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PATENT SPECIFICATION

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(54) DRY FLUID DRIVE AND ROTOR THEREFOR

(71) We, RELIANCE ELECTRIC COMPANY, a corporation of the State of Delaware, United States of America, of 500 South Union Street, Mishawaka, Indiana 46544, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

For a number of years dry fluid drives have been used in industry to couple motors to the power input shafts of equipment, such as conveyors and machinery which place an initial heavy starting load on the motor or are subjected to a large magnitude in variation of heavy loads from time to time in the normal operation of the equipment. One type of dry fluid drive, or coupling or clutch, as it is sometimes referred to, is disclosed in U.S. Patent No. 2,813,606, for connecting two rotatable shafts in end to end relation. This prior drive consists of a casing mounted on and secured to one of the shafts for rotation therewith and having a rotor cavity therein, and a rotor disposed in the cavity and secured to a sleeve or bushing, which in turn is mounted on and secured to the other shaft for rotation therewith and for rotation relative to the casing. The cavity contains the dry fluid, normally consisting of small heat treated steel shot, which is thrown by centrifugal force transmitted from the drive shaft to the casing and, as the drive shaft and casing accelerate in rotation, the shot initially permits slippage or relative rotation between the casing and rotor, and as the rotation approaches full or normal operating speed, it forms virtually a solid mass packed between the internal walls of the casing and rotor and effectively locking these components together. The slippage which occurs during the initial stages of starting, produces a smooth acceleration without placing an abrupt load on the motor or equipment, and the formation of the solid mass as the casing approaches full acceleration, results in freedom of slippage, giving an operating efficiency in transmitting power from the drive shaft to the driven shaft approaching one hundred percent.

The dry fluid drive or coupling has many advantages over mechanical or other fluid couplings, in that relatively smaller motors can be used in all or most installations, maintenance on the motors and equipment is significantly reduced by the smooth starting performance, the initial rush of electrical current is reduced to minimum duration, approaching the requirements of no-load starting, and the shock or strain from overloading during normal operation on the motor and equipment is eliminated or minimized. However, the foregoing dry fluid drives have certain inherent disadvantages or problems under certain operation conditions, these including a tendency of the drives to over-heat if slippage occurs over an appreciable period of time during starting and acceleration or while the motor and equipment coupled by the drive are operated at frequent intervals or for an extended period of time in an overload condition. Other disadvantages include the necessity of relatively large drives for certain installations, and the inability of the shot to distribute itself uniformly efficiently and effectively during acceleration, causing vibration in the drives which may in some instances be transmitted to the motors and equipment. Attempts have been made in the past to obtain more torque with compact drive structures, one of these consisting in utilizing two rotors disposed in separate cavities in the housing, thus in effect forming a dual or multiple housing structure. In this type, the surface of the inner or intermediate walls may be of the same configuration as the surface of the two outer walls defining the cavities, or they may have a somewhat different configuration such as disclosed in U.S. Patent No. 2,901,074. While improved torque characteristics resulted, the unit is relatively inefficient when its increased size and weight over the conventional single cavity drive are taken into consideration.

According to the present invention there is provided a rotor assembly for a dry fluid drive including a radially extending portion and a laterally extending flange disposed near the periphery of said radially extending portion at substantially right angles thereto, circumferentially spaced projections on the periphery of said flange for engaging dry fluid, and spaced holes in said flange through which the dry fluid passes when the drive is in operation, for facilitating distribution of dry fluid.

According to a further aspect of the present invention there is provided a dry fluid drive including a rotor assembly as described above wherein a housing has a centre axis about which said housing rotates, said housing having two spaced side walls and an annular peripheral portion therebetween defining a cavity in said housing concentric therewith, dry fluid in said cavity, and the rotor assembly disposed in said cavity and having a hub in alignment with the centre axis of said housing and extending axially from the housing, said side walls, peripheral portion of said housing and said rotor flange forming a restricted region at the periphery of said rotor for containing a continuous mass of dry fluid when the drive is in operation, the holes permitting a distribution of the dry fluid to said restricted region.

The invention will now be described by way of example only with particular reference to the figures of the accompanying drawings, wherein:

Figure 1 is a perspective view of an equipment installation in which a dry fluid drive is shown mounted on the equipment and being driven by a motor through a plurality of V-belts;

Figure 2 is a side elevational view of the dry fluid drive shown in Figure 1;

Figure 3 is an axial cross sectional view of the drive shown in the preceding figures, the section being taken on section station 3—3 of Figure 2; and

Figure 4 is a transverse cross sectional view of the dry fluid drive shown in the preceding figures, the section being taken on section station 4—4 of Figure 3.

Referring to Figure 1 in particular, numeral 10 designates generally a dry fluid drive showing the drive mounted on a shaft 12 of a motor 14 for driving a machine or other equipment, such as a conveyor, blower drive, or tumbling drum. The drive of the present invention may be used in a number of different types of installations, including, for example, those having a sheave and belt or belts and those having two shafts in end-to-end relation, in which the present drive operates as a coupling, either alone or in conjunction with other types of couplings such as a flexible coupling to compensate for misalignment of the two shafts. In Figure 3 of the drawings, a sheave 16 for a V-belt 17 is mounted on and connected to drive 10 on a cylindrical projection 18 with key and key ways 20 and 22, respectively, being used as a means for securing the sheave 16 to the drive 10.

The drive 10 consists of a housing 30 having two sections 32 and 34 secured together to form a rigid unit by a plurality of bolts 36 extending through holes disposed around the peripheral margin of the two sections. The two sections have inwardly extending side walls, and section 34 has a laterally extending sleeve 38 joined integrally with its side wall at base portion 40 so that the housing 30 and sleeve 38 rotate together. Sleeve 38 has a bore 42 for receiving shaft 12, which is secured to the sleeve by a key 44 in key ways 46 and 48 in the shaft and sleeve, respectively. A collar 50, having one or more set screws 52 extending radially therein, is mounted on sleeve 38 and, when the drive 10 is mounted on shaft 12, the set screws 52 extend through the sleeve 38 and engage either the shaft 12 or key 44, thus assisting in securing the drive rigidly to the shaft 12. A rotor assembly, indicated generally by numeral 60, includes a rotor 62 constructed of two lateral sections 64 and 66 of identical construction, the two sections having disc shaped radially extending inner members 67 and 68 in face-to-face contact with one another. The two sections are secured to a hub 70 by a plurality of screws 72 extending through hub section 74 and spacer 76 into hub section 78, the screws 72 clamping the two hub sections together with members 67 and 68 disposed rigidly therebetween. The hub 70 is supported on a ball bearing 80 and needle bearing 82 for rotation relative to the housing 30, and the hub 70 includes cylindrical member 18 on which the sheave 16 is mounted.

One of the important features of the present invention is shown in the figures and consists in the construction and design of rotor 62. It is in two sections have laterally extending annular flanges 90 and 92 which form rim 88 and are preferably the same size and shape and, as shown in the drawings, are provided with a plurality of equally spaced holes 94 and spaced projections such as ribs 96 (Figure 4). The holes 94 assist in distributing the dry fluid in the periphery of the chamber and the ribs 96 increase the torque transmitted between the rotor 62 and housing 30, as will be more fully explained below. In the embodiment shown, members 67 and 68 form a radially extending center portion on which the two flanges are mounted. The flanges, which may be formed integrally with one another, are essentially a single axially extending flange and they may be formed integrally with a single radially extending inner member. The single or dual flange construction preferably extends laterally from the center portion at right angles thereto.

The rotor 62 is disposed in cavity 100 in housing section 32 which contains the dry fluid which may be heat treated steel shot, indicated generally by numeral 102 shown lodged in the periphery of the cavity around the peripheral flanges 90 and 92 of the rotor, the position assumed when the drive is in operation. Under inoperative conditions, the shot falls to the bottom of the cavity and remains there until the housing is rotated, at which time the centrifugal force causes the shot to distribute itself uniformly around the periphery of the cavity as shown in the drawings. Dry fluids other than steel shot may be used; however, the heat treated steel shot has been found satisfactory and will give optimum performance in the drive over extended periods of time. As explained hereinbefore, holes 94 through the peripheral flanges assist in distributing the shot as the rotor and rotor housing rotate relative to one another and permit the shot readily to migrate to a restricted peripheral region 104 (shown as an area in the section of Figure of the cavity, so that the said region or area will be filled. The shot also normally extends around the edges of the flange and on the inner side thereof. The ribs 96 assist in obtaining effective torque between the end of the housing 30 and the rotor 62 under all operating conditions of the drive 10.

The inwardly sloping side walls 110 and 112 on housing sections 32 and 34 form the sides of restricted area 104 and cause the dry fluid to migrate readily to the area where maximum resistance is created between the rotor 62 and housing 30. The two housing sections 32, 34, are clamped rigidly together by a plurality of bolts 36 extending through the peripheral flange of housing section 32 and being threaded into the peripheral flange of section 34. Openings 116 and 118 which are closed by plugs 120 and 122, respectively, provide access to the cavity for adding dry fluid to the cavity and removing it therefrom. The housing 30, rotates with shaft 12 and the rotor 62 and hub 70 rotate with sheave 16 on bearings 80 and 82, the cavity being sealed between the hub and housing by seals 124 and 126 so that the cavity is fully closed when the drive has been assembled and with the dry fluid in cavity 100.

The two sections of the rotor 62 are preferably constructed of steel sheet or plate material, heat treated or coated to provide a hard, long wearing surface unaffected appreciably by abrasive action resulting from frictional engagement with the steel shot. Since the housing rotates relative to the rotor assembly, the internal surface of the housing defining cavity 100 may also have a specific surface configuration such as ribs or grooves in the side walls 110 and 112 and end wall 130, which cooperate with the ribs 96 or other types of projections on peripheral flanges 90 and 92, to increase the torque output of the drive. However, slippage between the rotor and the housing is essential for proper operation of the drive, in that the slippage permits a soft start requiring less torque than at normal operating speed. As the rotation accelerates, there is a substantial reduction of slippage until a solid connection is obtained between the rotor sections and the housing when the shot is lodged in mass in restricted area 104 at the periphery of cavity 100.

The ball bearing 80 is held in position on sleeve 38 of the housing by annular shoulder 140 and a snap ring 142, and the rotor assembly is held from axial movement relative to the housing 30 by a snap ring 144 disposed in a groove in the outer face of bearing 80 and between the inner end of annular member 18 and retainer 146. In order to facilitate heat transfer from the rotor 62 to the housing 30 and thence to fins 148 on the surface of the housing 30, the spacing between the rotor and the housing is preferably rather small, normally with the lateral edges of peripheral flanges 90 and 92 being relatively close to the internal surface of housing sections 32 and 34 and the peripheral end surface 130.

The wedge shape cross sectional configuration of the cavity utilizes to the fullest advantage the mechanical wedging effect which results from lodging the shot between the housing and the rotor in the area around the peripheral flanges 90 and 92 and end wall 130 in restricted area 104. This gives a larger component of force than in the conventional design of drives of this type, permitting a smaller unit to be used for a given torque output. Further, the design permits the rotor to be effectively used either as the driving or the driven element without any substantial difference resulting in the torque transmitted between the driving and driven shafts or other elements, thus providing maximum versatility for the unit in various applications and installations.

In the operation of the dry fluid drive described herein, with the drive mounted on shaft 12 of motor 14 and drive belts connected to sheave 16, rotation of shaft 12 rotates housing 30. As the housing 30 accelerates in rotation the dry fluid 102 in cavity 100 which has settled to the bottom is propelled by centrifugal force into restricted area 104 at the periphery of the cavity between flanges 90 and 92 and peripheral end surface 130. The amount of dry fluid in the cavity normally is sufficient completely to surround flanges 90 and 92 and extend inwardly therefrom. The holes 94 in the peripheral flanges permit the dry fluid to pass through the flanges and distribute itself readily in area 104. In view of the restricted nature of the cavity resulting from the tapered side walls and the laterally extending flanges 90 and 92, the torque transmitted to the housing is efficiently transmitted to the rotor 62 and thence to hub 70 and to sheave 16. If there is any appreciable load on the equipment to be driven by the drive, substantial slippage may initially occur between the housing and rotor, and as the housing continues to rotate, the dry fluid is lodged firmly at the periphery of the cavity in area

104 and around flanges 90 and 92, thus effectively forming a solid connection between the housing and the rotor assembly so that the drive is substantially one hundred percent efficient in transmitting torque from shaft 12 to sheave 16. The heat generated during the starting operation and when the drive is under load, is readily transmitted from the rotor to the housing and dissipated through the external wall of the housing and the fins thereon. The present drive permits the use of a smaller, more compact unit to obtain the same torque for any given torque requirement, with a smooth start and without overheating while under heavy loads.

WHAT WE CLAIM IS:—

1. A rotor assembly for a dry fluid drive including a radially extending portion and a laterally extending flange disposed near the periphery of said radially extending portion at substantially right angles thereto, circumferentially spaced projections on the periphery of said flange for engaging dry fluid, and spaced holes in said flange through which the dry fluid passes when the drive is in operation, for facilitating distribution of dry fluid.

2. The rotor assembly for a dry fluid drive according to claim 1 in which said flange extends laterally in both directions from said centre portion at right angles thereto.

3. The rotor assembly for a dry fluid drive according to claim 1 in which said openings consist of holes spaced around said flange, and said projections on said flange consist of axially disposed ribs.

4. The rotor assembly for a dry fluid drive according to claim 2 in which said holes are spaced around said flange on both sides of said centre portion and said projections on said flange consist of spaced ribs.

5. A dry fluid drive including a rotor assembly according to any preceding claim wherein a housing has a centre axis about which said housing rotates, said housing having two spaced side walls and an annular peripheral portion therebetween defining a cavity in said housing concentric therewith, dry fluid in said cavity, and the rotor assembly disposed in said cavity and having a hub in alignment with the centre axis of said housing and extending axially from the housing, said side walls, peripheral portion of said housing and said rotor flange forming a restricted region at the periphery of said rotor for containing a continuous mass of dry fluid when the drive is in operation, the holes permitting a distribution of the dry fluid to said restricted region.

6. The dry fluid drive according to claim 5 in which the projections are a plurality of axially disposed ribs on the periphery of said flange.

7. The dry fluid drive according to claim 5 in which said flange extends in both lateral directions from said radially extending centre portion at right angles thereto.

8. A dry fluid drive as claimed in claim 6 in which said flange extends in both lateral directions from said radially extending centre portion and extends throughout the major portion of the width of said restricted region.

9. A dry fluid drive substantially as hereinbefore described and as shown in the figures of the accompanying drawings.

10. A rotor assembly substantially as hereinbefore described and as shown in the figures of the accompanying drawings.

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1592277 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

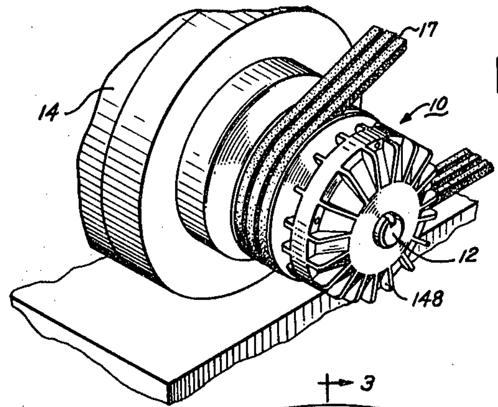

Fig. 1

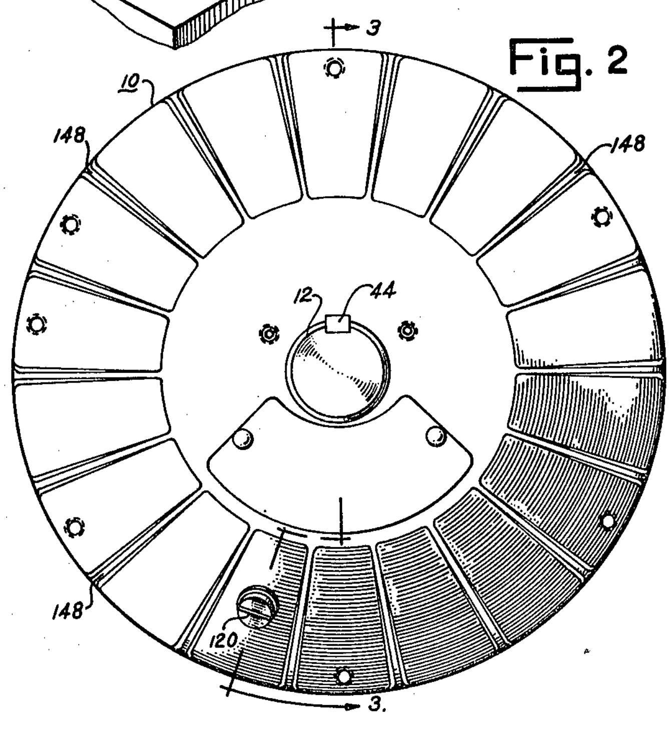

Fig. 2

1592277 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

Fig. 4

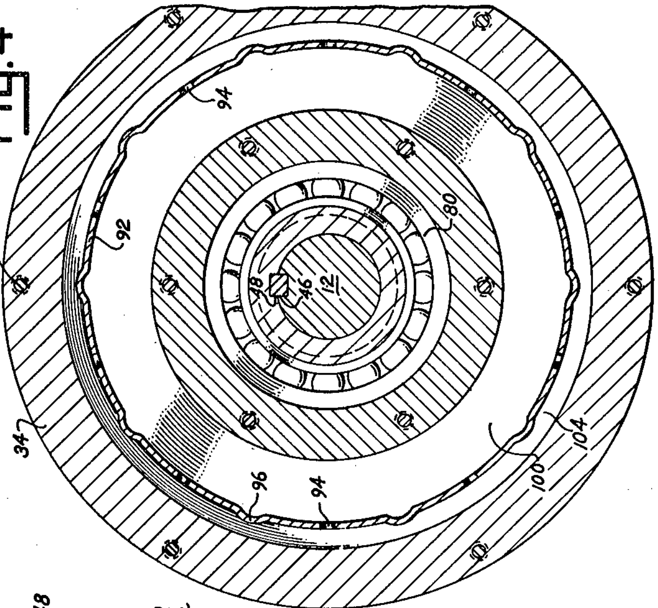

Fig. 3