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(57) Abstract

A drive chain has opposed pairs of inner link plated that are interconnected by cast outer links. Pins pass through aligned apertures in overlapping end portions of the inner and outer links. Each pin is fixed relative to the inner link. The outer link has open or blind bores that receive end portions of the pins in a pivotal relationship. A bearing area is defined between the outer surface of the pin and an inner surface of the outer link bore. The provision of a bearing area in the outer link makes maintenance and sealing easier.

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A DRIVE CHAIN

The present invention relates to a drive chain and more particularly, but not exclusively, to a roller-type chain.

A conventional roller chain comprises pairs of opposed inner link plates interspersed along the length of the chain by pairs of opposed outer link plates. Each outer link overlies the adjacent ends of neighbouring inner links such that an aperture at each end of the outer link is aligned with an corresponding aperture in the end of the underlying inner link plate. The inner and outer link plates are interconnected on opposite sides of the chain by means of a pin that passes through the aligned apertures on each side. The pin is fixed at each end to the opposed outer link plate but is pivotal relative to the inner link plates within a bush that extends between opposed apertures in the inner link plates.

A problem with most drive chains of this type is deterioration owing to wear in the bearing surface between the bush and the pin. In particular, the location of the bearing surface in the middle of the chain makes it difficult to seal effectively against contamination. Alternatively, when it is possible to provide effective sealing the bearing surface is generally difficult to access for maintenance or lubrication purposes.

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages.

According to the present invention there is provided a drive chain having opposed pairs of inner link plates, each inner link plate being connected to an adjacent outer link by means of at least one pin that passes through overlapping portions of the respective links, wherein each outer link has at least one bore that receives an end portion of the pin and is pivotally retained thereon, and wherein a bearing is defined between an outer surface of the pin and an inner surface of the outer link bore.

In a preferred embodiment the pin is received in a blind bore in the outer link in which case the outer link may be releasably retained on the pin by means of a fixing member that is removably housed in the outer link and is engageable in a

groove or slot defined on the pin. Lateral movement of the outer link relative to the pin in the direction of the longitudinal axis of the pin is thereby prevented. Preferably the fixing member comprises a staple having legs that are releasably housed in apertures in the outer link and are engageable in the groove or slot on the pin. When the staple is not present the apertures may also be used to convey lubricant to the bearing.

Alternatively the fixing member may be provided entirely within the bore. For example, the fixing means may comprise a split collar having ends that engage in slots or groove provided in the pin and the blind bores to prevent lateral movement of the outer link relative to the pin in the direction of the longitudinal axis of the pin.

In an alternative embodiment the pin is conveniently received in an open bore and the outer link is retained on the pin by means of a cover plate that is larger than the bore and is connected to an end face of the pin. The cover plate may for example be connected by means of a screw.

Preferably the bearing is provided with at least one seal to prevent egress of lubrication. The seal may for example be an O-ring housed in an annular groove provided in the pin or the blind bores.

The outer link is preferably cast and may have an internal reservoir for lubricant that is fed to the bearing. Alternatively lubricant may be supplied to the bearing via a grease nipple or the like.

Preferably the pin is fixedly connected to the inner link plate by means of an interference fit.

Specific embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a sectioned plan view of a first embodiment of a drive chain according to the present invention;

Figure 2 is a perspective view of an outer link of figure 1;

Figure 3 is a scrap view of alternative lubrication means for the chain of figures 1 and 2;

Figure 4 is a partially sectioned plan view of a second embodiment of a drive chain according to the present invention:

Figure 5 is a side view in the direction of arrow X of the drive chain of figure 4;

Figure 6 is a schematic side view of a third embodiment of half of an outer link of a drive chain according to the present invention, shown before machining.

Figure 7 is a schematic view of the outer link of figure 6 shown after insertion of bearings and machining;

Figure 8 is a sectioned view along line A-A of figure 7;

Figure 9 is a scrap view of an end of a pin for insertion into the outer link of figure 7;

Figure 10 is a part-sectioned plan view of a fourth embodiment of part of a drive chain according to the present invention;

Figure 11 is a section along line Z-Z of figure 10;

Figure 12 is a side view of an outer link of a fifth embodiment of the present invention; and

Figure 13 is a sectioned plan elevation along line B-B of figure 12.

Figure 14 is a scrap side view of further alternative embodiments of the present invention;

Figure 15 is a sectioned view along line Q-Q of Figure 16; and

Figure 16 is a side view corresponding to Figure 14, with the outer link rotated through 90^{o} to permit assembly.

Referring now to the drawings, figure 1 shows a fragment of a roller drive chain for engagement with a sprocket (not shown) in a conventional manner.

The chain comprises a plurality of inner link assemblies indicated generally by arrow 1 and interconnected by outer links 2. Each inner link assembly 1 comprises a pair of opposed inner link plates 3 connected by a pair of spaced parallel pins 4 that pass through aligned apertures 5 in opposite inner link plates 3. Each pin 4 is an interference fit with the inner link plate apertures 5. Freely supported on each pin 4 in

a region between the inner link plates 3 is a cylindrical roller 6. In use the teeth of the sprocket (not shown) engage between adjacent rollers 6 in the conventional way.

Each outer link 2 is a casting having two blind bores 7 which each receive an end portion of a pin 4 from an inner link assembly 1. Each outer link 2 receives two pins 4, one from each adjacent inner link assembly 1 thereby connecting them together. The outer link 2 is pivotally moveable relative to each pin 4 and is retained thereon by means of a staple 8 whose ends 9 pass through bores 10 in the casting and engage in an annular groove 11 formed on the end of the pin 4. The outer link 2 is thereby prevented from moving relative to the pins 4 in the direction of the longitudinal axes of the pins 4. Alternative means of retaining the outer links 2 on the pins 4 may be used as described below.

The interior surface of each blind bore 7 in the outer link 2 forms a bearing area with the adjacent outer surface of the pin 4. The bearing area may be supplied with lubricant by various means (examples are described below) and the lubricant is sealed by means of one or more O-rings 12 that are each seated in an annular groove 13 formed in the blind bore 7. Not only does the O-ring seal 12 prevent egress of the lubricant but it also prevents ingress of dirt or other contaminants.

In the above described design, lubrication may be provided during a maintenance cycle when the chain is not in use. In such a cycle the chain is indexed past a lubricant station (not shown) where for each outer link 2 the staple 8 is removed and oil (or other suitable lubricant) is dispensed to the bearing area through the bores 10. The staple 8 is then replaced and the chain is indexed by one outer link 2 and the procedure is repeated for each link in the chain. This arrangement is particularly suitable for applications where the chain has periods of non-use such as, for example, drive chains for amusement rides or roller-coasters that close down at night.

In an alternative design of chain, lubrication for the bearing area is provided from an interior reservoir 14 formed in the outer link casting 2 (shown in the right-hand outer link of figure 1). The lubricant is supplied to the bearing area via lubrication bores 15 connected to the reservoir 14. In a further alternative (shown in figure 3) a grease nipple 16 is provided for manual or automatic lubrication.

An alternative design of the present invention is shown in figures 4 and 5 in which parts corresponding to those of figures 1 and 2 are indicated by the same reference numerals increased by 100 and are not further described except insofar as they differ from their counterparts in figures 1 and 2.

Each outer link 102 has open bores 107 that receive the end portions of the pins 104, and is retained on the pins 104 by means of an end cap 117 that is fixed to the exposed end face of the pin 104 by means of a screw 118. The end cap 118 is larger in diameter that the pin 104 and therefore bears against the region around edge of the outer link bore 107 to prevent the outer link 102 from being removed from the pin 104. In this embodiment an O-ring seal 112 is provided at each end of the bearing area to prevent lubricant escaping through the open bore 107.

A further alternative design is shown in figures 6 to 9, in which the outer link 202 is cast with two blind bores 207 each of which has a top slot 230 that extends along the length of the bore 207. Adjacent the closed end of the bore 207 there is an annular groove 231 which is provided for engagement with the pin 204 (as described below). The wall of each blind bore 207 is recessed to receive two bearing materials 232 that extend axially within the bore 207 up to the edge of the annular groove 231.

The outer link 202 with the blind bores 207 and the axial slot 230 is formed by, for example, casting. Two bearing apertures 233 are then machined adjacent the periphery of each blind bore 207 in a direction parallel therewith. This configuration of the outer link 202 is shown in figure 6. Cylindrical rods of bearing material 232 are then inserted into the bearing apertures 233 before each of the blind bores 207 is machined to a larger diameter as shown in figure 7. In enlarging the blind bores 207 parts of the cylindrical bearing materials 232 are machined away so that they are flush with the internal surface of the bore 207.

The bearing material 232 may be of a known type that swells when it comes into contact with lubricant. The swelling of the material 232 ensures, in use, a better quality bearing contact with the pin 204.

A nipple or other protrusion 234 is formed on the end of the pin 204 as shown in figure 9. The pin 204 is inserted into the blind bore 207 of the outer link 202 with

the protrusion 234 aligned with the elongate slot 230. Once the pin 204 is fully inserted it is then twisted relative to the bore 207 so that the protrusion 234 moves out of slot 230 and engages with the groove 231. The outer link 202 is thereby retained on the pin 204.

Figures 10 and 11 show a drive chain in which the outer links 302 each have arcuately tapered side faces 340 so that each link is generally oval in cross section (see in particular figure 11). The bearing in the outer link is not shown for clarity. Each outer link 302 has two through bores 307 designed to receive the pins 304. A retaining circlip 341 or the like engages with an annular groove 341 adjacent each end of the pin 304 to retain the outer link 302 on the pin 304. Each of the through bores 307 is tapered in the vertical plane (as shown in fig 11) so that it increases in diameter towards the nearest circlip 341 and adjacent free end of the pin 304. In the horizontal plane the bores 307 are not tapered.

In use, this arrangement permits lateral flexing of the chain with the outer link 304 being not only pivotal on the pin 304 in the conventional manner but also tiltable in a perpendicular direction relative to the pin 304 and the inner link 303 by virtue of the bore taper and the oval shape of the outer link.

This may permit, lateral flexing of, for example, 90^0 in a chain of sufficient length. This is a significant improvement over prior designs which require complex arrangements such as universal joints at connections between adjacent links and a sprocket with specifically designed tooth profiles. It will be appreciated that a conventional sprocket can be used with this chain design.

Figures 12 and 13 show an outer link 402 with an alternative bearing design. The end of each pin 404 is stepped to define a trunnion 445 of substantially elliptical cross-section significantly smaller than a through bore 407 provided in the outer link 402. The trunnion 445 is received in the outer link bore 407 where it contacts an insert 446 (of suitable bearing material) embedded in the outer link and of cross-section similar to that of the trunnion 445. The insert 446 projects into the through bore 407 such that its arcuate surface intersects the centre of articulation of the link Q.

The insert 446 remains fixed and as the chain articulates the trunnion 445 rolls relative thereto such that the point of contact Q moves. The outer face of the trunnion 445 (i.e. the one not in contact with the insert 446) slides relative to the edge of the outer link bore 407. This arrangement ensures that the thrust load is always acting at the contact point (Q) and significantly reduces wear since the trunnion 445 is in rolling contact with the bearing rather than sliding.

In a further alternative embodiment, shown in figures 14 to 16, the pin 504 is received in the outer link 502 by an annular bush 550 that forms the outer link bearing. The bush 550 has a radially outwardly directed lobe 551 that is of a depth less than the axial length of the bush 550 and is designed to retain the outer link 502 against inner link 503. The pin 504 is an interference fit with the bush 550 and the outer link 502 is free to rotate relative to the bush 550.

In order to allow assembly the outer link aperture 507 has a groove 552 complementary to the lobe 551 on the bush 550. To assemble the chain, the bush 550 is fitted to the pin 504 and the outer link 502 is then presented to the pin and bush assembly such that the lobe 551 is oriented to pass through the groove 552. In this orientation the longitudinal axes of the inner and outer links 503, 502 are at right angles to one another (see FIG 16). Once the lobe 551 passes through the length of the groove 552 the outer link 502 is rotated through 90° until the longitudinal axes of the links are aligned (see FIG 14). In this configuration the lobe 551 prevents separation of the inner and outer links 503, 502. The outer link 502 may be countersunk at 553 around its aperture 507 so that the lobe 551 is flush with the outer surface of the link 502.

It will be understood that in the design according to the above embodiments of the present invention the bearing area is positioned in a more accessible place as compared to a conventional roller chain, thereby making sealing and maintenance easier. The material from which the outer link is manufactured can be selected according to the bearing and load requirements for a particular application. The outer link may be manufactured by forging, sintering, pressing, injection moulding or other appropriate means.

It is to be understood that the above described connection arrangement between the pin and outer link bore and the manufacturing method could be used with open bores instead of blind bores.

It will be appreciated that numerous modifications to the above described design may be made without departing from the scope of the invention as defined in the appended claims. For example, alternative connections between the outer link and the pins may be used such as a split circular clip or collar fitted in the blind bore of the outer link configuration shown in figures 1 and 2. The ends of the clip are designed to engage in suitable grooves or recesses of the pin and outer link.

Another modification to the designs described is the provision of a separate bush between the outer surface of the pin and in the inner surface of the bores in the outer link to provide a better quality bearing surface. Furthermore, the bearing may be a sealed unit with the lubricant being retained therein, thereby obviating the need to supply fresh lubricant.

Finally, the O-ring seals 12, 112 may be housed in annular grooves in the pins 4, 104 rather than in the bores 7, 107 or alternatively may be replaced by other suitable equivalents such as lip seals or metal labyrinth seals.

CLAIMS

1. A drive chain having opposed pairs of inner link plates, each inner link plate being connected to an adjacent outer link by means of at least one pin that passes through overlapping portions of the respective links, wherein each outer link has at least one bore that receives an end portion of the pin and is pivotally retained thereon, and wherein a bearing is defined between an outer surface of the pin and an inner surface of the outer link bore.

2. A drive chain according to claim 1, wherein the end portion of the pin is received in a blind bore in the outer link.

3. A drive chain according to claim 2, wherein the outer link is releasably retained on the pin by means of a fixing member that is removably housed in the outer link and is engageable in a groove or slot defined on the pin.

4. A drive chain according to claim 3, wherein the fixing member is a staple having legs that are releasably housed in apertures in the outer link and are engageable in the groove or slot on the pin to prevent movement of the outer link in the axial direction of the pin.

5. A drive chain according to claim 4, wherein when the staple is removed the apertures may be used to convey lubricant to the bearing.

6. A drive chain according to claim 2, wherein the fixing member is provided entirely within the bore.

7. A drive chain according to claim 6, wherein, the fixing member is a split collar having ends that engage in slots or grooves provided in the pin and the blind bores to prevent movement of the outer link in the axial direction of the pin.

8. A drive chain according to claim 1, wherein the pin is received in an open bore of the outer link and the outer link is retained on the pin by means of a cover plate that is larger than the open bore and that is connected an end face of the pin.

9. A drive chain according to claim 2 or 8, wherein the outer link bore has a slot defined along at least part of its length and the pin has a protrusion that is engageable in the slot during insertion.

10. A drive chain according to claim 9, wherein the bore has an annular groove which receives the protrusion once the chain is assembled, thereby ensuring the outer link is releasably retained on the pin.

11. A drive chain according to claim 8, wherein the cover plate is connected to the pin by means of a screw.

12. A drive chain according to any preceding claim, wherein the bearing is provided with at least one seal to prevent egress of lubrication.

13. A drive chain according to claim 12, wherein the seal is an O-ring that is housed in an annular groove provided in the pin or (blind or open) bores.

14. A drive chain according to any preceding claim, wherein the outer link is a casting.

15. A drive chain according to any preceding claim, wherein the outer link has an internal reservoir for lubricant that is fed to the bearing.

16. A drive chain according to any one of claims 1 to 14, wherein lubricant is supplied to the bearing via a grease nipple or the like.

17. A drive chain according to any preceding claim, wherein the pin is fixedly connected to the inner link plate by means of an interference fit.

18. A drive chain according to any preceding claim in which bearing material is received in a recess in a wall of the outer link bore.

19. A drive chain according to any preceding claim, wherein the outer link bore is tapered so as to permit relative lateral movement of adjacent outer link plates.

20. A drive chain according to claim 19, wherein walls of the outer link bore are tapered in a first plane but are parallel in a second plane, the second plane being substantially perpendicular to the first plane.

21. A drive chain according to claim 20, wherein the outer link has tapered side faces.

22. A drive chain according to claim 21, wherein said side faces are arcuately tapered.

23. A drive chain according to any one of claims 20 to 22, wherein said bores are tapered in said first plane such that they increase in width in a direction away from the inner link.

24. A drive chain according to any preceding claim, wherein said outer link bore has a bearing with a convex arcuate face against which the pin bears, said face intersecting the centre of rotation of the link about the pin.

25. A drive chain according to claim 24, wherein each end of said pin has a reduced portion which contacts said bearing at said centre of rotation in a pivotal relationship.

26. A drive chain according to claim 24 or 25, wherein the bearing is an insert which is embedded in said outer link bore.

27. A method of manufacturing a drive chain as defined in claim 17, wherein at least one bearing aperture is machined in the outer link adjacent the bore, the bearing material is inserted into the bearing aperture and the bore is enlarged until the bearing material is exposed to the bore.

28. A method according to claim 27, wherein the bearing material is in the form of a cylindrical rod before the bore is enlarged.

29. A drive chain substantially as hereinbefore described with reference to figures 1 and 2, figure 3, figures 4 and 5, or figures 6 to 9 of the accompanying drawings.

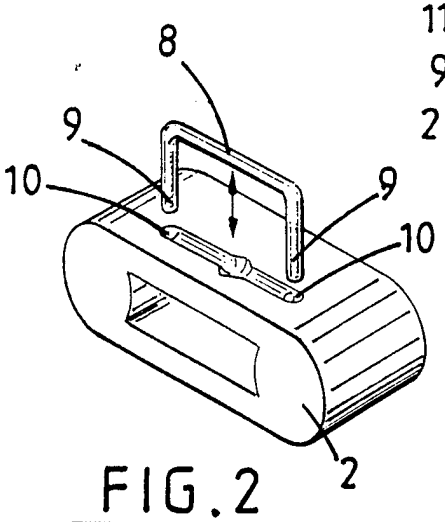

FIG. 2

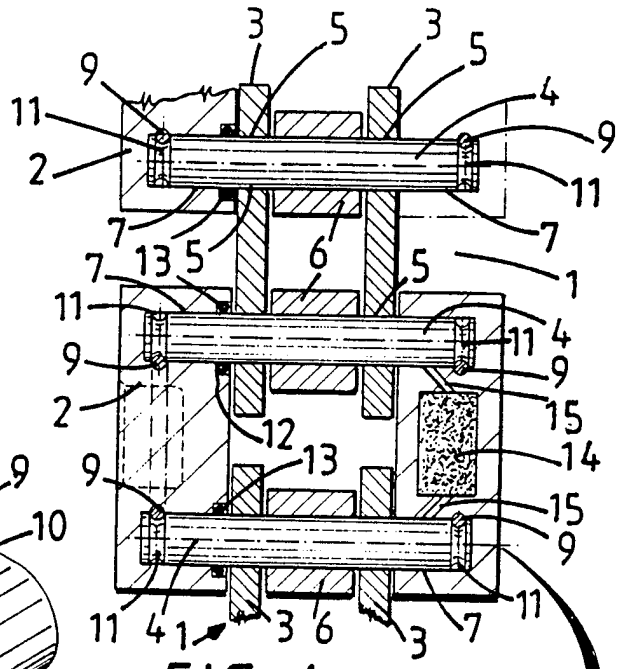

FIG. 1

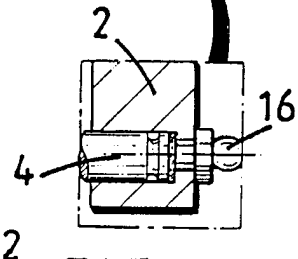

FIG. 3

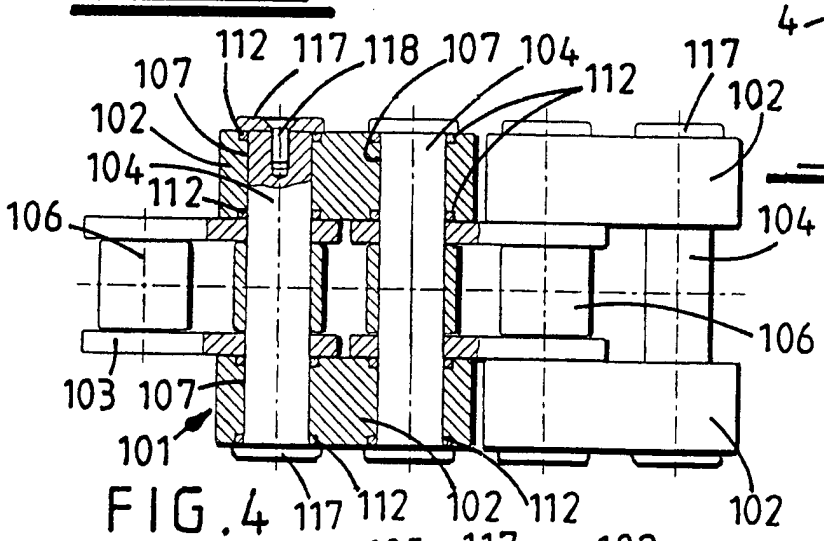

FIG. 4

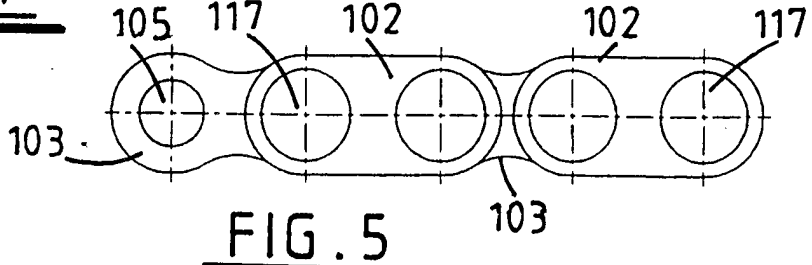

FIG. 5

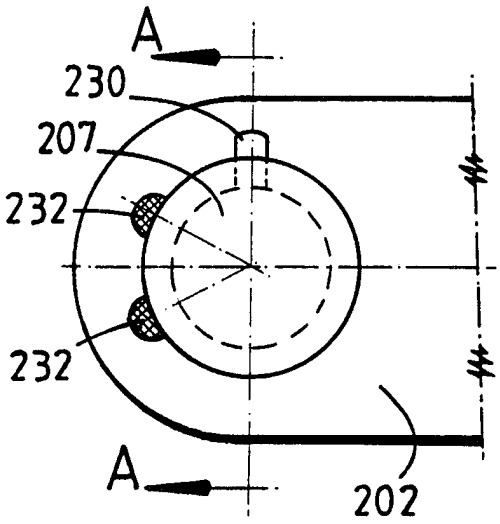

FIG. 7

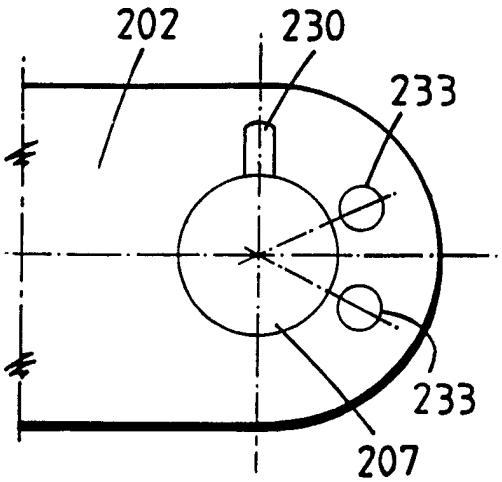

FIG. 6

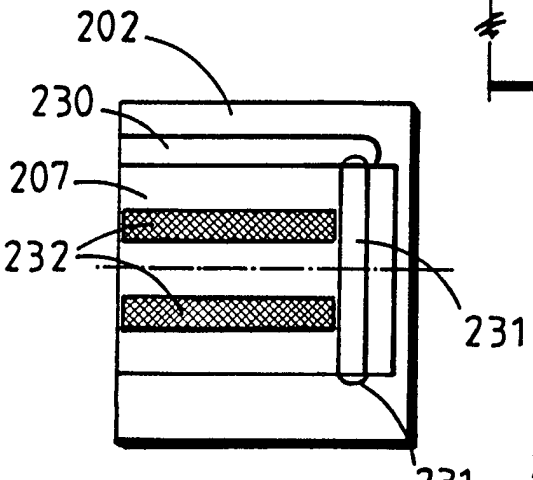

FIG. 8

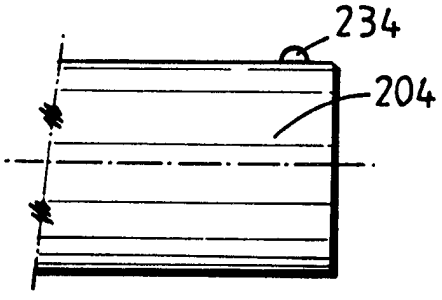

FIG. 9

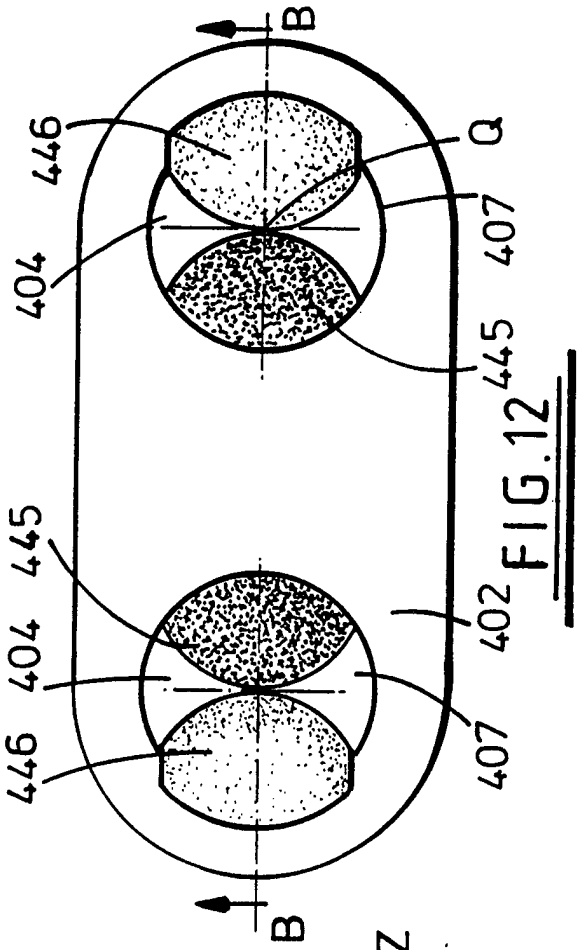

FIG.12

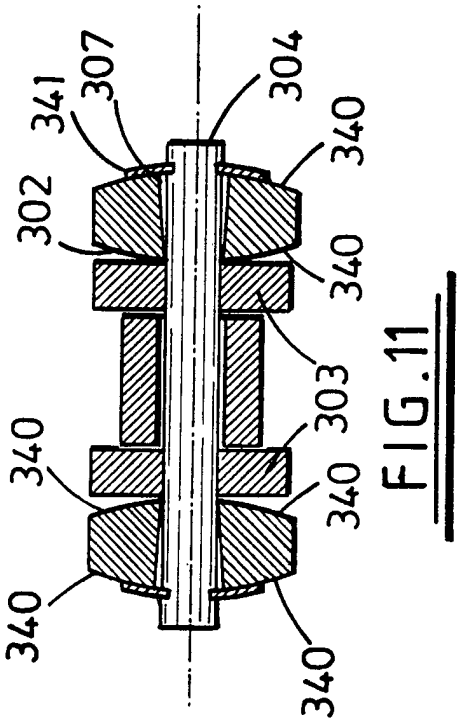

FIG.11

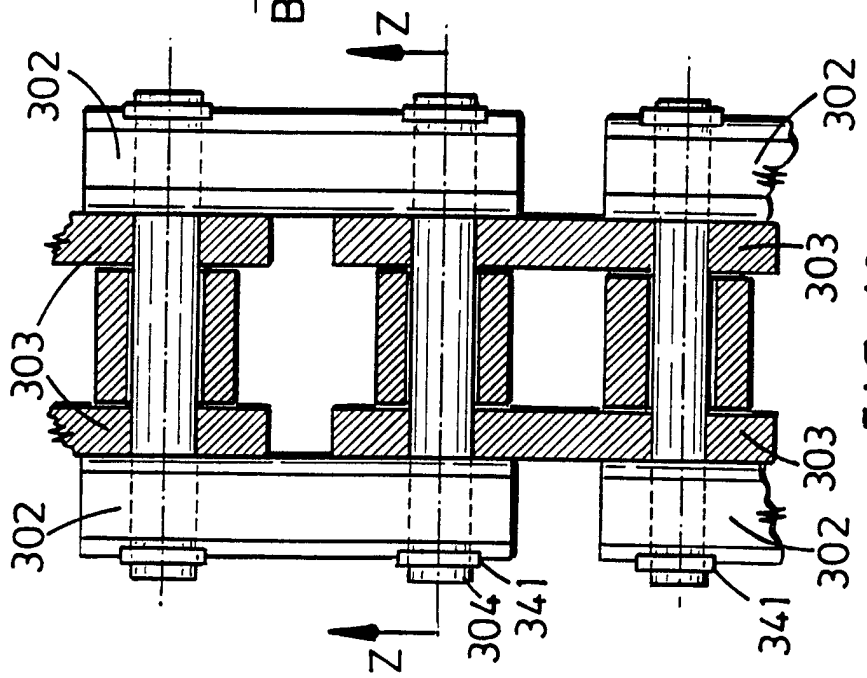

FIG.10

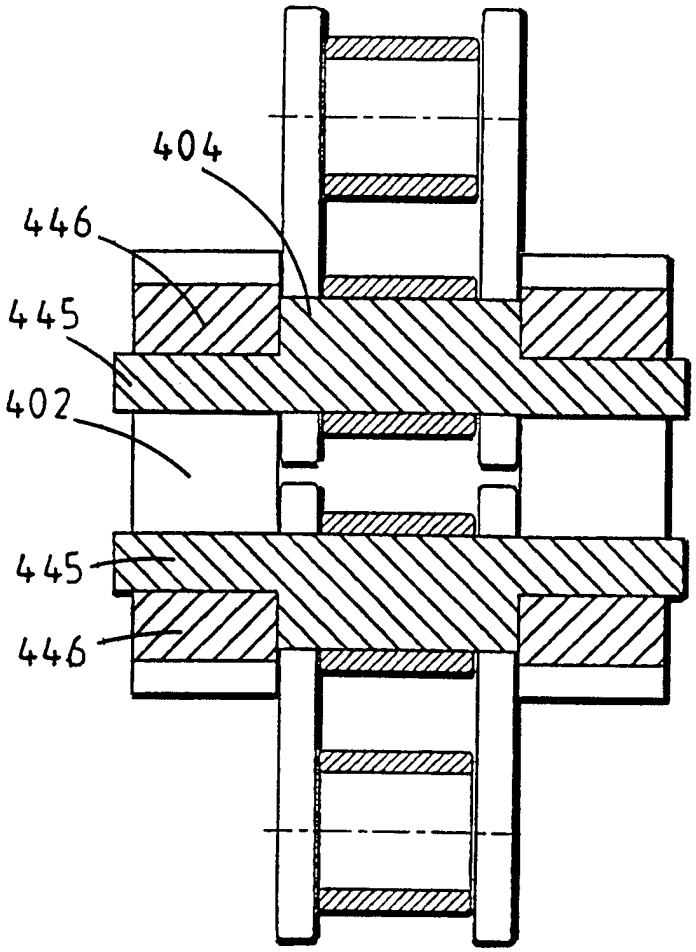

FIG. 13

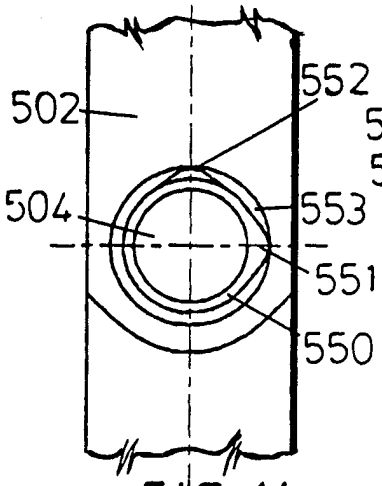

FIG.14

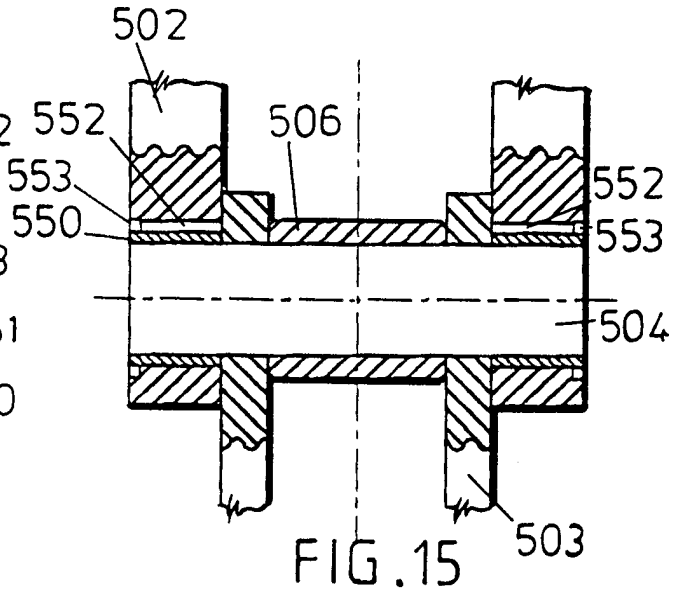

FIG.15

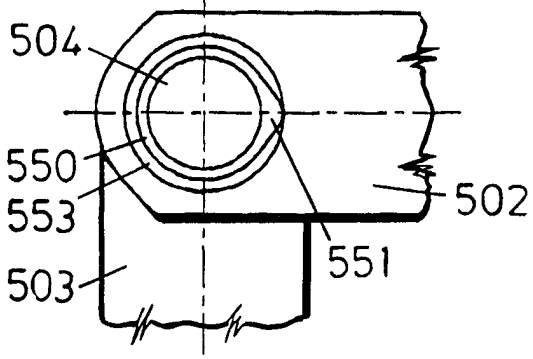

FIG.16