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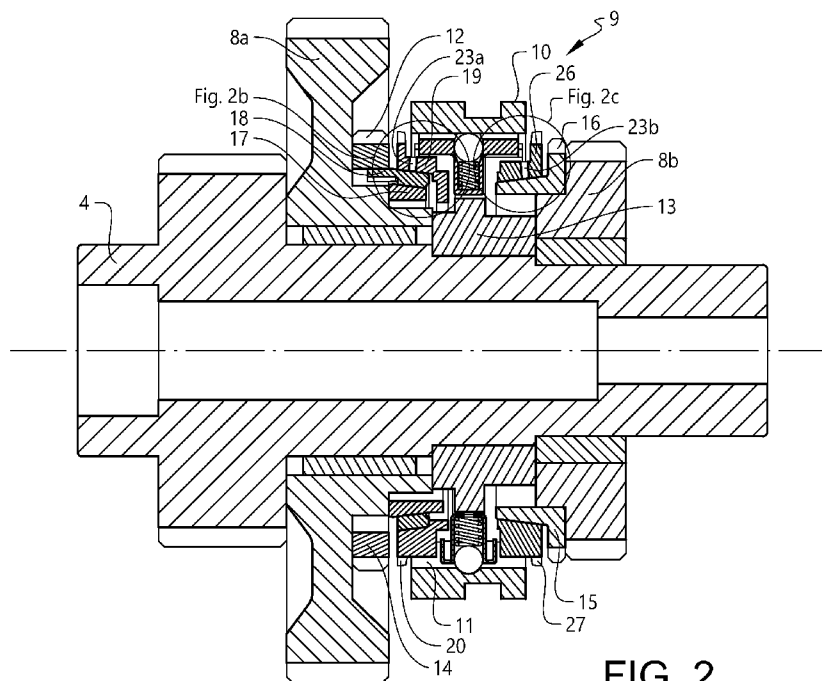


FIG. 2

(57) Abstract: The invention relates to a synchronizing ring (19; 26) for a synchronizer (9) having an inner ring (18; 15). The synchronizing ring is designed to be arranged outside of and to abut against the inner ring for achieving friction between an outer surface (21; 28) of the inner ring (18; 15) and an inner surface (22; 29) of the synchronizing ring during synchronization. The synchronizing ring (19; 26) has a plurality of through holes (23a; 23b) extending from the inner surface (22; 29) to an outer surface (24; 30) of the synchronizing ring for evacuation of oil from the interface (25; 31) between the inner ring and the synchronizing ring.



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A synchronizing ring

TECHNICAL FIELD

The invention relates to a synchronizing ring for a synchronizer, and a synchronizer for a vehicle transmission, comprising such a synchronizing ring.

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BACKGROUND

Vehicle transmissions usually have synchronizers for shifting gears. For example, an idle gear wheel that is journaled on an output shaft and engaged with a gear wheel arranged on an input shaft, can be connected to the output shaft by a synchronizer. The
10 synchronizer has a sleeve that is brought into engagement with for example a dog ring of the idle gear wheel. The sleeve is connected to a hub by means of a spline joint. The hub is in turn rotationally locked relative to the output shaft. Thus, when the sleeve and the dog ring are engaged, the idle gear wheel and the output shaft are rotationally locked relative to each other by means of the synchronizer and torque can be transferred from
15 the input shaft to the output shaft via the gear wheels.

When shifting gears, before displacement of the sleeve for engaging the dog ring, the rotation speeds of the idle gear wheel and the sleeve have however to be synchronized. For this reason, synchronizing rings or friction rings can be used. The first step of synchronizing the speeds is to increase the friction between the synchronizing rings.

20 SUMMARY

An objective of the invention is to provide a synchronizing ring enabling an improved synchronization.

The objective is achieved by a synchronizing ring for a synchronizer having an inner ring,
25 wherein the synchronizing ring is designed to be arranged outside of and to abut against the inner ring for achieving friction between an outer surface of the inner ring and an inner surface of the synchronizing ring during synchronization, and the synchronizing ring has a plurality of through holes extending from the inner surface to an outer surface of the synchronizing ring for evacuation of oil from the interface between the inner ring and the
30 synchronizing ring.

The invention is based on the insight that by such a synchronizing ring the oil can be removed very quickly from the friction surfaces via the through holes due to the centrifugal force. The time to reach the maximum friction coefficient can be reduced and the friction coefficient can be kept more constant during the synchronization phase. This in turn will
5 improve the synchronization performance and reduce the shifting time.

According to one embodiment, a longitudinal extension direction of each of said plurality of through holes deviates with an angle α , where $0 < \alpha < 90^\circ$, preferably in the range $5-45^\circ$, from a radial direction passing through the centre of the synchronizing ring when looked at
10 the synchronizing ring in a direction in parallel with a longitudinal axis of the synchronizing ring, and preferably the synchronizing ring has an intended rotational direction in operation, and when looked at the synchronizing ring in the direction in parallel with the longitudinal axis of the synchronizing ring, the longitudinal extension direction of each of said plurality of through holes is pivoted with the angle α in the opposite direction to the
15 intended rotational direction relative to the radial direction passing through the centre of the synchronizing ring. Hereby, the evacuation of oil from the friction surfaces can be further improved.

According to another embodiment, the synchronizing ring has a first row of said plurality of
20 through holes arranged along the circumference of the synchronizing ring and a second row of said plurality of through holes arranged along the circumference of the synchronizing ring, and the first row and the second row are arranged spaced apart from each other in a direction in parallel with a longitudinal axis of the synchronizing ring, and preferably said plurality of through holes of the first row and said plurality of through holes
25 of the second row are arranged alternately along the circumference of the synchronizing ring. Herby, a considerable number of through holes can be arranged in the synchronizing ring while maintaining sufficient strength of the synchronizing ring.

The number of through holes is preferably in the interval 10-100, more preferably 15-60
30 and often 20-50. The size of each through hole is preferably within the range 0.5-6 mm in diameter, and often 2-4 mm in diameter. The number of through holes and the size of each through hole are to some extent dependent on the size of the synchronizing ring.

According to a further embodiment, the area of the inner surface of the synchronizing ring
35 covered by said plurality of through holes is within the range 3-30 %, and preferably 5-

15 % of the total area of the inner surface of the synchronizing ring. Hereby, an improved evacuation of oil can be achieved at the same time as a sufficient friction surface area can be maintained.

- 5 According to another aspect of the invention, a further objective is to provide a synchronizer for a vehicle transmission enabling an improved synchronization.

This objective is achieved by a synchronizer for a vehicle transmission, wherein the synchronizer comprises a synchronizing ring and an inner ring, and the synchronizing ring
10 is arranged outside of and to abut against the inner ring for achieving friction between an outer surface of the inner ring and an inner surface of the synchronizing ring during synchronization, and the synchronizing ring has a plurality of through holes extending from the inner surface to an outer surface of the synchronizing ring for evacuation of oil from the interface between the inner ring and the synchronizing ring.

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The advantages of the synchronizer are similar to the advantages already discussed hereinabove with reference to the different embodiments of the synchronizing ring.

Further advantages and advantageous features of the invention are disclosed in the
20 following description and in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a more detailed description of
25 embodiments of the invention cited as examples.

In the drawings:

Fig. 1 is a schematic view of a vehicle transmission,
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Fig. 2 is a cut view of a synchronizer of a vehicle transmission,

Fig. 2b is an enlarged view of double cone synchronizer rings of the synchronizer illustrated in Fig. 2,

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Fig. 2c is an enlarged view of single cone synchronizer rings of the synchronizer illustrated in Fig. 2,

Fig. 3 is a perspective view of one embodiment of the synchronizing ring according to the
5 invention,

Fig. 4 is a partly cut plane view of the synchronizing ring in Fig. 3,

Fig. 4b is a side view of the synchronizing ring in Fig. 3,
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Fig. 5 is a perspective view of a further embodiment of the synchronizing ring according to the invention,

Fig. 6 is a partly cut plane view of the synchronizing ring in Fig. 5,
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Fig. 6b is a side view of the synchronizing ring in Fig. 5,

Fig. 7 is a partly cut plane view of a variant of the synchronizing ring in Fig. 3,
20 Fig. 7b is a side view of the synchronizing ring illustrated in Fig. 7,

Fig. 8 is a partly cut plane view of a further variant of the synchronizing ring in Fig. 3,

Fig. 8b is a side view of the synchronizing ring in Fig. 8, and
25

Fig. 9 is a side view of a further variant of the synchronizing ring in Fig. 3.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

30 Fig. 1 is a schematic illustration of a vehicle transmission 1. This is an example of a transmission to which the synchronizing ring and the synchronizer according to the invention can be applied. As will be evident from the description herein, the invention can be applied to any transmission having a synchronizer with friction rings for synchronizing a first and a second rotating member relative to each other. Such a synchronizer can be
35 arranged on an output shaft as described hereinafter or be arranged on an input shaft

provided with idle gear wheels. Synchronization is usually performed when shifting gears and a sleeve is to be engaged with a gear wheel for transferring torque from an input shaft to an output shaft (or vice-versa) of the transmission.

- 5 The transmission illustrated in Fig. 1 has an input shaft 2 and a first output shaft 3 and a second output shaft 4. The input shaft 2 is driven and can be connected to any kind of motor via a clutch. The first and second output shafts 3, 4 are connected to a differential 5 which in turn is connected to the driven wheels of a vehicle. Gear wheels 6 are arranged on the input shaft 2. Each of the gear wheels 6 is connected to a gear wheel 7 of the first
10 output shaft 3 or a gear wheel 8a, 8b of the second output shaft 4. The output shaft gear wheels 7, 8a, 8b are idle wheels, i.e. each gear wheel is journaled on the respective output shaft and can be rotationally locked to the output shaft by a synchronizer 9.

- Fig. 2 shows in a cut view an example of such a synchronizer 9. The synchronizer 9 has a
15 sleeve 10 that is displaceable (to the left in Fig. 2) into engagement with a first idle gear wheel 8a. The sleeve 10 has internal teeth 11 and the first idle gear wheel 8a is provided with a dog ring 14 with corresponding external teeth 12 such that the sleeve 10 and the first idle gear wheel 8a can be rotationally locked to each other. The first idle gear wheel 8a is engaged with another gear wheel (not shown in Fig. 2) arranged on the input shaft 2.
20 The sleeve 10 is further connected to a hub 13 by means of a spline joint. The hub 13 is in turn rotationally locked relative to the output shaft 4. Thus, when the sleeve 10 and the first idle gear wheel 8a are engaged, the first idle gear wheel 8a and the output shaft 4 are rotationally locked relative to each other via the synchronizer 9 and torque can be transferred from the input shaft 2 to the output shaft 4.

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- In an analogous way the sleeve 10 is displaceable (to the right in Fig. 2) into engagement with a second idle gear wheel 8b. The second idle gear wheel 8b is provided with a clutch cone ring 15 having external teeth 16 corresponding to the internal teeth 11 of the sleeve 10 such that the sleeve 10 and the clutch cone ring 15 can be engaged. The clutch cone
30 ring 15 is rotationally locked to the second idle gear wheel 8b. Hereby, the second idle gear wheel 8b and the sleeve 10 can be rotationally locked relative to each other. The second gear wheel 8b is engaged with another gear wheel (not shown in Fig. 2) arranged on the input shaft. Thus, when the sleeve 10 and the second idle gear wheel 8b are engaged, the second idle gear wheel 8b and the output shaft 4 are rotationally locked

relative to each other via the synchronizer 9 and torque can be transferred from the input shaft 2 to the output shaft 4.

For performing the synchronization, the synchronizer 9 comprises friction rings. As regards the synchronization of the first idle gear wheel 8a, the synchronizer has a double cone design. The synchronizer 9 comprises an internal ring 17, an intermediate ring 18 and a first blocking ring 19. These rings are further illustrated in an enlarged view in Fig. 2b.

10 A blocking ring has teeth for blocking a sliding movement of a synchronizer sleeve arranged externally of the blocking ring. In Fig. 2, movement of the sleeve 10 is blocked by the first blocking ring 19 when the sleeve 10 is displaced towards the first idle gear wheel 8a. The sleeve 10 is blocked by roof-to-roof contact between the teeth 11 of the sleeve 10 and teeth 20 of the first blocking ring 19 until the rotational speed is
15 synchronized. Thereafter, the sleeve 10 can be further displaced for engagement with the first idle gear wheel 8a.

In Fig. 2b the first blocking ring is an example embodiment of a synchronizing ring 19 according to the invention. The first blocking ring, hereinafter called the first synchronizing ring 19, is designed to be arranged outside of and to abut against the intermediate ring, hereinafter called the first inner ring 18, for achieving friction between an outer surface 21 of the first inner ring 18 and an inner surface 22 of the first synchronizing ring 19 during synchronization. The first synchronizing ring 19 has a plurality of through holes 23a extending from the inner surface 22 to an outer surface 24 of the first synchronizing ring
25 19 for evacuation of oil from the interface 25 between the first inner ring 18 and the first synchronizing ring 19. One of these through holes 23a is shown Fig. 2b.

As regards the synchronization of the second idle gear wheel 8b, the synchronizer 9 has a single cone design. The synchronizer comprises the inner clutch cone ring 15 and a
30 second blocking ring 26. These rings are further illustrated in an enlarged view in Fig. 2c.

As said before, a blocking ring has teeth for blocking a sliding movement of a synchronizer sleeve arranged externally of the blocking ring. In Fig. 2, movement of the sleeve 10 is blocked by the second blocking ring 26 when the sleeve 10 is displaced
35 towards the second idle gear wheel 8b. The sleeve 10 is blocked by roof-to-roof contact

between the teeth 11 of the sleeve 10 and teeth 27 of the second blocking ring 26 until the rotational speed is synchronized. Thereafter, the sleeve 10 can be further displaced for engagement with the second idle gear wheel 8b.

5 In Fig. 2c the second blocking ring is a further example embodiment of a synchronizing ring 26 according to the invention. The second blocking ring, hereinafter called the second synchronizing ring 26, is designed to be arranged outside of and to abut against the clutch cone ring, hereinafter called the second inner ring 15, for achieving friction between an outer surface 28 of the second inner ring 15 and an inner surface 29 of the second
10 synchronizing ring 26 during synchronization. The second synchronizing ring 26 has a plurality of through holes 23b extending from the inner surface 29 to an outer surface 30 of the second synchronizing ring 26 for evacuation of oil from the interface 31 between the second inner ring 15 and the second synchronizing ring 26. One of these through holes 23b is shown Fig. 2c.

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Fig. 3 shows the first synchronizing ring 19 in a perspective view. The through holes 23a are distributed along the circumference of the synchronizing ring 19. In the example embodiment illustrated in Fig. 3, the synchronizing ring has a first row 40 of said plurality of through holes 23a arranged along the circumference of the synchronizing ring and a
20 second row 41 of said plurality of through holes 23a arranged along the circumference of the synchronizing ring. The first row 40 and the second row 41 are arranged spaced apart from each other in a direction in parallel with a longitudinal axis 33 of the synchronizing ring. This direction is also called the longitudinal direction 33 of the synchronizing ring hereinafter. Further, said plurality of through holes 23a of the first row 40 and said plurality
25 of through holes 23a of the second row 41 are arranged alternately along the circumference of the synchronizing ring 19. The blocking teeth 20 arranged at one end of the synchronizing ring are also illustrated.

Such a through hole is suitably drilled and has circular shape. Alternatively, any other
30 suitably method for obtaining the through holes can be used. All through holes can have the same size or the size may vary between different through holes. The number of through holes is preferably in the interval 10-100, more preferably 15-60 and often 20-50. The size of each through hole is preferably within the range 0.5-6 mm in diameter, and often 2-4 mm in diameter. The number of through holes and the size of each through hole
35 are suitably adapted to the size of the synchronizing ring.

The area of the inner surface 22 of the synchronizing ring covered by said plurality of through holes is suitably within the range 3-30 %, and preferably 5-15 %, of the total area of the inner surface 22 of the synchronizing ring 19. In other words; the total area of the through hole openings at the inner surface of the synchronizing ring can be within the
5 range 3-30 %, and preferably 5-15 %, of the total area of the inner surface including both the through hole openings and the surface parts without through hole openings.

Fig. 4 is a plane view of the synchronizing ring in Fig. 3 and Fig. 4b is a side view of the synchronizing ring. Fig. 4 is partly cut along A-A as also indicated in Fig. 4b to show some
10 of the through holes 23a.

As can be seen from Fig. 4, a longitudinal extension direction 50 of each of said plurality of through holes 23a preferably deviates with an angle α , where $0 < \alpha < 90^\circ$, from a radial direction 51 passing through the centre 32 of the synchronizing ring 19 when looked at the
15 synchronizing ring in a direction in parallel with the longitudinal axis 33 of the synchronizing ring 19. The angle α is suitably in the range 5-45°, preferably in the range 10-40°, and more preferably in the range 15-35°. All through holes can have the same angle α or the angle may vary between different through holes.

20 The synchronizing ring 19 has an intended rotational direction 34 in operation. Looked at the synchronizing ring in the longitudinal direction 33 of the synchronizing ring 19, each of said plurality of through holes 23a suitably has the longitudinal extension direction 50 pivoted or inclined with the angle α in the opposite direction to the intended rotational direction 34 relative to the radial direction 51 passing through the centre 32 of the
25 synchronizing ring 19. This means that when the synchronizing ring 19 rotates an oil inlet opening 35 of respective through hole 23a on the inner surface 22 of the synchronizing ring is leading and an oil outlet opening 36 of the respective through hole 23a on the outer surface 24 of the synchronizing ring is trailing.

30 Fig. 5 shows the second synchronizing ring 26 in a perspective view. Figs. 6 and 6b show the synchronizing ring 26 in a partly cut plane view and a side view. This synchronizing ring is a blocking ring to be used together with the clutch cone ring 15 in the single cone design illustrated in Fig. 2c, whereas the first synchronizing ring 19 illustrated in Figs. 3, 4 and 4b is a blocking ring to be used together with the intermediate ring 18 in the double
35 cone design illustrated in Fig. 2b. Both the first synchronizing ring 19 and the second

synchronizing ring 26 have so-called blocking teeth 20, 27 for interaction with the sleeve 10. As regards further details of the second synchronizing ring 26 illustrated in Figs. 5, 6 and 6b, reference is made to the description hereinabove for the first synchronizing ring, since these features are similar to the both synchronizing rings.

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The synchronizing ring 19, 26 may have a first intended rotational direction 34 and second intended rotational direction 34' in operation. This is further illustrated in Figs. 7 and 8 for the first synchronizing ring 19. In this case, looked at the synchronizing ring in a direction in parallel with the longitudinal axis 33 of the synchronizing ring, the longitudinal extension direction 50 of each through hole of a first set 60 of said plurality of through holes 23a is preferably pivoted with the angle α in the opposite direction to the first intended rotational direction 34 relative to the radial direction 51 passing through the centre 32 of the synchronizing ring, and the longitudinal extension direction 50' of each through hole of a second set 61 of said plurality of through holes 23a' is preferably pivoted with the angle α in the opposite direction to the second intended rotational direction 34' relative to the radial direction 51' passing through the centre 32 of the synchronizing ring. In other words; the longitudinal extension direction of some of the through holes 23a can be adapted to the first intended rotational direction 34 and the longitudinal extension direction of other through holes 23a' can be adapted to a second opposite rotational direction 34'.

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Figs. 7 and 7b show a variant of the first synchronizing ring illustrated in Fig. 3. This synchronizing ring 19 has one row of through holes 23a, 23a'. The synchronizing ring 19 has a first set 60 of through holes adapted to the first rotational direction 34 and a second set 61 of through holes 23a' adapted to the second opposite rotational direction 34'. As illustrated, the longitudinal extension direction of each other through hole 23a can be adapted to the first rotational direction 34 and the longitudinal extension direction of each other through hole 23a' can be adapted to the second rotational direction 34'.

Figs. 8 and 8b show a further variant of the first synchronizing ring illustrated in Fig. 3. This synchronizing ring 19 has two rows of through holes 23a, 23a'. The synchronizing ring 19 has a first set 60 of through holes 23a adapted to the first rotational direction 34 and a second set 61 of through holes 23a' adapted to the second opposite rotational direction 34'. The first set 60 can be arranged in a first row 40 along the circumference of the synchronizing ring 19 and the second set 61 can be arranged in a second row 41 along the circumference of the synchronizing ring 19. The first row 40 and the second row

41 are arranged spaced apart from each other in the longitudinal direction 33 of the synchronizing ring 19. As illustrated, the longitudinal extension direction of each through hole 23a of the first row 40 can be adapted to the first rotational direction 34 and the longitudinal extension direction of each through hole 23a' of the second row 41 can be adapted to the second rotational direction 34'.

Fig. 9 shows a further variant of the synchronizing ring illustrated in Fig. 3. In addition to the angle α present between the longitudinal extension direction of the through hole and the radial direction passing the centre of the synchronizing ring, described for example embodiments of the first synchronizing ring and the second synchronizing ring hereinabove, as illustrated for one of the through holes 23a'' in Fig. 9, the outlet opening 36 on the outer surface 24 and the inlet opening 35 on the inner surface 22 of the through hole 23a'' can be displaced relative to each other in the longitudinal direction 33 of the synchronizing ring. (See also Figs. 3 and 4 as regards the inner and outer surfaces 22, 24.) Thereby, the longitudinal extension direction 50'' of the through hole 23a'' forms an angle β , where $30^\circ < \beta < 90^\circ$, relative to the longitudinal direction 33 of the synchronizing ring, when looked at the synchronizing ring in radial direction towards the centre 32. The angle β is preferably in the range 40° - 85° , and often 60° - 80° .

It is to be understood that the present invention is not limited to the embodiments described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the appended claims. For example, the invention can be applied in a synchronizer having a triple cone design.

CLAIMS

1. A synchronizing ring (19; 26) for a synchronizer (9) having an inner ring (18; 15), the synchronizing ring being designed to be arranged outside of and to abut against the inner ring for achieving friction between an outer surface (21; 28) of the inner ring (18; 15) and an inner surface (22; 29) of the synchronizing ring during synchronization, **characterized in that** the synchronizing ring (19; 26) has a plurality of through holes (23a; 23b) extending from the inner surface (22; 29) to an outer surface (24; 30) of the synchronizing ring for evacuation of oil from the interface (25; 31) between the inner ring and the synchronizing ring.
2. A synchronizing ring according to claim 1, **characterized in that** the synchronizing ring (19; 26) is a blocking ring having teeth (20; 27) for blocking a sliding movement of a synchronizer sleeve (10) arranged externally of the synchronizing ring.
3. A synchronizing ring according to claim 1 or 2, **characterized in that** a longitudinal extension direction (50) of each of said plurality of through holes (23a) deviates with an angle α , where $0 < \alpha < 90^\circ$, from a radial direction (51) passing through the centre (32) of the synchronizing ring when looked at the synchronizing ring in a direction in parallel with a longitudinal axis (33) of the synchronizing ring.
4. A synchronizing ring according to claim 3, **characterized in that** the angle α is in the range $5-45^\circ$.
5. A synchronizing ring according to claim 3, **characterized in that** the angle α is in the range $10-40^\circ$.
6. A synchronizing ring according to claim 3, **characterized in that** the angle α is in the range $15-35^\circ$.
7. A synchronizing ring according to any of claims 3-6, **characterized in that** the synchronizing ring (19; 26) has an intended rotational direction (34) in operation, and when looked at the synchronizing ring in the direction in parallel with the

longitudinal axis (33) of the synchronizing ring, the longitudinal extension direction (50) of each of said plurality of through holes (23a) is pivoted with the angle α in the opposite direction to the intended rotational direction (34) relative to the radial direction (51) passing through the centre (32) of the synchronizing ring (19; 26).

5

8. A synchronizing ring according to any of claims 3-6, **characterized in that** the synchronizing ring (19) has a first intended rotational direction (34) and second intended rotational direction (34') in operation, and when looked at the synchronizing ring in the direction in parallel with the longitudinal axis (33) of the synchronizing ring, the longitudinal extension direction (50) of each through hole of a first set (60) of said plurality of through holes (23a) is pivoted with the angle α in the opposite direction to the first intended rotational direction (34) relative to the radial direction (51) passing through the centre (32) of the synchronizing ring, and the longitudinal extension direction (50') of each through hole of a second set (61) of said plurality of through holes (23a') is pivoted with the angle α in the opposite direction to the second intended rotational direction (34') relative to the radial direction (51') passing through the centre (32) of the synchronizing ring.

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9. A synchronizing ring according to any preceding claim, **characterized in that** the synchronizing ring (19) has a first row (40) of said plurality of through holes (23a) arranged along the circumference of the synchronizing ring and a second row (41) of said plurality of through holes (23a') arranged along the circumference of the synchronizing ring, the first row and the second row being arranged spaced apart from each other in a direction in parallel with a longitudinal axis (33) of the synchronizing ring.

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10. A synchronizing ring according to claim 9, **characterized in that** said plurality of through holes (23a) of the first row and said plurality of through holes (23a') of the second row being arranged alternately along the circumference of the synchronizing ring (19).

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11. A synchronizing ring according to any preceding claim, **characterized in that** the area of the inner surface (22) of the synchronizing ring covered by said plurality of through holes (23a) is within the range 3-30 % of the total area of the inner surface (22) of the synchronizing ring.

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12. A synchronizing ring according to any preceding claim, **characterized in that** the area of the inner surface (22) of the synchronizing ring covered by said plurality of through holes (23a) is within the range 5-15 % of the total area of the inner surface (22) of the synchronizing ring.
13. A synchronizing ring according to any preceding claim, **characterized in that** the size of each of said plurality of through holes (23a; 23b) is within 0.5-6 mm in diameter.
14. A synchronizing ring according to any preceding claim, **characterized in that** the size of each of said plurality of through holes (23a; 23b) is within 2-4 mm in diameter.
15. A synchronizer (9) for a vehicle transmission (1), the synchronizer comprising a synchronizing ring (19; 26) and an inner ring (18; 15), the synchronizing ring being arranged outside of and to abut against the inner ring for achieving friction between an outer surface (21; 28) of the inner ring and an inner surface (22; 29) of the synchronizing ring during synchronization, **characterized in that** the synchronizing ring has a plurality of through holes (23a; 23b) extending from the inner surface (22; 29) to an outer surface (24; 30) of the synchronizing ring for evacuation of oil from the interface (25; 31) between the inner ring and the synchronizing ring.
16. A synchronizer according to claim 15, **characterized in that** a longitudinal extension direction (50) of each of said plurality of through holes deviates with an angle α , where $0 < \alpha < 90^\circ$, from a radial direction (51) passing through the centre (32) of the synchronizing ring when looked at the synchronizing ring in a direction in parallel with a longitudinal axis (33) of the synchronizing ring.
17. A synchronizer according to claim 16, **characterized in that** the synchronizing ring (19; 26) has an intended rotational direction (34) in operation, and when looked at the synchronizing ring in the direction in parallel with the longitudinal axis (33) of the synchronizing ring, the longitudinal extension direction of each of said

plurality of through holes (23a) is pivoted with the angle α in the opposite direction to the intended rotational direction (34) relative to the radial direction (51) passing through the centre (32) of the synchronizing ring (19; 26).

5 18. A synchronizer according to any of claims 15-17, **characterized in that** the synchronizer (9) comprises a sleeve (10) for connecting a shaft (4) and a gear wheel (8a; 8b) journaled on the shaft to each other, the synchronizing ring (19; 26) being a blocking ring having teeth (20; 27) for blocking a sliding movement of the synchronizer sleeve (10) arranged externally of the blocking ring.

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19. A synchronizer according to any of claims 15-18, **characterized in that** the inner ring (15) is a clutch cone ring.

15 20. A synchronizer according to any of claims 15-18, **characterized in that** the synchronizer comprises an internal ring (17) and the inner ring (18) is an intermediate ring arranged outside of the internal ring.

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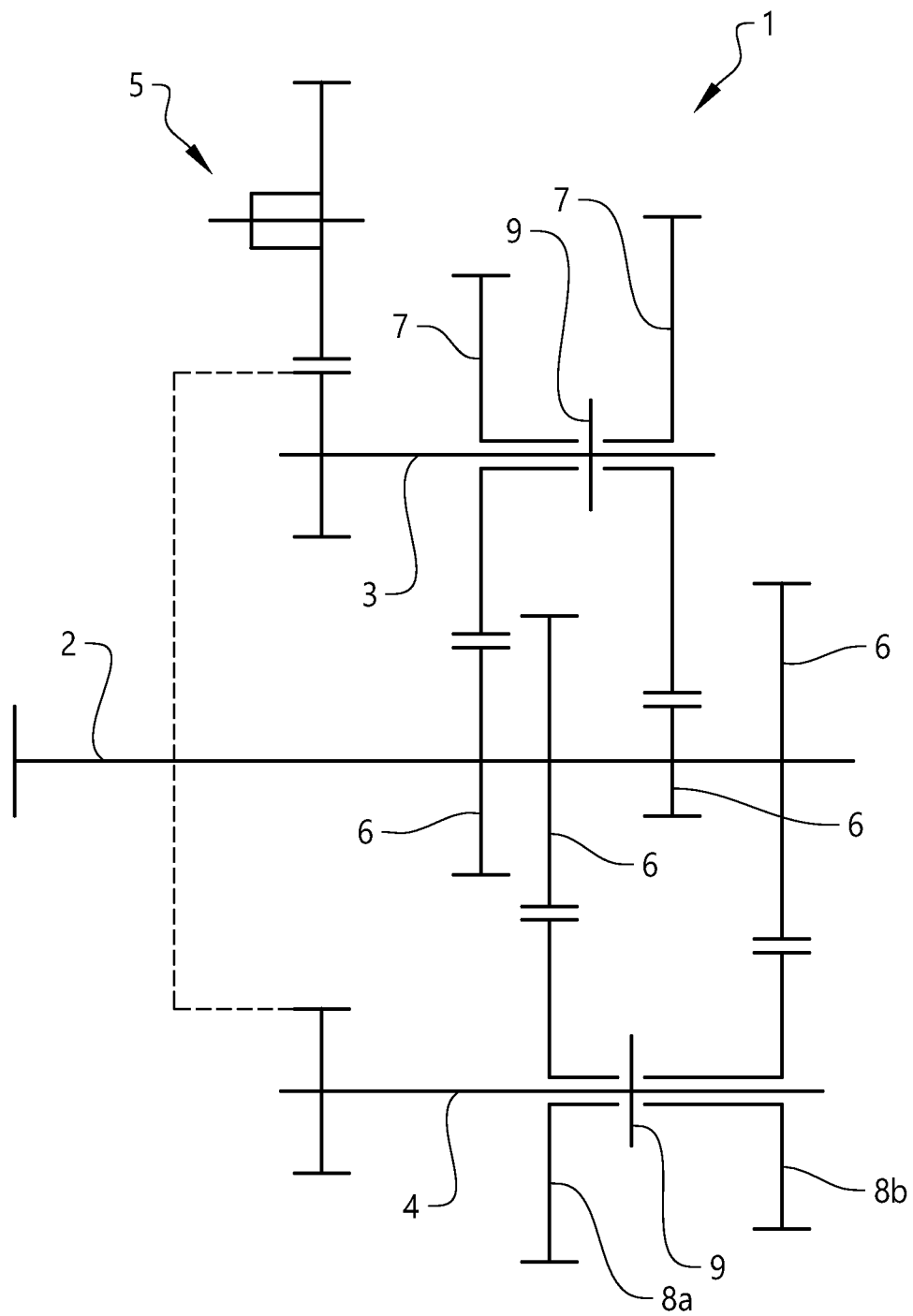
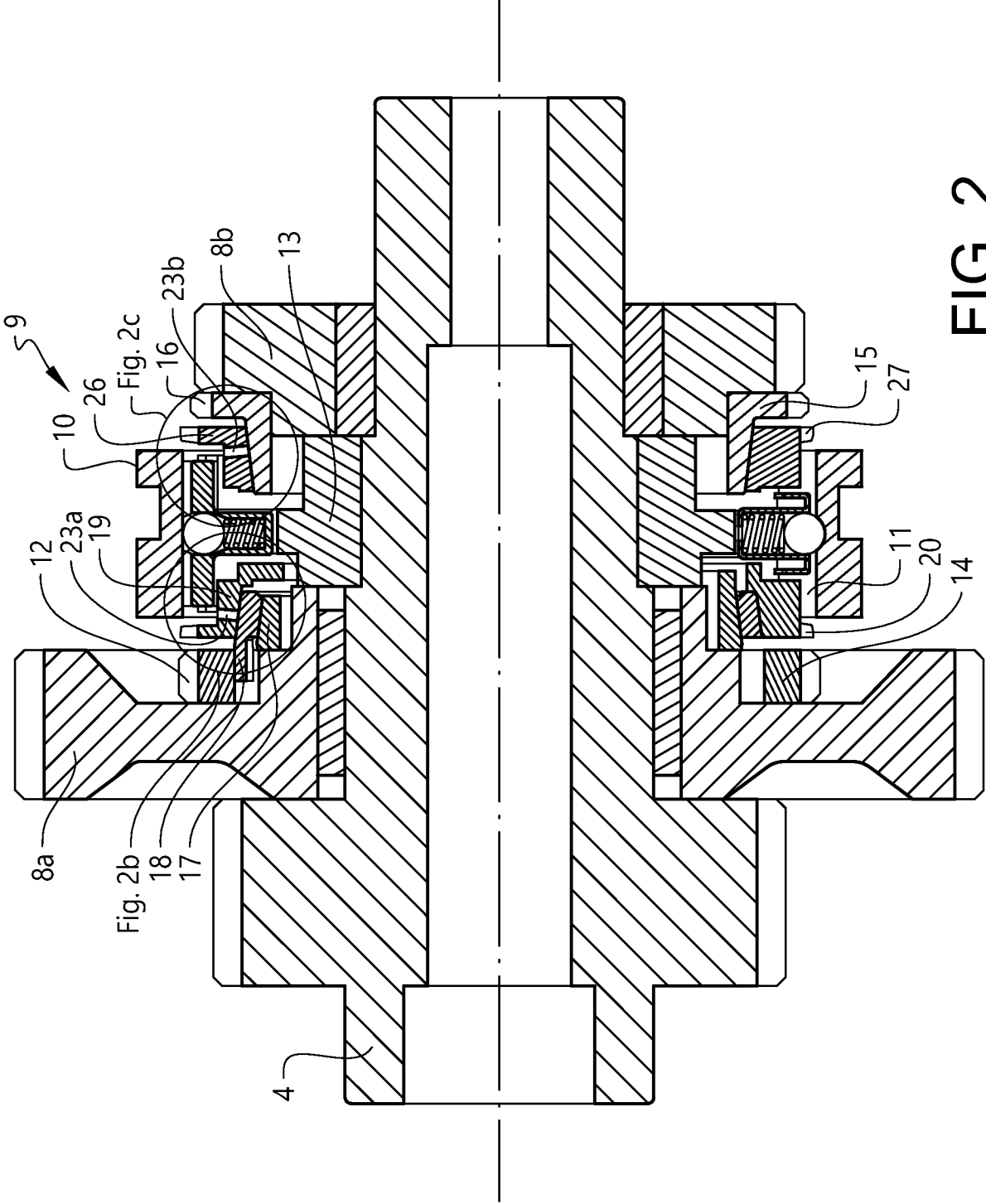
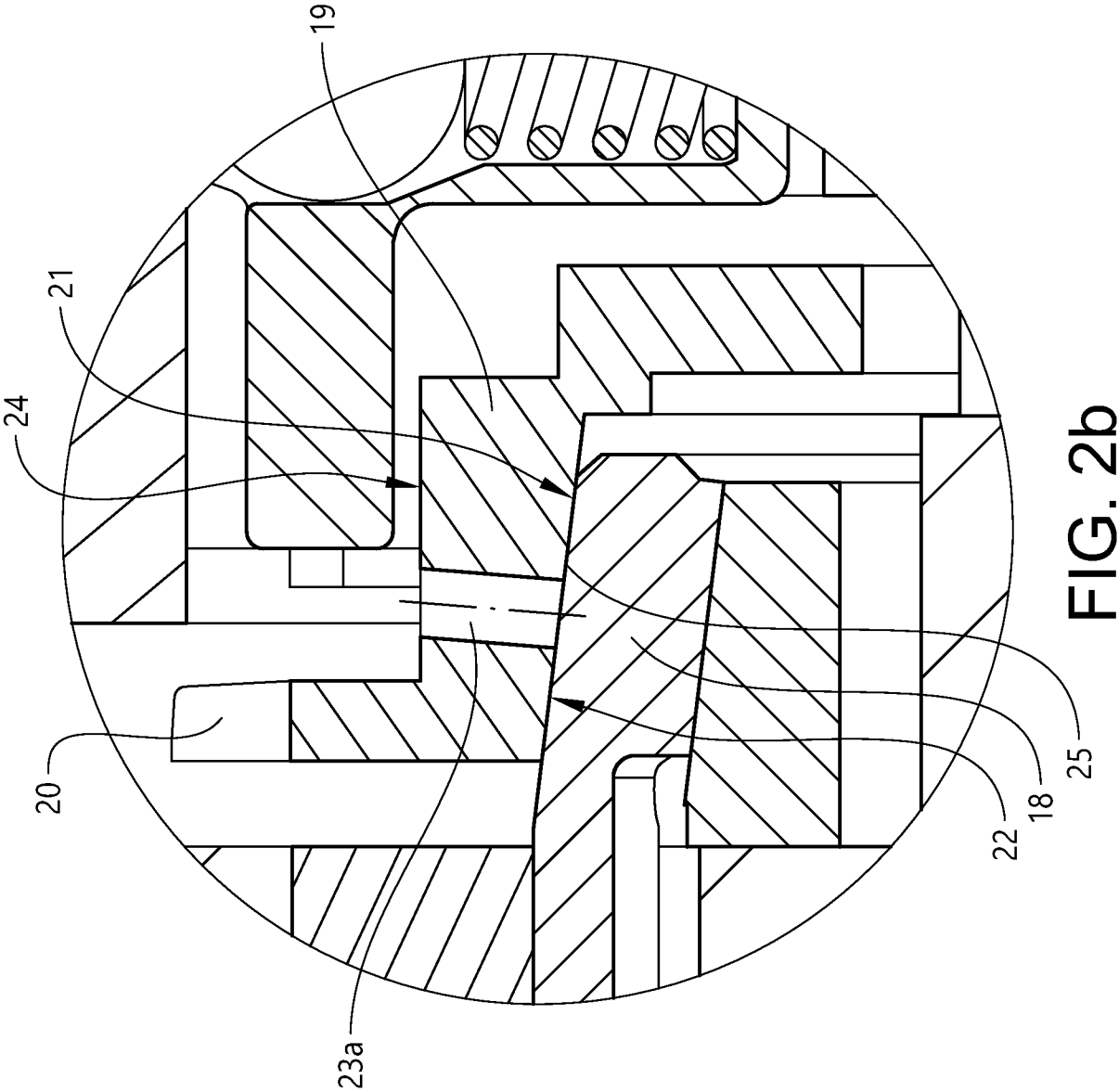


FIG. 1





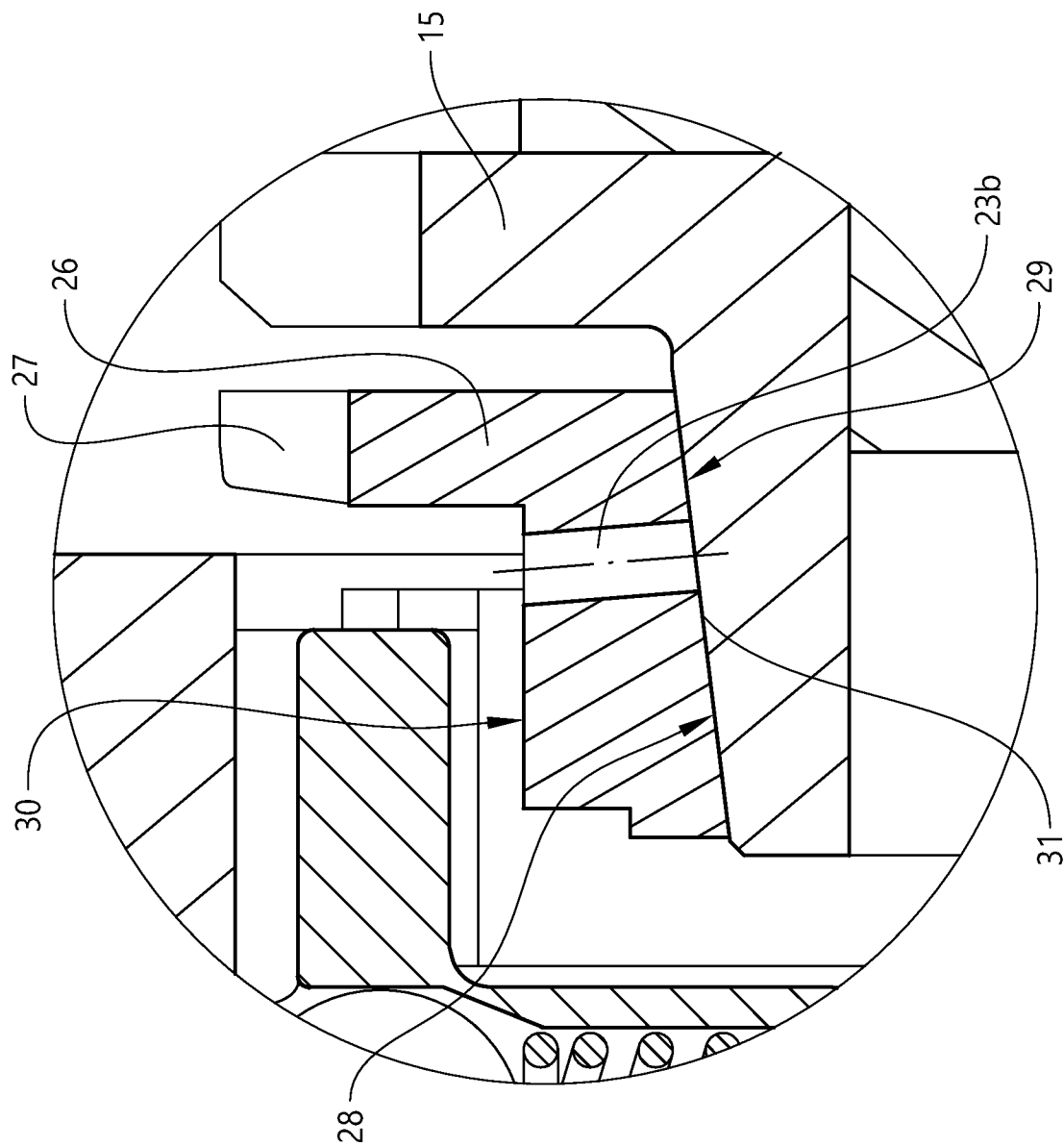


FIG. 2c

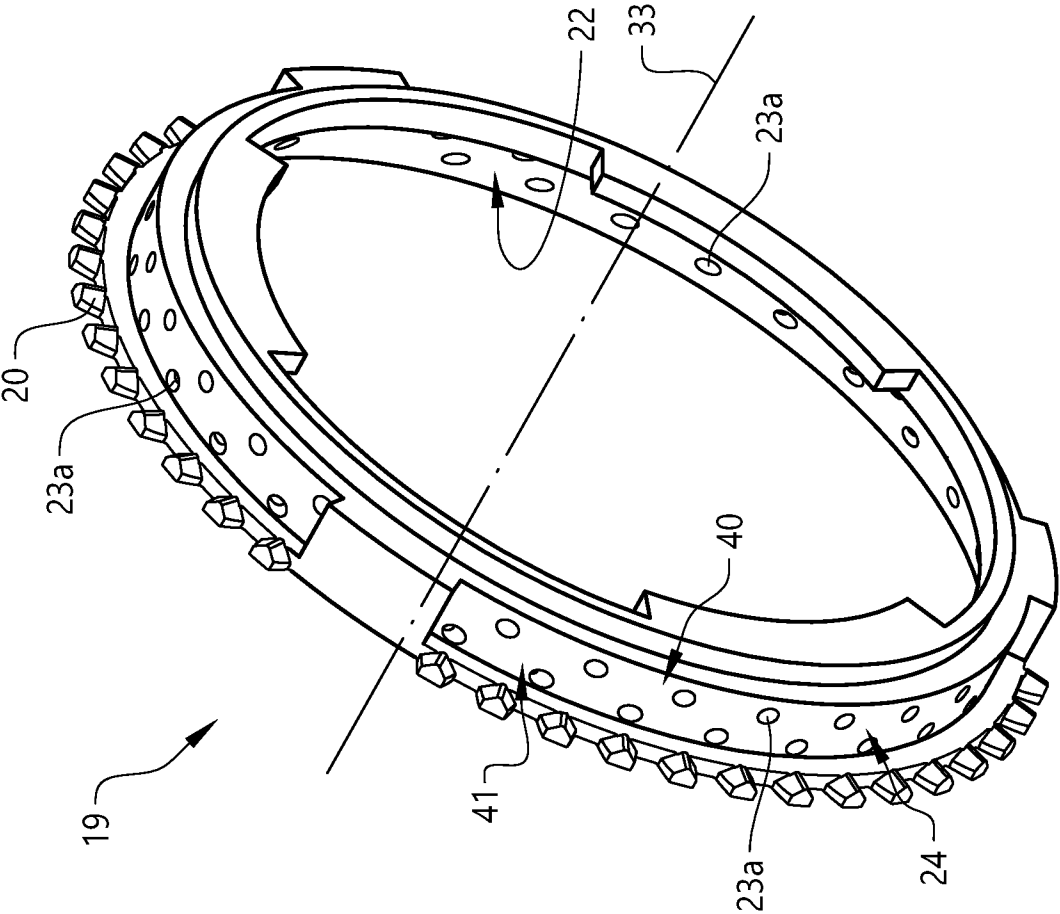


FIG. 3

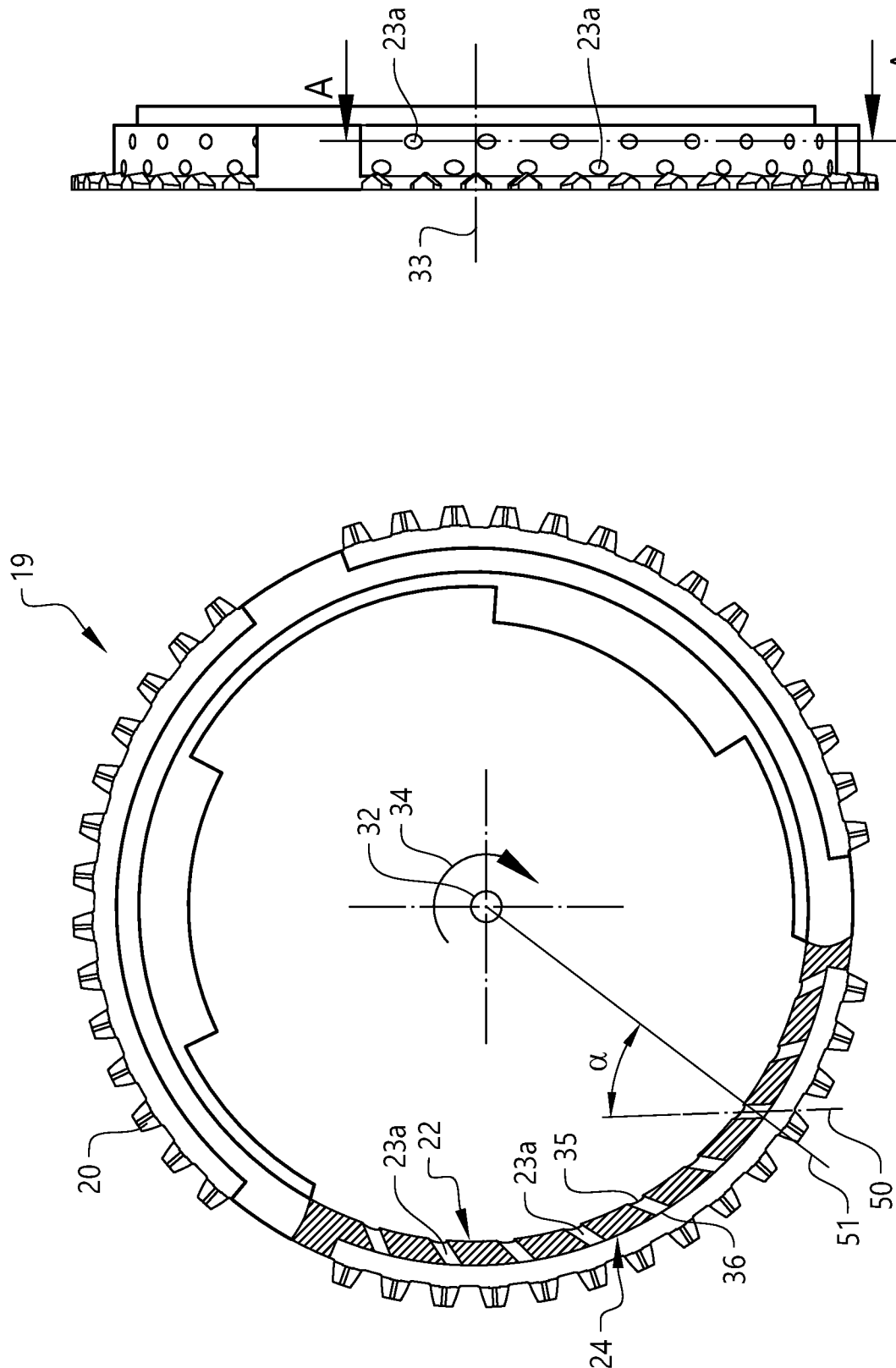


FIG. 4 (A-A)

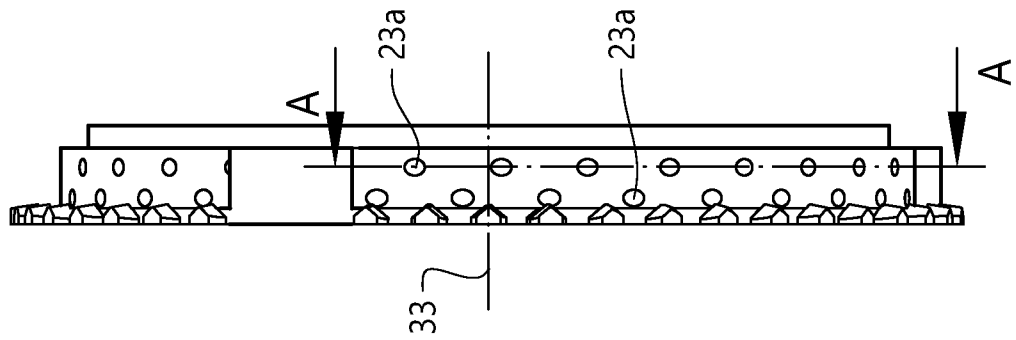


FIG. 4b

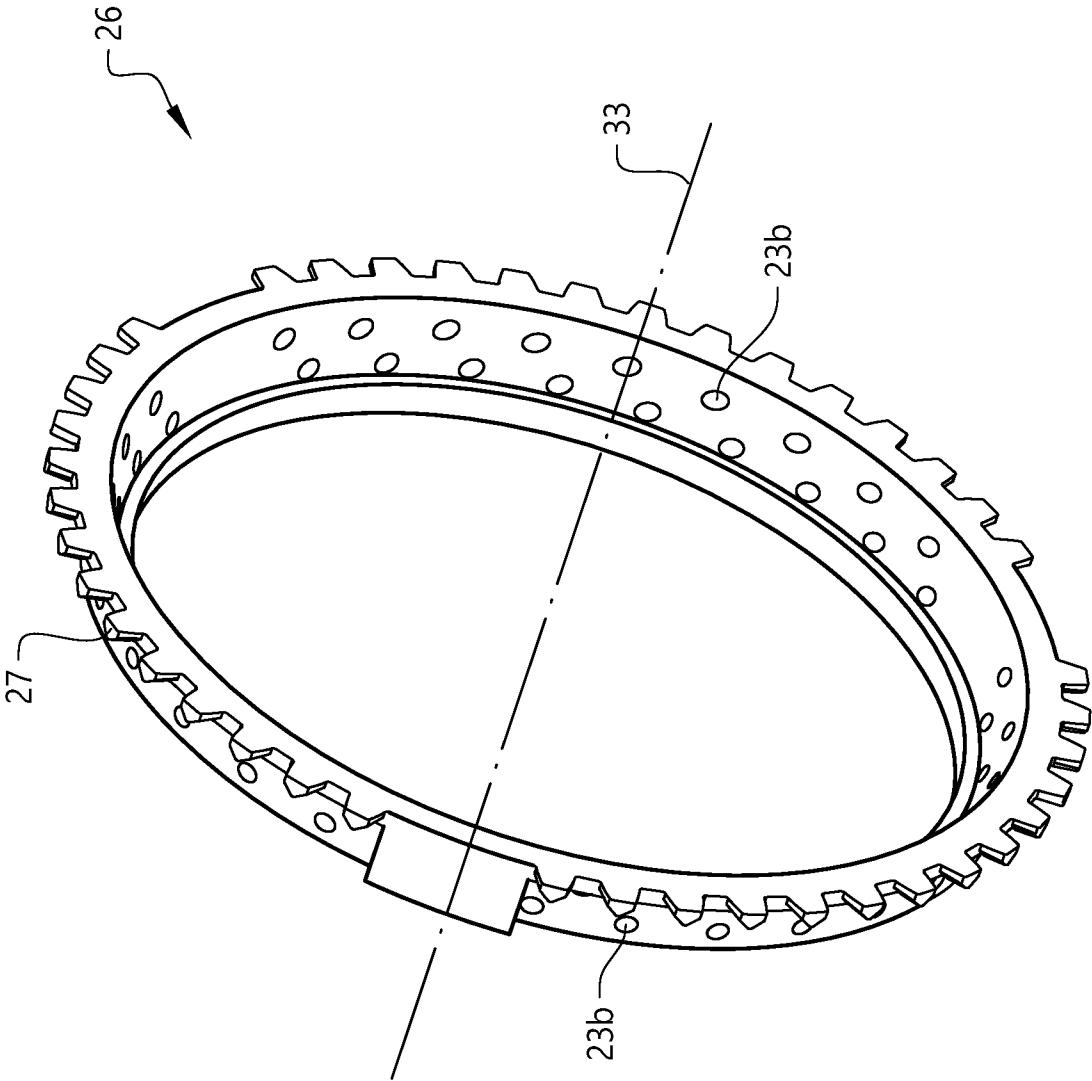


FIG. 5

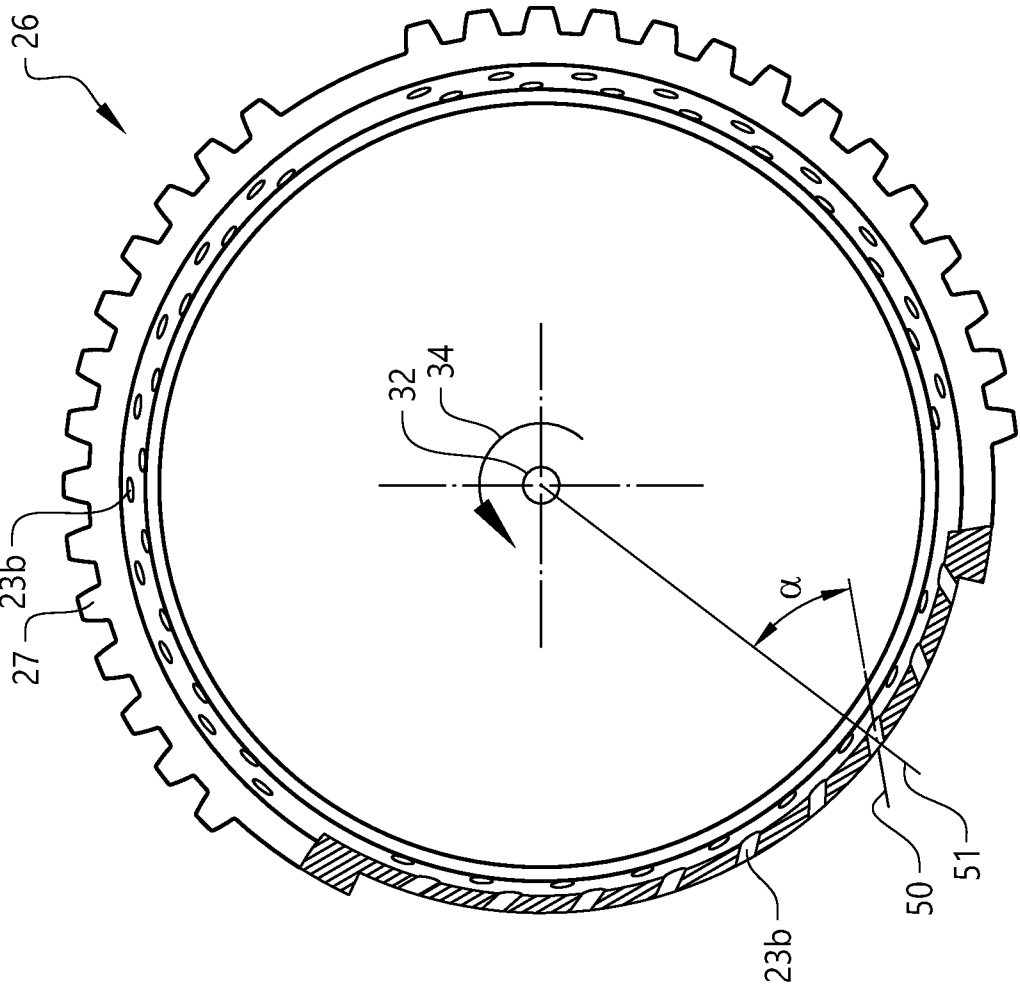


FIG. 6 (B-B)

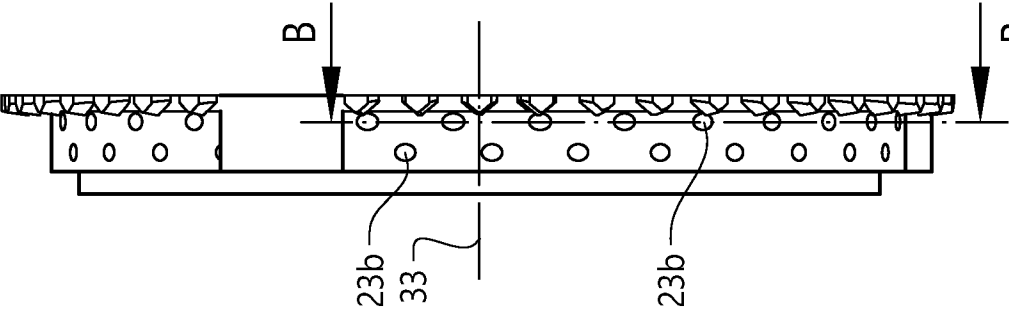
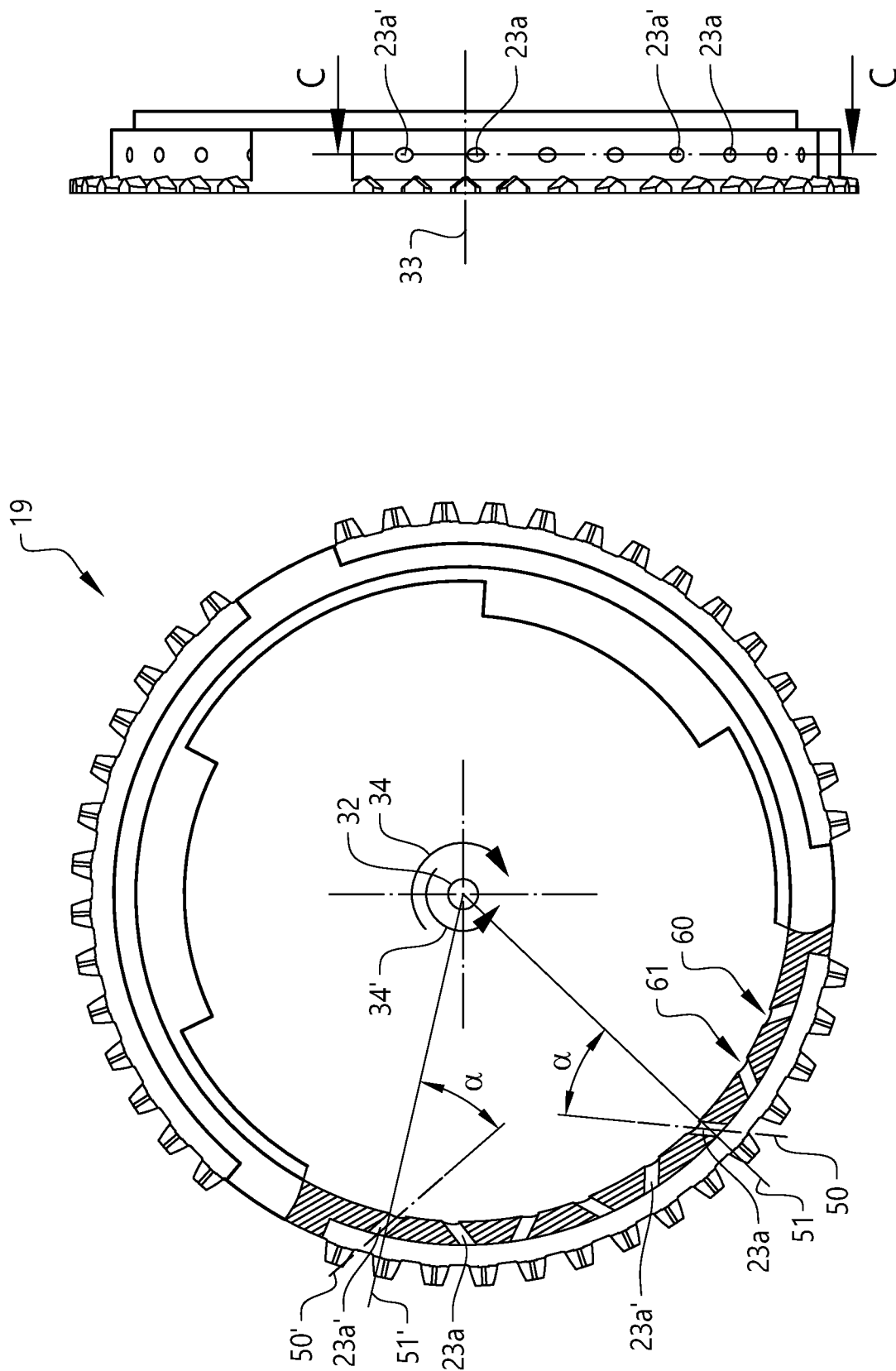


FIG. 6b



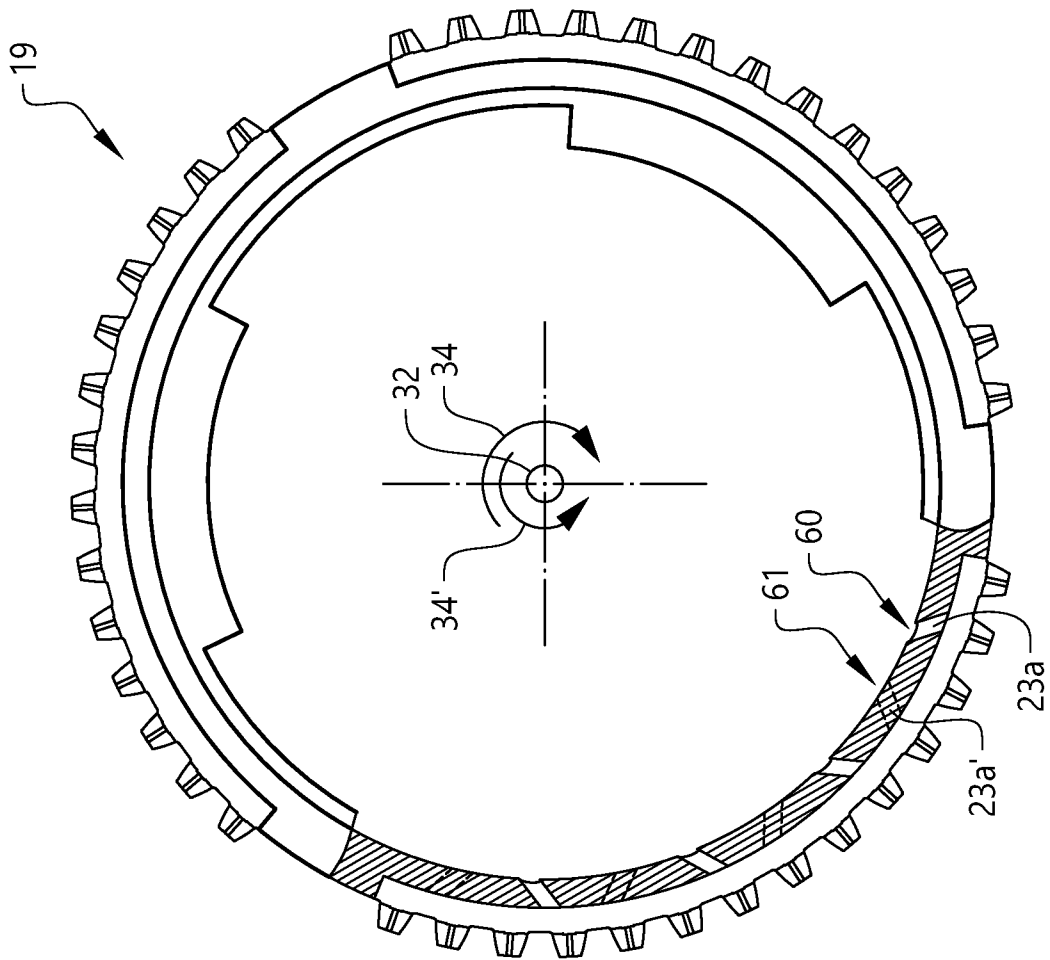


FIG. 8 (D-D)

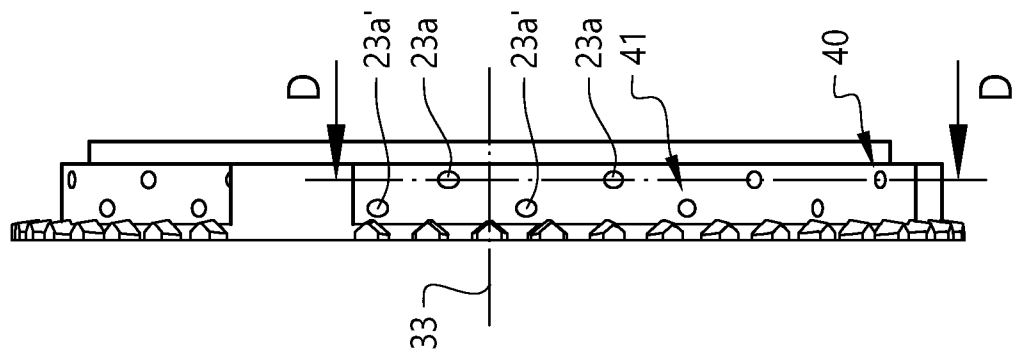


FIG. 8b

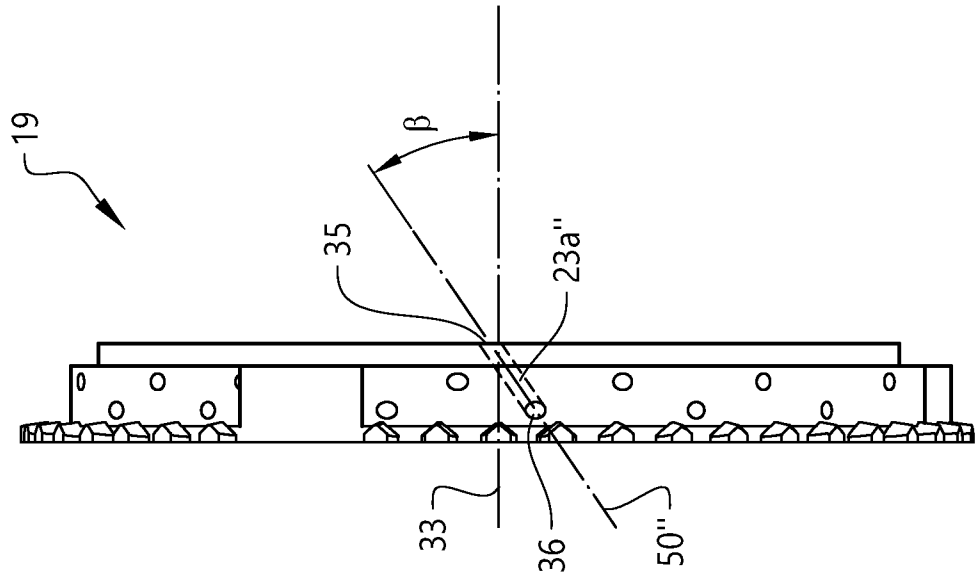


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/109904

A. CLASSIFICATION OF SUBJECT MATTER

F16D 23/02(2006.01)i

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)

CNKI,CNPAT,WPI,EPODOC,IEEE,3GPP:synchronizer, synchronizing, ring, hole, opening, oil, friction, inner, outer, surface

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016281798 A1 (GM GLOBAL TECHNOLOGY OPERATIONS LLC) 29 September 2016 (2016-09-29) description, paragraphs [0026]-[0031] and figures 2-6	1-20
X	DE 102007042800 A1 (SCHAEFFLER KG) 12 March 2009 (2009-03-12) description, paragraphs [0011]-[0014] and figures 1-2	1-20
A	CN 105317875 A (HOERBIGER ANTRIEBSTECHNIK HOLDING GMBH) 10 February 2016 (2016-02-10) the whole document	1-20
A	US 5135087 A (NEW VENTURE GEAR, INC.) 04 August 1992 (1992-08-04) the whole document	1-20

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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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

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“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

07 December 2018

Date of mailing of the international search report

29 December 2018

Name and mailing address of the ISA/CN

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Telephone No. 86-(10)-53961738

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/109904

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2016281798	A1	29 September 2016	DE	102016105090	A1	29 September 2016
				CN	105987089	A	05 October 2016
				IN	201634004300	A	17 November 2017
DE	102007042800	A1	12 March 2009	None			
CN	105317875	A	10 February 2016	DE	102014108202	A1	17 December 2015
US	5135087	A	04 August 1992	None			