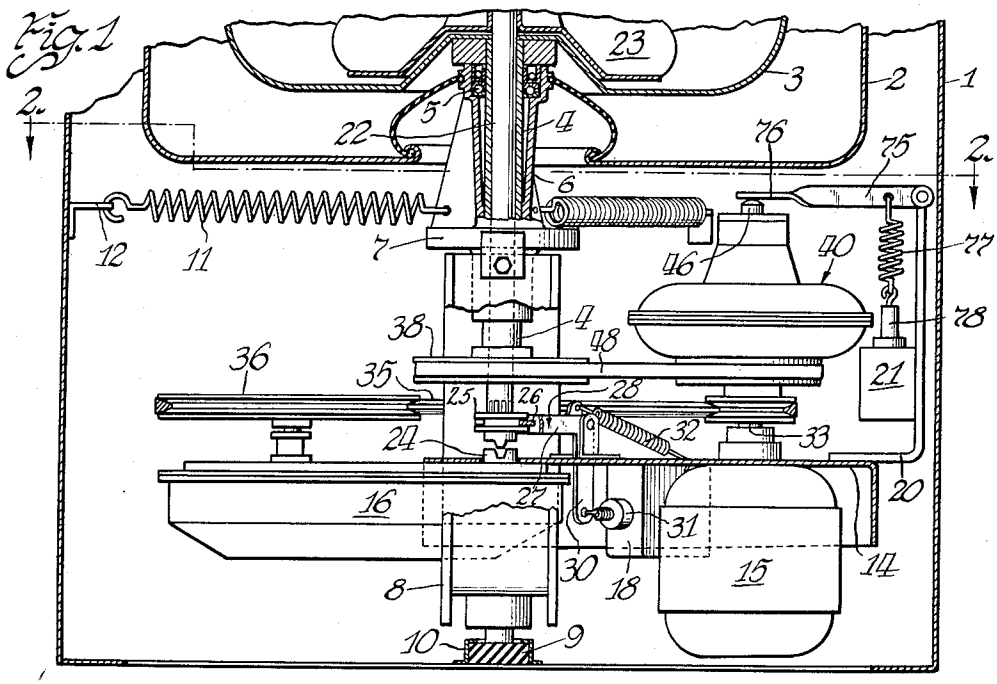
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Fig. 1



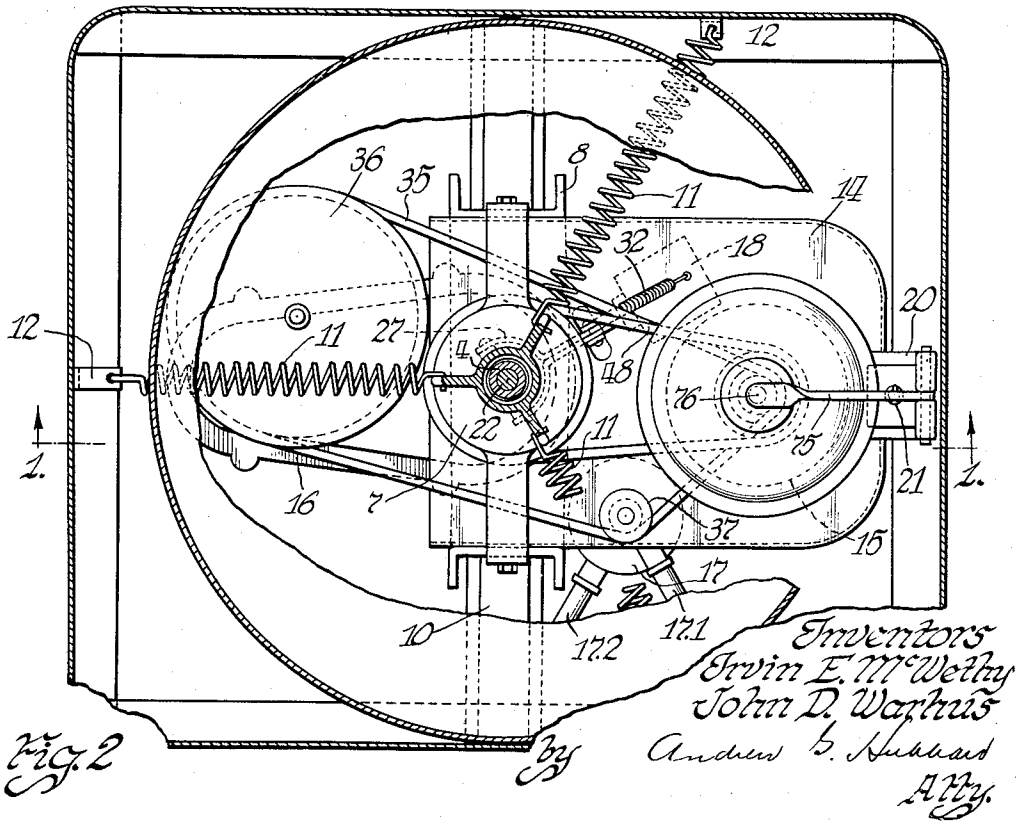


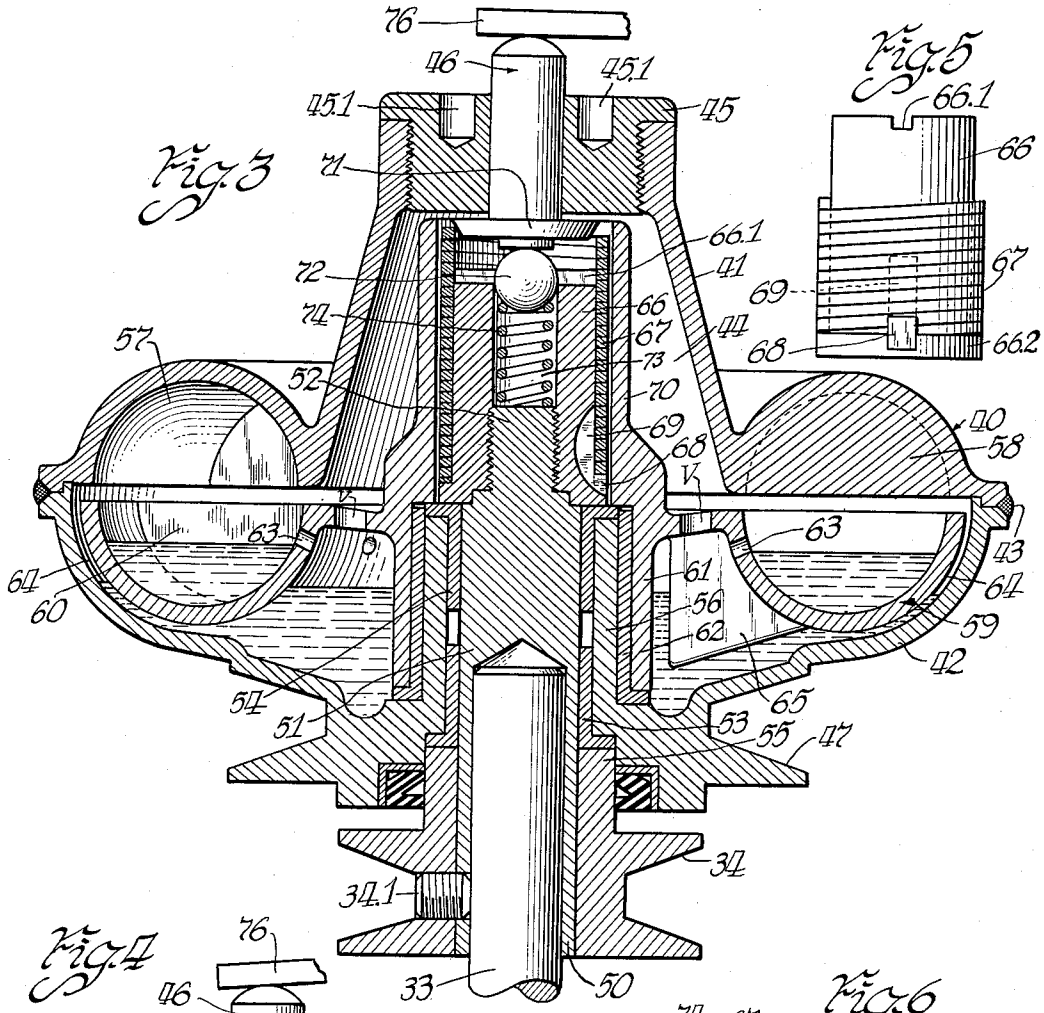
Fig. 2

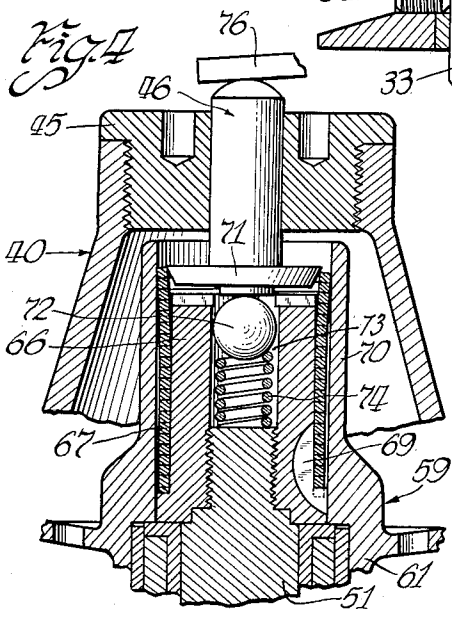
Inventors
Irvin E. McWethy
John D. Warhus
By Andrew B. Hubbard
Atty.

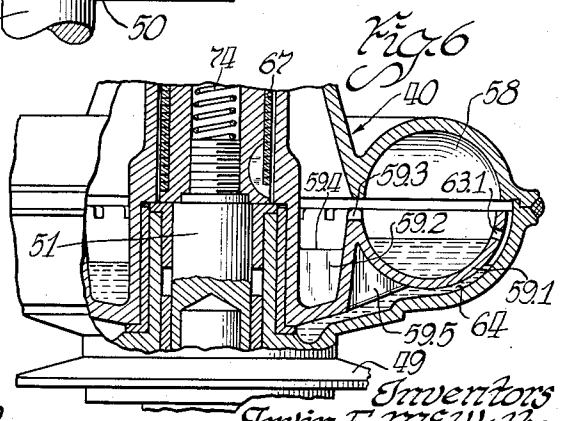
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CLUTCH AND FLUID COUPLING

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Inventors
Irvin E. McWethy
John D. Warhus
By Andrew B. Hubbard
Atty.

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CLUTCH AND FLUID COUPLING

Irvin E. McWethy, Western Springs, and John D. Warhus, Lombard, Ill., assignors to General Electric Company, a corporation of New York

Application December 28, 1951, Serial No. 263,924

9 Claims. (Cl. 60—54)

This invention relates to an improved clutch and fluid drive unit for transmitting power.

The mechanically simple and effective drive unit disclosed herein is adaptable to many mechanisms in which a structure having substantial inertia is to be brought rapidly to high speed rotation. For example, in some types of clothes washing machines the clothes are washed and rinsed, and a large part of the water centrifugally extracted therefrom, in a single receptacle or tub. It is advantageous to carry out the extraction operation at rather high speed so that a large portion of the water will be removed from the clothes before they are taken from the washing machine for final drying. In some domestic washing machines, the tub and its contents at the start of extraction may weigh as much as 200 pounds, and the drive motor is only of one-quarter horsepower. The load imposed on the motor is sometimes unusually heavy because eccentric distribution of the clothes load in the tub causes the tub to gyrate and vibrate excessively as it comes up to speed.

It has been found that the transmission of motive power to the tub through a fluid drive unit provides an inherent compensation for the severe loads imposed on the motor at the start of rotation of the heavily loaded tub, for the slippage in the fluid drive unit relieves the motor load by effecting a gradual acceleration of the tub. Specifically, it appears that a fluid drive unit or coupling establishes a tub spinning speed which may be said to vary according to the amount of unbalance of the tub and its load of clothes. The fluid drive unit smoothly accelerates the spinning speed of the tub as the free water is discharged therefrom, and the final spin speed is reached without excessive vibration of the tub and mechanism.

We have devised a fluid coupling and clutch mechanism in which the torque which may be transmitted at the commencement of rotation of the load is only a fraction of the ultimate capacity of the coupling, and we provide means for subsequently bringing the coupling up to its full capacity. In other words, we provide a fluid coupling and clutch having predetermined torque characteristics; and it may therefore be said to be a principal object of our invention to provide a fluid coupling having improved control over the starting torque and the "buildup" of torque, transmitted thereby.

It is yet another object of the invention to provide an improved clutching means for transmitting power from a drive motor to the impeller of a fluid coupling.

It is still another object of the invention to provide an improved impeller for the fluid coupling.

It is still another object of the invention to provide a fluid coupling which has distinct reservoirs of fluid which become sequentially effective in the transmission of torque, thereby establishing predetermined starting torque and final torque-transmitting capacities.

Presently preferred embodiments of our invention will best be understood by reference to the following detailed

description, read in the light of the accompanying drawings, in which Fig. 1 is a somewhat schematic side elevation of the lower portion of a washing machine to which our improved clutch and fluid coupling has been applied; Fig. 2 is a top plan view of the machine with certain portions broken away to reveal underlying structure; Fig. 3 is a side sectional elevation of a clutch and fluid coupling assembly embodying one form of our invention; Fig. 4 is a sectional elevation of the upper portion of the assembly showing the clutch at the instant of engagement; Fig. 5 is a side elevation of the clutch carrier with a portion of the clutch coil thereon; and Fig. 6 is a fragmentary sectional elevation showing a second form of fluid coupling embodying the invention.

By way of an example of use, our invention is shown as applied to a washing machine of the above-noted centrifugal extraction type. Such a machine has an outer casing 1 within which is secured a water collector 2. A tub 3 within said water collector is rotatably carried by a tubular shaft 4 suitably supported and journaled, as by the bearings 5 in a supporting sleeve 6. Said sleeve has a base 7 secured to the upper end of a U-shaped main support 8 which in turn is supported for gyratory movement about a resilient base block 9 carried in a transversely extending frame member 10. The tub is held in a normally upright position by suitable means; for example, by the centering springs 11 extending between sleeve 6 and brackets 12 fixed to the casing.

The drive mechanism is mounted on a plate 14 secured to the support 8. Carried by said plate is a drive motor 15, an oscillation-producing mechanism 16, a pump 17, a solenoid 18, and a bracket 20 for mounting a second solenoid 21. A shaft 22 is rotatable within spin shaft 4 and carries on its upper end an agitator 23 which as is now well known in the art oscillates to effect the washing of the clothes when the clothes load and necessary quantity of washing liquid are in the tub 3. Shaft 22 extends downwardly through the spin shaft 4 and may seat within a socket provided in a jaw clutch member 24 arranged to be oscillated by the mechanism 16. Such mechanism may be similar to that disclosed in U. S. Patent No. 1,964,440, granted June 26, 1934, to Allen J. Patch.

To connect shaft 22 to the mechanism 16, there is provided a shiftable clutch element 25 splined on shaft 22 for free axial movement thereon. A shift yoke 26 riding freely within a slot in clutch element 25 is arranged for operation by the forked arm 27 of a bell crank 28 pivotally mounted on plate 14. Arm 30 of said bell crank is suitably operatively associated with the plunger 31 of solenoid 18. A spring 32 anchored between plate 14 and an upstanding ear of crank arm 27 normally urges the bell crank into rotation to disengage the respective jaw clutch elements 24 and 25. It is seen therefore that to connect the agitator shaft 22 to power, solenoid 18 must be energized. In an automatic washing machine the periods of energy of such a solenoid are controlled by a time-cycle switch (not shown).

Motor 15 is arranged with its shaft 33 vertical. On said shaft is a drive sheave 34 connected by suitable belt means 35 to the drive sheave 36 of the oscillation mechanism 16. Said belt may also drive the sheave 37 of pump 17, which as is well understood in the art has its inlet 17.1 arranged to receive water from the water collector 2 and its outlet 17.2 arranged to discharge into a laundry tub or the like (not shown) having connection with the plumbing waste line of the building. The spin shaft sheave 38 is arranged to be driven from the fluid coupling and clutch assembly constituting the present invention.

In the embodiment shown in Fig. 3, the coupling has

a housing 40 comprising upper and lower casing portions 41, 42 respectively suitably secured in fluid-tight relationship as by a peripheral weld 43 or other conventional means. The frusto-conical central portion of the upper casing portion provides a concentric cavity 44 which accommodates the clutch mechanism, as presently explained, and also provides a relatively large chamber within which entrapped air and oil vapor may expand without generating excess pressure as the apparatus heats up in use. The charge of coupling liquid may be introduced into the housing, and the clutch mechanism within the housing made available for service, by removal of the screw plug 45. Said plug also serves as a guide or bearing for the clutch actuator 46. The power take-off sheave 47 may be placed at any suitable location on the housing; conveniently, it is formed as an integral part of the lower casing portion 42. Said sheave accommodates the drive belt 48 which connects to the spin sheave 38.

The housing 40 is arranged for free rotation about the motor shaft 33. For example, we fix to the end of said shaft an extension 50 having an upper cylindrical bearing portion 51 and a threaded extension 52 of reduced diameter. On said shaft extension we mount sleeve bearings 53 and 54; the former may be supported on the hub extension 55 of sheave 34, secured to the shaft 33 by a set screw 34.1 passing through the shaft extension. The housing is rotatably mounted on the bearings by its hub 56.

The upper casing portion 41 contains the runner component of the fluid coupling. Although the runner could well be an independent structure suitably secured within the housing, it is advantageous to make it integral therewith, and accordingly, we cast the casing 41 with a semitoroidal peripheral portion 57 subdivided by a plurality of walls 58 to provide a suitable number of buckets as is usual in the fluid coupling art. The driving element of the coupling is the impeller 59 which has a complementary semitoroid shape and is similarly divided by walls 60 into a plurality of buckets. The impeller is rotatable relative to hub 56. Accordingly, we provide an elongated impeller hub 61 which is rotatably carried on a bearing 62 mounted on said hub 56.

We establish specific torque-transmission characteristics of the fluid coupling by maintaining the initially effective quantity of liquid less than that needed for transmission of the full torque of which the coupling is capable. We therefore provide means for maintaining distinct bodies of fluid when the coupling is at rest, and bring these bodies sequentially into operation. The desired amount of starting torque is established by maintaining in impeller 59 what may be termed a "permanent" charge of liquid capable of transmitting a predetermined fraction of the ultimate torque between the impeller and the runner. According to the desired starting torque, the permanent charge may fill the impeller buckets, or, as illustrated, fill the buckets only to the level of bucket spill ports 63 through which liquid draining into the impeller as it comes to rest overflows into the housing. The free liquid level of the total impeller and housing liquid charge is below the level of the runner. The necessary liquid for ultimate torque transmission is drawn from the housing by causing liquid within the lower casing portion to flow by centrifugal force along the passages 64 and over the outer rim of the impeller. Such liquid movement will commence shortly after the impeller begins rotation, and may be accelerated by providing a suitable number of radially extending vanes 65 which reach downwardly from the impeller wall into the liquid within the lower casing portion. The vent openings V permit the escape of oil vapors into the chamber 44.

The clutch by which the impeller 59 is connected to motive power is of the coil spring type. A tubular cylindrical clutch carrier 66 is screw-threadedly attached to the extension 52 of the shaft portion 51. The end of the carrier is provided with a screw driver slot 66.1 to assist assembly and removal. A cylindrical coil spring 67 wraps about the carrier 66; the end of the lowermost coil abuts the rigid projection 68 of a drive key or equivalent 69 seated within the carrier. A shoulder 66.2 of the carrier supports the spring as shown in Fig. 5. Disposed concentrically about said spring 67 with but slight clearance (the illustrated clearance is exaggerated) is the cylindrical extension 70 of the hub 61. It will be obvious that when the spring 67 is expanded to bring a suitable number of its coils into contact with the inner wall of said hub extension, the spring will constitute a drive link between the clutch carrier and the hub extension.

The operation of the coil spring expansion means will be evident by comparison of Figs. 3 and 4. The actuator 46 is freely axially movable in the plug 45 and has a frusto-conical base 71 which enters the upper portion of the spring. A thrust ball 72 operates within the axial bore 73 of the clutch carrier and is urged upwardly against the base 71 by a coil spring 74. Depression of the actuator 46 will cam the upper spring coils outwardly against hub extension 70 and the spring will then uncoil into large-area engagement with the hub extension. In this connection it will be noted that Fig. 4 represents the uncoiling of spring 67 at the initial instant of operation of the actuator 46. The exact area of contact of the spring 67 with the extension 70 is dependent upon the amount of torque to be transmitted. As is well known, various ways have been proposed to establish the torque-transmission characteristics of coil spring clutches. Any suitable means for depressing clutch actuator 46 may be used. For example, we may pivotally mount on bracket 20 a lever 75 having a relatively wide end portion 76 maintained in permanent contact with the rounded end of actuator 46 by a light spring 77 interposed between the lever and the plunger 78 of the solenoid 21. Said spring 77 also insures that the plunger will "bottom" within the solenoid cavity when the solenoid is energized. In this connection it will be noted that with the lever 75 depressed fully—representing the maximum retraction of the solenoid plunger—the actuator head comes to rest before it strikes the end of the carrier 66. The clutch carrier assembly and spring may be serviced by unscrewing cap 45 using a suitable tool seated in the sockets 45.1 and then unscrewing the carrier 66 from its mounting post 52.

Fig. 6 fragmentarily shows a second form of impeller which provides a predetermined starting torque and desired rate of torque increase. In this embodiment the impeller 59.1 is formed with an annular reservoir 59.2 with which the individual impeller buckets communicate through suitable passages 59.3. Passage 59.3 may be provided by castellating the radially innermost wall of the impeller. The reservoir 59.2 may have any suitable number of radially extending vanes 59.4 which serve both to strengthen the structure and to urge the liquid content of the reservoir into motion with the impeller at the instant of rotation. It will be noted that the reservoir walls diverge upwardly; hence, when the impeller is coupled by spring 67 to clutch carrier 66, as above described, centrifugal forces developed by the rotation of the impeller will cause the liquid to flow up the walls of the reservoir and spill over through the passages 59.3 into the impeller to supplement the permanent charge established therein by the spill ports 63.1. If desired, spill ports (not shown) may be provided to maintain a desired liquid level in reservoir 59.2.

A third reservoir of liquid is provided by the lower casing portion into which liquid will flow by spillage through the ports 63.1 as the impeller comes to rest. Stiffening vanes 59.5 between the bucket wall and the reservoir 59.2 serve to initiate rotation of the liquid, which will drive by centrifugal force through the passage 64 for eventual spillover into the impeller.

It will be apparent that the torque characteristics of the fluid coupling may be made to conform quite closely to the job requirements. The spring clutch is almost instantaneously effective and the impeller of the fluid coupling comes quickly to operating speed. The first fluid to be effective in torque transmission is that within the impeller; it quickly begins its toroidal movement and establishes driving connection with the runner **58** of the upper casing portion. The location of the various spill ports is selected in conformity with the starting torque requirement. In the respective embodiments the liquid in the lower casing portion **42** may be the second liquid body to become effective, and said liquid joins that initially in the impeller to effectively increase the transmitted torque. In the Fig. 6 embodiment the liquid in reservoir **59.2** may be the last to operate, although we are not able to speak with authority as to the relationship or effectiveness of the liquid within reservoir **59.2** as respects that within the lower casing portion. In any event, the relative quantities of liquid in the reservoir and lower casing may be established as desired by control of the volumetric capacities of said structures.

When the coupling is de-clutched, as by de-energization of the solenoid **21**, to permit the spring **74** to lift the actuator head **71** out of engagement with the coil spring **67**, the impeller **59** comes quickly to rest. The liquid which was active during operation had a volume greater than the capacity of the impeller, and therefore spills from the impeller or passes through the various ports or passages into the reservoirs, leaving the residual impeller charge as determined by the impeller spill ports.

In view of the foregoing, it is apparent that we have provided a clutch and fluid drive unit which does not subject the drive motor immediately to full load. The torque which the coupling is capable of transmitting at the instant of connection to the motor is designedly less than the ultimate.

While there has been described what is at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

We claim:

1. In a fluid coupling, a housing having first and second hollow casing portions secured to each other in opposing relation to define a closed chamber of substantial volume, a first of said casing portions forming a fluid-coupling runner, means for mounting said housing for rotation about a vertical axis, an upwardly facing semitoroidal impeller disposed within said second casing portion beneath the runner and mounted for independent rotation therein about said axis, said impeller being adapted to be connected of motive power, means for maintaining within said housing a predetermined quantity of liquid having a free level below the level of the runner, means for maintaining only within said impeller, when at rest, a predetermined quantity of liquid less than the maximum capacity thereof to provide a desired starting torque, means for urging the liquid in said housing into rotation upon rotation of said impeller to effect centrifugal flow of liquid from said housing into said impeller to supplement the said initial charge therein, and means for connecting said housing to a mechanism to be driven thereby.

2. In a fluid coupling, a housing having first and second hollow casing portions secured to each other in opposing relation to define a closed chamber of substantial volume, a first of said casing portions forming a fluid-coupling runner, means for mounting said housing for rotation about a vertical drive shaft, an upwardly facing semitoroidal impeller disposed within said other casing portion beneath said runner and mounted for independent rotation therein about said drive shaft, means for releasably connecting said impeller to said drive shaft, means for maintaining within said housing a predetermined quantity of liquid having a free level below the level of the runner, means for maintaining within said impeller, when at rest, a predetermined quantity of liquid to provide a desired starting torque, means extending from said impeller into the liquid in said housing for urging the same into rotation upon rotation of said impeller to effect centrifugal flow of liquid from said housing into said impeller to supplement the said initial charge therein, and means for connecting said housing to a mechanism to be driven thereby.

3. In a fluid coupling arranged for rotation about a vertical axis, a housing having upper and lower portions secured together to define a chamber of substantial volume, the lower housing portion defining a reservoir for liquid and the upper housing portion being substantially semitoroidal at its outer periphery and having a plurality of vanes in said peripheral portion to define a runner, an upwardly facing semitoroidal impeller disposed within said lower housing portion beneath said runner and mounted for independent rotation relative thereto about said vertical axis, means for maintaining within said impeller when at rest a predetermined quantity of liquid less than the maximum capacity thereof, a quantity of additional liquid in said reservoir, means for releasably connecting said impeller to a source of motive power, and means effective upon rotation of said impeller to introduce liquid from said reservoir into said impeller.

4. In a fluid coupling arranged for rotation about a vertical axis, a housing having upper and lower portions secured together to define a chamber of substantial volume, the lower housing portion defining a reservoir for liquid and the upper housing portion being substantially semitoroidal at its outer periphery and having a plurality of vanes in said peripheral portion to define a runner, an upwardly facing semitoroidal impeller disposed within said lower housing portion below said runner and mounted for independent rotation relative thereto about said vertical axis, means for maintaining within said impeller when at rest a predetermined quantity of liquid less than the maximum capacity thereof, a quantity of additional liquid in said reservoir, means for connecting said impeller to a source of motive power, rigid vanes extending outwardly and downwardly from said impeller into said additional liquid to cause said liquid to flow from said reservoir by centrifugal force generated by said impeller vanes upon rotation of said impeller, and passage means communicating between said reservoir and said impeller to accommodate flow of said liquid from said reservoir into said impeller.

5. In a fluid coupling arranged for rotation about a vertical axis, a housing having upper and lower portions secured together to define a chamber of substantial volume, the lower housing portion defining a reservoir for liquid and the upper housing portion being substantially semitoroidal at its outer periphery and having a plurality of vanes in said peripheral portion to define a runner, an upwardly facing semitoroidal impeller disposed within said lower housing portion below said runner and mounted for independent rotation about said vertical axis, said impeller and said lower housing portion being in relatively close spaced relation at the radially outermost wall portions thereof, means for maintaining in said impeller when at rest a predetermined quantity of liquid less than the maximum capacity thereof, a quantity of additional liquid in said lower housing portion, means within said housing for connecting said impeller to a drive shaft rotating in said vertical axis, and a plurality of rigid vanes extending from said impeller into said additional liquid to cause said liquid to flow, by centrifugal force generated by said impeller vanes during rotation of said impeller, through the passage afforded by the spacing between said impeller and said lower housing portion to enter said impeller over the radially outermost edge thereof to supplement the initial quantity of liquid therein.

6. In a fluid coupling, a housing having first and second hollow casing portions secured together in opposing relationship to define a closed chamber of substantial volume, a first of said casing portions forming a runner, means for mounting said housing for rotation about a vertical axis, an upwardly facing semitoroidal impeller disposed within the second casing portion below said runner for cooperation with said runner for torque transmission therebetween, said impeller being independently rotatable about said vertical axis, passage means communicating between said second casing portion and said impeller, means for connecting said impeller to a source of motive power to rotate the same, a charge of liquid in said last-named casing portion having a free surface below the level of said runner, means for maintaining in said impeller when at rest a predetermined quantity of additional liquid to provide a desired starting torque, means carried by said impeller to accommodate a third charge of liquid, means providing for passage of said last-named liquid into said impeller upon rotation of said impeller, means extending from said impeller into said first-named charge of liquid to cause said liquid to flow by centrifugal force into said impeller, and means for connecting said runner to a mechanism to be rotated thereby.

7. In a fluid coupling, a housing having first and second hollow casing portions secured together in opposing relationship to define a closed chamber of substantial volume, a first of said casing portions having means disposed about its periphery to form a downwardly-facing semitoroidal runner, means for mounting said housing for rotation about a vertical axis, an upwardly facing semitoroidal impeller disposed within the second casing portion below said runner for cooperation therewith, said impeller being independently rotatable about said vertical axis, means for connecting said impeller to a source of power for rotating the same, a charge of torque transmission liquid in a reservoir defined by said second casing portion, the free surface of said liquid being substantially below the runner, passage means between said reservoir and said impeller, means secured to said impeller for rotation therewith and engaging the liquid in said reservoir to induce the same into rotation upon rotation of said impeller and cause said liquid by centrifugal force to flow through said passage means into said impeller, means for draining said impeller, when at rest, to retain a predetermined amount of said liquid therein to provide a desired initial transmisison of torque between said impeller and said runner at the commencement of rotation of said impeller, means fixed to said impeller about a periphery thereof to accommodate a third quantity of liquid, means providing for the passage of said third quantity of liquid into said impeller upon rotation thereof to supplement flow from said reservoir into said impeller, and means providing a power take-off from said runner.

8. A fluid coupling as in claim 7, in which the reservoir-forming means carried by said impeller comprises an upwardly facing annular structure having upwardly and outwardly flaring walls, and radial vanes extending between adjacent walls of said impeller and said reservoir-forming means enter the charge of fluid in said reservoir to initiate centrifugal movement thereof.

9. A fluid coupling as in claim 7, in which the fluid-accommodating means carried by said impeller comprises an upwardly-facing annular structure depending from the radially innermost periphery of said impeller, the adjacent walls of said impeller and reservoir being castellated to provide overflow passages between said structure and said impeller.

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