

[54] ONE-WAY SELF-ALINING TORQUE UNIT

3,236,337 2/1966 Marland et al.....188/82.84

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[57] ABSTRACT

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[21] Appl. No.: 69,584

A one-way, self-aligning torque unit well suited for heavy duty on a vertical shaft subject to misalignment with respect to coaxing torque applying structure. The unit comprises a one-way torque coupling and an alinement coupling integrated together for mounting on a vertical shaft and providing for compensation for misalignment of the shaft with reference to coaxing structure which applies torque to the shaft in only one direction through the assembly. Working parts of the alinement coupling and underlying working parts of the torque coupling are continuously bathed in flowing lubricant that descends through a succession of comating working parts all to the end that the unit will operate reliably for many years in locations where access for service is impractical. A reversible cam ring in the unit permits adaption of the unit to transmit torque to the shaft in either direction without structural modification of components of the unit. Interfitting toothed rings accommodate misalignment of the shaft and minimize the overall length of the unit.

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 827,400, May 23, 1969, which is a continuation-in-part of Ser. No. 737,965, June 18, 1968, abandoned.

[52] U.S. Cl.....188/82.84, 192/45

[51] Int. Cl.....F16d 63/00

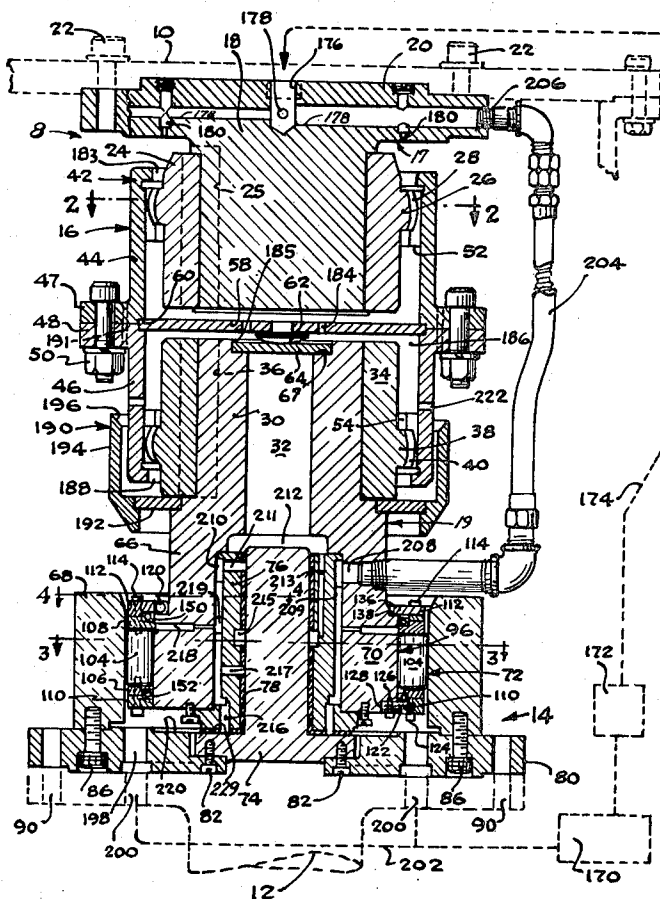
[58] Field of Search.....188/82.8, 82.84, 264 B; 192/45, 45.1

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12 Claims, 12 Drawing Figures



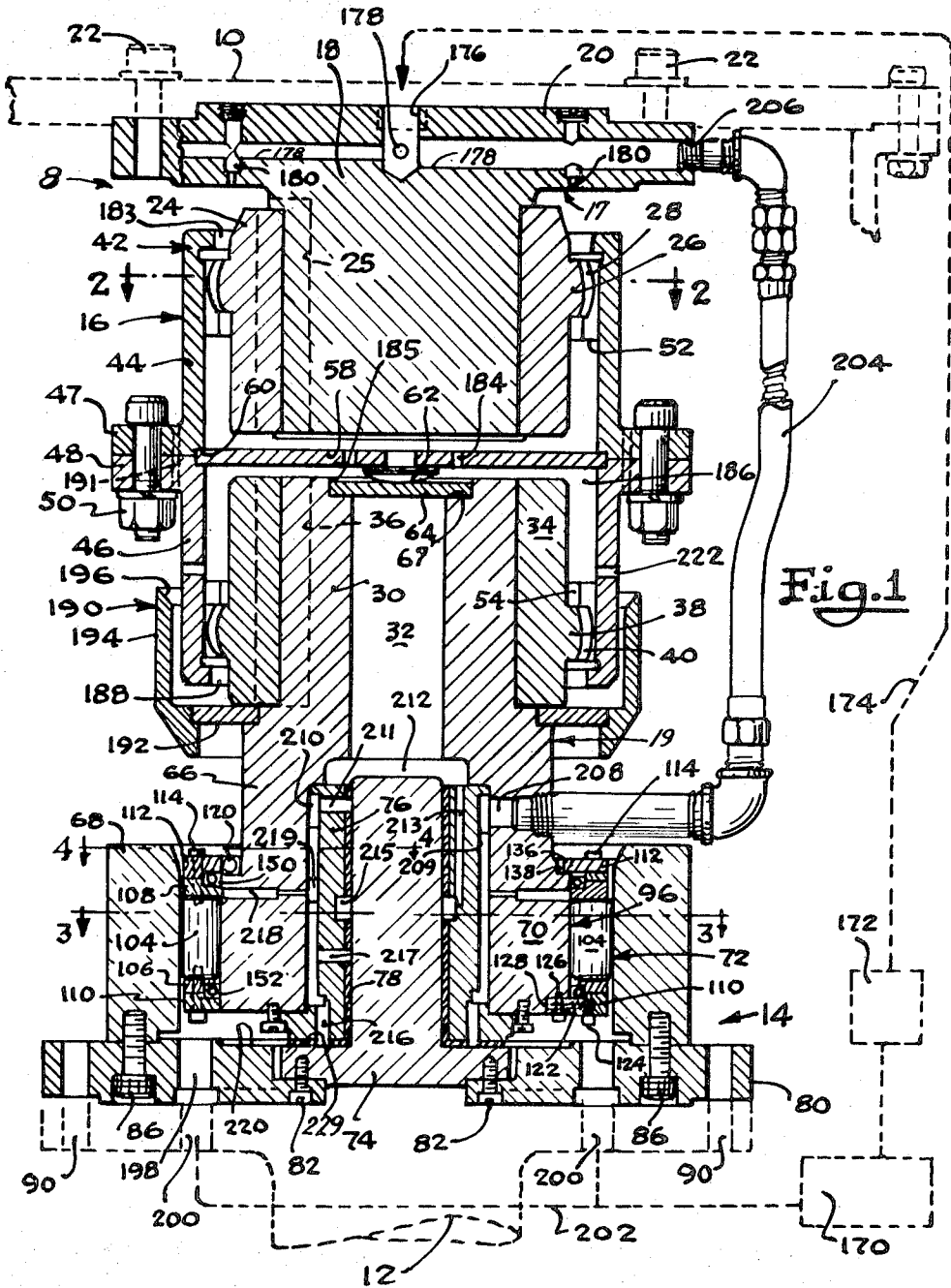
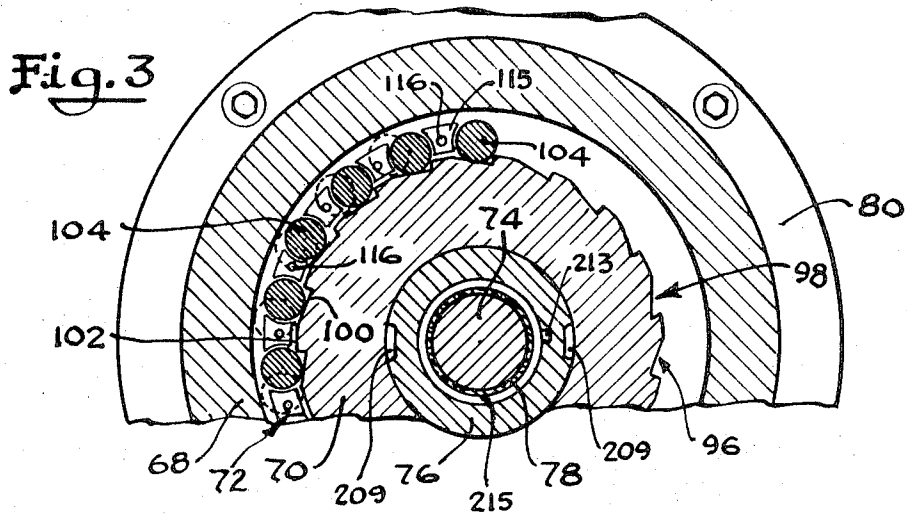
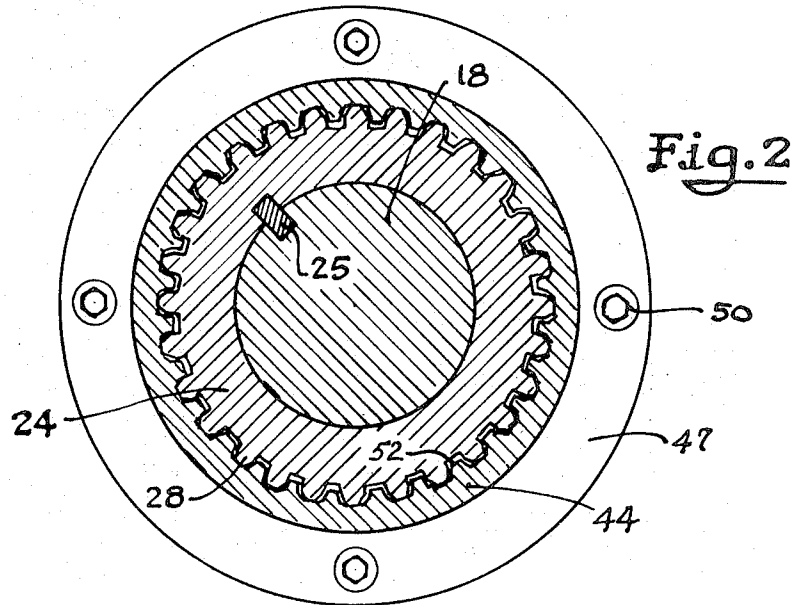


Fig. 1

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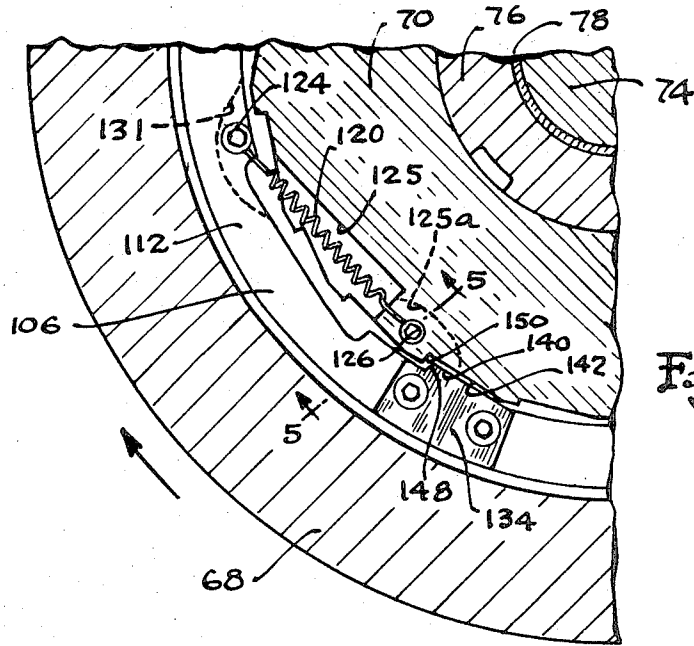


Fig. 4

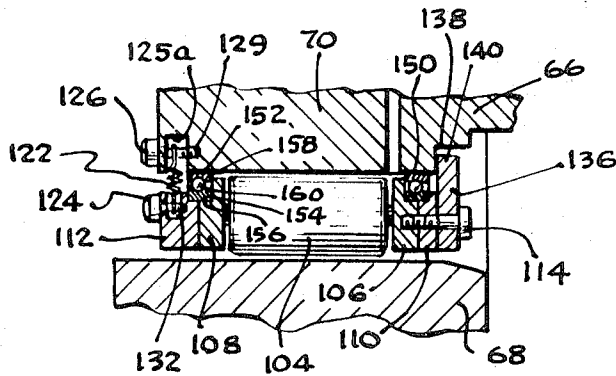
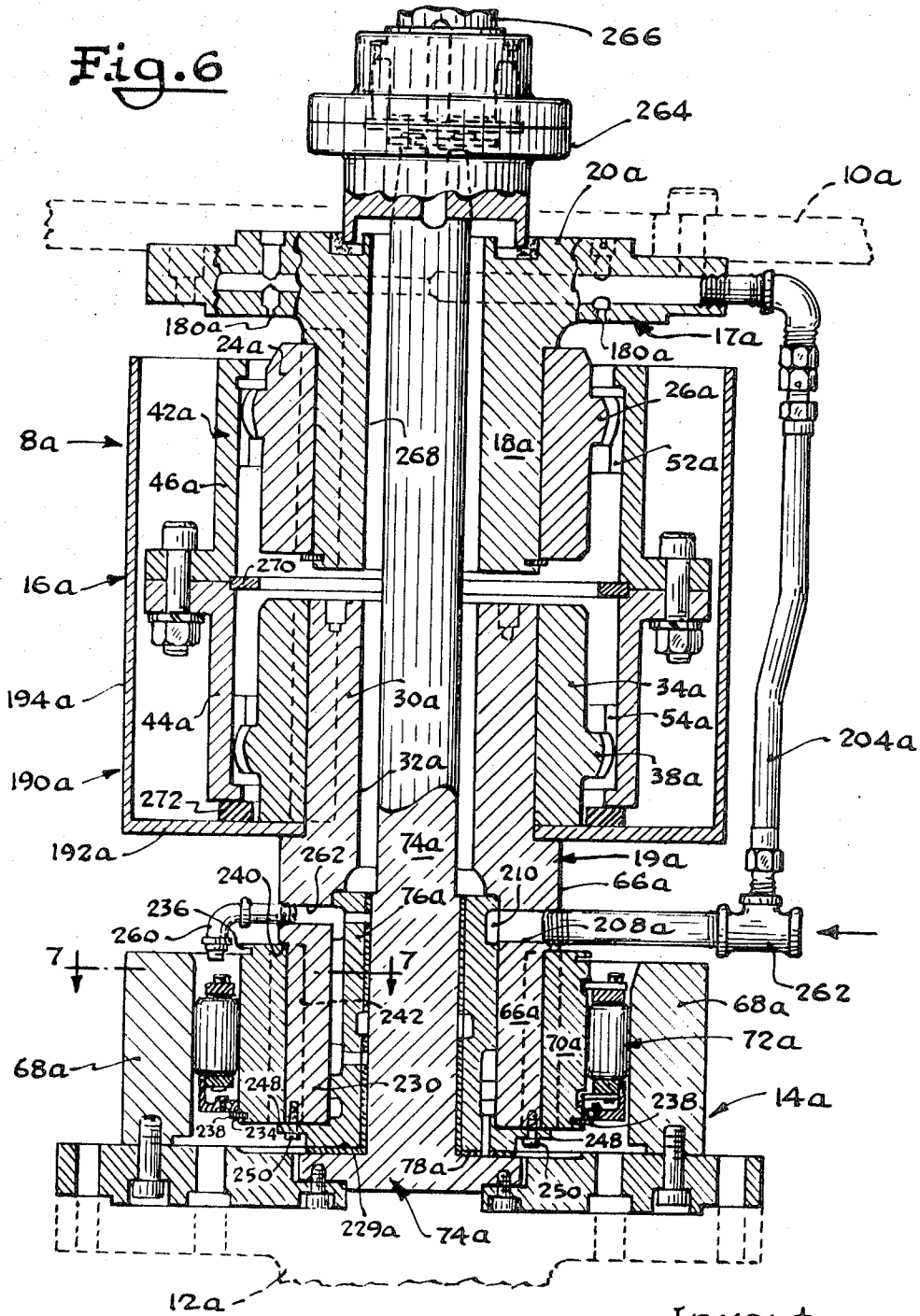


Fig. 5

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Fig. 6



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Fig. 7

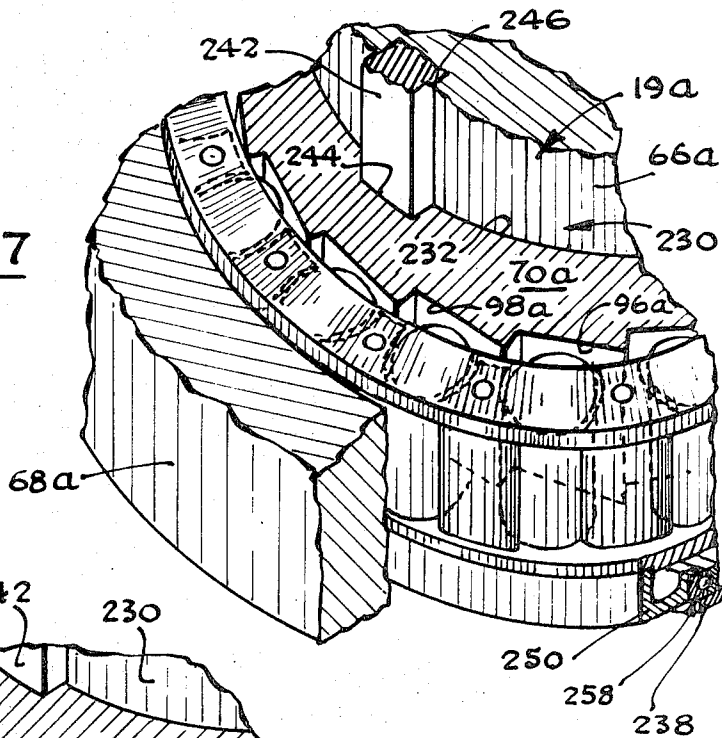


Fig. 8

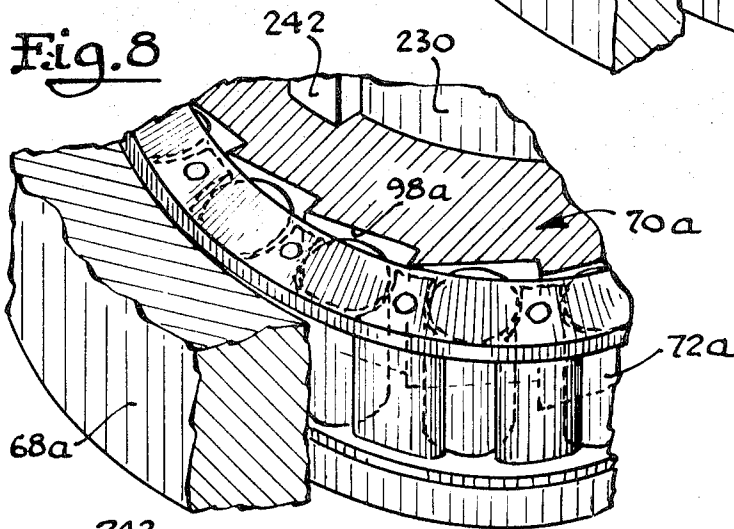
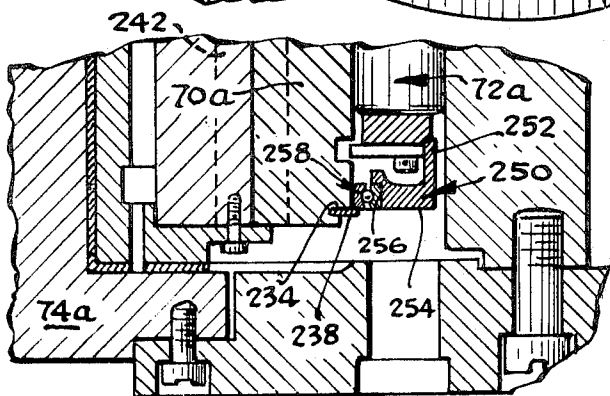
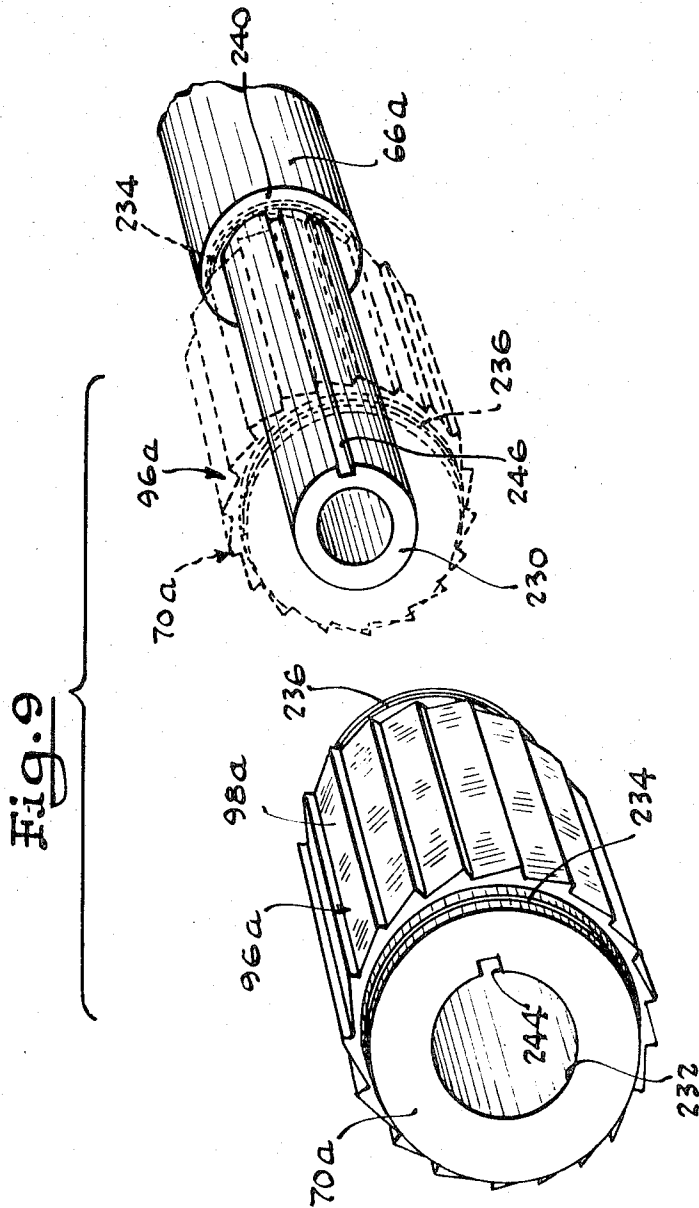


Fig. 8A



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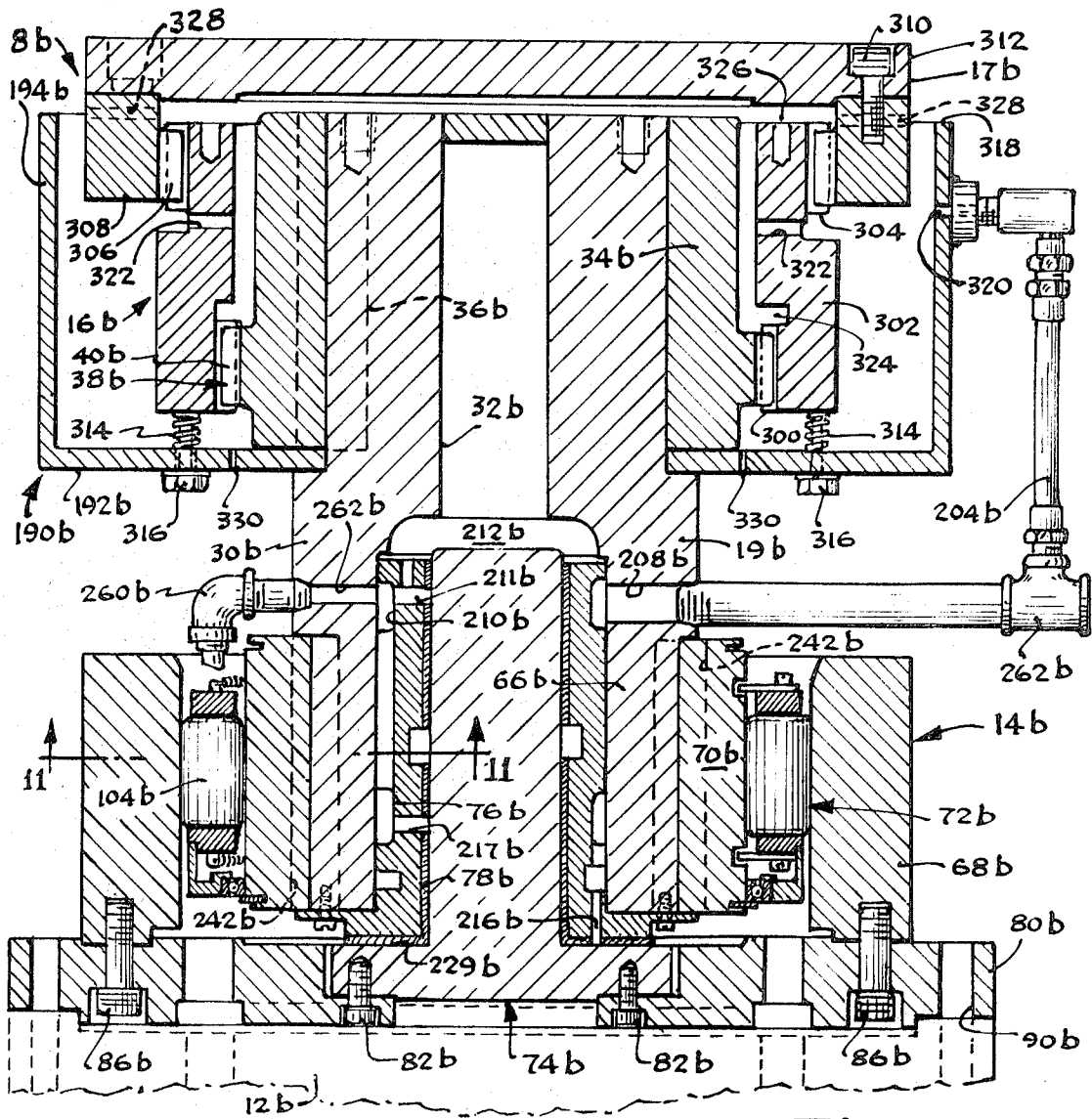


Fig. 10

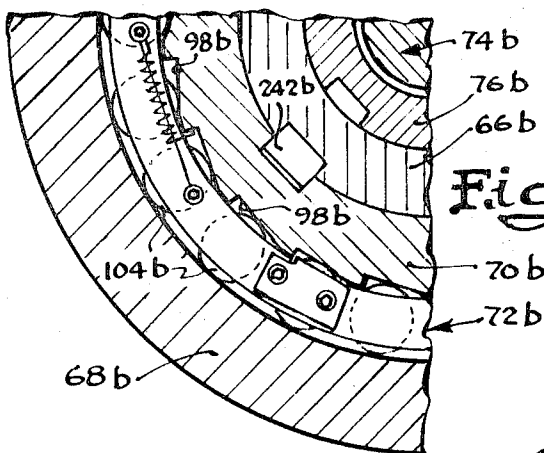


Fig. 11

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ONE-WAY SELF-ALINING TORQUE UNIT

This application is a continuation-in-part of copending application Ser. No. 827,400 filed May 23, 1969, which in turn is a continuation-in-part of application Ser. No. 737,965, filed June 18, 1968, and now abandoned.

DISCLOSURE

This invention relates to one-way torque couplings for rotatable shafts, and is concerned particularly with the control and operation by such couplings of vertical shafts subject to misalignment and located in environments where access for service is impractical.

One-way torque couplings are recognized mechanisms for limiting rotation of a rotatable shaft to one rotational direction, as clearly indicated by U.S. Pat. No. 2,865,474 of one of the present inventors, Mr. Joseph A. Marland, entitled "ONE-WAY AUTOMATIC BACKSTOPS," and by Mr. Marland's U.S. Pat. No. 3,247,935 entitled "ONE-WAY BRAKE ASSEMBLY AND SEAL MEANS THEREFOR." These patents disclose backstops in which a rotatable shaft is mechanically mounted on the inner race of a one-way coupling, the outer race of the one-way coupling being connected to a stationary structure by means of a beam extending normally from the axis of the shaft. The beam is affixed at one end to the structure and at the other end to the outer race of the coupling. The outwardly extending beam requires substantial lateral space.

One object of the invention is to provide, for applying torque to a shaft in one direction only, a one-way torque unit having a new and improved construction which minimizes the lateral size of the unit while at the same time providing an inherent capability for accommodating misalignment of the shaft in a manner which does not subject the unit to wear or strain with the consequence that an extremely long, trouble-free service life is obtained.

A further object is to provide a one-way torque unit of the character recited that is especially well adapted for use on a vertical shaft in such manner that the unit is supported largely on the vertical shaft with consequent determination of the axial positions of major components of the unit, the unit comprising a one-way coupling adapted for support on a shaft and integrated with an alignment coupling supported on the one-way coupling and functioning at once to sustain the torque reaction of the shaft on the one-way coupling and to accommodate misalignment of the shaft.

A further object is to provide a one-way, self-aligning torque unit, as recited, having an improved construction which enables the unit to operate dependably in continuous use over a very long service life that may extend literally for decades without repairs or service except for the supplying of lubricant which may be pumped into the unit.

A further object is to provide a one-way, self-aligning torque unit of the character recited having an improved and highly advantageous construction which facilitates support of the unit on a vertical shaft while at the same time utilizing a cascading flow of oil to a maximized advantage in assuring most advantageous lubrication of working parts coming on a plurality of levels in the unit.

Another object is to provide a one-way, self-aligning torque unit as recited in which concentricity of major components of a one-way torque applying mechanism in the unit is maintained in an advantageous manner.

Another object is to provide a one-way, self-aligning torque unit as recited in which alignment of an annular series of torque transmitting rollers with respect to inner and outer coacting races is maintained to advantage by a cage journaled on antifriction bearings.

Another object is to provide one-way, self-aligning torque unit as recited which can be adapted, through assembly, without structural modification of its component elements to transmit torque to a coacting shaft in either desired direction.

Another object is to provide a one-way, self-aligning torque unit as recited which can function positively to preclude reverse rotation of the shaft while at the same time providing for driving of the shaft through the unit in the normal direction of shaft rotation.

A further object is to provide a one-way, self-aligning torque unit having an improved construction which accomplishes the foregoing objects while at the same time minimizing the length of the unit without expanding significantly the transverse overall dimensions of the unit.

A further object is to provide an improved one-way, self-aligning torque unit according to the previous objects having an improved construction which materially shortens the unit while at the same time providing most effective lubrication for coacting working surfaces on component elements of the unit.

Other objects and advantages will appear from the following description of the exemplary embodiments of the invention illustrated in the drawings in which:

FIG. 1 is a vertical sectional view showing in solid lines a one-way torque unit constructed in accordance with the invention and illustrating in phantom lines a housing to which the unit is anchored and a vertical turbine shaft to which the unit is attached;

FIG. 2 is a transverse sectional view of the unit taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary transverse sectional view taken with reference to the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary sectional view on an enlarged scale taken along the line 4—4 of FIG. 1;

FIG. 5 is a fragmentary sectional view on an enlarged scale taken along the line 5—5 of FIG. 4;

FIG. 6 is a vertical sectional view similar to FIG. 1 but illustrating a modified embodiment of the invention;

FIG. 7 is a fragmentary perspective view on an enlarged scale taken with reference to the line 7—7 of FIG. 6;

FIG. 8 is a fragmentary sectional view similar to FIG. 7 but showing the inner race reassembled on its support in a reversed position to transmit torque to the shaft in the opposite direction;

FIG. 8A is a fragmentary sectional view on an enlarged scale corresponding to the lower right-hand portion of FIG. 6;

FIG. 9 is a perspective view showing in solid lines the inner race and its support in exploded relation to each other and illustrating in phantom lines the position of the race when reversed and assembled onto its support to adapt the unit to transmit torque in the opposite direction;

FIG. 10 is a vertical sectional view similar to FIG. 1 but showing another modified embodiment of the invention; and

FIG. 11 is a fragmentary transverse sectional view taken along the line 11—11 of FIG. 10.

Referring now to the drawings, the one-way, self-aligning torque unit 8 forming the first illustrated embodiment of the invention, FIGS. 1 to 5, functions as a backstop mechanism for preventing reverse rotation of a coacting shaft. The unit 8 is anchored to the cover plate 10 of a stationary housing and connected to the upper end of a vertically disposed shaft 12 of an installation, which is to be controlled by the backstop. The unit 8 comprises a shaft misalignment coupling 16 which couples a one-way torque coupling 14 of the unit to the housing cover plate 10. The shaft 12 may be of any vertical shaft, especially a relatively high speed shaft, mounted on any type of installation.

The one-way torque unit 8 serves as a particularly useful backstop mechanism to prevent reverse rotation of one of a plurality of centrifugal pumps utilized to deliver a liquid coolant, such as water, to cool a nuclear reactor. An efficient and reliable backstop mechanism is particularly required for such installations because in the event of motor shut down or failure of one of the pumps the hydraulic head of water from the other pumps would reverse the rotor of the failing or shut down pump and lead to runaway speeds which could result in centrifugal explosion of the motor or the pump rotor. Such a breakdown leads to hazards of possible radioactive con-

tamination from the nuclear reactor. A backstop mechanism of the type disclosed is rugged and reliable and may be left unattended for many years when used with such nuclear reactor.

The shaft misalignment coupling 16 allows the components of the one-way torque coupling 14 to adjust concentrically to a true geometric center of the vertical pump or motor shaft 12, and such adjustment is attained whether the shaft 12 is rotating or is static. The coupling 16 includes an upper or first coupler 17 secured to the cover plate 10, and comprising a centrally located stub shaft 18 having an upper flange 20 secured to the cover plate 10 by bolts 22. A geared hub 24 is keyed to the stub shaft 18 by a key 25 and has a radial gear 26 comprising an annular series of crowned male gear teeth 28, FIGS. 1 and 2.

A lower or second coupler 19 is positioned immediately below the first coupler 17, and this second coupler is carried by the one-way coupling 14. The second coupler 19 comprises a centrally located body shaft 30 having a centrally disposed passage 32 and forming an integral component of the one-way coupling 14 as will presently appear. A geared hub 34 is keyed to the shaft 30 by a key 36 and has a radial gear 38 having an annular series of crowned gear teeth 40.

A cylindrical coupler sleeve 42 spans and engages the upper and lower couplers 17, 19. The sleeve 42 has an upper wall part 44 and a lower wall part 46 which have respectively circular protruding flanges 47 and 48 that are joined by a plurality of bolt and nut assemblies 50. The upper and lower parts 44, 46 have respectively internal annular gears 52 and 54, each of which has straight cut gear teeth.

The common coupler sleeve 42 is supported on the one-way coupling 14 by thrust member or plate 58 which is secured to and seated in a continuous peripheral groove 60 in the inside wall of the common coupler sleeve 16 at the junction of the parts 44 and 46. The thrust plate 58 has a centrally located depending thrust button 62 which bears against a smaller thrust plate 64 mounted in an annular groove 67 on the upper end of the shaft 30. The weight of the coupler sleeve 42 is transferred by the button 62 to the thrust plate 64 and hence to the shaft 30.

The one-way coupling 14 is coupled to the lower coupler 19 of the alignment coupling 16 through a body portion 66 of the shaft 30 which extends from the lower coupler 19 to an inner race 70 of the one-way torque coupling 14. The torque coupling 14 has an outer race 68 which concentrically encircles the inner race 70 as shown. Disposed between the inner and outer races 70, 68 is a roller assembly 72.

It will be noted that in the construction described the upper and lower couplers 17, 19, the common sleeve 42, the shaft 30, and inner race 70 are all attached to the stationary cover plate 10 and are stationary. The outer race 68 and its related mechanism rotate with the shaft 12.

Precise alinement of the inner and outer races 70, 68 is assured by a centering spindle 74 mounted on the outer race 68 and journaled within the inner race 70. The centering spindle 74 is coaxially disposed relative to the inner and outer races 70, 68 and to the shaft 12. The inner race 70 is mounted on a coaxial bearing 76 which has a layer of bearing material 78 that journals the spindle 74. A drive plate 80 is secured to the centering spindle 74 by screws 82 and is secured to the outer race 68 by screws 86. The rotatable shaft 12 is secured to the drive plate 80 by bolts (not shown) which extend through aligned bores 90 in the shaft 12 and drive plate, FIG. 1.

When the one-way torque coupling 14 is in free wheeling operation, the shaft 12, drive plate 80, centering spindle 74, and outer race 68 rotate as a unit. The inner race 70 does not rotate. Movement of the alignment coupling 16 in the installation described is limited to working of the parts to accommodate misalignment of the shaft 12.

The inner race 70 has a cammed peripheral surface 96, FIGS. 1 and 3. This peripheral surface of the inner race has a plurality of spaced indentations 98 each of which has a low surface or edge 100 and a high surface or edge 102.

The roller assembly 72 is mounted on the inner race 70 and includes a plurality of rollers 104 which are movable between the low and high surfaces 100, 102, the rollers 104 moving toward the low surfaces or edges 100 during free wheeling operation. The rollers 104 move toward the high surfaces or edges 102 as an incident to incipient reverse rotation of the shaft 12 to become wedged between the inner race 70 and outer race 68 to lock the shaft against reverse rotation.

The rollers 104 of the roller assembly 72 are caged between two rings 106 and 108 having respectively adjoining support rings 110, 112 secured to the sides thereof away from the rollers. The rings 106 and 110 are fastened together by screws 114, FIG. 5, to form a first ring member and the rings 108 and 112 are secured together to form a second ring member of the cage. Adjacent rollers 104 are spaced apart by a spacer member 115 disposed between each pair of adjacent rollers, each spacer member 115 having conforming concave sides confronting the adjacent rollers and being secured on the ring members by pins 116 which extend through the spacer members 115.

The roller assembly 72 is spring biased by a pair of springs 120 and 122 on opposite sides of the radial axis of the inner race and extend between the rings 110 and 112 and the inner race 70, respectively. The spring 120 is anchored at one end to ring 110 and at the other end to the inner race 70. In like manner, FIGS. 4 and 5, the other spring 122 extends through an elongated slot 125 in the cammed surface 96 in the inner race 70. The slot 125 communicates with a slotted pocket 125a of smaller width in the inner race 70 and one end of the spring 122 is secured to the inner race 70 by a screw 126 which passes through the pocket 125a and engages a tapped bore 129 in the body of the inner race 70. The other end of the spring 122 is secured in an arcuate slot 131 extending into the ring 112. This end of the spring 122 is secured to the cage ring 112 by a screw 124 which passes through slot 131 into a tapped bore 132 in the ring 112. The springs 120, 122 urge the cage in the direction to move the rollers 104 towards the raised edges 102 of the cams and insure early and concurrent engagement of the rollers 104 between the inner race 70 and the outer race 68 in response to incipient reverse rotation of the shaft 12.

The roller assembly 72 also includes at least one stop lug 134 disposed in each of the rings 106 and 108, FIG. 4. The stop lug 134 has an inwardly extending portion 140 which extends into slot 142 in the inner race 70. Each lug has a tooth portion 148 adapted to abut an adjacent ledge 150 on the inner race 70 intervening between the inner and outer edges 100, 102 of two adjacent indentations 98 in the inner race. The stop lugs 134 are a part of the rings 106 and 108 and limit the distance which the rollers 104 can move toward the inner edges 100 of the indentations 98 to keep the rollers from abutting the inner race 70 at the raised edges 102 of the adjacent indentations 98 thereby eliminating friction.

The cage is also provided with a support ring 136 on the side of the plate 110 away from the rollers 104. The support ring 136 rests on an arcuate shoulder 138 to support the weight of the roller assembly and prevent axial movement.

In addition to the bearing surface formed by the support ring 136 and shoulder 138, the roller cage is supported by an upper ball bearing assembly 150 and a lower ball bearing assembly 152. As best illustrated in FIG. 5, each ball bearing assembly has an outer raceway 154 which is secured to and seated in a groove 156 formed in one of the end members of the cage. In particular, the outer raceway 154 of ball bearing assembly 152 is seated in adjoining portions of end ring 108 and plate 112. Each of the ball bearing assemblies 150, 152 has an inner raceway 158 abutting a cylindrical surface of the inner race 70. A plurality of ball bearings 160 are conventionally caged between the raceways 154 and 158 of each bearing assembly. As illustrated, the ball bearing assembly 150 is similarly secured between end ring 106, plate 110 and inner race 70.

The ball bearing assemblies 150 and 152 maintain the roller cage in radial alignment with the inner race 70. Thus, the ball bearing assemblies 150 and 152 prevent radial misalignment from causing a portion of the rollers 104 to abut the relatively high-speed metallic surface of the rotating outer race 68 in free wheeling, which would cause wobbling. This construction thus leads to prolonged life of the clutch elements in that physical contact is markedly reduced, during free wheeling operation, between the relative stationary elongated rollers 104 and the inner surface of the outer race 68.

An important feature of the one-way torque unit 8 described is the lubrication system which delivers lubricant to the bearing surfaces of the alignment coupling 16 and the underlying one-way torque coupling 14. The lubrication system has a source tank or reservoir 170, FIG. 1, from which liquid lubricant is delivered under pressure by a pump 172 into a line 174 and then to a lubricant entry or port 176 in the stub shaft 18 of the uppermost coupler 17. Entry 176 communicates with a plurality of transverse lubricant passageways 178, and a plurality of downwardly extending outlet ports 180 allow such drops of lubricant to fall onto the meshing gears 26 and 38 of the alignment coupling 16. The drops of liquid lubricant fall between the geared hub 24 and the upper part 44 on the common coupler sleeve 42.

The thrust member plate 58 receives excess lubricant from the relatively stationary gears 26 and 38 which floods the entire region between the upper wall part 44 and the geared hub 24, and overflows the upper end or lip 183 of the wall part 44. A small aperture 184 in the thrust plate 58 allows a few drops of the lubricant to fall on the thrust plate 64. The plate 64 is provided with a protruding ring 185 which retains a pool of lubricant about the thrust button 62. The lubricant overflowing the ring 185 flows into the space 186 between the hub gear 34 and the lower part 46 of the common coupler sleeve 42. The aperture 184 is sufficiently small in its cross-sectional area so that a sufficient body of lubricant is allowed to pool and flood the meshing gears of the upper coupler.

The lubricant moves through space 186 through opening 188 at the bottom of the common coupler sleeve 42 and then pools in a cup-shaped member or oil collector 190. The oil collector 190 receives lubricant overflowing the lip 183 of the coupler sleeve 42 from the space between the top coupler hub 24 and the upper common coupler part 44 and flowing through channels 191 formed in the flanges 47 and 48 in parallel relation to the axis of the coupler sleeve 42. The collector 190 has a bottom wall 192, which is normal to the axis of the spindle 30, and a continuous cylindrical side wall 194 coaxial with the spindle 30 and provided with an inwardly tapering lower end. The lubricant floods the cup-shaped oil collector 190 and overflows the top edge 196, whereupon it flows down the wall 194 and drips on the roller assembly 72.

Thereafter the lubricant flows through the roller assembly 72 by gravity, lubricating it and the surfaces of the inner race 70 and outer race 68, before draining from the outlets 198 and 200 in the drive plate 80 and shaft 12, respectively. Such drained lubricant is returned to the reservoir 170 as indicated by dotted line 202, FIG. 1, but it is to be understood that an open container below the outlets 200, not shown, must be utilized to collect the liquid lubricant since the shaft 12 is rotating at high speed.

The foregoing lubrication system adequately and efficiently lubricates the bearing surfaces in the alignment coupling 16, but a further lubrication system is provided for delivering lubricant to the one-way torque coupling 14 and to the bearing surface of the spindle 74 to assure adequate and efficient lubrication thereof.

A conduit, such system flexible metal conduit 204, is connected at one end, through coupler means, to outlet 206 of one of the transverse passageways 178. The other end of the conduit 204 is connected, through other coupler means, to an inlet 208 disposed in the body member 66. The inlet 208 communicates with a circular cavity 210 defined by the body member 66 and the confronting surface of the bearing

member 76. The circular cavity 210 communicates with a plurality of depending passageways 209 in the body member, and also communicates with a plurality of upper transverse bearing passageways 211.

Lubricant flowing from the passageways 211 lubricates the surface between the spindle 74 and the layer of bearing material 78. A vertical passageway 213 communicates with a central circular cavity 215 which extends through the layer 78 of bearing material and into the body 66, and the passageway 213 communicates with a cavity 212 on the top side of the spindle 74. The cavity 212 and passage 32 fill with oil due to the oil pressure between the spindle 74 and the layer 78 of bearing material, thus applying pressure against the upper surface of the spindle 74 and assuring a thick oil film between the bearing surfaces, the spindle 74 and the layer 78. A plurality of lower transverse passageways 217 extend between the vertical passageways 209 and the spindle 74 to convey lubricant from the vertical passageways 209 and the spindle 74 to convey lubricant from the vertical passageways 209 to the rotating bearing surface of centering spindle 74. Passageways 209 also communicate with inset vertical passageways 216 to allow lubricant to contact the horizontal surface 229 of the centering spindle 74, which surface must be adequately lubricated since it supports the weight of the inner race 70, roller assembly 72, and lower coupler assembly 19. The vertical passageways 209 also communicate with lateral passageways 218 which extend to the upper end of the roller cage to convey lubricant to the roller assembly 72. Lubricant flows downward over the roller assembly 72 and collects in a circular recess 220 disposed about the spindle 74, which also receives lubricant from the bearing surfaces between the spindle 74 and layer 78 of bearing material thereby maintaining a pool of lubricant for the horizontal bearing surfaces between these elements. The excess lubricant flows out of drain outlets 200.

It is to be noted that a plurality of vent apertures 222 are disposed in the lower wall member 46 of the alignment coupling 16. These vent apertures are to prevent a static air pressure from developing within the lower sleeve member 46 which would prevent flooding of the gears 38 and 40 with lubricant.

With reference to the modified embodiment of the invention illustrated in FIGS. 6 through 9, component elements which are counterparts of the unit 8 described are identified with the same reference numbers with the addition of the suffix *a*.

The integrated one-way torque unit 8*a* forming the modified embodiment of the invention referred to is so constructed that it can be readily adapted through selective assembly of its components, without structural modification of its parts, to transmit torque to the coaxing vertical shaft 12*a* in either direction that is preselected.

In the construction of the unit 8*a*, the inner race 70*a* of the one-way torque coupling 14*a* is fabricated as an independent annular part, as shown in FIGS. 6 through 9, separate from the coupler 19*a* that is a common integral component of both the one-way torque coupling 14*a* and the alignment coupling 16*a*.

The outer periphery of the separately formed inner race 70*a*, which has a generally cylindrical annular shape over all, is fashioned, between its opposite ends, to define a cammed peripheral surface 96*a* shaped similarly to the cammed peripheral surface 96 on the inner race 70 of the previously described unit 8.

The lower end of the bottom portion 66*a* of the common coupler element 19*a* is externally shaped to define a cylindrical race support 230 dimensioned to fit into a cylindrical axial bore 232 defined within the separately formed race 70*a*.

At its opposite ends, FIGS. 1 and 9, the separately formed race 70*a* is shaped outwardly of the cammed peripheral surface 96 to define two narrow grooves 234, 236 opening outwardly to receive selectively a retaining ring 238 for supporting the roller assembly 72*a*, as will be presently described.

The annular race 70*a* is designed to be turned end for end and fitted onto the cylindrical support 230 on the coupler part

66a so that either end of the race 70a abuts against an annular shoulder 240 formed on the coupler part 66a at the alignment coupling end of the cylindrical support element 230.

The race 70a is precluded from turning on its cylindrical support 230 by one or more axial keys 242 fitted into aligned keyways 244, 246 formed in the inner periphery of the race 70a and the outer periphery of the cylindrical support 230 as illustrated in FIGS. 7 and 9. The upper end of the assembled race 70a is held in engagement with the annular abutment 240 on the coupler part 66a by a radial annular extension 248 on the lower end of the sleeve bearing 76a that fits within the lower portion of the part 66a and journals the spindle 74a. The sleeve bearing 76a is moved into place in the lower end of the part 66a and secured in place by small screws 250 which extend through the marginal edge of the radial annular extension 248 on the sleeve bearing and are threaded axially into the lower end of the cylindrical support part 230 for the inner race 70a as shown in FIG. 6. The annular bearing extension 248 is sufficiently large in diameter to radially overlap the lower end of the race 70a and hold the race and its driving key or keys 242 against axial dislodgement from their normal positions.

It may be noted here that the radial annular extension 248 on the sleeve bearing 76a is covered on its lower side with the layer of bearing material 78a and rests slidably on the generally flat annular bearing face 229a on the spindle 74 to support the common coupler 19a in the manner described previously in relation to the torque unit 8.

It will be noted with reference to FIGS. 7, 8 and 9 that the sloping roller support surfaces of the indentations 98a forming the cammed periphery 96a all have a common circumferential orientation in that such surfaces slope outward in the same circular direction as will be evident from the previous description of the unit 8. Moreover, it will be appreciated that the direction of orientation of the slope of the roller support surfaces of the indentations 98a determines the direction in which the unit will transmit torque to the coacting shaft 12a and conversely the rotary direction in which the unit will sustain, through the integrated couplings 14a and 16a, a torque reaction from the shaft 12a.

In the unit 8a, provision is made by means of the construction described for adapting the unit to transmit torque to the shaft 12 in either direction, which can be predetermined as desired by selective orientation of the race 70a as it is assembled onto its generally cylindrical support 230. By turning the race 70a end for end between a first position illustrated in solid lines in FIG. 9 and a second position illustrated in phantom in FIG. 9 and assembling the race in either one position or the other, the roller engaging surfaces of the indentations 98 may have either the orientation illustrated in FIG. 7 or the orientation illustrated in FIG. 8 with the consequence that the shaft 12a can be allowed to rotate freely in the particular direction desired and the unit 8a will function accordingly to sustain a torque reaction of the shaft 12a on the unit in the corresponding reverse direction.

As illustrated best in FIG. 8a, the cage assembly 72a is supported by a ring 250 having a vertical leg 252 directly supporting the cage assembly 72a and joining at its lower edge a thicker leg 254 extending radially inward into overlapping relation to the outer race 256 of a ball bearing 258 that is supported by the previously mentioned retaining ring 238 releasably fitted into the lower ring support groove 234.

In the event the inner race 70a is assembled in its inverted position to provide for free rotation of the shaft 12a in the opposite direction, the cage assembly 72a is supported in the same manner, the support ring 238 being lodged in this instance in the ring groove 236, FIG. 6, in the opposite end of the race 70a.

Continuous and adequate lubrication of the cage assembly 72a and coacting working surfaces on the outer race 68a and inner race 70a is assured for either of the two preselected assembly positions of the inner race 70a by means of one or more continuously fed lubricant discharging fountains 260 positioned as illustrated in FIG. 6 to pour lubricant through

the annular space between the upper ends of the inner and outer races 70a, 68a onto the cage assembly 72a.

The fountain 260 is supported in a radial lubricant supply bore 262 extending radially through the annular wall of the common coupler part 66a into the annular chamber 210a that is continuously supplied with incoming lubricant through the bore 208a connected with a lubricant supply fitting 262 which also supplies lubricant to the supply line 204a.

The torque unit 8a not only functions to preclude reverse rotation of the shaft 12a in either direction as preselected by the orientation of the inner race 70a within the unit, but also provides for power driving of the shaft 12a through the unit 8a as this may be desirable. The transmission of torque through the unit 8a either to drive the shaft 12a or to effect driving by the shaft of structure located at the opposite end of the unit is provided by extending the spindle 74a upwardly through the center of the unit to connect, as shown in FIG. 6, with a drive coupling 264 that connects as illustrated with an auxiliary drive shaft 266.

The spindle 74, elongated to extend upwardly through the unit 8a as described, passes through the central passage 32a in the common coupler 19a, which is enlarged to provide clearance around the spindle 74a, and continues upwardly through an axial passage 268 formed centrally within the upper coupler 17a, the end of the spindle 74 connecting with the drive coupling 264 above the coupler 17a as shown.

Clearance between the upper coupler 17a and the lower coupler 19a for accommodation of the extended spindle 74a is provided by assembling between the upper and lower components 44a, 46a of the upper coupling sleeve 42a an annular ring 270 widely spaced radially from the spindle 74a.

In the unit 8a, the upper coupling sleeve 42a is supported on the oil collector 190a by means of a resilient ring 272 positioned between the lower edge of the sleeve 42a and the bottom wall 192a of the oil collector. In this instance, the oil collector bottom wall 192a is enlarged radially somewhat beyond the sleeve 42a and the cylindrical side wall 194a of the collector is extended upwardly substantially to a flush relation to the upper end of the sleeve 42a with the consequence that lubricant cascading downwardly from the supply ports 180a enters the space between the sleeve 42a and the working parts of the upper coupling 16a which operate in a continuously refreshed lubricant bath maintained around the working parts of the upper coupling 16a by virtue of the capability of the upwardly extended oil collector 190a to contain oil up to the upper level of the working parts in the upper coupling.

The torque unit 8b illustrated in FIGS. 10 and 11 constitutes another modified embodiment of the invention in which component elements which are counterparts of corresponding components of the torque units previously described are denoted with the same reference numbers but with the usage of the suffix b.

Structural features incorporated into the torque unit 8b materially reduce the overall axial length of the unit while at the same time preserving the strength, durability and longevity of the working components. Thus, the shaft misalignment coupling 16b is compressed in its axial extent so that it is substantially accommodated within the axial length of the hub 34b which supports the gear 38b integral with the hub 34b. The hub 34b has a rather substantial length along the supporting shaft 30b thus providing a steady and most secure support to the gear hub 34 by the shaft 30b while at the same time facilitating fixing of the gear hub 34b against rotation relative to the shaft 30b by means of a long key 36b, which makes for economical manufacture and assembly of the shaft 30b and gear hub 34b in the construction of the lower coupler 19b.

The external, torque transmitting teeth 40b on the gear hub 34b mesh with an annular series of internal, torque transmitting teeth 300 formed within one end of a hollow and generally cylindrical connecting coupler or sleeve 302. The connecting coupler or sleeve 302 extends upwardly from its geared lower end which meshes with the lower external teeth 40b to an upper end of the coupler sleeve 302 that defines an

annular series of external, torque transmitting teeth 304. The overall radial thickness of the connecting coupler sleeve 302, including the lower internal teeth 300 and upper external teeth 304, is minimized and the torsional strength of the coupler sleeve is maximized by shaping this sleeve as shown so that the internal diameter of the sleeve including that of the lower teeth 300 is generally constant throughout the length of the sleeve and the external diameter of the sleeve 302 including the external teeth 304 is generally constant throughout the length of the sleeve.

The upper annular series of teeth 304 on the connecting coupler 302 mesh with an annular series of internal, torque transmitting teeth 306 on a stationary ring 308 fixed by screws 310 to an overlying mounting plate 312 adapted to be anchored to stationary support structure, such for example as the cover plate 10 illustrated in FIG. 1 and forming the upper coupler 17b.

The connecting coupler sleeve 302 is floatingly supported on an annular series of helical compression springs 314 underlying the lower end of the sleeve 302 as shown in FIG. 1 and held in place by the upper ends of a corresponding annular series of screws 316 threaded through the flat horizontal bottom wall or floor 192b of the annular oil collector cup 190b, the bottom wall 192b providing support to the lower ends of the springs 314 as shown.

The cylindrical side wall 194b of the oil collector cup 190b extends upwardly in encircling relation to the intermeshing elements of the misalignment coupling 16b to an upper edge 318, FIG. 10, disposed slightly above the upper extremities of the intermeshing gear teeth 304, 306 into substantially flush relation to the upper ends of the generally conterminous shaft 30b and inner gear hub 34b.

A jet of lubricating oil is continuously introduced into the oil cup 190b through an oil inlet orifice 320 formed in the side wall 194b of the cup 190b slightly below the stationary gear ring 308 and fed with oil under pressure through the oil supply conduit 204b leading from the oil inlet fixture 262b. Circulation of oil within the collector cup 190b around working elements of the misalignment coupling 16b is aided by provision of a plurality of circumferentially spaced oil circulation bores 322 formed in the coupling sleeve 302 below the upper gear teeth 304 as shown in FIG. 1. Oil can flow through the bores or ports 322 into the annular space 324 intervening between the coupling sleeve 302 and the upwardly extending gear hub 34b. The space 324 communicates at its lower end with the meshing lower gear teeth 40b and 300 and communicates at its upper end with the head space 326 intervening between the upper end of the sleeve 302 and the mounting place 312. Any excess oil entering the head space 326 can escape outwardly through a plurality of radial ports 328 formed in the upper gear ring 308 above the gear teeth 306.

A plurality of small drainage openings 330 formed in the bottom 192b of the oil collector cup 190b provide for an outflow of oil from the bottom of the collector cup 190b at a sufficient rate to scavenge sediment from the bottom of the collector cup so that the working parts of the coupling 16b remain clean. Excess oil entering the collector cup through the orifice 320 circulates around the working parts of the coupling 16b to overflow the upper edge 318 of the collector cup.

Other components of the unit 8b are constructed and operate in the same manner as counterpart elements of the unit 8a previously described.

The invention is claimed as follows:

1. A one-way backstop for engaging a rotatable shaft to limit the shaft to rotation in one direction comprising, in combination, a stationary housing, a first coupler having a first member mounted on the housing and a second member pivotally mounted on the first member, said first member comprising a first cylindrical hub secured to the stationary housing and protruding therefrom, said first hub having a radial gear disposed thereabout, a second coupler having two pivotally connected members, the second member of the first coupler being one of the members of the second coupler, the

other member of said second coupler having a second cylindrical hub spaced from the first coupler and having a central axis generally parallel and approximately aligned with the central axis of said first hub, said central axes of the first and second hubs being disposed generally vertical, said second hub having a radial gear disposed thereabout, said second member of the first coupler being a hollow cylindrical sleeve disposed about and adjoining said first and second hubs, said sleeve having spaced interior radial gears meshed with the gears of said first and second hubs, a one-way torque coupling having a first race and a second race, said first race being coaxially disposed about the second race, said torque coupling having a plurality of drive elements disposed between said races, the drive elements transmitting torque from the first race to the second race for rotational moments between the races in one direction of relative rotation of the races, said drive elements permitting the first and second races to rotate freely with respect to each other in the other direction of relative rotation of the races, one of said races being secured to the other member of the second coupler, the other race of the one-way torque coupling being adapted to be rigidly coupled to the shaft to be limited to rotation in one direction, a cup-shaped lubricant collector secured to said second hub below the gear engagement of said second hub with said sleeve, said collector having a continuous cylindrical side wall coaxial with the axis of the second hub and having a horizontal upper edge disposed above the gear of the second hub, and means for maintaining the collector substantially full of liquid lubricant, thereby maintaining the gear of the second hub in a pool of lubricant.

2. A one-way backstop for engaging a rotatable shaft to limit the shaft to rotation in one direction comprising the combination of claim 1 wherein the first hub is provided with a transverse lubricant passageway above the gear of said first hub, said first hub defines a lubricant entry communicating with said transverse lubricant passageway, a source of liquid lubricant connected to said lubricant entry in said first hub, and an outlet port in said transverse passageway, said outlet port being positioned above and confronting the gear of said first hub and the upper gear of the sleeve so that lubricant falls from said port on the meshed gears of the first hub and sleeve.

3. A one-way backstop for engaging a rotatable shaft to limit the shaft to rotation in one direction comprising the combination of claim 1 wherein the sleeve is provided with a flat generally horizontal plate extending within the inner wall thereof between the gears thereof, said plate carrying a protruding part-spherical button disposed on the lower side thereof and concentric with the central axis of the first hub, said button resting on a generally horizontal surface on the second hub, and said horizontal plate having an aperture confronting said horizontal surface on the second hub so that lubricant from the gears of the first hub collecting on the generally horizontal plate flows through the aperture thereof to flood the flat surface on the second hub and lubricate the button and flat surface of the second hub.

4. A one-way backstop for engaging a rotatable shaft to limit the shaft to rotation in one direction comprising the combination of claim 1 wherein the cup-shaped collector is disposed above the region of the one-way torque coupling between said inner and outer races thereof, whereby liquid lubricant overflowing the upper edge of the cylindrical wall of said collector drips on the one-way torque coupling.

5. A one-way, self-aligning torque unit comprising, in combination, a generally circular upper coupler having one face adapted for attachment to a stationary support, said upper coupler having a gear support on the underside thereof, an upper external gear fixed to said gear support and defining an annular series of radially projecting crowned gear teeth, a lower coupler disposed in underlying generally coaxial relation to said upper coupler, a lower external gear fixed to said lower coupler and defining an annular series of radially projecting crowned gear teeth, a connecting coupler sleeve axially spanning said upper and lower gears in encircling relation

thereto, said sleeve having an upper internal gear and a lower internal gear meshing respectively with said upper and lower external gears to transmit torque therebetween while allowing movement of said lower coupler and said lower external gear thereon in relation to said upper coupler, said upper coupler having thereon a lubricant fountain positioned in overlying relation to said upper external gear and said upper internal gear to direct lubricant downwardly thereonto, a sleeve support disc medially positioned axially on said coupler sleeve and extending transversely thereacross in overlying relation to said lower coupler, said support disc defining on the underside thereof a convex thrust element supported on the upper end of said lower coupler, said support disc having an aperture medially located therein to direct lubricant through the support disc onto said lower coupler adjacent said thrust element to lubricate the latter and to flow over said lower coupler onto said lower external gear and said lower internal gear to lubricate the latter, a lubricant retaining cup mounted on said lower coupler in encircling relation to the latter below said internal and external lower gears and extending upwardly in encircling spaced relation to the lower portion of said sleeve to retain lubricant in pooling relation to said lower gears, a first one-way torque coupling race disposed below said cup and fixed to said lower coupler, a second one-way torque coupling race disposed in encircling relation to said first race for rotation relative thereto, a roller cage assembly disposed between said races in coaxing relation thereto to transmit torque therebetween in only one rotary direction to preclude rotation of the races relative to each other in said one direction while permitting free relative rotation of the races in the opposite direction, said races and said roller cage assembly being positioned to receive lubricant overflowing said lubricant cup, a sleeve bearing supported within said first race in coaxial relation to said lower gear, a spindle connected with said second race and journaled within said sleeve bearing to maintain said races in mutually coaxial relation, means for connecting said second race nonrotatably with a rotary part, lubricant supply means connected with said lower coupler for supplying lubricant thereto, and a lubricant fountain connected to receive lubricant from said lower coupler and positioned to pour lubricant onto the cage assembly intervening between said races.

6. A one-way, self-aligning torque unit comprising, in combination, an upper coupler adapted to sustain a torque reaction, an upper external gear fixed to said upper coupler, a lower coupler disposed in underlying generally coaxial relation to said upper coupler, a lower external gear fixed to said lower coupler, a connecting coupler sleeve axially spanning said upper and lower gears in encircling relation thereto, said sleeve having an upper internal gear and a lower internal gear meshing respectively with said upper and lower external gears to transmit torque therebetween while allowing movement of said lower coupler and said lower external gear thereon in relation to said upper coupler, a lubricant outlet positioned to flow lubricant onto said upper external and internal gears, a sleeve support element supporting said coupler sleeve on said lower coupler, a lubricant retaining cup mounted on said lower coupler in encircling relation to the latter below said internal and external lower gears and extending upwardly in encircling spaced relation to the lower portion of said sleeve to retain lubricant in pooling relation to said lower gears, a first one-way torque coupling race of annular form defining a circumferential series of roller support surfaces sloping outwardly in a common circumferential direction; said lower coupler including means for supporting said annular race thereon below said cup in generally coaxial relation to said gears in either of two mounting positions, which positions are turned end for end in relation to each other so that the common slope of said roller supporting surfaces is selectively oriented circumferentially in either of two circumferential directions; a second one-way coupling race encircling said first race, an annular series of rollers disposed between said races in alignment with said respective surfaces to transmit torque between the

races in only one direction predetermined by the selected orientation in which said inner race is assembled onto said lower coupler thereby precluding relative rotation of said races in said one direction while continuously permitting relative rotation of the races in the opposite direction, said races and said rollers being positioned to receive lubricant overflowing said cup, means for connecting said second race nonrotatably with a rotary part, and a lubricant fountain positioned to flow lubricant into the space intervening between said races.

7. A one-way, self-aligning torque unit comprising, in combination, an upper coupler adapted to sustain a torque reaction, an upper external gear fixed to said upper coupler, a lower coupler disposed in underlying generally coaxial relation to said upper coupler, a lower external gear fixed to said lower coupler, a connecting coupler axially spanning said upper and lower external gears in encircling relation thereto, said connecting coupler having an upper internal gear and a lower internal gear meshing respectively with said upper and lower external gears to transmit torque therebetween while allowing movement of said lower coupler and said lower external gear thereon in relation to said upper coupler, a lubricant outlet positioned to flow lubricant onto said gears, a first one-way torque coupling race of annular form defining a circumferential series of roller support surfaces sloping outwardly in a common circumferential direction; said lower coupler including means for supporting said annular race thereon in generally coaxial relation to said gears in either of two mounting positions, which positions are turned end for end in relation to each other so that the common slope of said roller supporting surfaces is selectively oriented circumferentially in either of two circumferential directions; a second one-way coupling race encircling said first race, an annular series of rollers disposed between said races in alignment with said respective surfaces to transmit torque between the races in only one direction predetermined by the selected orientation in which said inner race is assembled onto said lower coupler thereby precluding relative rotation of said races in said one direction while continuously permitting relative rotation of the races in the opposite direction, means for connecting said second race nonrotatably with a rotary part, and a lubricant outlet positioned to flow lubricant into the space intervening between said races.

8. A one-way, self-aligning torque unit comprising, in combination, an upper coupler adapted to sustain a torque reaction, a first annular series of torque transmitting teeth on said upper coupler, a lower coupler disposed below said upper coupler, a second annular series of torque transmitting teeth on said lower coupler, a connecting coupler of generally cylindrical overall form extending axially into axially overlapping relation to said first and second series of teeth on said upper and lower couplers respectively, said connecting coupler having an upper annular series of torque transmitting teeth and a lower annular series of torque transmitting teeth meshing respectively with said first and second annular series of teeth to transmit torque between said upper and lower couplers while allowing movement of said lower coupler nonrotatably in relation to said upper coupler, an oil collector cup mounted on said lower coupler in encircling relation to the latter below said connecting coupler and extending upwardly in encircling relation to the connecting coupler to retain an annular pool of oil in immersing relation to torque transmitting teeth on the connecting coupler and coupler teeth meshing therewith, lubricating means including a lubricant outlet positioned to direct a flow of oil onto meshing torque transmitting teeth of the aforementioned couplers and into said oil collector cup to form a pool of oil therein, a first one-way torque coupling race of generally circular form disposed below said cup and fixed to said lower coupler, a second one-way torque coupling race of generally circular form disposed in encircling relation to said first race for rotation relative thereto, one of said races defining an annular series of roller support surfaces sloping toward the other race in a common circumferential direction, an an-

nular series of rollers disposed between said races in alinement with said respective roller support surfaces to transmit torque between the races in only one direction to preclude rotation of the races relative to each other in said one direction while permitting free relative rotation of the races in the opposite direction, a sleeve bearing supported within said second coupler in coaxial relation to said first race, a spindle connected with said second race and journalled within said bearing to maintain said races in mutually coaxial relation, means for connecting said second race nonrotatably with a rotary part, lubricating oil supply means connected with said lower coupler for supplying lubricating oil thereto, and means on said lower coupler defining a lubricating oil passage for directing lubricating oil from said lower coupler onto said rollers intervening between said races.

9. A torque unit according to claim 8 in which said connecting coupler is floatingly supported by a plurality of springs disposed within said oil collector cup.

10. A torque unit according to claim 8 in which said first annular series of torque transmitting teeth on said upper coupler are internal teeth meshing with external teeth constituting said upper annular series of torque transmitting teeth on said connecting coupler and said second annular series of torque trans-

mitting teeth on said lower coupler are external teeth meshing with internal teeth constituting said lower annular series of torque transmitting teeth on said connecting coupler.

11. A torque unit according to claim 10 in which said second annular series of torque transmitting teeth are formed on the lower end portion of a generally cylindrical hub extending upwardly along said lower coupler in encircling relation thereto for an axial distance which is several times greater than the axial extent of the mutually overlapping relation of said second series of teeth on said lower coupler with said lower series of teeth on the connecting coupler, a key is recessed into said hub and said second coupler in axially extending relation thereto to hold the hub and the second coupler against rotation relative to each other, and said first annular series of torque transmitting teeth and said upper series of teeth on the connecting coupler are located substantially in encircling relation to the upper end portion of said hub.

12. A torque unit according to claim 11 in which said oil collector cup extends upwardly into overlapping encircling relation to the mutually meshing teeth of said first series and of said upper series on the connecting coupler to hold an annular pool of oil in immersing relation thereto.

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