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(54) Universal joint

(57) In this universal joint, rolling elements (8) for each arm (3) of the spider (2) have a diabolo (as shown) or barrel (Figs. 8, 9 and 10 (not shown)) shape and their axes (X—X) are inclined to that of the arm. The rolling elements roll along a spherical surface (4) and a toric surface (7) and the generatrices of the toic surface and the surfaces of the rollers have a radius equal to that of the spherical surface. Clearances may be adjusted using nut 12.

FIG.1

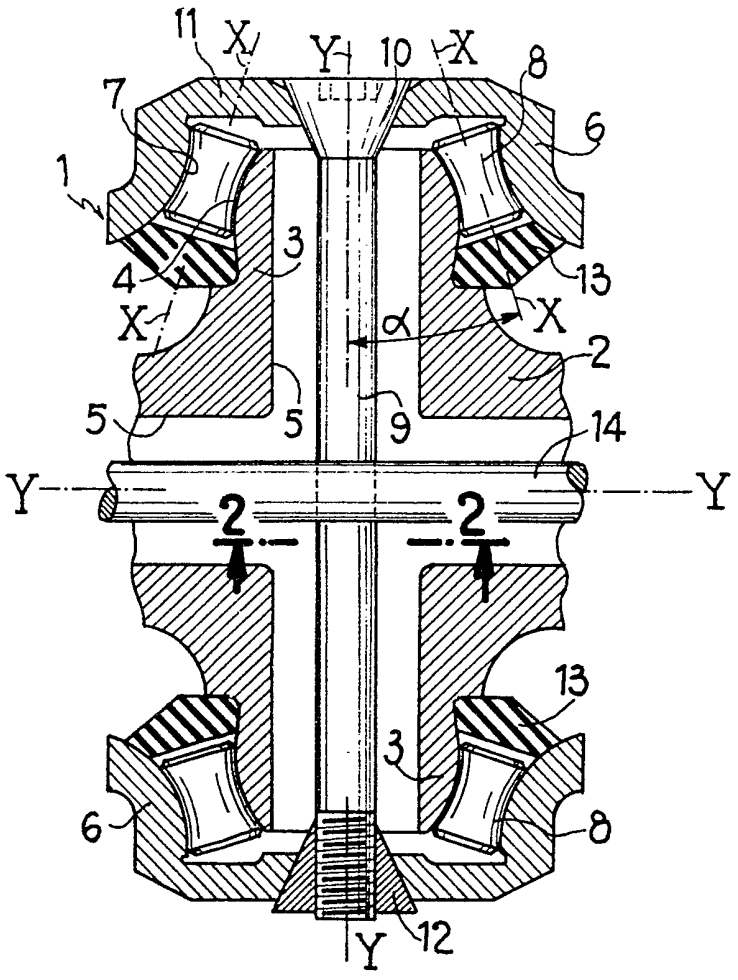

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FIG.1

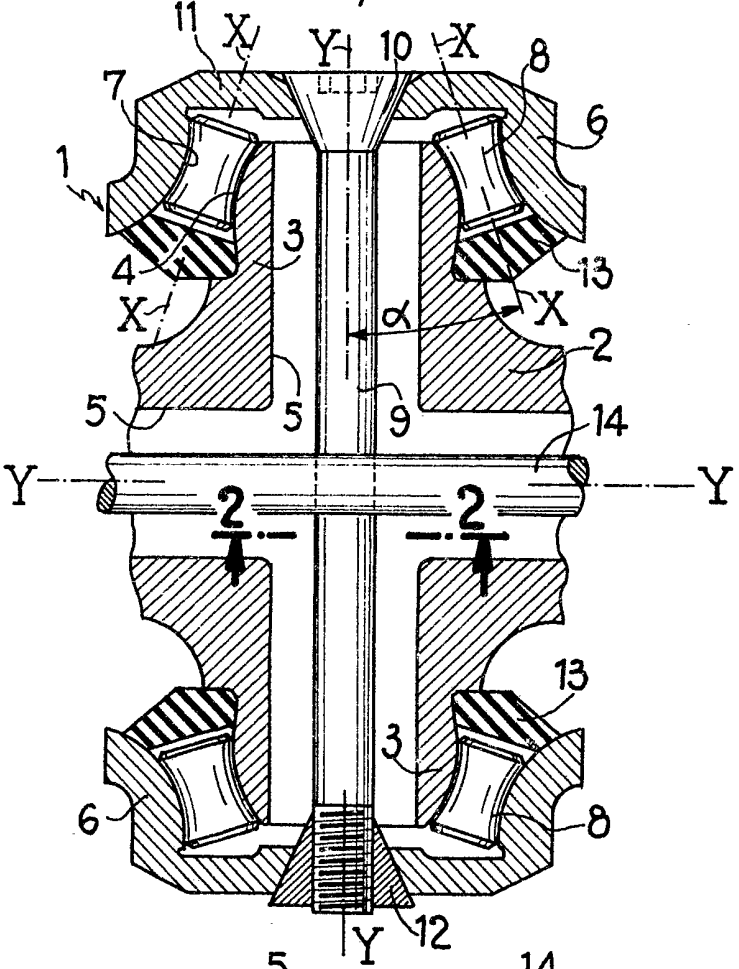


FIG_2

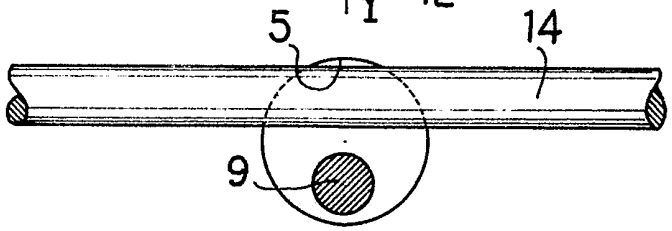


FIG_3

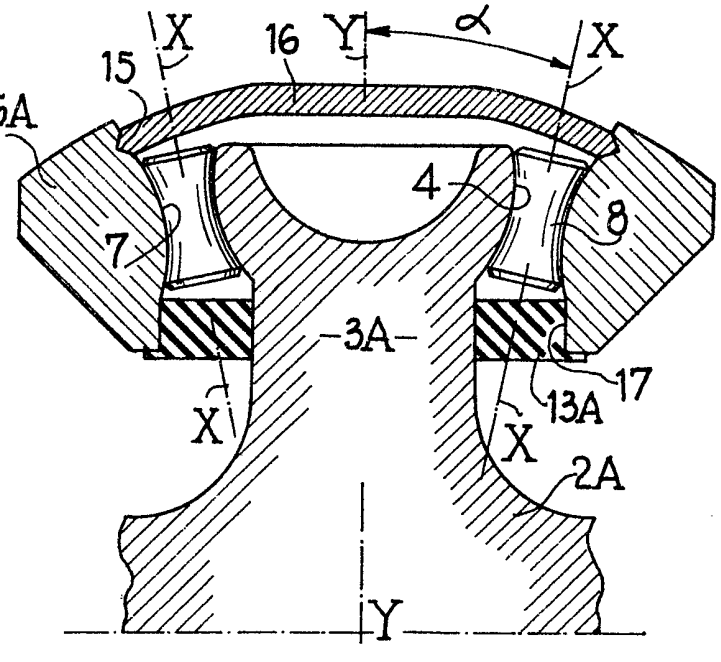


FIG.4

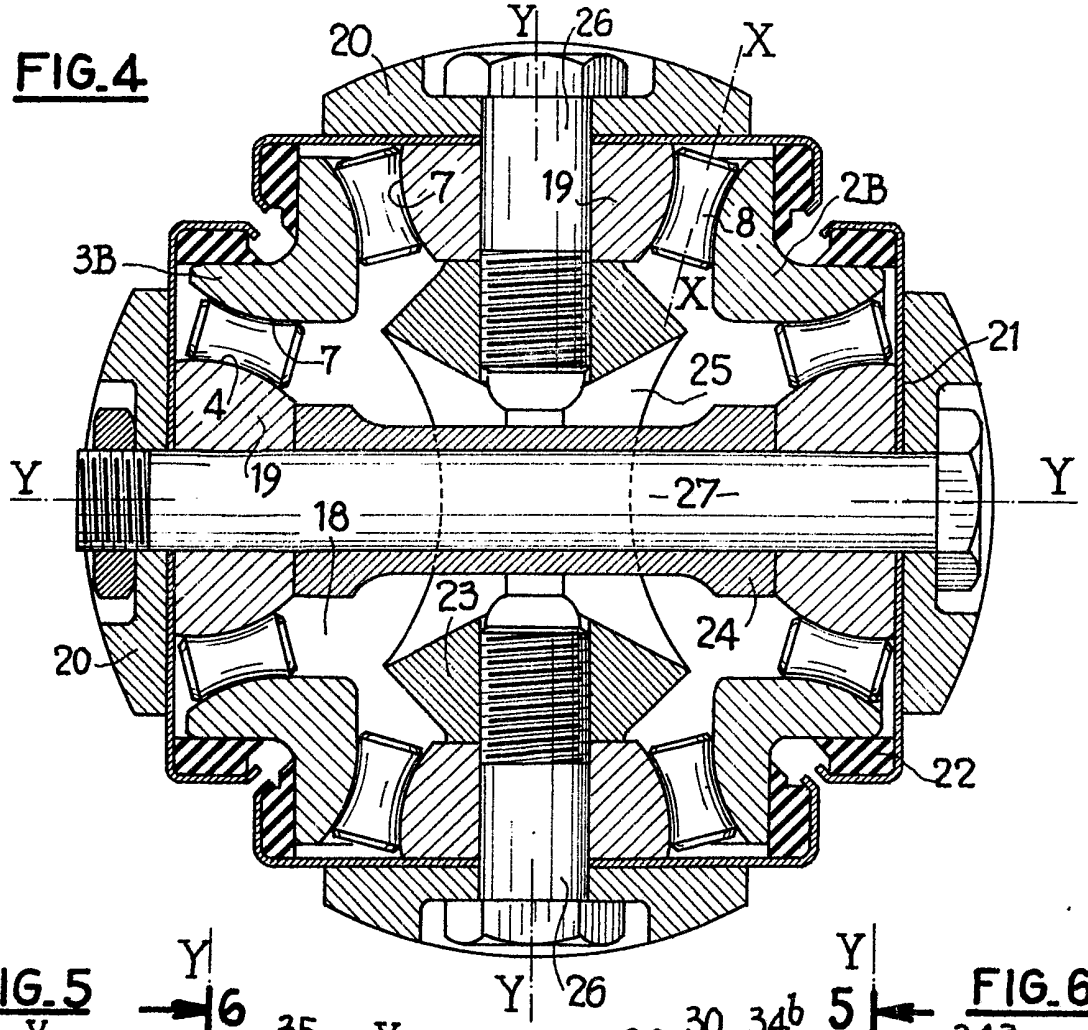


FIG.5

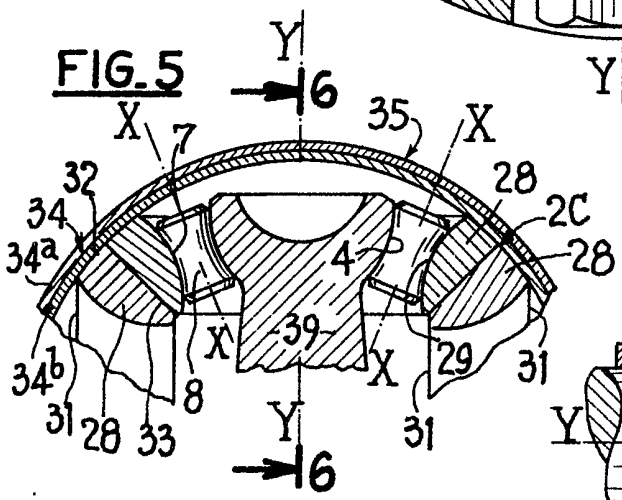
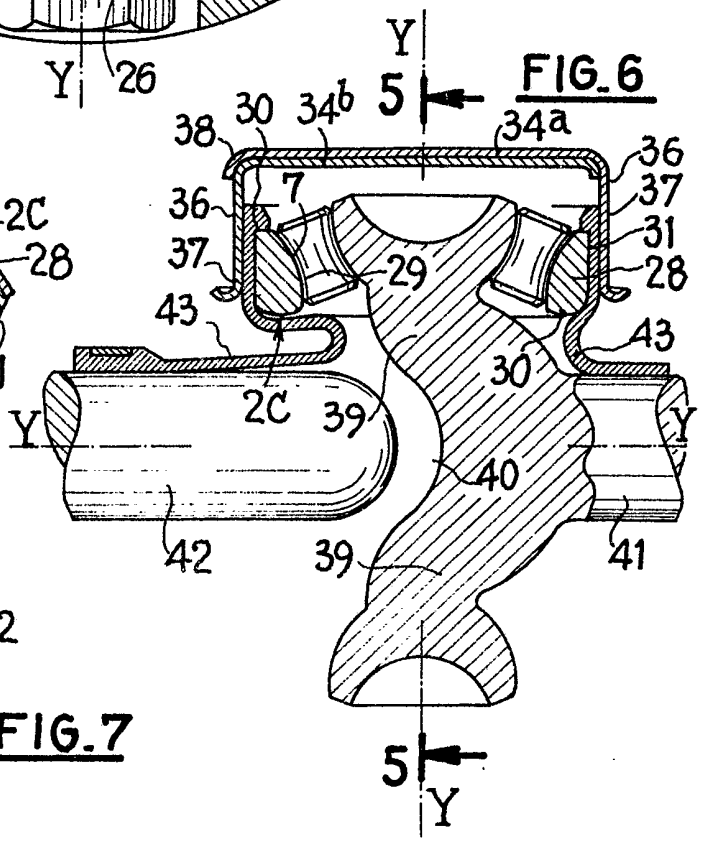


FIG.6



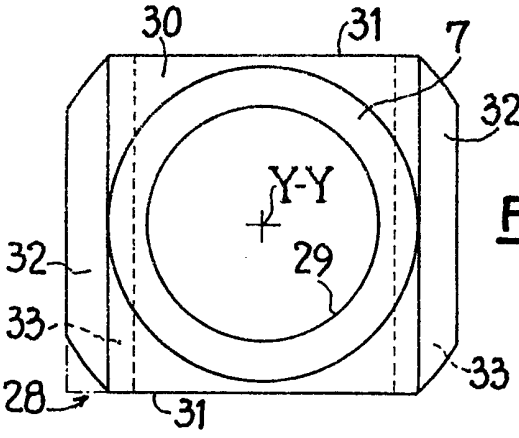


FIG.7

FIG_8

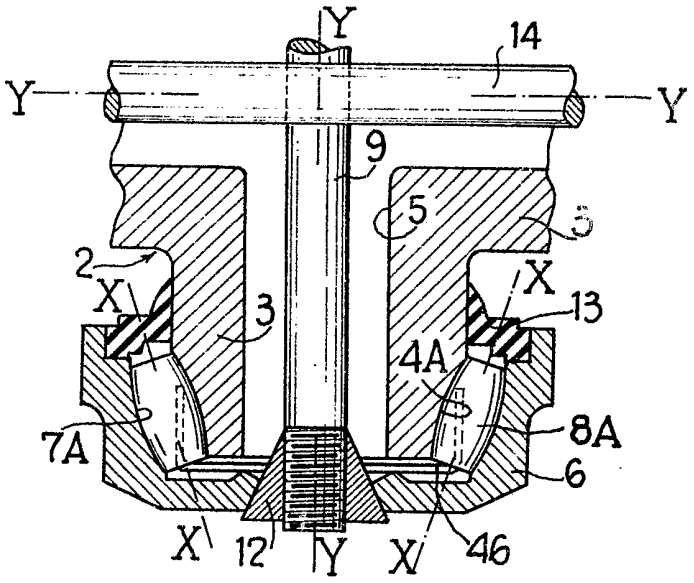


FIG_9

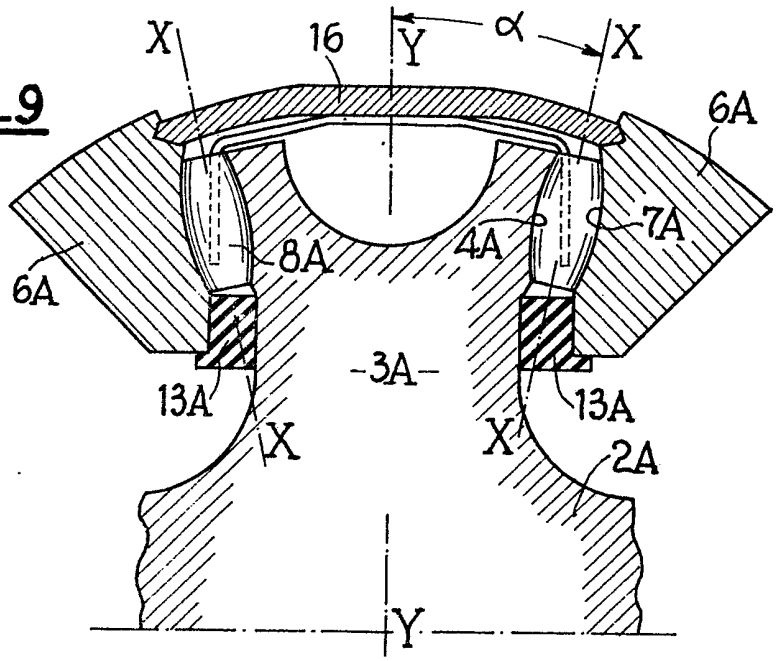


FIG_10

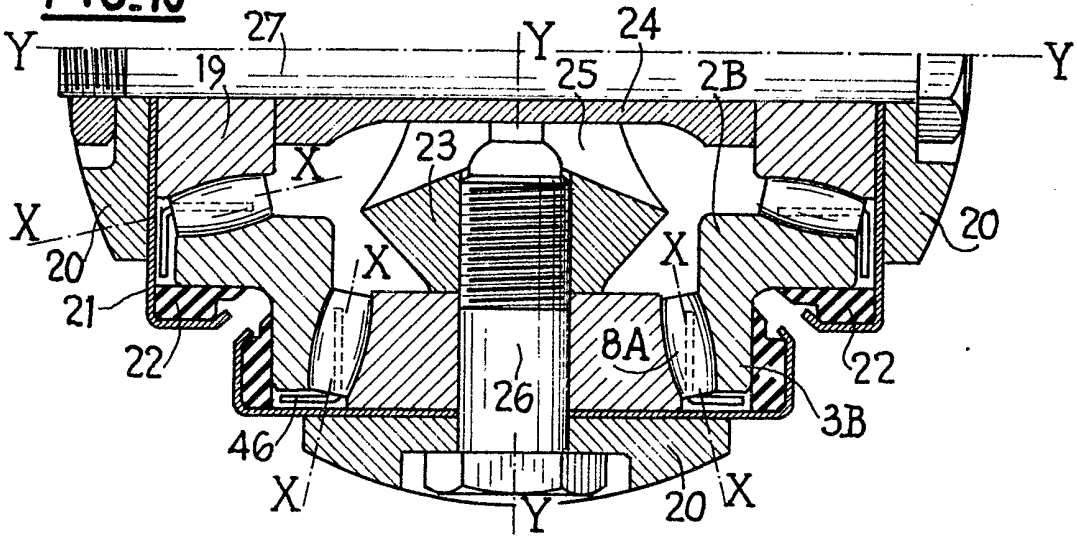
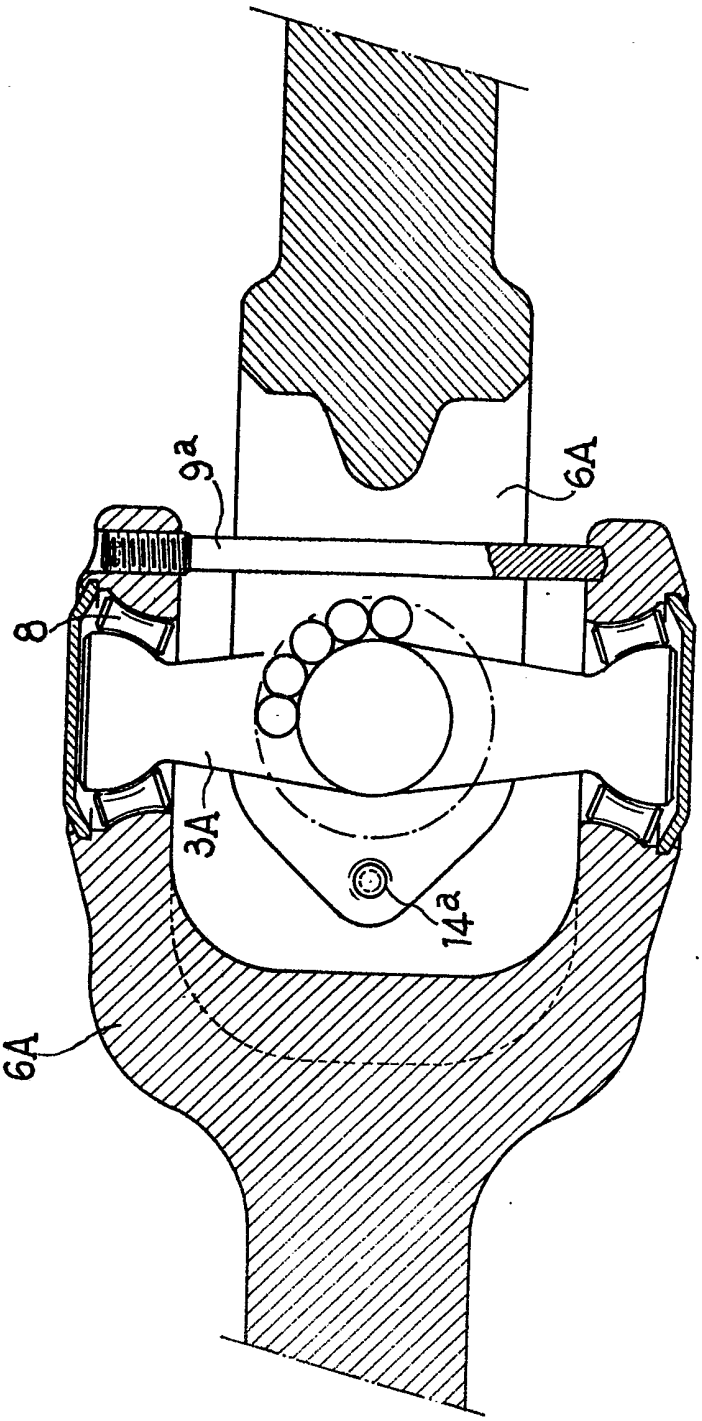


FIG.11



SPECIFICATION

Universal joint

This invention relates to universal joints and their articulations.

The construction of universal joints (or Hooke joints) is well known. These universal joints have been used in millions for transmission shafts in the automobile industry, agriculture, since the beginning of the century.

Conventional universal joints mainly comprise a spider whose four cylindrical bearing surfaces are journalled on needles contained in rollers fitted in the branches of the two fork members. This journalling by means of needles, which constitutes the active mechanical part, has been universally adopted owing to its mechanical qualities of long life and efficiency. However, the following drawbacks and defects are associated therewith:

1) When the joint is subjected to torque, the elastic deformations of the fork members and the elastic deformations of the spider create bending moments in each of the needle bearings with the unfortunate result of considerable overloads on the ends of the needles bringing about premature deteriorations of the bearing surfaces.

2) The contacts of the ends of the needles on the end of the bearing cups tend to incline these needles and block the bearings. The needles thus tend to be engaged in the bottom of the bearing cups and there is a risk of fracture of the needles.

3) The needle bearing does not accept an axial load. In order to complete the bearing, it is therefore necessary to provide an axial bearing. This is achieved by grinding the end faces of the bearing portions of the spider which bear against the ends of the bearing cups. This smooth bearing has the following drawbacks:

rise in temperature when the universal joint rotates at high speed, as is often the case; while the rotation on needles occurs by a rolling action, the direction bearing of the spider on the end of the bearing cup produces sufficient friction to raise the temperature of the assembly;

the bearing against the end of the bearing cup is very delicate to regulate; indeed, if the clearance is considerable, noises result owing to complementary moments produced by the joint operating under torque at an angle, which are converted into cyclic radial forces which take up the clearance suddenly and create noise; if, on the other hand, the spider is prestressed, the temperature produced by the friction creates a risk of a seizure of the bearing surface against the end of the bearing cup.

4) The assembly of these bearing cups on the fork members and on the spider is rather delicate, since each of the two bearing cups, associated by an axis of the spider, ensures a radial and directional guiding and these two bearing cups must therefore by perfectly aligned so as to permit the easy mounting and an easy rotation of the needles. Further, the two journals of each of the axes of the spider must also be perfectly aligned.

5) The capacity condition of the journals including needles forbids any substantial radial clearance; this condition implies a precise production of the diameter of the journals, of the needles and the bore of the bearing cup, and even a matching of these parts or a classification for an assembly in mass-production.

These various drawbacks are well known to those skilled in the art of universal joints, and various improvements of details have been proposed to overcome these drawbacks for many years. However, generally, the problems have been shifted without being really solved, owing to the maintenance of needle bearings.

An object of the present application is to provide a universal joint in which the aforementioned serious drawbacks are all avoided.

The invention therefore provides a universal joint of the type comprising a spider each of the arms of which spider has a first bearing surface, two fork elements each ear of which fork elements defines a second bearing surface, and a ring arrangement of rolling elements having linear contacts and interposed between the two bearing surfaces of each pair, wherein one of the bearing surfaces of each pair is spherical and the other of the bearing surfaces is toric, and the rolling elements have a diabolo or barrel shape, the generatrices of the toric surface and of said rolling elements having a radius equal to the radius of the spherical surface and all the rolling elements having their axes inclined in the same direction relative to the centre of the spider.

The invention is described hereinafter in more detail with reference to the accompanying drawings which show merely some embodiments. In the drawings:

Fig. 1 is a partial sectional view of a universal joint according to the invention;

Fig. 2 is a partial sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a partial view of a modification of the joint shown in Fig. 1;

Fig. 4 is a sectional view of another embodiment of the joint according to the invention;

Figs. 5 and 6 are partial sectional views taken respectively on lines 5—5 of Fig. 6 and 6—6 of Fig. 5, of another embodiment of the joint according to the invention;

Fig. 7 is a view of a component part of the joint shown in Figs. 5 and 6;

Figs. 8 to 10 are half-sectional views of modifications of the joint shown in Figs. 1, 3 and 4, respectively, and

Fig. 11 is a sectional view of a modification of a constructional detail.

The universal joint 1 shown in Figs. 1 and 2 comprises a centre spider 2 having three arms 3 which are coplanar and spaced 90° apart. Each arm has at its free end a spherical bearing surface 4 and an axial bore 5.

An ear 6 in the shape of a cup caps the end of each arm 3. The two opposed ears 6 shown in Fig. 1 are rigid with the first fork element (not shown)

which is rigid with the first shaft (not shown) and the other two ears 6 are rigid with a second fork element which is rigid with a second shaft (not shown).

The inner peripheral surface of each ear 6 has a convex toric shape and defines a second bearing surface 7. A ring arrangement of three diabolo-shaped rolling elements 8 is interposed between the surfaces 4 and 7. The generatrix of these rolling elements is an arc of a circle whose radius is substantially equal to the common radius of the surfaces 4 and 7. The axes X—X of all these rolling elements are inclined in the same direction at the same angle α with respect to the axis of the arm 3 so that all the axes X—X meet the axis Y—Y at a common point. On the four arms, the axes X—X converge outwardly of the joint. The angle α is preferably between 5° and 20°.

A tie rod 9, whose head 10 bears against an end wall 11 of an ear 6, extends with clearance through two corresponding aligned bores 5 and is screwed by its other end in a nut 12 which bears against the end wall of the opposite ear 6. By way of modification, this screwing may also be effected directly in a screwthread formed in the end wall of this ear in combination with suitable lock means. An annular sealing element 13 mounted on each arm 3 maintains the lubricant in the joint and protects each articulation 3-6-8.

The joint 1 is assembled in the following manner:

Initially, the distance between the two ears 6 of each fork element exceeds by a few millimetres the distance between them in the assembled state. Thus, the insertion of an arm 3 and then the opposite arm 3 in the two ears 6 is effected easily. The rolling elements 8 are first placed in position in respect of one ear and then in respect of the other ear without difficulty, owing to an excess amount of clearance between the two ears. Then the tie rod 9 is mounted and screwed into the nut 12.

The clearance or prestressing both radially and axially of the articulations 3-6-8 is adjusted with precision and facilitated by tightening the nut 12 on the tie rod 9 to a greater or lesser extent. In this way, a rapid, precise, rigid and reliable assembly is achieved.

The articulations of the other two arms 3 of the spider are assembled in the same way. The adjustment is provided by the second tie rod 14 which crosses the first tie rod 9 without contacting the latter. For this purpose, as shown in Fig. 2, each tie rod 9, 14 bears against the end walls 11 of the associated ears in an eccentric manner and also extend through the corresponding bore 5 in an eccentric manner.

By way of modification, the tie rods 9 and 14 may be placed outside the spider between the ends of the fork elements as shown by the screw jacks 9a, 14a in Fig. 11.

This first embodiment clearly shows that the defects and drawbacks of conventional universal joints having needle bearings are avoided. Indeed:

(1) The articulations 3-6-8 permit resilient deformations of the fork elements and of the spider without altering the equal distribution of the pressure along the generatrices of the rolling elements, owing to the spherical surface of the bearing surface 14.

(2) The rolling elements 8 are axially positioned without the use of an end abutment, as would be the case for needles or cylindrical rolling elements. Consequently, the shape of their end requires no particular care or precision.

(3) The rolling elements can in no way become inclined, or assume a position on a skew, owing to their contact with the convex toric region 7. Therefore, no jamming is possible and no cage is necessary.

(4) The reactions along the axes Y—Y of the spider coming from complementary moments are absorbed by the rolling elements with no additional means and with no heating or risk seizure.

(5) The axial and radial clearances or the initial prestressings are adjusted with great facility and without necessity of a very high precision or a matching of the component parts, and consequently cheaply and reliably.

(6) The capacity and the reliability of the articulations are ensured cheaply, and operation is silent and without heating.

(7) The production of the main component parts of steel and their bearing surfaces lends itself very well to cold-forming operations. A grinding finishing operation on the bearing surfaces may be eliminated. The added bearing cups existing in conventional universal joints may be eliminated.

By way of a modification (Fig. 3), the direction of the convergence of the axes X—X of the rolling elements may be reversed, which increases the load capacity. In this case, the ear 6A, which may be in one piece with the fork element carrying this ear, preferably has a centre opening 15 allowing the passage of the arm 3A and in which a closing member 16 of annealed steel is a drive fit and held in position by a forming-over operation.

The joint is assembled in the following manner:

Before placing the closing members 16 in position, the spider 2A, provided with sealing elements 13A ready for use on the arms 3A, is inserted in the openings 15 of one fork element, one arm after the other. Then the rolling elements are placed in position for one of the journals or trunnions. The two ears 6A of the fork elements are then compressed toward each other in a vice or a press so as to urge them a few millimetres resiliently toward each other. In this position, the rolling elements of the second articulation 3A-6A-8A are easily inserted. The fork element is then released and it resumes its original position and provides the desired prestressing, which is not subsequently adjustable in this embodiment, after which the closing members 16 are placed in position, the lubrication is carried out and the sealing elements 13A are placed in position in their cavity 17.

However, there may also be provided

transverse screws, such as 9 and 14 (Fig. 2), which act in compression so as to adjust with precision the distance between the two ears of each fork element. These screws may then be located either inside the spider as shown in Fig. 2, or outside at the end of the two ears of each fork element as shown in Fig. 11.

The choice of the direction of convergence of the axes X—X of the rolling elements 8 depends on the application and on the envisaged production methods.

In the embodiment shown in Fig. 4, in which the axes X—X of the rolling elements diverge inwardly as in Fig. 3, the spider 2B is hollow and has a large cavity 18. Each arm 3B is annular and has internally the toric bearing surface 7. Each spherical bearing surface 4 is defined on a ring 19 which is screwthreadedly mounted on one end of a fork element 20 with interposition of a cup 21 of a sheet metal. This cup caps with clearance the associated arm 3B, with interposition of a sealing element 22 which provides the seel and retains the lubricant in the joint.

Each pair of rings 19 is blocked by screwing, at the same time as the ends of its fork element 20, on the two end surfaces of a spacer member 23, 24. The spacer member 23 has a bi-divergent centre bore 25 through which extends the spacer member 24 which is tubular. The rings 19 are fixed by two separate screws 26 to the first spacer member and by a common bolt 27 to the second spacer member through which latter this bolt extends.

The fork elements 20 may be advantageously turned externally as cylinders in order to facilitate production and reduce overall size. The fact that they are blocked against the spacer members 23 and 24 imparts great rigidity to the assembly and permits a precise choice of the prestressing. In this way, a universal joint is provided whose precision and smooth operation are essential in certain mechanical application.

Fig. 5 to 7 show another embodiment in which axes X—X of the rolling elements 8 diverge relatively to the centre of the joint. Here again, the spider 2C is hollow. It is formed by the assembly of four rings or segments 28, one of which is shown in Fig. 7.

Each ring 28 has a circular aperture 29 defined by the toric surface 7. A planar surface 30, perpendicular to the axis Y—Y of the aperture and having a roughly square shape, is provided at each end of this aperture 29. The surfaces 30 are interconnected on both sides by planar surfaces 31 which are perpendicular thereto and, on the other two sides, by two cylindrical surfaces 32 extended by two planar surfaces 33 which converge towards each other and are perpendicular to each other.

The rings 28 are assembled in the general shape of a square by their planar surfaces 33. They thus define by their surfaces 32 a cylindrical surface which is surrounded with prestressing by the cylindrical skirt 34 of a housing 35 constituted by two halves 36 in the shape of annular cups with a planar end wall.

More precisely, the cylindrical peripheral surface 34a of one cup 36 overlaps the peripheral cylindrical surface 34b of the other and its edge portion 38 is formed over after assembly so as to constitute the skirt 34 by a setting assembly.

The fork elements of the joint are formed by two pairs of branches 39 located inside the spider 3C and forming a v which defines a space 40 allowing movements thereof. Each fork element is rigid with one of two shafts 41, 42 to be coupled. The seal and the retention of the lubricant are ensured by the housing 35 and by two gaiters 43 which are inserted by their large end between the ends 37 of the housing and the planar surfaces 31 of the segments 28 and fixed in a sealed manner to the shafts 41 and 42 by their small end.

The rings 28 may be produced by a cold stamping operation and it is unnecessary to form their corners 44 by rounded surfaces 45 as shown in Fig. 7.

In each embodiment of the articulation or of the universal joint according to the invention, the diabolo-shaped rolling elements 8 may be replaced, as shown in Figs. 8 to 10, by barrel-shaped rollers 8A whose generatrices are also arcs of the circle of the same radius. In this case, the inner bearing surface 4A is a concave toric surface and the outer bearing surface 7A is a concave spherical surface. All the advantages achieved with the diabolo-shaped rolling elements are then retained, provided that there are provided, in addition, cages 46, for example of the comb type, which ensure that the axis X—X of each of the barrel-shaped rolling elements 8A and the axis of the inner bearing surface are coplanar. In the case of the diabolo-shaped rolling elements, the cages are not required, but spacer members circumerentially interposed between the rolling elements cay be provided in order to prevent contacts between the rolling elements.

It will be understood that the particularities of the various embodiments described hereinbefore may be combined in different ways so as to form other embodiments without departing from the scope of the invention. These features are in particular the direction of convergence of the axes X—X of the rolling elements, the central or annular configuration of the spider and the outer or inner type of its bearing surfaces, the construction of the spider in a single piece or in a plurality of segments, and the barrel or diabolo shape of the rolling elements, and the modes of assembly and elimination of the bearing clearances.

CLAIMS

1. A universal joint of the type comprising a spider, each arm of which spider defines a first bearing surface, two fork elements, each ear of which fork elements defines a second bearing surface, a ring arrangement of rolling elements having linear contacts and interposed between the two bearing surfaces of each pair of bearing surfaces, wherein one of the bearing surfaces of

each pair is spherical and the other bearing surface is toric, and the rolling elements have a diabolo or barrel shape, the generatrices of the toric surface and of said rolling elements having a radius equal to the radius of the spherical surface and all the rolling elements having their axes inclined in the same direction with respect to the centre of the spider.

2. A universal joint according to claim 1, wherein said means bears against one ear and is rolling elements with respect to the axis of the corresponding arms is between 5° and 20°.

3. A universal joint according to claim 1 or 2, wherein the two ears of each pair are interconnected by means having an adjustable effective length.

4. A universal joint according to claim 3, wherein said means bears against one ear and is screwthreadedly engaged in the other ear, or in a nut which is rigid with said other ear.

5. A universal joint according to claim 3 or 4, wherein the two means cross each other without touching in two parallel planes and are eccentric with respect to the ears.

6. A universal joint according to claim 3 or 4, wherein the two means are disposed outside the spider between the ends of the ears of each fork element.

7. A universal joint according to any one of the claims 1 to 6, wherein each ear surrounds the associated arm of the spider.

8. A universal joint according to claim 7, wherein the axes of the rolling elements converge toward the interior of the joint and each ear has, in the region of the associated arm, an opening provided with a mounted closing member.

9. A universal joint according to claim 1, wherein the spider is hollow and contains in the cavity thereof the rolling elements and the bearing surface of the ears.

10. A universal joint according to claim 9, wherein each ear is fixed to the end of a spacer member which connects the ear to the opposed ear, the two spacer members crossing without touching each other.

11. A universal joint according to claim 10, wherein one of the spacer members has centre bi-divergent bore, through which the other spacer member extends with clearance.

12. A universal joint according to claim 10 or 11, wherein each ear comprises a cup which caps the associated arm of the spider with clearance but with the provision of a sealing element.

13. A universal joint according to caim 9, wherein the spider comprises four annular segments in abutting relation to each other and maintained assembled by an annular housing.

14. A universal joint according to claim 13, comprising two gaiters each of which gaiters has one end fixed to a shaft to be coupled by the joint and an opposite end clamped between the housing and the segments of the spider.

15. A universal joint, substantially as hereinbefore described with reference to and as shown in Figs. 1 and 2, or Fig. 3, or Fig. 4, or Figs. 5, 6 and 7, or Fig. 8, or Fig. 9, or Fig. 10, or Fig. 11 of the accompanying drawings.

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