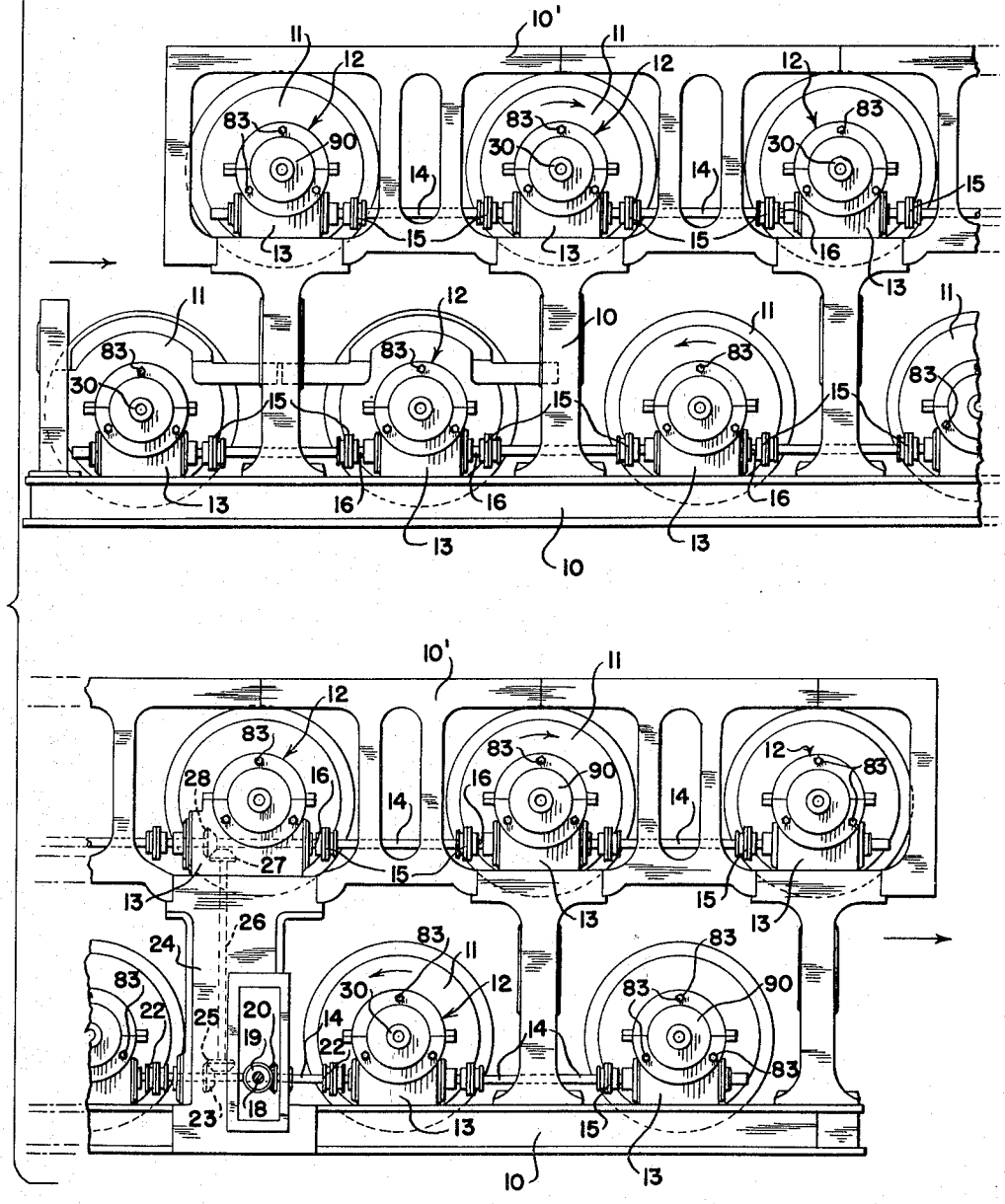
Dec. 1, 1959 E. W. CLEM 2,914,864

WORM GEAR DRIVE

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FIG. 1



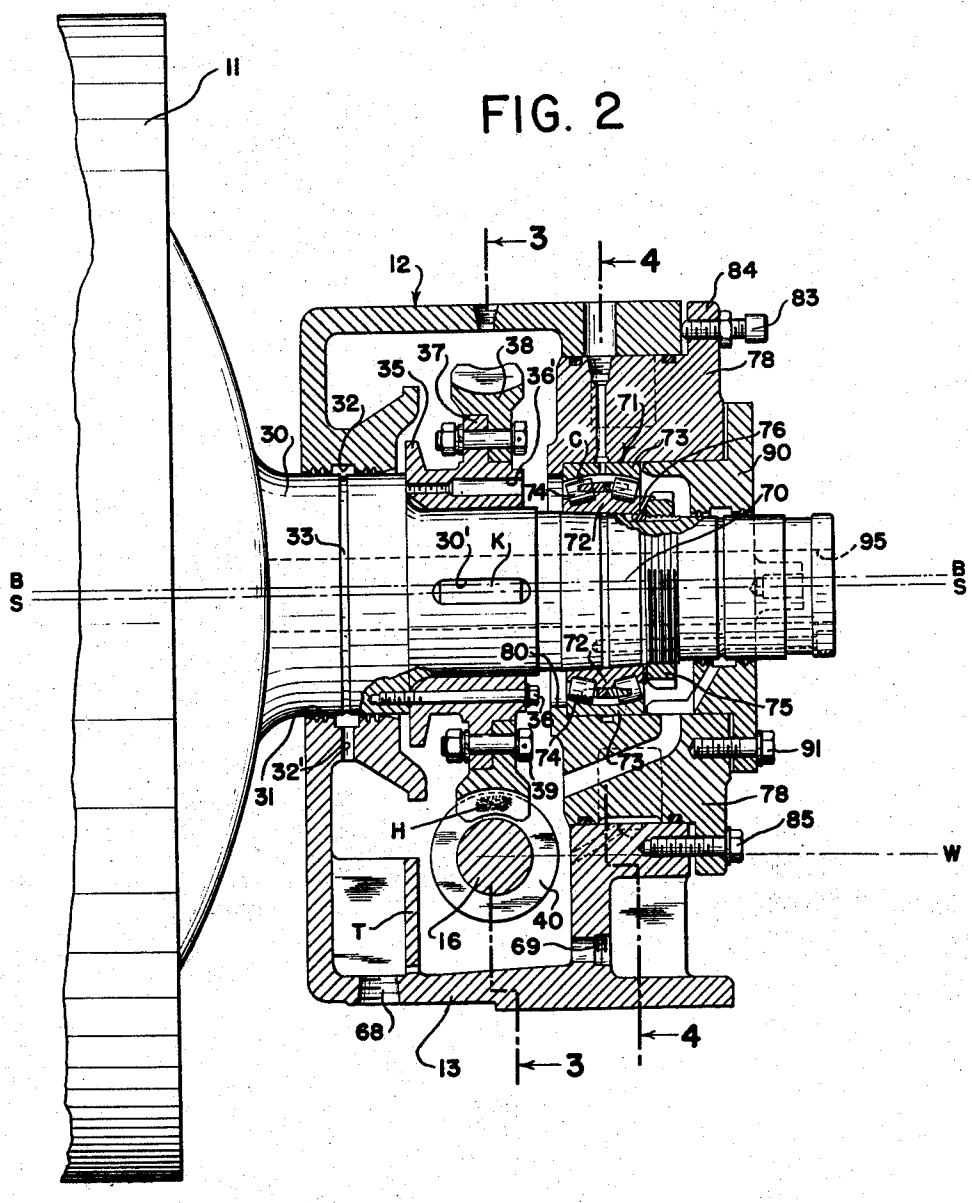
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WORM GEAR DRIVE

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FIG. 2



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WORM GEAR DRIVE

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FIG. 3

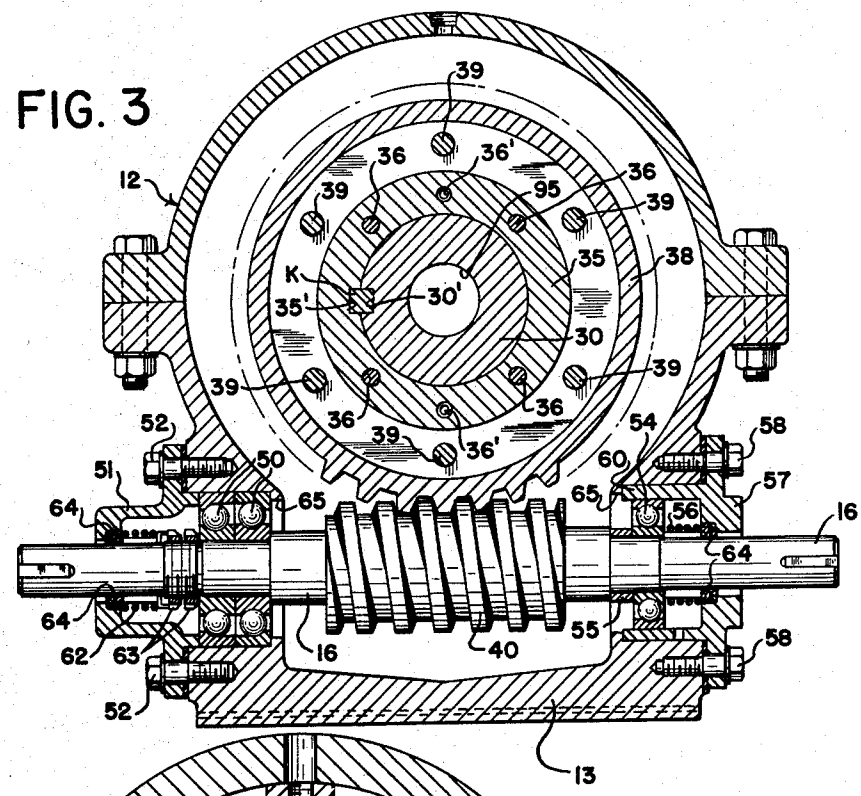
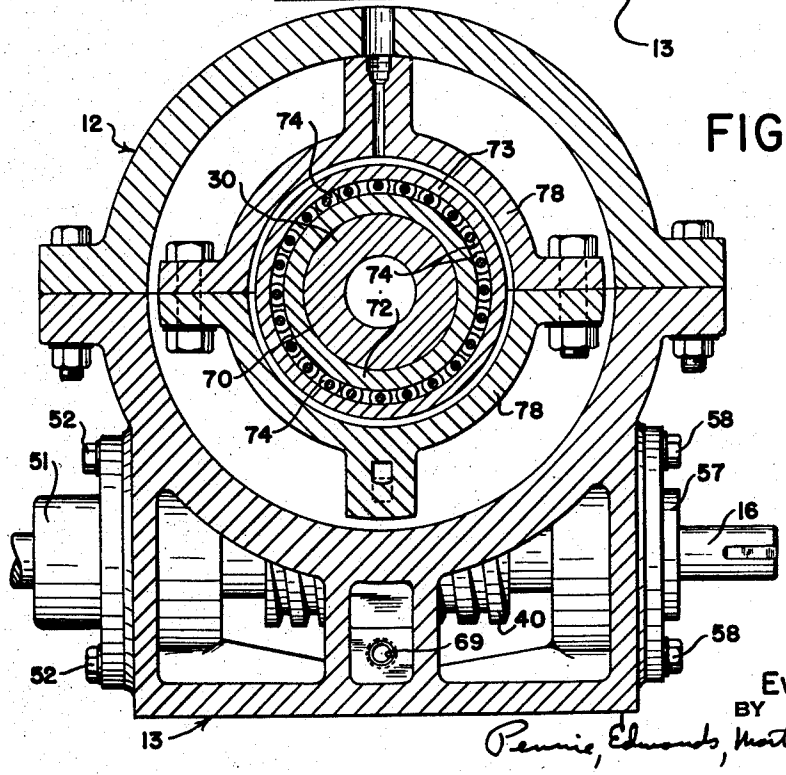


FIG. 4



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2,914,864

WORM GEAR DRIVE

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Application January 24, 1956, Serial No. 561,004

15 Claims. (Cl. 34—121)

This invention relates to worm gear drives for hot journal applications and more particularly to such a drive in which the operating members will properly coact with one another throughout a wide range of operating temperatures. More especially the invention is concerned with a worm gear drive particularly useful for driving the drying rolls of drums of a paper machine dryer section.

Considerable difficulty has heretofore been encountered in the maintenance of the driving mechanisms for paper machine dryer sections. Many of the conventional driving mechanisms have taken the form of gear trains directly interconnecting the driving shafts of all or a large number of the drying rolls of the dryer sections. Because of the substantial weight of the driven parts and the speeds at which they are driven, gear wear, both from starting the dryer section in operation and bringing it up to speed and from slowing it down and finally stopping it, is substantial. Backlash, which has a cumulative effect on such wear, can and will result.

A further important disadvantage and limitation of direct gear train drives is encountered when, in an effort to obtain a greater exposure of the web being dried so that the moisture therein will have a greater opportunity to leave, the drying rolls are spread farther apart. This is, of course, because when the rolls are spread farther apart larger gears must be employed and as a result the linear velocity of the open gear teeth is increased and may approach or even exceed the safe maximum. In such cases, gear life is quite naturally radically reduced.

Various different drive mechanisms have therefore been proposed and employed in the past in an effort to minimize the effect of backlash to permit greater drying roll separation and to accommodate out-of-balance etc., some involving the interposition and use of smaller gears between the main gears supported on the dryer roll shafts and others involving the employment of a direct gear train connection for only a portion of the dryer rolls, the remainder being individually directly driven from individual gears of the gear train. Some have additionally involved the use of chain or belt drives but chain stretch and the normal limitations of belt drives have prevented their being entirely satisfactory. Still others have employed worm gear drives whereby each roll is individually driven through a worm gear or a series of spur gears from a single worm shaft for the rolls of one tier of the dryer section. The last-mentioned approach was hindered, however, by difficulties encountered by reason of the fact that the drive mechanisms for paper machine drying sections must be operable over a wide variation of temperature conditions. This results from the fact that high temperature steam for heating the drying rolls may have to be supplied thereto through their supporting shafts upon which are also supported the driving gears. Hence the driving mechanisms and journals for supporting and driving the rolls may be subjected to substantial heat.

It is the primary object of this invention to provide

a worm gear drive which will be satisfactorily operable and substantially free from backlash over a wide range of operating temperatures. It is a further object of the invention to provide such a drive which permits operation at increased speeds and at greater roll spacings than heretofore possible. The invention therefore contemplates the provision of an individual drive for each drying roll of a drying section for a paper machine whereby any backlash occurring in one drive is substantially confined thereto and has no effect whatever on any other drive and whereby the gears may be maintained small enough so that at the higher speeds of operation the linear velocities of the gear teeth are well below the safe maximums.

Hence my invention advantageously contemplates the provision, in a worm gear drive for hot journal applications, of a worm, a worm gear mounted thereabove upon the shaft of an object to be driven, and a bearing supporting the shaft, the axis of the worm and the axis of the bearing (axis of outer race) being spaced apart a greater distance than the sum of the pitch radii of the worm and the worm gear for reasons that will hereinafter be fully explained. Also contemplated by my invention is the provision of a bearing support of such construction as to permit removal of the worm gear from the shaft without removal of the bearing and the provision of a worm support accommodating ready removal of the worm and its supporting shaft for purpose hereinafter noted. In addition, my invention contemplates the employment of an anti-friction bearing, advantageously a spherical roller bearing, and includes a worm gear the teeth of which are so hobbed as to permit satisfactory meshing with the worm despite shift of the worm gear axially as a result of a shifting of the inner race of the bearing in response to the riding of the spherical rollers up the outer race in either direction because of a change in thrust imposed axially under changing loading conditions such as will be experienced in acceleration and deceleration in the speed of rotation of the driven object. Furthermore, the drive of my invention contemplates adjustment means for adjusting the position of the worm gear axially with respect to the worm to obtain the optimum relative positioning thereof under a particular running condition. Also my invention contemplates provision for ready removal of the support bearing.

For a more detailed understanding of the invention, reference may be made to the following description of one embodiment thereof employed specifically in the drive of the dryer rolls of a paper machine dryer section. This specific description will be given in connection with the accompanying drawings in which:

Fig. 1 is a side elevation of a paper machine drying section provided with my novel worm gear drive;

Fig. 2 is a sectional view in elevation of one of the worm gear drives employed; and

Figs. 3 and 4 are sectional views taken respectively along lines 3—3 and 4—4 of Fig. 2.

Referring first to Fig. 1 of the drawings, there is illustrated a paper machine drying section made up generally of a supporting framework **10** for supporting a plurality of drying rolls or drums **11** in two tiers and a felt framework **10'**. Each of the driving rolls **11** is supported at one end in a journal housing indicated generally by the reference numeral **12**. Each housing **12** also encloses a portion of a worm gear drive, the remainder of which is enclosed within a worm housing **13**. The individual worm drives are interconnected by connecting shafts **14** carrying at their opposite ends semi-flexible couplings **15** by which they are connected to the worm shafts **16**. Driving power for shafts **14** and the worm shafts **16** is supplied to the dryer section through a main drive shaft **18** to which is secured a bevel gear **19** meshing with a bevel gear

20 on one of the connecting shafts 14 of the lower flight. This connecting shaft 14, which may be termed the intake shaft, supports at its opposite ends fully flexible couplings 22 by which it is secured to the worm shafts of the two adjacent dryer rolls. This intake connecting shaft 14 also supports a second bevel gear 23 within housing 24 which meshes with a bevel gear 25 supported at the lower end of a drive connecting shaft 26 to the upper end of which is secured a further bevel gear 27 which meshes with a like bevel gear 28 within worm housing 13 located above the intake connecting shaft 14. Bevel gear 28 is secured to the worm shaft 16 extending through said upper worm housing and hence provides the "intake" for the drives of the upper tier of dryer rolls.

The dryer section illustrated in Fig. 1, it should be understood, is not complete in detail in that numerous doctor blades, guide rolls, etc., are not illustrated.

In Figs. 2 through 4, one of the individual drives for a dryer roll 11 having a supporting shaft 30 is illustrated in greater detail. The journal housing 12 and worm housing 13, as illustrated, are formed in part from a two-part casting (Fig. 3) having an opening 31 through the rear end thereof to receive shaft 30. This opening 31 in the housing is provided with a channel 32 surrounding a groove 33 in the surface of the shaft 30 which cooperate to trap any oil tending to escape from the housing through opening 31 and return it thereto through bore 32'. A worm gear support member 35 surrounds a forward portion of shaft 30 of reduced diameter and is tightly secured thereto by a plurality of bolts 36 (Figs. 2 and 3). Two drilled holes 36' tapped at their ends adjacent the shoulder on shaft 30 are provided to accommodate jacking of supporting member 35 for removal thereof from the shaft. Worm gear support 35 is also provided with a flange 37 provided with a plurality of axially extending bolt holes adapted to correspond in location and number to those of a worm gear 38 which may be secured thereby to support member 35 by a plurality of bolts 39. Complementary keyways 30' and 35' are forced in shaft 30 and worm gear support member 35 respectively, a torque carrying key K being located therein for transmitting driving force from the latter to the former. While keyway 30' is of limited length, as shown in Fig. 2, and is adapted to have the key dropped into it and to hold the key in place, keyway 35' extends throughout the length of member 35 thereby permitting it to be slid onto the shaft over the key. Worm gear 38 is adapted to be drivingly engaged by a worm 40 mounted on worm shaft 16 which traverses the lower portion of the composite worm-worm gear housing.

As best illustrated in Fig. 3, the opposite ends of the worm shaft 16 are keywayed for ready reception in a coupling, such as shown at 15, in Fig. 1. Worm shaft 16 is supported on ball bearings 50 at one end thereof located within an opening in the worm housing and maintained therein by a capping member or cover 51 secured by bolts 52 to the housing and surrounding the end of shaft 16. Ball bearings 50 surround a reduced portion of shaft 16 and are shrunk fit thereon, one abutting the shoulder so formed. The opposite end of worm shaft 16 is supported in a ball bearing 54 also shrunk fit thereon and abutting a shoulder thereon through a spacer 55. A spring 56 is interposed between the ball bearing 54 and a packing 64 and urges the latter into sealing relation with an inner face of a cap or cover 57 surrounding this end of worm shaft 16 and again secured to the worm housing by suitable bolts or tap screws 58. In this instance ball bearing 54 is located within an inwardly extending flange 60 of cap or cover member 57. A similar spring 62 surrounds the end of worm shaft 16 within cap member 51 and is compressed between a pair of collars 63 threadedly mounted on this end of shaft 16 and a packing 64 to urge the latter into sealing relation with the inner face of cap member 51. Packings 64 prevent the escape

of lubricant through the openings in cap members 51 and 57.

Removal of the worm and its supporting shaft may, as will be clear from the above, therefore be simply accomplished merely by removal of the cap members and turning of worm and shaft to thread the former past worm gear 38, openings 65 (Fig. 3) in the worm housing being large enough to pass the worm. This feature is of considerable importance for the reason pointed out below.

Taps 68 and 69 (Fig. 2) are provided through the worm housing wall to accommodate the drainage of the lubricant therefrom and cleaning of the interior thereof respectively.

Shaft 30 forwardly of the worm gear supporting section is provided with a tapered section 70 adapted to receive or be received by a spherical roller bearing 71 having inner and outer races 72 and 73 respectively, between which are contained spherical rollers 74. The inner race 72 of the bearing is maintained on the tapered section 70 of shaft 30 by a retaining collar 75 adapted to be threaded on shaft 30. A lock washer 76 is interposed between collar 75 and the roller bearing.

The outer race of the bearing is supported by a two-part (Fig. 4) bearing supporting member 78 adapted to surround it within the forward portion of the composite housing 12—13. Bearing supporting member 78 is provided with an inwardly depending flange 80 at its inner end adapted to engage the rear face of outer race 73 of roller bearing 71. The purpose of this flange 80 will be subsequently explained.

A plurality of adjusting screws 83, only one of which may be seen in Fig. 2, but three in number, as may be seen in Fig. 1, for each bearing supporting member, two being contained in the lower half of the bearing supporting member and the third, which is that illustrated in Fig. 2, being contained in the upper half thereof, extend through the peripheral forward flange 84 of the composite bearing supporting member 78. These adjusting screws 83, as illustrated in Fig. 2, are adapted to engage the forward rim of the composite journal housing 12—13. A plurality of positioning bolts or tap screws 85 (Fig. 2) also pierce flange 84 of the bearing supporting member and are adapted to be threaded into the composite journal housing to secure the bearing supporting member in any adjusted position therein. A one-piece cap member 90 adapted to surround the outer end of the shaft and close the bearing exposing opening in the outer face of bearing supporting member 78 is provided and is secured to the bearing supporting member by a plurality of bolts or cap screws 91.

Dryer roll shaft 30 is hollow, being provided with an axially extending bore 95 therethrough through which a heating medium may be supplied to the interior of dryer roll 11. For this purpose the extreme outer end of shaft 30 is so designed as to receive a steam joint adapter.

There are two features of primary importance in the illustrated construction, the first of which is that the worm 40 is located below the driven worm gear 38. The second feature is that the construction is so designed that the center line of the bearing, that is, the center line of the outer race, which center line is labeled "B" (Fig. 2) is above the center line S of shaft 30, the center line B of the bearing being the center line of the outer race 73 thereof. Hence, as heretofore mentioned, the axis B of the bearing is spaced from the axis W of the worm a distance greater than the sum of the pitch radii of worm 40 and worm gear 38, the axis of worm gear 38 coinciding with the axis S of shaft 30.

The importance of these two features is as follows. Under normal conditions, due to the weight of dryer roll 11 which is substantial, the inner race of the bearing is positioned downwardly off-center from the outer race, leaving the clearance that has exaggeratedly been shown as clearance C in Fig. 2. This means that were the center

line B of the bearing to coincide with the center line S of the shaft and worm gear **38** as it would be were the design purely theoretical, under normal cold operation (room temperature) worm gear **38** and worm **40** would mesh too tightly. With the indicated construction, however, the shift downwardly of the inner race of the bearing is such that the axis of the worm gear is properly spaced from the axis of the worm for cold operation. As the shaft and its supported parts and the bearing **71** heat up during operation of the dryer, worm gear **38** expands, which would normally result in too tight a mesh between it and worm gear **40**. However, at the same time bearing **71** expands, thus raising shaft **30** and hence worm gear **38** away from worm **40**. A bearing **71** is therefore chosen having an internal clearance and an expansion characteristic such that when it expands it raises the worm gear and its supporting part to cancel out substantially the expansion of the worm gear, thereby tending to maintain the mesh of it and the worm **40** constant. While standard bearings are not available with infinitely different amounts of clearance or expansion characteristics, the characteristics of a standard bearing employed in the illustrated construction may be modified by the axial positioning of the bearing on tapered section **70** of shaft **30**. This positioning may be accomplished by employing collar **75** to urge the bearing onto the shaft beyond the position to which it may be urged by hand pressure alone.

Hence in the illustrated construction, a proper uniform meshing of worm gear **38** and worm **40** may be maintained both in "cold" operation as well as in hot operation. It will be clear that were the worm to be located above the worm gear, either the cumulative expansions of the worm gear and its supporting parts and of the bearing might prevent optimum meshing under hot operating conditions or might require a design which would not permit optimum meshing under "cold" operation.

Proper meshing of worm gear **38** and worm **40** also involves proper positioning of the two relative to each other in a direction axially of the worm gear. The relative position in this direction is also affected by change in temperature as well as by thrust forces imposed during operation. To permit adjustment for optimum meshing in this respect, provision is made for moving shaft **30** and hence worm gear **38** axially. Hence bearing **71**, which as heretofore described is tightly held onto the shaft by collar **75**, may be pulled to the right, as shown in Fig. 2, by loosening bolts or tap screws **85** securing the bearing supporting member **78** to the composite journal housing **12—13** and resetting adjusting screws **83**. The need for adjustment by this means may, however, be minimized by proper choice of bearing to partially compensate for shaft movement. When necessary, however, the axial adjustment of worm gear **38** may normally be done by visual inspection during operation under given conditions. Such visual observation may be accomplished by removal of the upper portion of journal housing **12**. By observing, after a short period of observation under the actual conditions of operation, where the teeth of worm gear **38** are being marked, a determination can be made as to whether or not the worm gear is properly located axially with respect to the worm, and if not, the lower two adjusting screws **83** set to reposition it to proper relative position. The top half of the journal is then replaced and securing bolts **85** tightened. Because, as noted, the adjustment may be made during operation, no compensating need be provided for.

As indicated in Fig. 2 by the reference letter H, I find it advantageous to have a substantial central portion of the worm gear teeth hobbed for proper meshing with worm **40** despite temporary relative axial movement of the worm gear with respect to the worm, such for example as will be encountered in acceleration and deceleration of the speed of rotation of the shaft **30**. This axial movement results in such instances because of the riding up of the spherical rollers **74** of bearing **71** upon the outer race in one direction or the other.

There are additional beneficial features in the illustrated construction. Hence, for example, by reason of this construction worm gear **38** may be removed without removal of bearing **71**. This is accomplished by first removing the upper portions of both the journal housing **12** and the bearing supporting member **78** as well as end cap **90**. The securing bolts **85** for the lower portion of bearing supporting member **78** may then be removed and the lower portion of the bearing supporting member **78** revolved on the bearing, the outer race of the latter being free, and the shaft **30** then being supported temporarily by the lower portion of the journal housing surrounding opening **31**. Upon a half revolution of movement or thereabouts, the lower portion of the bearing supporting member may be removed in an upward direction. Thereafter worm gear **38** may be detached from its supporting member **35** and drawn outwardly over bearing **71**.

By the same partial dismantling of the journal housing and removal of the bearing supporting member **78**, the bearing itself may be removed from shaft **30** without requiring removal of the dryer roll from the dryer or the shaft thereof completely from the journal.

By employing a worm of shallow pitch as illustrated, backlash encountered in the operation of the dryer section illustrated and provided with the worm gear drive of this invention may be absorbed in the individual worm gear drive. Furthermore, the stopping torque may be taken up almost entirely in the worm if the pitch thereof is sufficiently shallow.

Another feature of the construction which should not be overlooked is the provision of a weir T in the lower portion of the gear housing (Fig. 2) which is provided to maintain a proper level of the lubricant therein for lubrication of the worm, and which will provide a safety reserve of lubricant in the event of a failure of the supply of lubricant to the gear housing. While this safety reserve will not permit extended operation of the drive mechanism without additional lubricant, it will prevent damage being done for a short time.

Among the advantages of the above-described worm gear drive in a paper machine dryer section are that it reduces substantially the expense of drive gear maintenance and permits operation of the dryer section at greater speeds than have heretofore been possible, the contemplated speeds of operation of the illustrated dryer being as much or more than 2500 feet per minute. Furthermore, a paper machine dryer section provided with the described worm gear drive is much more open in that the drive side is not closed or substantially closed by gear casings as it would be with a conventional direct gear train drive. In such drying apparatus this is of extreme importance, as good air circulation is depended upon for uniform drying. This latter feature also permits one a choice of providing the heating medium at the front or the back side of the section. In addition, the fact that the dryer section is open at both sides permits easier access to the interior thereof for the removal of broke if and when necessary.

Another important advantage of the above-described dryer section drive is that in the event of a cracked drying drum or roll, it permits skipping of such drum without any major change being necessary. As a matter of fact, more than one drum or roll may be skipped. This may be done without affecting the driving of the remainder of the drying rolls by simply removing the worm and its supporting shaft for any drum to be skipped from its gear housing **13** in the manner hereinbefore described, and substituting a drive shaft, similar to drive shafts **14**, therefor.

Still another advantage of the above-described drive mechanism is the fact that it permits limited relative movements or relocations of the dryer rolls with respect to

one another, as by reason for example of building settling, earthquakes or other causes for frame changes. This is so because the individual drives made up of a worm, worm gear, etc., are built in their individual housing and hence are relatively fixed with respect to one another, the flexible couplings 15 between shafts 14 and the worm shafts accommodating the changes instead. In open spur gear drives this is not possible and small changes in relative positions of the drying rolls as a result of earthquakes, building settlings, etc. may make the drives inoperable from a practical point of view.

Various changes and modifications may of course be made in the apparatus specifically illustrated and described without departing from the scope of this invention which rather should be limited only to the extent set forth in the appended claims.

I claim:

1. A worm gear drive for hot journal applications, where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, an anti-friction bearing having an outer race and adapted to support the weight of said shaft and object, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room temperature so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said worm gear and said anti-friction bearing having matched temperature expansion characteristics, the arrangement being such that the expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

2. A worm gear drive for hot journal application, where the object to be driven is of substantial weight, comprising a worm, a worm gear supporting member fixedly mounted on the shaft of the object to be driven, an annular worm gear adapted to be secured to the outer peripheral part of said worm gear supporting member, said worm being located below said worm gear, an anti-friction bearing for supporting the weight of the shaft and object and having an inner race such that it may be adjustably positioned on a seat on said shaft and thereby mechanically expanded to a predetermined degree, the diameter of the outer race of said roller bearing being smaller than the inner diameter of said annular worm gear, means for securing the bearing on said shaft in adjusted position against axial movement relative thereto, and a multi-piece bearing supporting means for supporting the outer race of said anti-friction bearing relative to the worm so that the axis of the outer race thereof is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm, and said worm gear teeth being hobbed to provide on each a section of substantial axial extent for proper meshing with the worm despite variation in the relative position of the worm and the worm gear axially of the latter.

3. A worm gear drive according to claim 2 which includes a housing for said worm in which there is an oil outlet and in which there is also a weir between the outlet and said worm for maintaining a pool of lubricant within the housing and around at least a portion of said worm.

4. A paper machine dryer section comprising a plurality of drying rolls each supported by a hollow drive shaft through which steam may be transmitted to the interior thereof, an individual worm gear drive for each drying roll and means interconnecting the worm gear drives, each of said worm gear drives comprising a worm, a worm gear supporting member mounted on the shaft of the adjacent drying roll, an annular worm gear adapted to be secured to the outer peripheral part of said worm gear supporting member, said worm being located below said worm gear, a spherical roller bearing having a tapered inner race for adjustable positioning on a tapered seat on said shaft, the diameter of the outer race of said roller bearing being smaller than the inner diameter of said annular worm gear, means for securing the bearing on said shaft in adjusted position against axial movement relative thereto, and a multi-piece bearing supporting means for supporting said spherical roller bearing relative to the worm so that during operation at room tempearture the axis of the outer race thereof is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm, and said worm gear teeth being hobbed to provide on each a section of substantial axial extent for proper meshing with the worm despite variation in the relative position of the worm and the worm gear axially of the latter.

5. A worm gear drive for hot journal application comprising a worm, a worm gear supporting member fixedly mounted on the shaft of an object to be driven, and spaced inwardly of the end of the shaft, an annular worm gear adapted to be secured to the outer peripheral part of said worm gear supporting member, an anti-friction bearing having an inner race such that it may be adjustably positioned on a seat on said shaft and thereby mechanically expanded to a predetermined degree, said bearing being positioned between said supporting member and the end of said shaft, the diameter of the outer race of said anti-friction bearing being smaller than the inner diameter of said annular worm gear, means for securing the bearing on said shaft in adjusted position against axial movement relative thereto, and a multi-piece bearing supporting means for supporting said anti-friction bearing, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm.

6. A paper machine dryer section comprising a plurality of drying rolls each supported by a hollow drive shaft through which steam may be transmitted to the interior thereof, an individual worm gear drive for each drying roll and means interconnecting the worm gear drives, each of said worm gear drives comprising a worm, a worm gear supporting member mounted on the shaft of the adjacent drying roll, an annular worm gear adapted to be secured to the outer peripheral part of said worm gear supporting member, a spherical roller bearing having a tapered inner race for adjustable positioning on a tapered seat on said shaft, the diameter of the outer race of said roller bearing being smaller than the inner diameter of said annular worm gear, means for securing the bearing on said shaft in adjusted position against axial movement relative thereto, and a multi-piece bearing supporting means for supporting said spherical roller bearing, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm, and said worm gear teeth being hobbed to provided on each a section of substantial axial extent for proper meshing with the worm despite variation in the relative position of the worm and the worm gear axially of the latter.

7. A paper machine dryer section comprising a plurality of drying rolls, an individual worm gear drive for each drying roll and means interconnecting the worm gear drives, each of said worm gear drives comprising a worm, a worm gear mounted on the shaft of the adjacent drying roll and spaced inwardly of the end of the shaft, a gear housing surrounding said worm and said worm gear and having a portion thereof removable for

visual access to said worm gear, an anti-friction bearing mounted on said drying roll shaft outwardly of the worm gear, a multi-piece bearing support member mounted in said gear housing, means for adjusting said bearing supporting member with respect to said gear housing whereby said worm gear may be adjusted with respect to said gear housing, and means fixedly positioning said worm in said gear housing, said last-mentioned means being removable to permit axial removal of said worm from said gear housing without disturbing said worm gear therein, said bearing supporting member and said worm gear being removable without disturbing the position of said bearing on said shaft.

8. A worm gear drive for hot journal application comprising a worm, a worm gear supporting member fixedly mounted on the shaft of the object to be driven, an annular worm gear adapted to be secured to the outer peripheral part of said worm gear supporting member, said worm being located below said worm gear, an anti-friction bearing having an inner race, such that it may be adjustably positioned on a seat on said shaft, the inner race of anti-friction bearing being tapered and the seat therefor on said shaft being similarly tapered whereby said inner race may be mechanically expanded to a predetermined degree, the diameter of the outer race of said roller bearing being smaller than the inner diameter of said annular worm gear, means for securing the bearing on said shaft in adjusted position against axial movement relative thereto, and a multi-piece bearing supporting means for supporting said anti-friction bearing relative to the worm so that the axis of the outer race thereof is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm, and said worm gear teeth being hobbed to provide on each a section of substantial axial extent for proper meshing with the worm despite variation in the relative position of the worm and the worm gear axially of the latter.

9. A worm gear drive for hot journal applications where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, an anti-friction bearing adapted to support the weight of said shaft and object, said bearing being provided with a tapered inner race for adjustable positioning on a tapered seat on said shaft, means for adjusting said inner race axially on said seat for regulating the expansion characteristics of said bearing, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room temperature so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, the arrangement being such that expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

10. A worm gear drive for hot journal applications where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, an anti-friction bearing having an outer race and adapted to support the weight of said shaft and object, means for securing the bearing on said shaft against axial movement relative thereto, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room tempertaure so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said bearing supporting means being adjustable for movement of the bearing, the shaft and the worm gear axially of the latter relative to the worm, the arrangement being such that expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

11. A worm gear drive for hot journal applications where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, an anti-friction bearing having an outer race and adapted to support the weight of said shaft and object, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room temperature so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, said bearing supporting means being made up of at least two pieces whereby it may be removed other than axially of the shaft, the worm gear being of annular form and having an internal diameter greater than the outer diameter of said bearing, whereby the worm gear may be removed and replaced without removing said bearing, the arrangement being such that expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

12. A worm gear drive for hot journal applications where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, an annular gear supporting member fixed to the shaft, said worm gear being annular and adapted to be secured to the outer peripheral portion of the worm gear supporting member, an anti-friction bearing having an outer race and adapted to support the weight of said shaft and object, said worm gear supporting member having an inner diameter greater than the outer diameter of the anti-friction bearing, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room temperature so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, the arrangement being such that expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

13. A worm gear drive for hot journal applications where the object to be driven is of substantial weight, comprising a worm, a worm gear mounted on the shaft of the object to be driven, said worm gear being located above said worm and being expandable upon heating, said worm gear teeth being hobbed to provide a section on each of substantial axial extent for proper meshing with the worm despite limited instantaneous variation in the relative position of the worm and the worm gear axially of the latter, an anti-friction bearing having an outer race and adapted to support the weight of said shaft and object, said anti-friction bearing being a spherical roller bearing, and means for supporting the outer race of said anti-friction bearing relative to said worm in operation at room temperature so that the axis of the outer race of said anti-friction bearing is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm and said worm gear, the arrangement being such that expansions of said anti-friction bearing and said worm gear upon heating tend to offset one another to maintain said worm and worm gear in proper mesh.

14. A paper machine dryer section comprising a plurality of drying rolls adapted to be heated, an individual worm gear drive for each drying roll and means inter-

connecting the worm gear drives, each of said worm gear drives comprising a worm, a worm gear mounted on the shaft of the adjacent drying roll and above said worm, said shaft being hollow to permit the transmission of a heating medium therethrough to the interior of said drying roll, an anti-friction bearing having an outer race and mounted on said shaft for supporting the weight of the shaft and drying roll, and means for supporting the outer race of said anti-friction bearing so that its axis is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm gear and worm.

15. A paper machine dryer section comprising a plurality of drying rolls adapted to be heated, an individual worm gear drive for each drying roll, said drying rolls being arranged in a plurality of flights the drives of an upper flight being connected to the drives of a lower flight by a single drive shaft an individual worm shaft being provided for each worm gear drive, individual shafts connecting each pair of adjacent worm shafts, a flexible coupling being mounted on each end of a connecting shaft to secure it to the end of the adjacent worm shaft, each of said worm gear drives comprising a worm, a worm gear mounted on the shaft of the adjacent drying roll and above said worm, an anti-friction bearing having an outer race and mounted on said shaft for supporting the weight of the shaft and drying roll, and means for supporting the outer race of said anti-friction bearing so that its axis is spaced from the axis of the worm a distance greater than the sum of the pitch radii of said worm gear and worm.

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