Sept. 5, 1961 T. J. RYAN ET AL 2,998,782

FLUID DRIVE ROTOR VANE TIE RING

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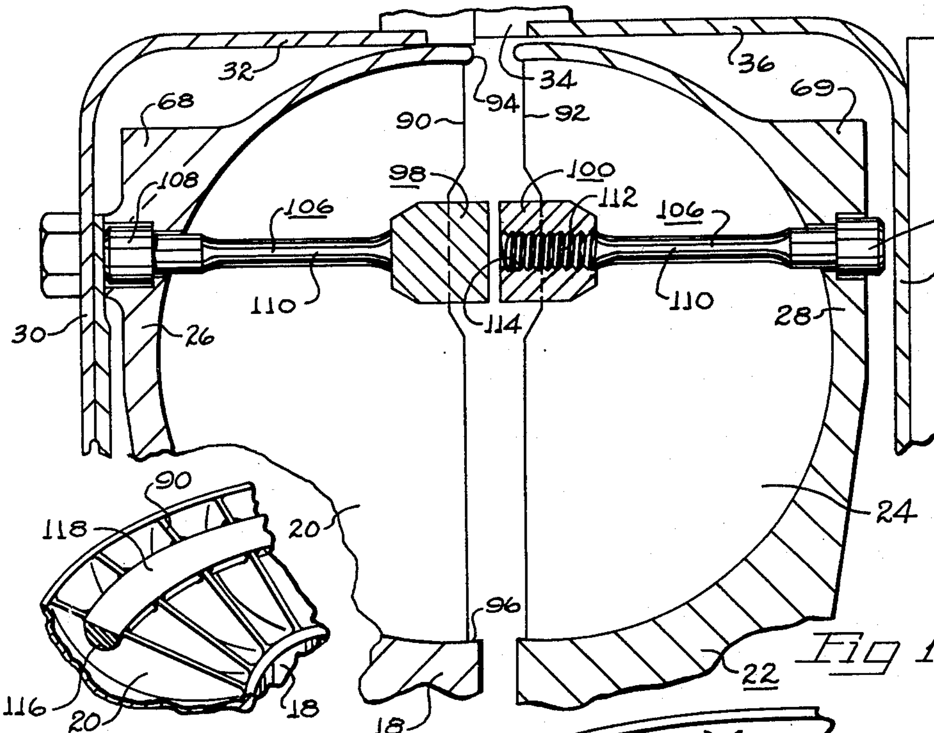

Fig 1

Fig 3

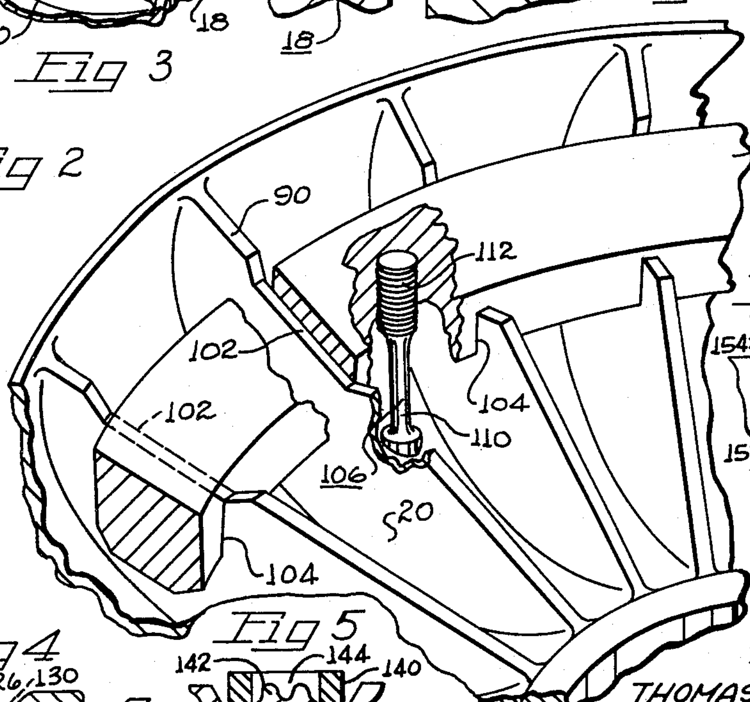

Fig 2

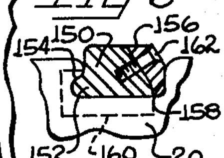

Fig 6

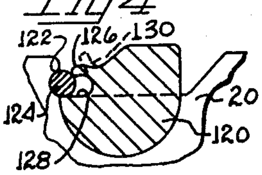

Fig 4

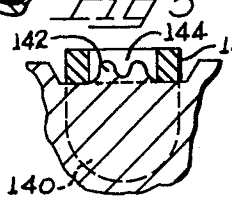

Fig 5

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FLUID DRIVE ROTOR VANE TIE RING

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6 Claims. (Cl. 103—115)

This invention relates to fluid couplings, and more particularly to power transmitting couplings adapted to be interposed between driving and driven elements to provide a cushioned drive, and wherein rotor vane dampening tie rings are provided to strengthen and reinforce the vanes of the rotatable impeller and turbine or runner members.

In the operation of fluid couplings energy is imparted to fluid as it moves radially outwardly in the impeller. The impeller is contoured to deflect the fluid axially as it approaches the outer periphery of the impeller thereby guiding the fluid axially to flow into the turbine or runner. The turbine is contoured to guide the fluid to flow radially inwardly from the outer periphery toward the inner periphery of the turbine, and energy is given up by the fluid and is imparted to the driven shaft. Torque is thus transferred from the impeller to the turbine as the fluid circulates in the fluid circuit, energy being imparted to the fluid by the impeller and absorbed from the fluid by the turbine.

The amount of fluid circulation in the fluid circuit is dependent on the quantity of fluid in the circuit and the load imposed on the driven shaft. Assuming that the quantity of fluid in the circuit remains constant, the circulation of fluid in the fluid circuit or the slip between the impeller and turbine members increases as the load on the driven shaft increases. The load exerted on the vanes of the impeller and runner members is dependent on and is a function of the load imposed on the driven shaft. As the individual vanes of the turbine or runner move relative to the individual vanes of the impeller there is a progressive loading and unloading of the vanes. The stresses to which the vanes are subjected increase as the slip between the impeller and turbine increases.

As the frequency of the loading and unloading cycles of the vanes increases, a vibrational frequency is developed which approaches the natural vibrational frequencies of the vane members. As the vibrational frequency thus imposed on the vanes approaches the natural vibrational frequency of the vanes, the stress imposed on the vanes approaches the vane rupturing point.

An object of our invention is to provide a rotor vane dampening tie ring adapted to be secured to the vanes to function as a de-tuner to alter the natural vibrational frequency of the vanes to such a degree that they will operate in a range different from the vibrational frequency imposed by the movement of the vanes of the impeller and turbine members relative to each other caused by slippage between the impeller and turbine members.

A further object of our invention resides in the provision of a tie ring secured to the free edges of the impeller or runner vanes to distribute the peak loads imposed on individual blades as they pass blades of the adjacent member.

Another object of our invention is to provide a reinforcing ring operably connected to the free edges of the vanes of a rotatable fluid energizing or energy-absorbing vane wheel to assist in distributing and equalizing the loads among the vanes.

Another object of our invention is to provide a fluid coupling having a rotor vane dampening tie ring to provide a rotor having greater strength.

Still a further object of our invention resides in the provision of a rotor vane dampening tie ring to provide a rotor wheel having improved hydraulic stability by strengthening the leading edges of the vanes, thereby substantially reducing vane flutter or vibration exerted on the vanes.

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Another object of our invention is to provide a fluid coupling having an annular reinforcing member secured to the vanes between the inner and outer peripheries to strengthen the vanes and to improve the performance of the coupling and to stabilize the pattern of the oil flow thereby reducing fluid turbulence.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

FIGURE 1 is a fragmentary sectional view illustrating the application of our invention to a fluid coupling;

FIG. 2 is a fragmentary perspective view illustrating the position of our improved dampening tie ring in a vane member;

FIG. 3 is a sectional view illustrating an alternate mechanism for attaching a tie ring of the invention to the vane members;

FIG. 4 is a sectional view illustrating another mechanism for attaching a tie ring of the invention to the vane members;

FIG. 5 is a sectional view illustrating an additional mechanism for attaching a tie ring of the invention to the vane members; and

FIG. 6 is another sectional view showing a still further mechanism for attaching the inventive tie ring to the vane members.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phaseology or terminology employed herein is for the purpose of description and not of limitation.

Our invention is applicable to torque transmitting hydraulic devices such, for example, as fluid couplings and torque converters. The applicable hydraulic devices may be one-way drives or reversible drives. The invention is illustrated as applied to a fluid coupling wherein aligned driving and driven shafts are provided with fluid energizing and energy absorbing impeller and turbine members **18** and **22** respectively. The impeller **18** is provided with radially extended vanes **20** adapted on rotation of the impeller to impart torque to hydraulic fluid in the fluid circuit defined by the impeller and turbine members. The turbine **22** is provided with radially extended vanes **24** adapted to receive the energized liquid from the impeller and impart it to the driven shaft.

The impeller and turbine members have radially extended confronting axially curved shell members **26** and **28** respectively from which the vanes **20** and **24** extend. A shell **30** is carried by the impeller **18** and has an axially extending cylindrical section **32** secured by a connector **34** to a reversely disposed member having an axially extending cylindrical section **36** terminating in an inwardly directed flange **38** housing the turbine **22**.

It will be noted that the impeller vanes **20** have leading edges **90**, and that the turbine vanes **24** have free edges **92**. The free edges **90** and **92** extend from outer peripheries **94** to inner peripheries **96** of each of the vaned members. Rotor vane dampening tie rings **98** and **100** may be secured to the impeller and turbine or runner members **18** and **22** respectively. The tie rings extend completely around the impeller and turbine members and serve to distribute to adjacent vanes the peak loads imposed on a single vane.

In the design of fluid couplings many couplings are designed with a different number of vanes in the impeller and rotor members. This avoids the simultaneous passing of the free edges 90 and 92 of all of the vanes of the impeller and turbine vanes and minimizes the possibility of the development of resonant frequencies which would impose undesirable loads on the members.

As shown more clearly in FIG. 2 the free edges 90 of the impeller vanes are relieved as illustrated at 102 to provide an axially extended depressed section. The tie ring 98 is preferably formed with radially extended slots 104 to receive the forward edges of the vanes 20 of the impeller. The slots 104 in the tie ring 98 are preferably accurately machined or otherwise formed to provide a few thousandths (for example, .002 inch) tolerance with respect to the side walls of the vane members 20 to restrict circumferential movement of the vanes in the fluid circuits as the loading thereon transmitted to the vanes by the fluid builds up to a peak as the vanes of the impeller and turbine move circumferentially relative to each other. The same is of course true with respect to the tie ring 100 of the turbine 22. It will be noted that the tie ring 98 is designed in such a manner that it is loaded by deflection of the vanes 20 to place the tie ring segments in compression, as load is imparted thereto by the vanes.

In fluid couplings having unequal numbers of vanes in the impeller and turbine members, the tie rings 98 and 100 function to restrict the circumferential displacement of the vanes and distribute the load in compression to the succeeding vanes. It will be noted that the tie rings 98 and 100 are positioned more closely adjacent the outer peripheries 94 than they are toward the inner peripheries 96. The tie rings are thus positioned at approximately the area of greatest loading and therefore of the maximum deflection of the vanes. In this manner the tie rings function to provide desired guidance to the circulating fluid, thereby minimizing turbulence in the circuit and allowing greater transmission of energy between the driving and driven member.

As the load imposed on the driven shaft increases the degree of slippage between the driven and driving members increases and the internal circulation of fluid increases. This increased circulation flow in the coupling induces the flow to move radially inwardly toward the inner peripheries 96. The tie rings 98 and 100 provide a desirable degree of guidance for the fluid to minimize fluid turbulence and increase the efficiency of the unit.

It will of course be understood that if desired tie rings 98 and 100 may simultaneously be employed in association with both the impeller and turbine members 18 and 22. If desired, however, it is unnecessary that tie rings be used on both, since it can advantageously be employed on either the impeller or the turbine members alone without sacrificing any of their advantages or resulting efficiency. Also, it will be seen that two or more tie rings may be employed on the impeller or turbine members if desired.

It will be noted that the tie rings 98 and 100 function to tie together the vanes at their free edges thereby providing a stronger construction whereby each of the vanes is permitted a degree of freedom to move in response to stresses imposed on it, but movement beyond a predetermined degree due to vibrational impulses is restricted.

We prefer to form the tie rings 98 and 100 of high tensile strength material. These rings may be formed in any desired manner as by fabricating, machining, precision casting, or any other suitable method may be employed whereby a ring having the desired properties and proportions is provided to tie together the free edges of the vanes.

As shown in FIG. 1 it will be noted that the vane dampening tie rings 98 or 100 are positioned axially and are held in clamped engagement with the vanes by means of the high tensile stress bolts 106. The heads 108 of the bolts 106 are recessed in the flanges 68 and 69 respectively of the impeller 18 and turbine 22. The bolts 106 have reduced sections 110 intermediate their head sections 108 and their threaded ends 112 to provide a desired degree of elasticity whereby the tie rings 98 and 100 are resiliently maintained in contact with the free edges 90 and 92 of the vanes 20 and 24 in the area of the relieved sections 102. The stress concentrations in the bolts 106 are thus reduced whereupon the member is permitted to seek a stabilized position. It will be noted that the threaded end 112 of the bolts 106 are threaded into the tapped holes 114 formed in the rings 98 or 100.

Referring now to FIG. 3, it will be noted that a modified form of our invention which may be applied to both the impeller and turbine members or to either is illustrated. The free edges 90 of the vanes 20 of the impeller 18 shown for illustrative purposes are contoured to provide an annular groove or recess 116 completely around the entire circumference of the impeller.

A ring 118 accurately dimensioned to correspond with the contour and dimensions of the recess 116 is positioned in the recesses and is secured to each of the vanes. The ring 118 may be fixedly secured to the vanes by a brazing operation, preferably in a furnace having controlled atmosphere. It will be understood that an additional advantage of placing the ring 118 in place resides in the fact that the rotors are stress relieved due to the annealing action imparted by heating them during the brazing operation.

It will be understood that the ring 118 ties through the vanes in such a manner as to reinforce them, equalize loads imparted on the vanes, and dampen vibrational stresses which might be imposed.

Referring now to FIG. 4, there is provided a ring 120 having a series of slots therein for fitting over the edge portions of vanes 20 in the manner of the aforementioned slots 104 (FIG. 2). Vanes 20 of the FIG. 4 embodiment are provided with notches 122 which receive portions of a locking rod 124 extending around ring 120. Section 126 of the ring is turned into engagement with rod 124 as shown in full lines to hold said rod partially within notches 122 and partially overlying surface 128 of ring 120, the arrangement being such that ring 120 is securely locked on the vanes 20. Prior to installation of ring 120 on the vanes, section 126 assumes the dotted line position 130 so as to accommodate positionment of ring 120 and rod 124 onto the vanes. Locking of the ring and rod onto the vanes is accomplished by displacing ring section 126 from its dotted line position to its full line position with suitable swedging devices (not shown).

Referring now to FIG. 5, there is provided a ring 140 having slots similar to the aforementioned slots 104 for fitting the ring onto vanes 20. The vanes in this embodiment are provided with integral tabs 142 which project through the ring into an endless channel or groove 144, the arrangement being such that the tabs may be bent down from their illustrated positions to clamp ring 140 onto the vanes.

Referring now to FIG. 6, there is provided a ring 150 having a section 152 thereof projecting into a lip-defining notch 154 formed in the edge of each vane 20. An annular wedge element 156 is inserted between ring 150 and edge surface 158 of the vane to retain the ring in its illustrated position. Screws 162 are provided for locking element 156 onto the ring for maintaining the ring in position. Circumferential displacement of the vanes is prevented by wall portions 160 formed integrally with ring 150 and closely engaging opposite faces of each vane. Wall portions 160 cooperate with one another to form slots similar to slots 104 shown in FIG. 2.

From the above description it will be noted that the vane-rigidifying element may be secured onto the vanes by various different mechanisms while still obtaining the desired rigidifying and vibration-dampenng features. Although the rigidifying element has been described as a continuous tie ring it should be noted that the tie construction could be formed as a series of discontinuous tie elements, each interconnecting two or more vanes. Thus, for example, with a shell having forty blades, there might be provided four segmented tie elements, each interconnecting ten of the blades.

Having thus described our invention, we claim:

1. In a fluid coupling the combination comprising a fluid torque transmitting shell; vanes carried within said shell; and a tie ring having a series of slots receiving the vane free edges, with a slight clearance between the slot-forming surfaces and the vane faces so that a highly loaded vane is enabled to be deflected prior to transfer of load onto the tie ring.

2. The combination of claim 1 wherein the aforementioned clearance is approximately .002 inch.

3. In a fluid coupling the combination comprising a fluid torque transmitting shell; vanes carried within said shell; tie means interconnecting at least some of said vanes at points remote from the points of connection of the vanes with the shell; said tie means having a yieldable connection with at least some of the vanes whereby circumferential loads placed on a particular vane are allowed to be partially absorbed by the vane and partially transmitted to the tie means and thence to the adjacent vanes; and a plurality of connector elements interconnecting the tie means with portions of said shell; said connector elements having an elasticity such that stress thereon is relieved during operation of the coupling.

4. The combination of claim 3 wherein the connector elements comprise elongated connector devices having enlarged end portions anchored in the shell and tie means respectively, and having intermediate portions of reduced dimension to provide an elastic connection between the tie means and shell.

5. In a fluid coupling the combination comprising a fluid torque transmitting shell; vanes carried within said shell; and tie means interconnecting at least some of said vanes at points remote from the points of connection of the vanes with the shell; said tie means having a yieldable connection with at least some of the vanes whereby circumferential loads placed on a particular vanes are allowed to be partially absorbed by the vane and partially transmitted to the tie means and thence to the adjacent vanes; said tie means being contoured to smoothly guide the fluid vortex as it moves through the shell, with the radial cross section of the tie means being approximately the same as the axial cross section thereof; the flow path between the tie means and the outer periphery of the shell being slightly greater than the tie means radial cross section.

6. In a fluid coupling the combination comprisng a fluid torque transmitting shell; vanes carried wtihin said shell; an annular tie element interconnecting the vanes at points remote from the points of connection of the vanes with the shell; said tie element having yieldable connections with the vanes whereby circumferentail loads placed on a particular vane are allowed to be partially absorbed by the vane and partially transmitted to the tie ring and thence to the adjacent vane; certain of said vanes having recesses formed therein defining lips and opposed abutment surfaces; said tie element having portions thereof seated in the recesses beneath the lips; a locking element wedged between the tie element and each of said abutment surfaces to retain said tie element in position underneath the lips; and means anchoring the locking element on the tie element.

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CERTIFICATE OF CORRECTION

Patent No. 2,998,782 September 5, 1961

Thomas J. Ryan et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, lines 66 and 67, for "leading" read -- free --; column 5, line 4, for "vibration-dampenng" read -- vibration-dampening --; line 10, for "segmented" read -- segmental --; column 6, line 18, for "circumferentail" read -- circumferential --.

Signed and sealed this 13th day of February 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents