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- (71) Applicant (for all designated States except US): **T.M.S. TECNOLOGIES MECCANICHE SPINAZZE S.R.L.** [IT/IT]; Via Cirogogno, 6, 30027 San Dona' Di Piave (IT).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **LUCCHINI, Giuseppe Giovanni** [IT/IT]; Via Principe Tommaso, 37, 10125 Torino (IT).
- (74) Agents: **JORIO, Paolo** et al.; c/o Studio Torta S.r.l., Via Viotti, 9, IT-10121 Torino (IT).
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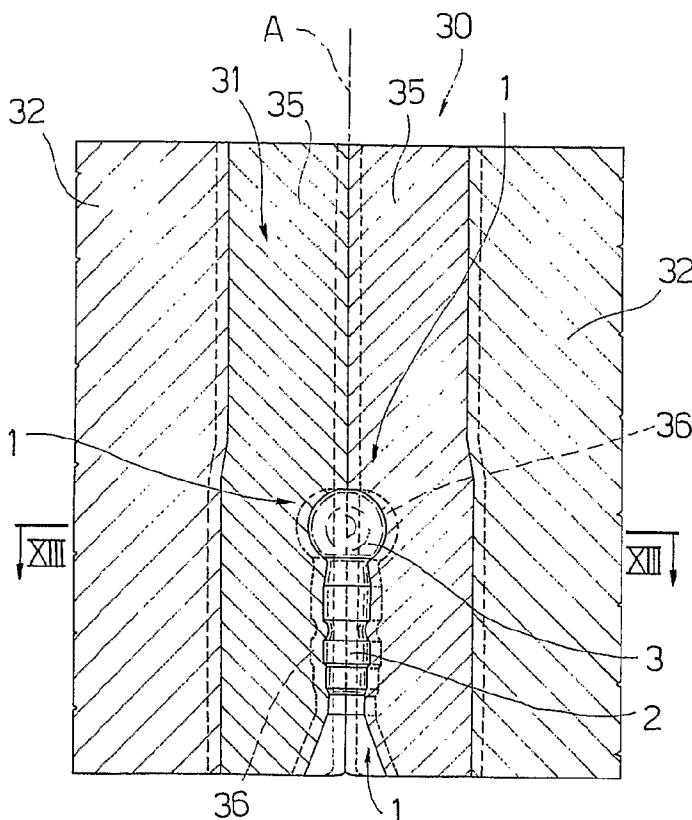
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(54) Title: METHOD FOR MANUFACTURING A PIN PROVIDED WITH A SPHERICAL END PORTION FOR ENGAGING A BALL JOINT



(57) Abstract: A manufacturing method is described for a pin (1) provided with an essentially spherical end portion (3) for engaging a ball joint; the manufacturing method comprising the steps of: plastically deforming a rough element so as to manufacture an elongated main portion (2) and the end portion (3) of said pin (1); and performing a finishing operation on a peripheral portion (8) of said pin (1) for reducing roughness of the peripheral portion (8) itself; a metal plate disk (10) is used as rough element in said plastic deformation step.

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**METHOD FOR MANUFACTURING A PIN PROVIDED WITH A SPHERICAL  
END PORTION FOR ENGAGING A BALL JOINT**

TECHNICAL FIELD

5       The present invention relates to a manufacturing method for a pin provided with a spherical end portion for engaging a ball joint in automotive applications.

BACKGROUND ART

10       There are known ball joints adapted to connect two members so as to manufacture a ball hinge, i.e. so as to allow relative rotations between the two members.

      In particular, each ball joint comprises a first pin integral with a first member, and a second pin integral with a second member and coupled to the first pin so as  
15       to turn within a cone having vertex within the first pin and extending towards the second pin.

      More precisely, the first and second pins are provided, at respective reciprocally coupled ends, respectively with a ball portion and with a portion  
20       defining a ball cavity, and with a portion defining, in coupling conditions of the first and second pins, the ball portion of the first pin, so as to allow the relative rotation between the first and second members.

      More precisely, in coupling conditions, the second  
25       member is turnable about the centre of the ball portion of the first member, while the first member is turnable

about the centre of the ball portion of the second member.

It is observed that a manufacturing method of the first pin comprises a first step of drawing a full bar; a  
5 second hot deformation step, by electrical upsetting, of the full bar so as to obtain a semi-finished product provided with the ball portion; a third step of hardening the semi-finished product by means of tempering and hardening treatments; a fourth step of removing a  
10 machining allowance layer, by stock removal, from the semi-finished product; and a fifth finishing step of the semi-finished product, by cold rolling, so as to complete the first pin.

The aforesaid method is not very cost-effective,  
15 because a full bar must be manufactured and considerable waste of material is generated during the fourth removal step.

Furthermore, the aforesaid method allows to obtain pins having full ball portions, with considerable weight  
20 increase of the pin itself.

#### DISCLOSURE OF INVENTION

It is the object of the present invention to create a method for manufacturing a pin provided with a ball end portion for engaging in a ball joint, which allows to  
25 simply and cost-effectively obtain said pin, thus avoiding waste of material at the same time.

The aforesaid object is reached by a present invention, in that it relates to a method for manufacturing a pin provided with a ball end portion for engaging in a ball joint, as defined in claim 1.

5           BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, a preferred embodiment will now be described only by way of non-limitative example, and with reference to the accompanying drawings, in which:

- 10           - figure 1 shows a side view of a pin provided with a ball end portion, manufactured by means of a method according to the present invention;
- figure 2 shows a perspective view of a metal plate disk used to manufacture the pin in figure 1;
- 15           - figures from 3 to 9 show an axially sectioned perspective view of sequential deformation steps of the disk in figure 1;
- figures 10 and 11 show in transversal section and in two different configurations, a fixture adapted to
- 20           perform a rotating hammering operation during deformation of the disk in figure 1;
- figure 12 shows in axial section the fixture of figures 10 and 11; and
- figure 13 is a section taken along line VIII-VIII
- 25           in figure 12.

BEST MODE FOR CARRYING OUT THE INVENTION

In figure 1, number 1 indicates a pin of axis A comprising a main portion 2 adapted to be operatively connected to a first member (not shown) and to a ball end portion 3, which is adapted to be accommodated within a complementary shaped seat of a second pin (also not shown) operatively connected to a second member; in this way, the first and second members are connected to the aforesaid pins in reciprocally turnable fashion about three reciprocally orthogonal directions and manufacture a ball joint.

In greater detail, the main portion 2 essentially comprises a cylindrical end segment 4 opposite to portion 3; a segment 9 joined to portion 3 and having a conical shape tapered towards portion 3; and a groove interposed between segments 4, 9 and joined to segments 4, 9 by means of a cylindrical segment 11 and a cylindrical segment 18, respectively.

More in particular, segment 4 ends, on the side opposite to segment 18, with a chamfer 4a and is joined to segment 18 with a chamfer 4b.

Pin 1 is obtained by means of a method comprising the steps of plastically deforming a rough element so as to make portions 2, 3 of the pin 1 itself; and to perform a finishing operation on a peripheral surface 8 of pin 1 to reduce roughness of the surface 8 itself.

Advantageously, a metal plate disk 10 (shown in figure 1) is used as rough element in the plastic deformation step.

In greater detail, the plastic deformation step  
5 comprises the steps of:

pressing the disk 10, so as to obtain a body 12 (shown in figure 8) axially and symmetrically provided with a main elongated portion 13 and a respective essentially spherical end portion 14, which internally  
10 define a cavity 15; and

radially hammering in centripetal direction the body 12, after the step of pressing the disk 10, so as to obtain the main portion 2 and the end portion 3 of pin 1.

Disk 10 presents an axis of symmetry coinciding,  
15 after deformation, with the axis A of pin 1, and indicated, for the sake of simplicity, with A in figure 2.

Body 12 extends about an axis coinciding after deformation with axis A of pin 1 and of plate 10; such  
20 extension axis of body 12 is indicated, for the sake of simplicity, with A in figure 8.

Figures from 3 to 8 show sequential pressing operations of the disk 10 at the end of which the body 12 is obtained.

25 Disk 10 is firstly pressed so as to obtain an axial and symmetric body 21 (figures from 3 to 7), which

comprises a hollow portion 22, extending along axis A and symmetrically extending with respect to axis A itself; the body 21 further comprises a bottom portion 23 axially delimiting portion 22.

5           Body 21 is therefore axially open on the opposite side of portion 23.

          More precisely, body 21 symmetrically extends about an axis coinciding, after deformation of plate 10, with axis A of plate 10 and indicated for the sake of  
10   simplicity with A in the figures from 3 to 7.

          Furthermore, body 21 is elongated in axial direction and shortened in radial direction during each of the operations shown in the figures from 3 to 7.

          During the operations shown in figures from 3 to 5,  
15   portion 23 of the body 21 is deformed so as to pass from a flat plan shape orthogonal to axis A and joined, at an external radially circumferential edge, to portion 22 (figures 3 and 4) with essentially half-spherical shape joined to portion 22 (figure 5).

20           Subsequently, portion 22 of body 21 is deformed so as to assume a tapered conical shape on the side opposite to portion 23 (figure 6).

          Portion 22 of body 21, from the configuration shown in figure 6, is further deformed, by pressing, so as to  
25   present (figure 7) a cylindrical segment 24 opposite to portion 23 and a segment 25 interposed between portion 23

and segment 24.

In particular, the segment 25 presents a tapered conical shape from portion 23 to segment 24.

Subsequently, segment 24 is further elongated, by  
5 deformation, so as to define portion 13 of body 12  
(figure 8), while segment 25 is deformed so as to define  
a segment 26, spherical zone shaped, axially interposed  
between segment 24 and portion 13.

Segment 26 and portion 23 define portion 14 of the  
10 body 12.

More precisely, the term spherical zone in the  
present description means a solid defined by the portion  
of a sphere comprised between two reciprocally parallel  
planes intersecting the sphere itself.

Body 12 is firstly hammered, at a respective outer  
15 surface 16, so as to reduce the radial dimension of a  
region 17 of cavity 15 accommodated within portion 13 and  
to obtain a semi-finished product 5 (figure 9), which is  
provided with a respective main elongated segment 6 and a  
20 respective essentially spherical end segment 7;  
subsequently, segment 6 and segment 7 of the semi-  
finished product 5 are radially hammered to obtain main  
portion 2 and end portion 3 of pin 1.

More precisely, the external radial surface 16 of  
25 portion 13 is deformed, by means of a first rotating  
hammering operation, so that each internal generating

line of region 17 is in contact with a corresponding internal generating line diametrically opposite to the same with respect to axis A and to obtain the full portion 6 of semi-finished product 5.

5 More precisely, region 17 is delimited by an internal cylindrical edge 27 of portion 13; during the first rotating hammering operation, the radial dimension of region 17 is progressively reduced to cancel out and the cylindrical edge 27 progressively reduces its side  
10 surface to become a segment S parallel to axis A (figure 9).

Furthermore, at the end of the first hammering operation, the radial thickness of the portion 6 (figure 9) is higher than the radial thickness of portion 13  
15 before the first hammering operation itself (figure 8).

At the same time as deformation of portion 13, the first rotating hammering operation deforms portion 14 so as to obtain the spherical portion 7 of the semi-finished product 5 and to join portion 7 to portion 6.

20 More precisely, segment 26 is deformed until it assumes a semi-spherical shape and the portion 7 results, when deformation is completed, hollow and closed on the axially opposite side of portion 6.

Subsequently, the semi-finished product 5 is  
25 subjected to a further rotating hammering operation at the end of which pin 1 is made.

During the further rotating hammering operation, portion 6 of semi-finished product 5 is deformed so as to obtain portion 2 of pin 1, and portion 7 of semi-finished product 5 is deformed so as to obtain portion 3.

5 In greater detail, the rotating hammering operations of body 12 to obtain the semi-finished product 5, and of the semi-finished product to obtain the body 1 are performed by means of a rotating hammering machine 30.

The rotating hammering machine 30 is shown in  
10 figures from 10 to 13 during a deformation step of semi-finished product 5 to obtain pin 1.

With reference to figures from 10 to 13, the rotating hammering machine 30 essentially comprises a die 31 with the semi-finished product 5 to obtain pin 1; a  
15 plurality of hammers 32 (two, in the case in point) cooperating on opposite sides with the die 31 and mobile from and to semi-finished product 5 so as to move the two counterpoised elements 35 of die 31 according to an approach or distancing stroke with respect to the semi-  
20 finished product 5 being machined and to carry out the deformation of the semi-finished product 5 itself; and a guiding assembly 33 adapted to delimit the distancing stroke of the hammers 32 on the opposite side of the elements 35.

25 In greater detail, elements 35 extend longitudinally according to a direction parallel to axis A of the semi-

finished product 5 being machined.

Each member 35 is adapted to cooperate, at a first internal radial end wall, with semi-finished product 5, and is operatively connected, at a second external radial end wall opposite to the first wall, with a respective hammer 32.

Each member 35, presents a concavity 36 at the respective first wall.

Concavities 36 are shaped so as to jointly define a cavity whose shape is complementary with that of pin 1.

The hammering action exerted by concavities 36 on semi-finished product 5, following the approach and distancing strokes of the hammers 32, plastically deforms the semi-finished product 5 itself to obtain pin 1.

Furthermore, each member 35 is operatively connected (in a way not shown) to the respective hammer 32 so as to be integral with the aforesaid respective hammer 32 during the approach and distancing stroke of the respective hammer 32 itself to and from the semi-finished product 5.

Hammers 32 are elastically connected together by a pair of springs 37 and are moved, by means of a motor not shown, according to a rotary motion with respect to axis A.

More precisely, springs 37 are preloaded so as to reciprocally distance hammers 32 and consequently

distance elements 35 from semi-finished product 5.

Hammers 32, springs 37, die 31 and body 12 or semi-finished product 5 being machined are accommodated within a through seat of a cylinder 38, which is coaxially  
5 arranged with respect to axis A.

The guiding assembly 33 comprises a cylinder 40 externally delimiting the hammering machine 30, coaxially surrounding the cylinders 38, and accommodated within a plurality of rollers 41 angularly equidistanced and  
10 coaxial, in operating conditions, to axis A.

More in particular, the cylinder 40 is delimited by a pair of radial end cylindrical walls 42, 43, external and internal, respectively.

The rollers 41 radially protrude from the wall 43  
15 towards the cylinder 40 and are radially distanced from a radial end wall 45 of the cylinder 38.

In this way, roller 41, wall 43 and wall 45 delimit a groove 46, which circumferentially extends between cylinders 38, 40 and present a variable radial dimension.

20 More precisely, groove 46 presents an alternating plurality of maximum and minimum radial dimension zones so that the hammers 32, during their rotation about axis A, alternatively describe an approach stroke and a distancing stroke related to the semi-finished product 5  
25 being deformed.

In particular, each minimum radial dimension zone is

defined at the space delimited by a generating line radially positioned more internally with respect to respective roller 41 and wall 45, and in each maximum radial dimension zone is defined at the space delimited  
5 between wall 45 and wall 43 in a position angularly interposed between two reciprocally consecutive rollers 41.

In this way, during the rotation of hammers 32 related to axis A, each hammer 32 alternatively crosses  
10 the maximum and minimum dimension zones of groove 46.

Therefore, hammers 32 and elements 35 of die 31, during their complete rotation about axis A, sequentially describe, for each roller 41, a distancing stroke from semi-finished product 5 and an approach stroke to semi-  
15 finished product 5.

More precisely, the distancing stroke ends when hammers 32 abut against wall 43 while the approach stroke ends when hammers 32 abut against the rollers 41.

At the end of each approach stroke, hammers 32 bring  
20 elements 35 in contact with semi-finished product 5 accommodated in die 31 and progressively deform semi-finished product 5 to obtain pin 1, due to the shape of the concavities 36 made in the elements 35.

In particular, the distancing stroke is determined  
25 by the action of springs 37 and the centrifuge force, while the approach stroke is determined by the guiding

action of the side surface of each roller 41 on the respective hammer 32.

It is important to underline that the hammering action of elements 35 on semi-finished product 5 could be generated by means of different relative movements of cylinder 38 and semi-finished product 5, for example by rotatably feeding semi-finished product 5 and keeping cylinder 38 still.

The rotating hammering machine 30 used for deforming body 12 and obtaining semi-finished product 5 presents an operation entirely similar to that previously described and illustrated in figures from 10 to 13, and differs only in that it comprises four hammers 32 and in that concavities 36 define therebetween a concavity whose shape is complementary to the shape of semi-finished product 5.

After ending the rotating hammering operation, the pin 1 is subjected to a thermal induction tempering treatment so as to confer predetermined hardness features to the pin 1 itself.

Finally, pin 1 is subjected to a terminal finishing operation, which confers the required surface precision and geometric tolerances to the surface 8 of pin 1.

Such finishing operation is performed completely by plastic deformation and in particular, by cold rolling by means of tools of the known type and not shown.

From an examination of the features of method 1 made according to the present invention the advantages that it allowed to obtain are apparent.

In particular, the method according to the present invention is particularly cost-effective.

More in detail, the method according to the present invention allows to obtain the pin 1 from disk 10 which is made of metal plate, thus presenting a lower cost with respect to drawn wire.

The method according to the present invention does not envisage machining by stock removal and consequent waste of material; therefore, the method according to the present invention allows to reduce the quantity of material needed to make pin 1 itself with respect to the methods of the known type.

The method according to the present invention further allows to obtain considerable energy saving because the terminal rolling operation is a cold operation.

Furthermore, the method according to the present invention increases the mechanical resistance of pins 1 in the presence of a twisting moment because, at the end of the first rotating hammering operation, portion 6 where twisting moment applied to pin 1 generates the highest stresses, presents higher radial thickness with respect to the radial thickness of portion 13.

The method according to the present invention allows to obtain pins 1 having hollow portion 3.

Therefore, pins 1 are particularly light and consequently advantageous for automotive use.

5 The method according to the present invention allows to obtain pins 1 having portion 3 completely closed on an axially opposite side of main portion 2.

In this way, the risks of possible infiltrations of humidity subsequent to the manufacturing of pin 1 and the  
10 consequent risks of oxidation of pin 1 itself are reduced.

Finally, it was observed by the applicant that the time needed to manufacture pin 1 according to the method of the present invention is shorter than that required by  
15 methods of the known type using a drawn wire.

It is apparent that changes and variations can be made to the method of the invention without departing from the scope of protection as defined by the claims.

In particular, the plastic deformation step may be  
20 performed by transfer pressing, progressive pressing, single pressing or plate turning.

## C L A I M S

1.- A manufacturing method for a pin (1) provided with an essentially spherical end portion (3) for engaging a ball joint, said manufacturing method comprising the steps of:

- plastically deforming a rough element so as to manufacture an elongated main portion (2) and said end portion (3) of said pin (1); and

- performing a finishing operation on a peripheral portion (8) of said pin (1) for reducing roughness of the peripheral portion (8) itself;

said method being characterised in that a metal plate disk (10) is used as rough element in said plastic deformation step.

2.- A method according to claim 1, characterised in that said plastic deformation step comprises the steps of:

- pressing said disk (10) so as to obtain an axial and symmetrical body (12) provided with a main elongated portion (13) and an essentially spherical end portion (14), which define within a cavity (15); and

- radially hammering in centripetal direction said body (12) after the step of pressing said disk (10), so as to obtain said main portion (2) and said end portion (3) of said pin (1).

3.- A method according to claim 2, characterised in

that said step of radially hammering in centripetal direction said body (12) comprises the steps of:

- radially hammering an external surface (16) of said portion (13) of said body (12) so as to reduce the radial dimension in a region (17) of said cavity (15) accommodated within said portion (13) and obtaining a semi-finished product (5), which is provided with an elongated segment (6) and an essentially spherical end segment (7); and

- radially hammering, after said step of hammering on said external surface (16), said elongated segment (6) and said end segment (7) of said semi-finished product (5) to respectively obtain said main portion (2) and said end portion (3) of said pin (1).

4.- A method according to claim 3 characterised in that said step of hammering said surface (16) comprises the step of bringing each internal generating line of said region (17) into contact with a corresponding generating line, diametrically opposite thereto, so as to cancel out said radial dimension.

5.- A method according to claim 3 or 4, characterised in that the step of radially hammering said end segment (7) confers to said end portion (3) a hollow conformation.

6.- A method according to any of the claims from 3 to 5, characterised in that said step of radially

hammering said end segment (7) confers to said end portion (3) a closed shape on the opposite side of said main portion (2).

7.- A method according to any of the claims from 2  
5 to 6, characterised in that said step of radially hammering said body (12) comprises the steps of:

- deforming said portion (13) so as to cause it to assume a first full cylindrical shape corresponding to said elongated segment (6); and

10 - deforming, after said deformation step of said portion (13), said elongated segment (6) so as to cause it to assume a second full shape; said second full shape comprising a plurality of segments (4, 4a, 4b, 18, 10, 11, 9) having reciprocally different radial dimensions  
15 with respect to an axis (A) of said body (12).

8.- A method according to any of the preceding claims, characterised in that said step of performing a finishing operation is exclusively performed by plastic deformation.

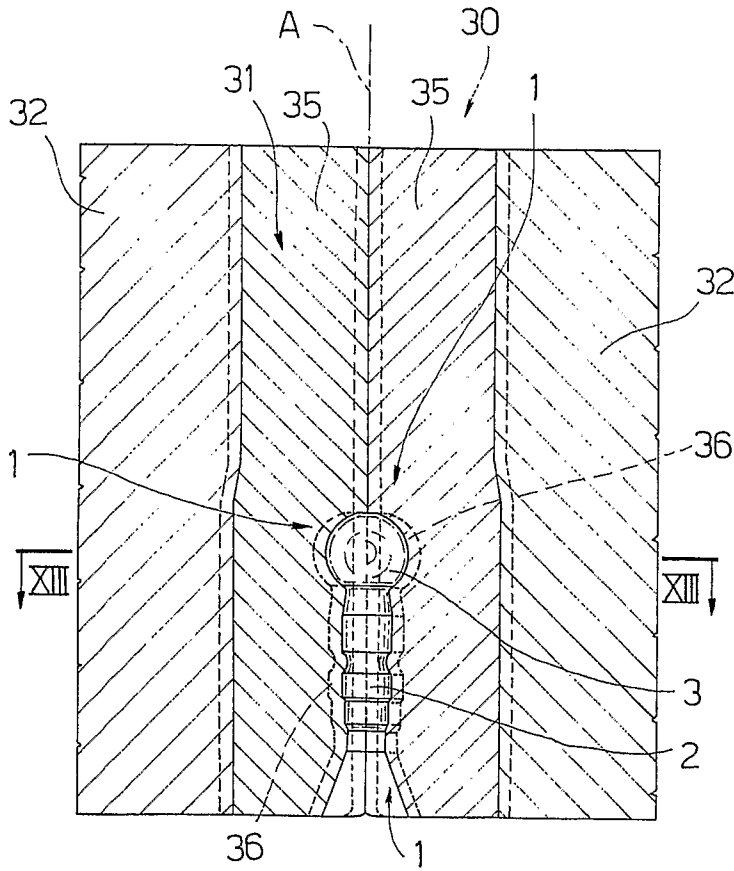


Fig.12

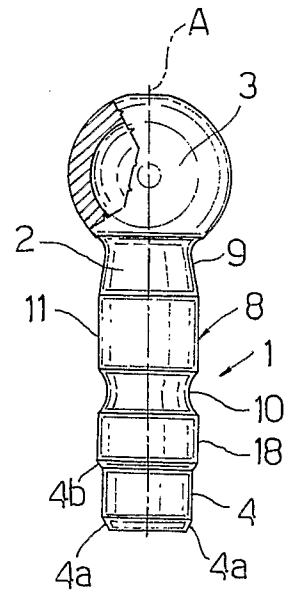


Fig.1

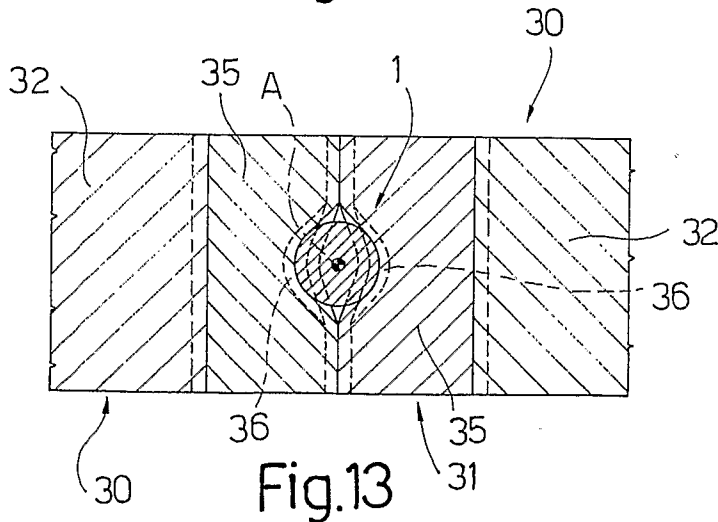


Fig.13

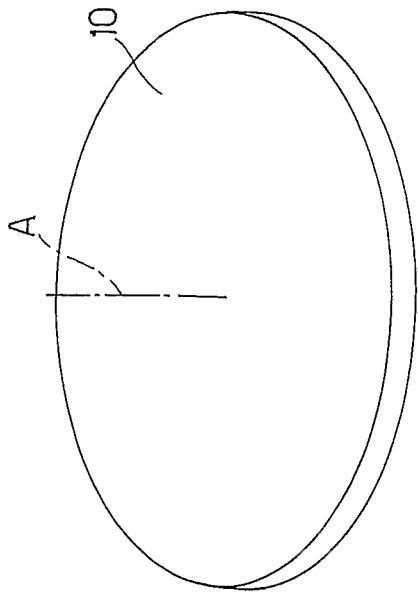


Fig. 2

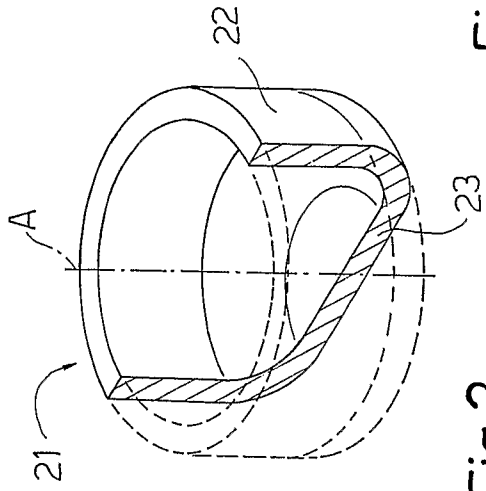


Fig. 3

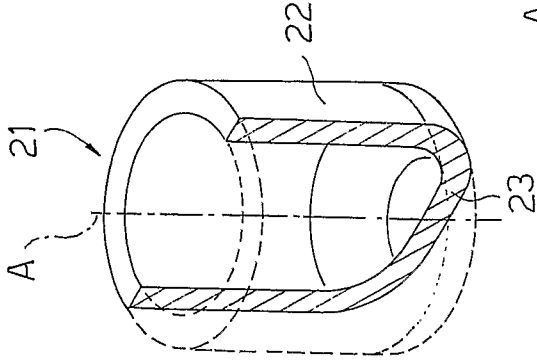


Fig. 4

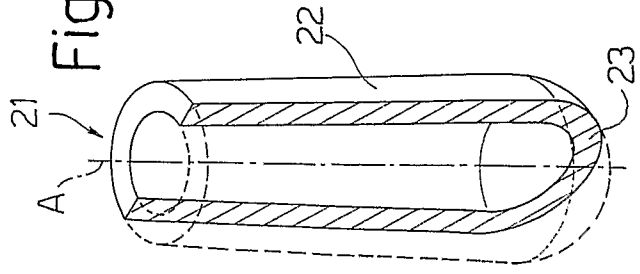


Fig. 5

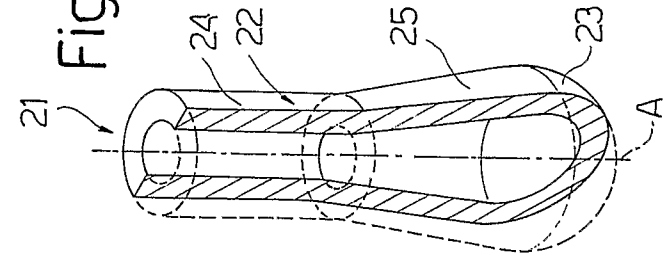


Fig. 6

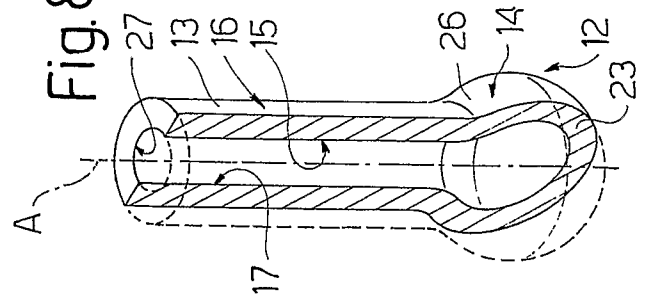


Fig. 7

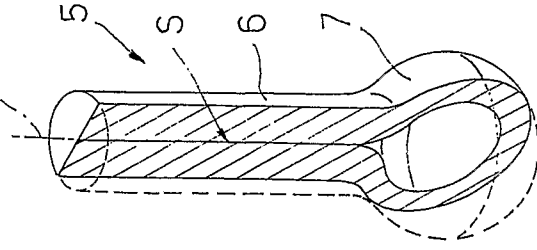


Fig. 8

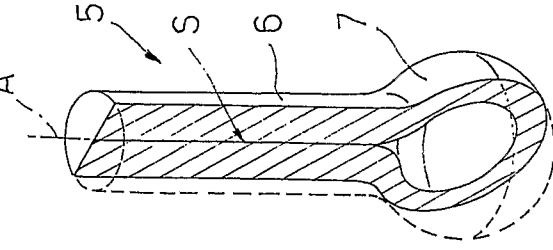


Fig. 9

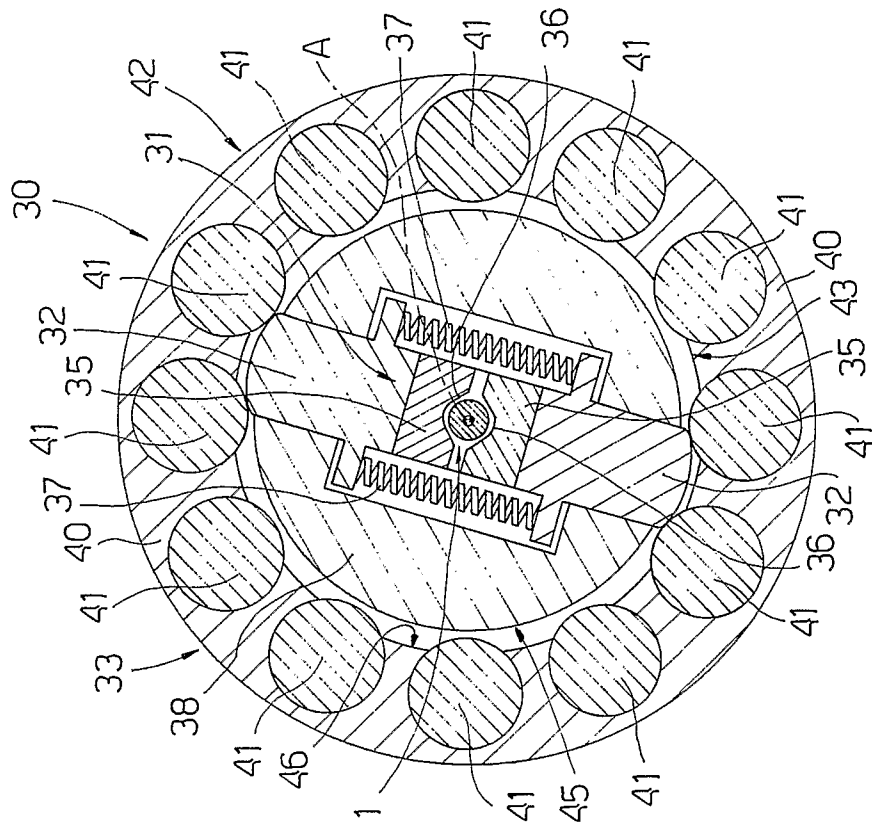


Fig.10

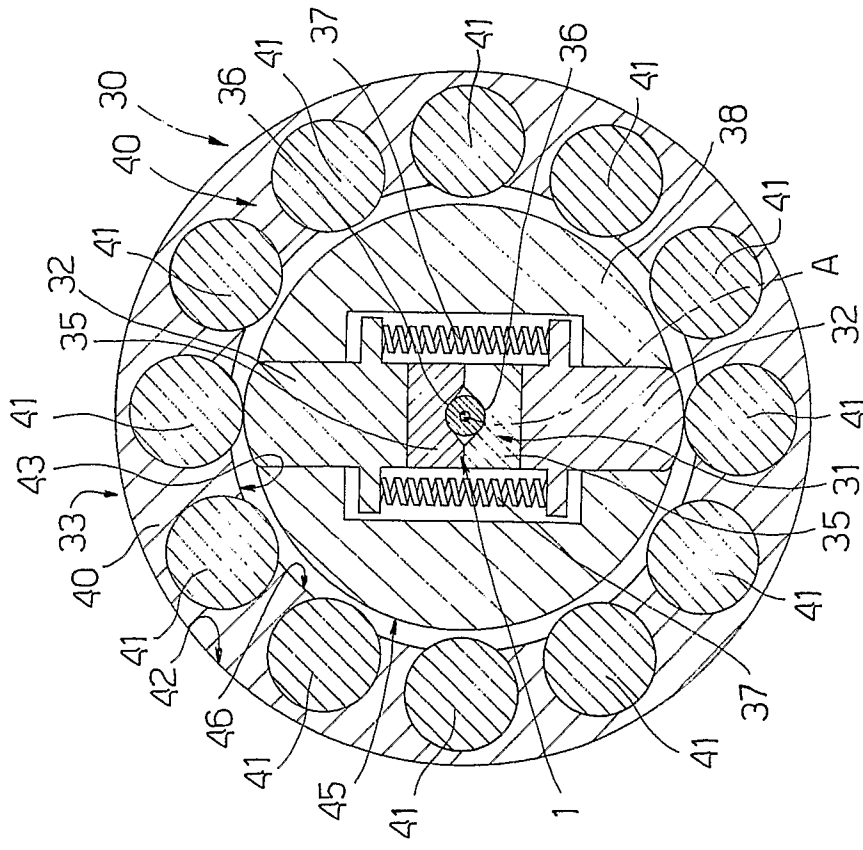


Fig.11

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2006/000486

A. CLASSIFICATION OF SUBJECT MATTER  
 INV. B21K1/76 F16C11/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
 B21K F16C B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1 913 459 A (NEWTON SKILLMAN ET AL) 13 June 1933 (1933-06-13) page 2, line 12 - line 29; figures -----	1-3,5,8
A	FR 858 396 A (GARDELLE) 23 November 1940 (1940-11-23) page 2, line 92 - line 102; figures -----	1-8
A	US 3 594 026 A (SCHMID LEOPOLD F) 20 July 1971 (1971-07-20) column 3, line 59 - line 66; figures -----	1,4,6,7
A	GB 528 710 A (LOUIS CAMILLE ANDRE GARDELLE; ANDRE ALFRED ARSENE EDOUARD LE) 5 November 1940 (1940-11-05) page 3, line 88 - line 101; claim 1; figures -----	1-3,5,7, 8

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search

24 January 2007

Date of mailing of the international search report

05/02/2007

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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