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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

(54) Title: DOUBLE STRUCTURE SYNCHRONIZER RING AND METHOD OF MANUFACTURING THEREOF

(57) Abstract: A double structure synchronizer ring (1) mainly comprises of a synchronizer body (11) and Cu-Zn friction surface (12d). Said synchronizer body (11) is made from stamped steel, forged steel, cast steel or sintered steel. Said Cu-Zn friction surface (12d) is made from strip, ring or pipe of Cu-Zn alloy. Said Cu-Zn friction surface (12d) provides friction property where Synchronizer body (11) of steel provides strength. Said Cu-Zn friction surface (12d) is pressed with synchronizer (11) with die and punch to fix said Cu-Zn friction surface (12d) and synchronizer body (11) mechanically and obtain present invention.

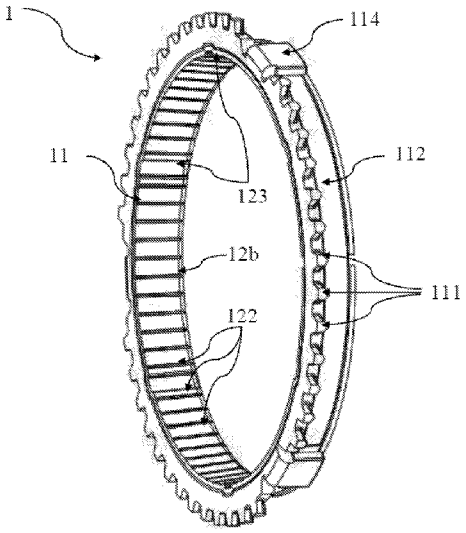

Fig.2

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"DOUBLE STRUCTURE SYNCHRONIZER RING AND METHOD OF MANUFACTURING THEREOF"

FIELD OF THE INVENTION:

The present invention relates to a double structure synchronizer ring and a method for manufacturing it. More particularly, the present invention relates to a mechanically combined brass-steel synchronizer ring, such that the synchronizer possess high structural strength, light in weight, easy to manufacture and is cost effective. Moreover, the obtained light weight synchronizer achieves the requisite decrease in moment of inertia and decreased requirement of shifting force while synchronization. The process is also highly consistent and provides a high production rate.

BACKGROUND OF THE INVENTION:

The manual transmission gear box is generally provided in all automobiles with manual transmission and automatic manual transmission for providing different speed and torque to the moving automobile as per the requirement of driving condition. A Gear box comprises of more than three gear pairs for decreasing or increasing speed of the vehicle. In order to change the speed of vehicle, gear engaged with the output shaft must be altered with nearby gear. This process of altering gears is called synchronization. To achieve this, synchronizer ring are used in manual transmission gear box.

The transmission system of the gears plays an important role in determining the behavior of automobile with respect to gear shift comfort. Said Synchronizer mechanisms are provided for the smooth and noiseless synchronization while gear shift. The key

characteristics required for the synchronizer ring to function effectively are: (i) that the coefficient of dynamic friction with respect to a mating member is large in order to synchronize two gears by frictionally engaging a tapered portion which is the mating member, and (ii) that the synchronizer ring has high wear resistance, i.e., sufficient mechanical strength and anti-abrasion characteristic in sliding with the mating member.

There are three different types of synchronizer ring, according to number of friction surfaces they possess, that are in common use i.e., i) single cone which have only one ring with only one friction surface (see Fig.1), ii) double cone which have an assembly of three rings with two friction surfaces and iii) triple cone having three rings assembly with three friction surfaces.

i) Single cone synchronizer ring:

Said ring comprises of a single ring with one friction surface, and is used when torque difference between synchronizing gears is small and requirement of shifting comfort is less.

ii) Double cone synchronizer ring:

Said synchronizer ring comprises of three rings with total of two friction surfaces comprising of outer ring and inner ring with one friction surface, or intermediate ring with two friction surfaces, and is used when torque difference between synchronizing gears is medium and requirement of shifting comfort is needed.

iii) Triple cone synchronizer ring:

Said synchronizer ring comprises of three rings with total three friction surfaces further comprising of outer ring with one friction surface and inner ring with two friction surface, and is used when torque difference between synchronizing gear is high and requirement of shifting comfort is high.

In manual transmission gear box the selection of type of synchronizer ring is based on torque difference between mating component and requirement of shifting comfort.

Popularly used conventional single cone synchronizer ring **1A** is as shown in Fig. 1. The single cone synchronizer developed so far, widely available and popularly used establishes a requisite of synchronizer rings to be made of frictional material; wherein mostly with Brass (Cu-Zn alloy) is used to obtain good frictional property.

Referring Fig.1 said conventional synchronizer ring **1A** are preferably made from forging, wherein said conventional synchronizer ring **1A** comprises of: outer face **102,** plurality of teeth **101**, an inner face **103,** lugs **104,** annular grooves **105,** axial grooves **106.** Said inner face **103** is provided for contacting the gear cone. Said plurality of teeth **101** are provided at a predetermined interval to the extreme outer periphery of conventional synchronizer ring **1A**. Said lugs **104** are for engaging with slot of corresponding member. To the inner face **103** of the conventional synchronizer ring **1A** a plurality of annular grooves **105** are provided for applying friction force. Further, said axial grooves **106** are provided, for allowing drainage of lubricating oil. Said annular grooves**105** and axial grooves**106** are provided by machining process.

At the time of synchronization said plurality of teeth **101** are subjected to shifting force applied by mating member and are in friction with mating member in order to synchronize the speed of gear. The lugs **104** are subjected to the tangential force from mating member while synchronization, that is why plurality of teeth **101** of synchronizer needs to be strong enough to withstand load applied while synchronization and should be wear resistant as there is frictional movement between synchronizer **1A** and mating part.

The single cone synchronizer rings are preferably made from hot forging of brass since these are stronger than those obtained from castings. Further in order to obtain the requisite strength of the synchronizer ring conventional methods uses hot forging process. However, Hot forging process is not consistent as this process includes shrinkages of materials.

Furthermore conventional ring comprises of annular and axial grooves made through machining which is a time consuming process.

However, the conventional synchronizer rings are entirely made from brass thereby making it bulky. Also brass not being heat –treatable material the wear resistant property of the conventional synchronizer ring of brass is poor which in turn wear out the teeth **101** of synchronizer ring. The strength of brass is less and it also cannot tolerate heat treatment and thereby fails to provide strength to the synchronizer ring. The larger size of the synchronizer ring is required in order to attain the required strength which thereby makes it bulky and imparts more moment of inertia which results in higher shifting force.

Further, the synchronizer ring made entirely from Cu-Zn alloy has to offer high strength and high friction force, which implies there is balance between mechanical and frictional property. In order to improve frictional property, it is necessary to compromise on strength of synchronizer ring.

There were many categories, according to material, of synchronizer ring popularly available in industry as listed below:

1. Brass
2. Sintered steel
3. Sintered steel and brass
4. Steel and molybdenum coating
5. Steel and fiber coating

There were many types of heat treatment available to improve strength and anti-abrasion characteristics of steel component in turns of hardness of components as per requirement:

1. Through hardening
2. Case carburizing
3. Carbo-nitriding
4. Induction hardening
5. Anodizing

PRIOR ART:

1. **US patent 4267912** granted to Borg-Warner-Stieber describes the fiber coating on annular body of synchronizer ring by cementing. Fiber coating imparts good friction property. However, this device limited to induction hardening and anodizing type of synchronizer. Moreover, this device has occasional issue of peeling of fiber coating as it is cemented on

annular body. Further, this device does not allow any machining process after coating to get final accurate dimension. Furthermore, fiber coating is very expensive, which makes the product expensive.

2. **US patent 6014807** granted to Hyundai Motor Company of Korea describes a double-structure synchronizer ring using copper powder sintering agent, to provide frictional property with an external ring body portion comprising sintering metal. The sintered synchronizer ring heat treatable by only anodizing process as its temperature is lower compare to any other heat treatment. Further machining operation is not possible after sintering to achieve final required dimensions. However this invention comprises sintering process which is complex and relatively expensive.

3. **US patent 4091904** describes wear-resistant, molybdenum sprayed on to one of the friction cone ring members whereas the other friction cone member has a manganese-alloyed carbon steel sprayed thereon. However, only induction hardening is possible on this device. Moreover, products of this invention have occasional issue of peeling of molybdenum coating and expensive to manufacture.

4. **US patent 4679681** describes a double structure synchronizer ring formed from composite material, which is made by roll cladding two metals. However invention is not generally used in practice as there is particular material can be cladded by roll cladding process. Further no heat treatment can be done to provide strength and anti-abrasion property in turns of hardness.

DISADVANTAGES OF PRIOR ART:

The prior art suffers from all or at least any of the following disadvantages:

- Brass Synchronizer Ring:
    1. Brass cannot be heat-treated that is why to provide strength and anti-abrasion property ring should be large enough. This makes synchronizer ring bulky, which in turns increase moment of inertia, thereby increase the shifting force.
    2. Brass has poor wear resistant property that is its teeth gets wear out in short time.
    3. Made from hot forging process, which is not consistent process as this includes shrinkages of material.
    4. It comprises of machining process, which is time consuming and is expensive.
- Sintered Steel Synchronizer ring:
    1. No friction surface is there.
- Steel and brass synchronizer ring by sintering:
    1. This synchronizer rings can only be subjected to anodizing type of heat-treatment process.
    2. Further machining not possible after sintering to achieve final accurate dimensions.
    3. Method of manufacturing is complex and expensive.
- Steel with molybdenum coating synchronizer ring:
    1. This synchronizer ring can only be subjected to induction hardening process.
    2. Products of this invention have occasional issue of peeling of molybdenum coating.

3. Further machining not possible after coating to achieve final accurate dimensions.
4. Product is expensive to manufacture.
5. Shift quality is not adequate.

- Steel with fiber coating synchronizer ring:
  1. Very expensive to manufacture.
  2. Has occasional issue of peeling of fiber coating.
  3. Further machining not possible after fiber coating to achieve final accurate dimensions.

Thus there is an unmet need to come up with the invention that obviates the problem of prior art.

OBJECTS OF THE PRESENT INVENTION:

The main object of the present invention is to provide a double structure synchronizer ring and a method to manufacture said ring.

Another object of the present invention is to provide a double structure synchronizer ring and method to manufacture said ring, wherein the obtained light weight synchronizer achieves the requisite decrease in moment of inertia and decreased requirement of shifting force while synchronization.

Still another object of the present invention is to provide a double structure synchronizer ring and method to manufacture said ring, wherein said synchronizer ring is heat treated by any type of heat treatment and further provides strength to the synchronizer ring.

Still another object of the present invention is to provide provide a double structure synchronizer ring and a method to manufacture

said ring that allows final finishing operations that includes machining and alike.

Still another object of the present invention is to provide a double structure synchronizer ring and a method to manufacture said ring that has a high production rate and is highly consistent.

Still further object of the present invention is to provide a double structure synchronizer ring and a method to manufacture said ring having axially extended grooves for drainage of lubricating oil.

Yet, the object of the present invention is to provide a double structure synchronizer ring and a method to manufacture said ring, having friction surface, thereby minimizing the complexity and cost of manufacturing operations.

Yet another object of the present invention is to provide a double structure synchronizer ring and a method to manufacture said ring, which improves the strength of synchronizer ring, thereby reducing weight and cost of synchronizer ring, without compromising the friction property of friction surface.

Further the object of present invention is to provide a double structure synchronizer ring and a method to manufacture said ring, wherein said ring made of double structure from which body made of steel, to provide structural strength, and friction surface made from friction material, to serve the purpose of friction force. Further, said friction surface not necessarily required to have structural strength, which allows to choose best friction material for the application without compromising on strength of synchronizer ring.

BRIEF DESCRIPTION OF THE DRAWINGS:

The present invention is illustrated in the accompanying drawings, throughout which like reference letters indicate corresponding parts in the various Figures. The embodiment/s herein and advantages thereof will be better understood from the following description when read with reference to the following drawings, wherein

Fig. 1 discloses the perspective view of the conventional synchronizer ring.

Fig. 2 shows the perspective view of the synchronizer ring of present invention.

Fig. 3 shows the perspective view of friction strip which is to be attach with synchronizer body.

Fig.4 shows the fragmentary view of first step of manufacturing of present invention to provide a friction surface by friction strip or ring.

Fig.5 shows perspective view and sectional view of first step of manufacturing of present invention to provide friction surface by friction strip of ring.

Fig. 6 shows perspective view and sectional view of final step of manufacturing of present invention to provide friction surface by friction strip or cap.

Fig. 7 shows fragmented sectional view of another embodiment of present invention for double cone synchronizer.

Fig. 8 shows sectional view of present improved synchronizer assembly illustrating embodiment of double cone synchronizer ring of present invention.

Fig. 9 shows fragmented sectional view of another embodiment of present invention for triple cone synchronizer.

Fig. 10 shows sectional view of present improved synchronizer assembly illustrating embodiment of triple cone synchronizer ring of present invention.

References used for the parts of the present invention illustrated in drawings:

1	:	Present Synchronizer ring
1A	:	Conventional Synchronizer ring
2	:	Double cone synchronizer ring
3	:	Triple cone synchronizer ring
101	:	Plurality of teeth
102	:	Outer face
103	:	Inner face
104	:	Lugs
105	:	Annular grooves
106	:	Axial grooves
11	:	Steel Synchronizer body
111	:	Plurality of teeth
112	:	Outer Face
113	:	Axial grooves
114	:	Inner face
12a	:	Cu-Zn Friction strip

12b : Cu-Zn Friction ring
12c : Cu-Zn Friction strip after bending
12d : Cu-Zn Friction strip after forming process
121 : Flange
122 : Axial streaks
123 : Axial grooves formed in friction ring
13A : Intermediate ring
14 : Inner ring of double cone synchronizer
15 : Cu-Zn Friction strip
16 : Inner ring of triple cone synchronizer
17 : Cu- Zn Friction cap

DETAILED DESCRIPTION OF THE PRESENT INVENTION:

The present invention provides a double structure synchronizer ring a method to manufacture said ring. More particularly, the present invention relates to a mechanically combined brass-steel synchronizer ring, such that the synchronizer possess high structural strength, light in weight, easy to manufacture, highly consistent and is cost effective. Moreover, the obtained light weight synchronizer achieves the requisite decrease in moment of inertia and decreased requirement of shifting force while synchronization. The process also provides a high production rate.

Said invention mainly comprises of:

- Steel Synchronizer body **11**
- Plurality of teeth **111**
- Outer Face **112**
- Axial grooves **113**
- Inner face **114**

- Cu-Zn Friction strip **12a**
- Cu-Zn Friction ring **12b**
- Cu-Zn Friction ring with flange **12c**
- Cu-Zn Friction surface after forming **12d**
- Flange**121**
- Axial streaks**122**
- Axial grooves formed in friction ring**123**

Said Cu-Zn friction surface **12d** provides friction to the present invention and is therefore also referred as friction surface herein after.

Said steel synchronizer body **11** made up of stamped steel, cast steel, sinter steel or forged steel is provided to engage with teeth of shifter, and said Cu-Zn friction surface **12d** made up of friction strip **12a** or friction ring **12b**, and is provided to be in contact with gear cone. In said hybrid structure, the steel synchronizer body **11** provides structural strength of rigidity whereas Cu-Zn friction surface **12d** provides friction to the present double structure synchronizer ring **1**. Further said friction surface **12d** can be made of any material which imparts high friction force. Referring to Fig.4, axial grooves **113** on said steel synchronizer body **11** of a synchronizer ring **1** is provided to constrain the relative rotation of synchronizer body **11** and friction surface **12d**. The Number of axial groove **113** depends on torque capacity of synchronizer ring **1** i.e., higher the torque capacity the more number of axial grooves **113** required.

The method of mechanical fixing the present assembly involves following points:

Step 1: In order to obtain the said hybrid structure, said steel synchronizer body **11** and said Cu-Zn friction ring **12c,** made from Cu-Zn friction strip **12a** or Cu-Zn friction ring **12b** or pipe of Cu-Zn alloy**,** which comprises of flange **121** as shown in Fig. 4**.**

Step 2: Referring to Fig.5 said Cu-Zn friction ring **12c** is inserted in steel synchronizer body **11** such that their relative axial movement in one direction gets constrain by flange **121** of Cu-Zn friction surface **12c**.

Step 3: In order to obtain the said hybrid structure, said steel synchronizer body **11** and friction strip **12c** are pressed with the help of die and punch to match the angle of outer face of Cu-Zn friction surface **12d** with angle of inner face of synchronizer body **11**, thereby constrains the axial and radial movement of synchronizer body **11** with respect to Cu-Zn friction surface **12d** as shown in Fig. 6. Further a punch is provide to the said hybrid structure such that it protruded axially extended streaks and bulge penetrate in friction surface **12d** to provide axially embossed streaks **122** and axial grooves **123**, to provide friction force on gear cone and means of drainage of lubricating oil as shown in Fig. 6.

FURTHER EMBODIMENTS OF PRESENT INVENTION:

A. Fig. 7 shows the double structure double cone synchronizer ring **2.** The double cone synchronizer **2** has two friction surfaces. One on outer ring **11** and other on outer face of inner ring **14.** As shown in Fig. 7 double structure double cone synchronizer ring **2** comprises of:

a. An steel synchronizer body **11**, made of stamped steel, cast steel, sinter steel or forged steel, with Cu-Zn friction surface **12d**,
b. A conventional intermediate ring **13A** made of stamped steel, cast steel, sinter steel or forged steel and
c. An improved Inner ring of double cone synchronizer **14,** made of stamped steel, cast steel, sinter steel or forged steel, with outer Cu-Zn friction strip **15**.

The steps involved in mechanical joining method of outer Cu-Zn friction surface **15** with improved Inner ring **14,** of double cone synchronizer**,** by press operation is same as described in description of main embodiment.

B. Fig. 9 shows the double structure double cone synchronizer ring **3.** The double cone synchronizer **3** has two friction surfaces. One on outer ring **11** and other two on inner ring **14.** As shown in **Fig. 9** the double structure triple cone synchronizer ring **3** comprises of:

a. Steel synchronizer body **11**, made of stamped steel, cast steel, sinter steel or forged steel, with Cu-Zn friction surface **12d**,
b. A convention intermediate ring **13A** made of stamped steel, cast steel, sinter steel or forged steel and
c. An improved Inner ring of triple cone synchronizer **16** for triple cone synchronizer**,** made of stamped steel, cast steel, sinter steel or forged steel, with Cu-Zn friction cap **17** that provides frictional surfaces on both sides.

The steps involved in mechanical joining method of friction cap **17** and improved inner body **16,** of triple cone synchronizer, by press operation is same as described in description of main embodiment.

The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

ADVANTAGES OF THE INVENTION:

There are many advantages of the present invention over prior art:

- Present invention provides double structure synchronizer ring with high strength, anti-abrasion and friction.
- It replaces the annular grooves with axially formed streaks, and thereby increases the productivity as machining time is excluded.
- It provides consistent double structure synchronizer ring.
- It allows final finishing operations that include machining and alike.

- Synchronizer ring of present invention heat treated by any heat treatment as per requirement of application.
- Present invention provides the method of manufacturing synchronizer ring, which is highly consistent and have high production rate.
- It allows choosing the best friction material for the application without compromising on strength of synchronizer.
- It reduces the weight.
- It is economical.

CLAIMS:

1. Present Double Structure Synchronizer Ring And Method Of Manufacturing Thereof wherein, said invention mainly comprises of:
    - Steel Synchronizer body**11,**
    - Plurality of teeth**111**,
    - Outer Face**112**,
    - Axial grooves**113**,
    - Inner face**114**,
    - Cu-Zn Friction strip**12a**,
    - Cu-Zn Friction ring**12b**,
    - Cu-Zn Friction surface after forming flange**12c**,
    - Cu-Zn Friction surface after bending **12d**,
    - Flange**121**,
    - Axial streaks**122**,
    - Axial grooves formed in friction ring**123**;

    wherein;

    said steel synchronizer body **11** is provided to engage with teeth of shifter, and said Cu-Zn friction surface **12d** made up of friction strip **12a** or friction ring **12b**, and is provided to be in contact with gear cone; in said hybrid structure, the steel synchronizer body **11** provides structural strength of rigidity whereas Cu-Zn friction surface **12d** provides friction force to the present double structure synchronizer ring **1**; further said Cu-Zn friction surface **12d** provides high frictional force on corresponding synchronizer components; said steel synchronizer body **11** of a synchronizer ring **1** is made from

forged steel, cast steel, sintered steel or stamped steel with axial grooves **113** formed in it and is provided to constrain the relative rotation of synchronizer body and friction surface **12d**; the Number of axial groove **113** depends on torque capacity of synchronizer ring **1**, higher the torque capacity the more number of axial grooves **113** required;

wherein further the method for manufacturing said double structure synchronizer ring comprises of steps;

a. in order to obtain the said hybrid structure, said Cu-Zn friction surface **12c** made from Cu-Zn friction strip **12a** or Cu-Zn friction ring **12b** or pipe of Cu-Zn alloy**,** which comprises of flange **121;**

b. said Cu-Zn friction ring **12c** is inserted in steel synchronizer body **11** such that their relative axial movement in one direction gets constrain by flange **121** of Cu-Zn friction surface **12c**;

c. said steel synchronizer body **11** and friction strip **12c** are pressed with the help of die and punch to match the angle of outer face of Cu-Zn friction surface **12d** with angle of inner face of synchronizer body **11**, thereby constrains the axial and radial movement of inner body with respect to outer body; further a punch is so designed that it protrudes axially extended streaks and bulge penetrate in friction surface **12d** to provide axially embossed streaks **122** and axial grooves **123**, to provide friction force on gear cone and means of drainage of lubricating oil.

2. Present Double Structure Synchronizer Ring And Method Of Manufacturing Thereof as claimed in claim 1, wherein said double structure double cone synchronizer ring **2** comprises of:

- an steel synchronizer body **11**, made of stamped steel, cast steel, sinter steel or forged steel, with Cu-Zn friction surface **12d**,
- a conventional intermediate ring **13A** made of stamped steel, cast steel, sinter steel or forged steel and
- an improved Inner ring of double cone synchronizer **14,** made of stamped steel, cast steel, sinter steel or forged steel, with outer Cu-Zn friction strip **15** which provides friction surface on outer face of inner ring **14;**

wherein the steps involved in mechanical joining method of outer Cu-Zn friction strip **15** with improved Inner ring of double cone synchronizer **14,** of double cone synchronizer, are same as claimed in point a to c of claim 1.

3. Present Double Structure Synchronizer Ring And Method Of Manufacturing Thereof as claimed in claim 1 and claim 2, wherein said double structure triple cone synchronizer ring **3** comprises of:

- steel synchronizer body **11**, made of stamped steel, cast steel, sinter steel or forged steel, with Cu-Zn friction surface **12d**,
- a convention intermediate ring **13A** made of stamped steel, cast steel, sinter steel or forged steel and
- an improved Inner ring of triple cone synchronizer **16** for triple cone synchronizer, made of stamped steel, cast

steel, sinter steel or forged steel, with Cu-Zn friction cap **17** that provides frictional surfaces on both sides;

wherein the steps involved in mechanical joining method of Cu-Zn friction cap **17** with improved Inner ring of triple cone synchronizer **16** for triple cone synchronizer by press operation is same as claimed in point a to c of claim 1.

AMENDED CLAIMS
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1. A synchronizer ring for a transmission assembly, the synchronizer ring comprising:

a synchronizer body (11), the synchronizer body (11) having an annular shape with an inner conical surface (114), a side of the inner conical surface having smaller diameter defining a first side; and

a friction surface (12d);

wherein the friction surface (12d) is fixed to the inner conical surface (114) by cold forming during which friction surface material flows into a plurality of axial groves (113) provided on the inner conical surface (114) of the synchronizer body (11) to prevent relative rotation of synchronizer body (11) and the friction surface (12d); and

wherein the friction surface (12d) incorporates an outward extending flange (121) on the first side that rests against a side face of the synchronizer body (11) on the first side to prevent axial displacement between the friction surface (12d) and the synchronizer body (11).

2. The synchronizer ring as claimed in claim 1, wherein the synchronizer body (11) is made of a material selected out of a group consisting of stamped steel, cast steel, sinter steel and forged steel; and incorporates a plurality of teeth (111) that engage with corresponding teeth of a shifter of the transmission assembly.

3. The synchronizer ring as claimed in claim 1, wherein the friction surface (12d) incorporates axial streaks (122), and wherein the axial streaks (122) are formed during the cold forming.

4. The synchronizer ring as claimed in claim 1, wherein the friction surface (12d) is made of a Cu-Zn alloy.

5. The synchronizer ring as claimed in claim 1, wherein the synchronizer ring is adapted for use with any of a single cone synchronizer assembly, a double cone synchronizer assembly and a triple cone synchronizer assembly.

6. A method for manufacturing a synchronizer ring, the method comprising the steps of:

manufacturing a synchronizer body (11) by any of stamping, casting, sintering or forging process; the synchronizer body (11) having an annular shape with an inner conical surface (114), a side of the inner conical surface having smaller diameter defining a first side; and the inner conical surface incorporating a plurality of axial groves (113);

manufacturing a friction ring with flange (12c) having a cylindrical portion and an outward extending flange (121) on one side of the cylindrical portion;

placing the friction ring with flange (12c) within the synchronizer body (11) by inserting the friction ring with flange (12c) from the first side of the synchronizer body (11) so that the flange (121) of the friction ring with flange (12c) is positioned against a side face of the synchronizer body (11) on the first side; and

pressing the friction ring with flange (12c) against the synchronizer body (11) using a die and punch to match outer surface of the cylindrical part of the friction ring with flange (12c) with inner conical surface of the synchronizer body (11), and wherein the pressing causes material of the friction ring with flange (12c) to flow into the plurality of axial groves (113) to prevent relative rotation of synchronizer body (11) and the friction surface (12d).

7. The method as claimed in claim 6, wherein the friction ring with flange (12c) is made of a Cu-Zn alloy.

8. The method as claimed in claim 6, wherein the friction ring with flange (12c) is made out of any of a strip, a ring or a pipe.

9. The method as claimed in claim 6, wherein the method further comprises a step of generating plurality of axial streaks (122) on inner surface of the friction ring with flange (12c), using a punch incorporating a plurality of axially protruding bulge that penetrate the inner surface of the friction ring with flange (12c) to form the plurality of axial streaks (122).

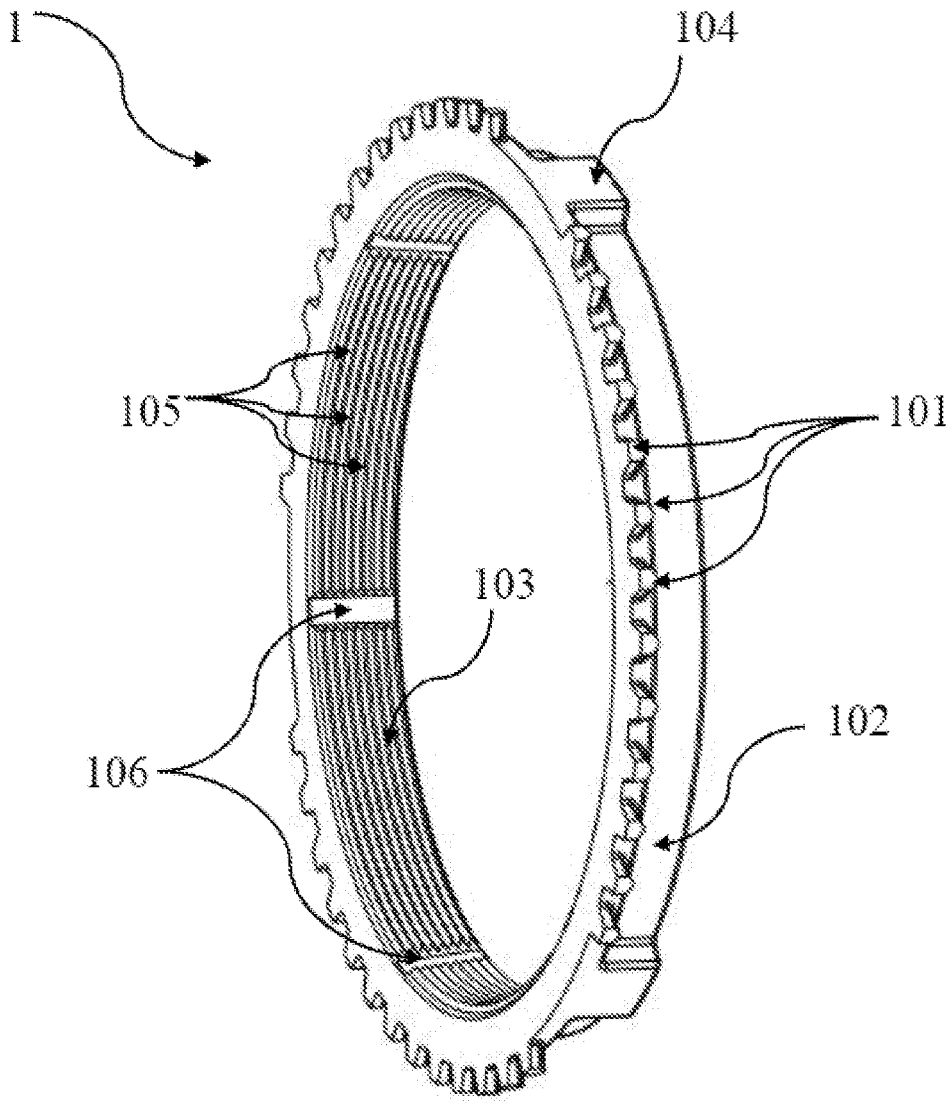

Fig. 1

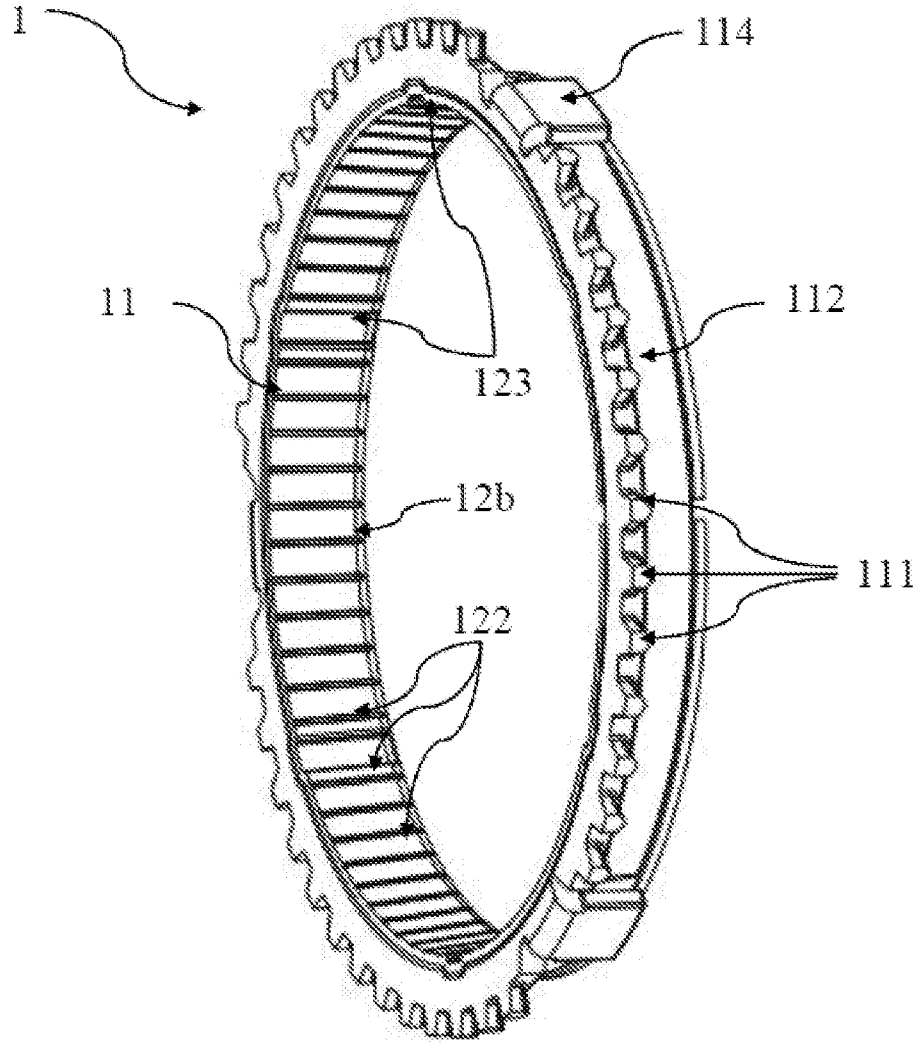

Fig.2

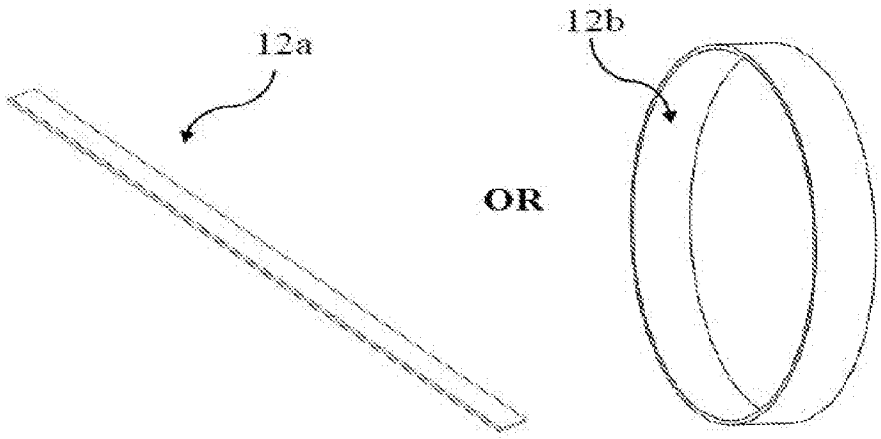

Fig.3

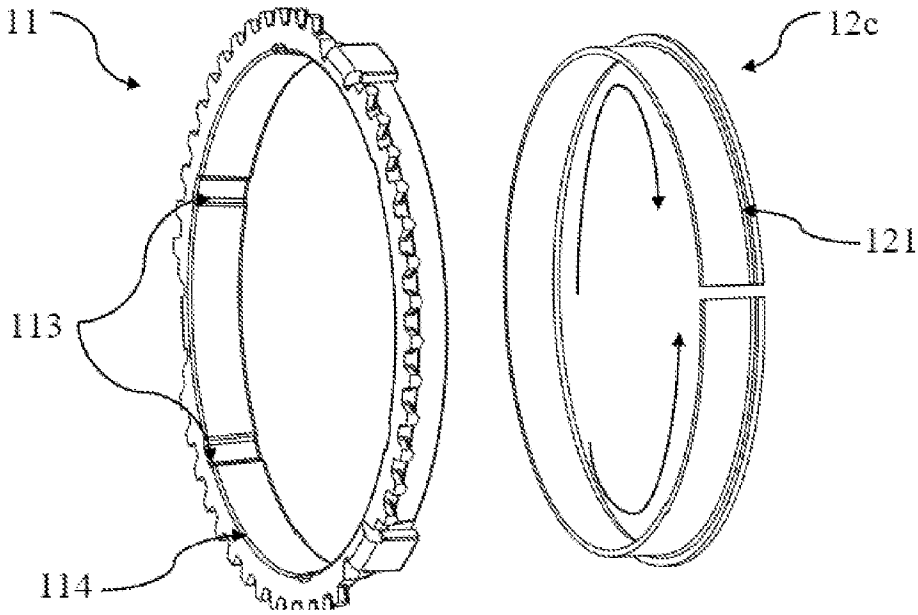

Fig.4

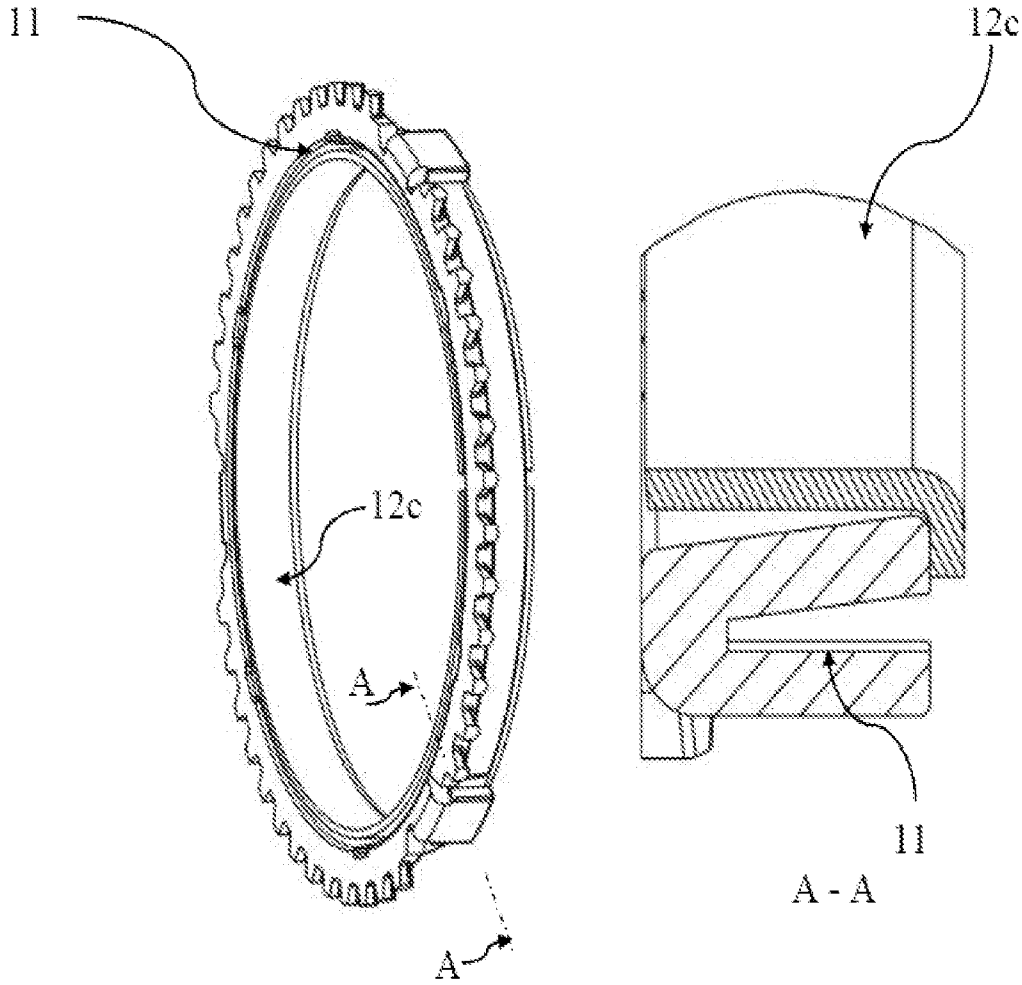

Fig.5

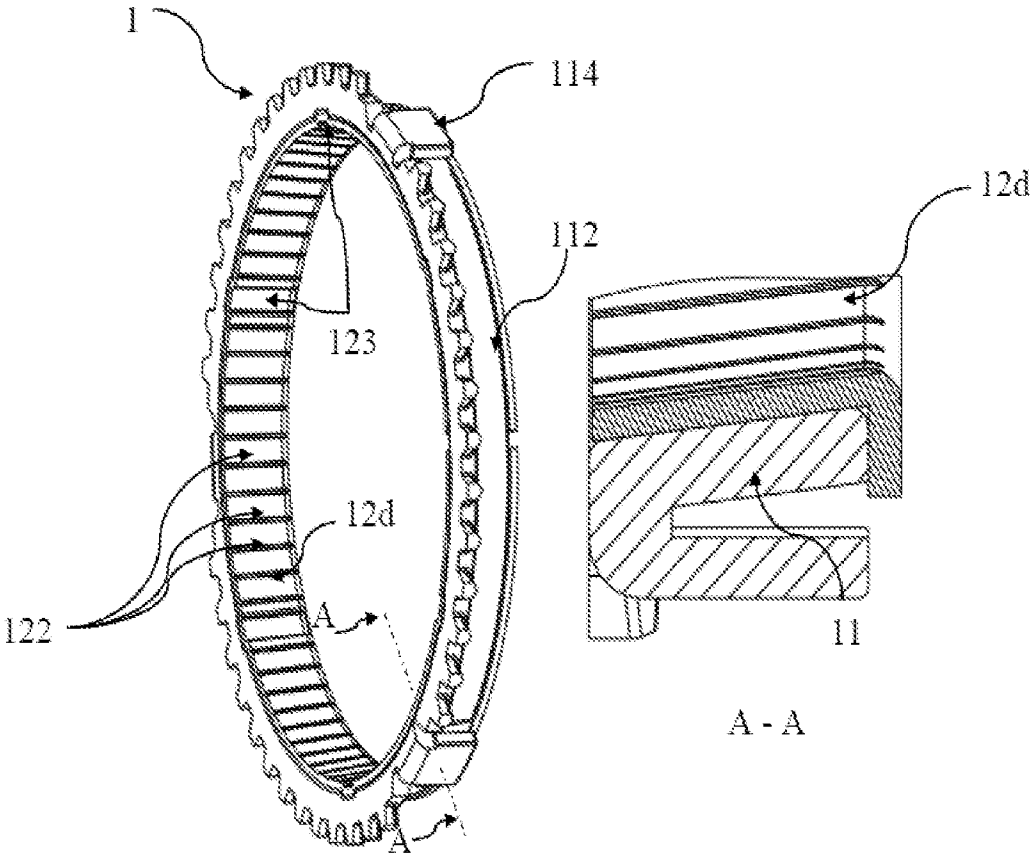

Fig.6

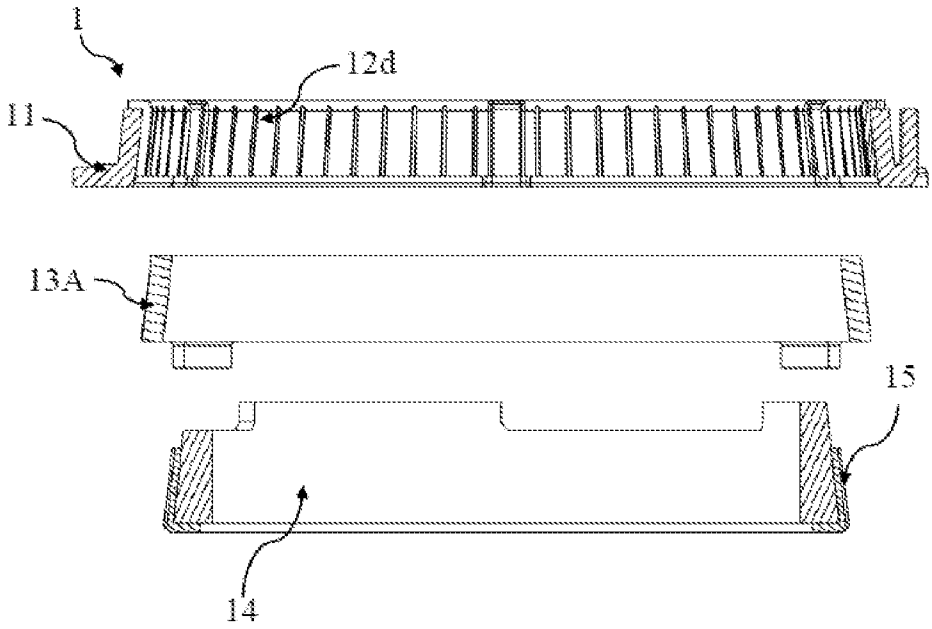

Fig.7

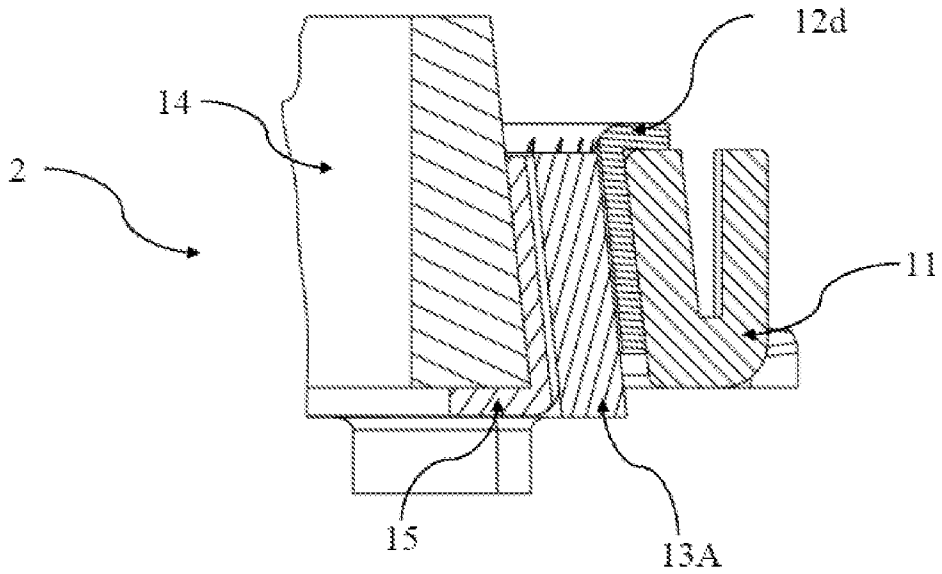

Fig.8

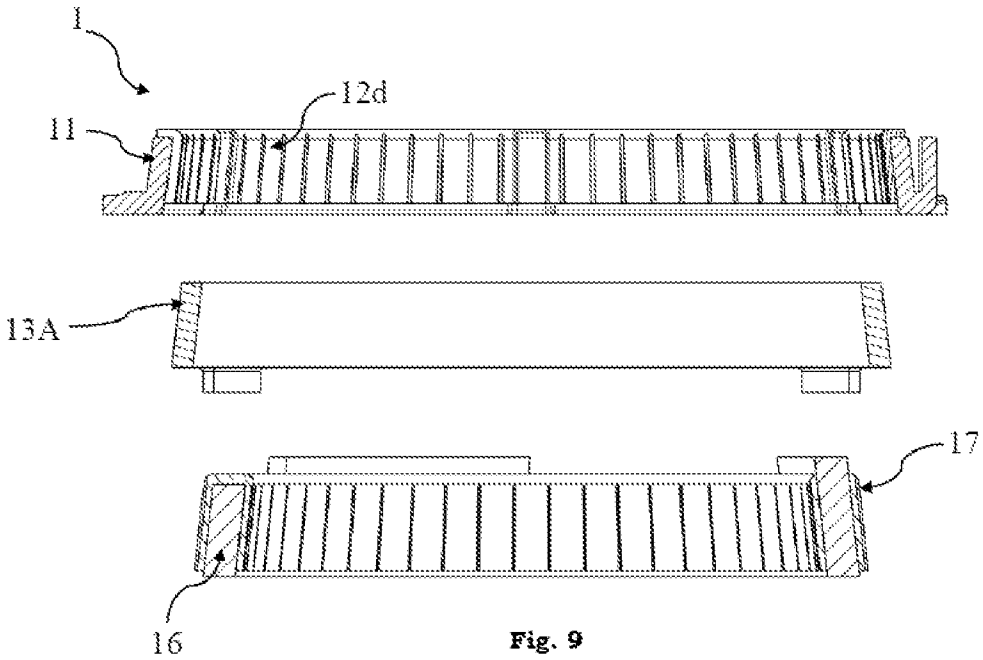

Fig. 9

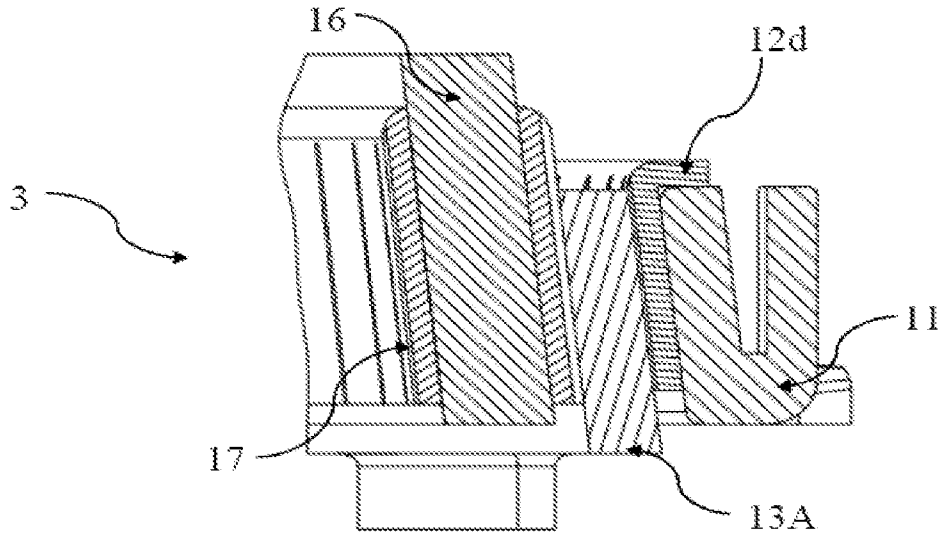

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2017/050455

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D23/02
ADD.

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)
F16D

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H10 287941 A (TOYOTA MOTOR CORP; NIPPON FUNMATSU GOKIN KK) 27 October 1998 (1998-10-27) figures 12,11	1-3
X	US 5 582 281 A (NAKASHIMA KUNIO [JP] ET AL) 10 December 1996 (1996-12-10) column 5, line 40 - column 6, line 7 figures 1-6	1-3

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 April 2018	04/05/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Melnichi, Andrei

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IN2017/050455

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H10287941 A	27-10-1998	NONE	
US 5582281 A	10-12-1996	DE 4428153 A1	15-02-1996
		US 5582281 A	10-12-1996