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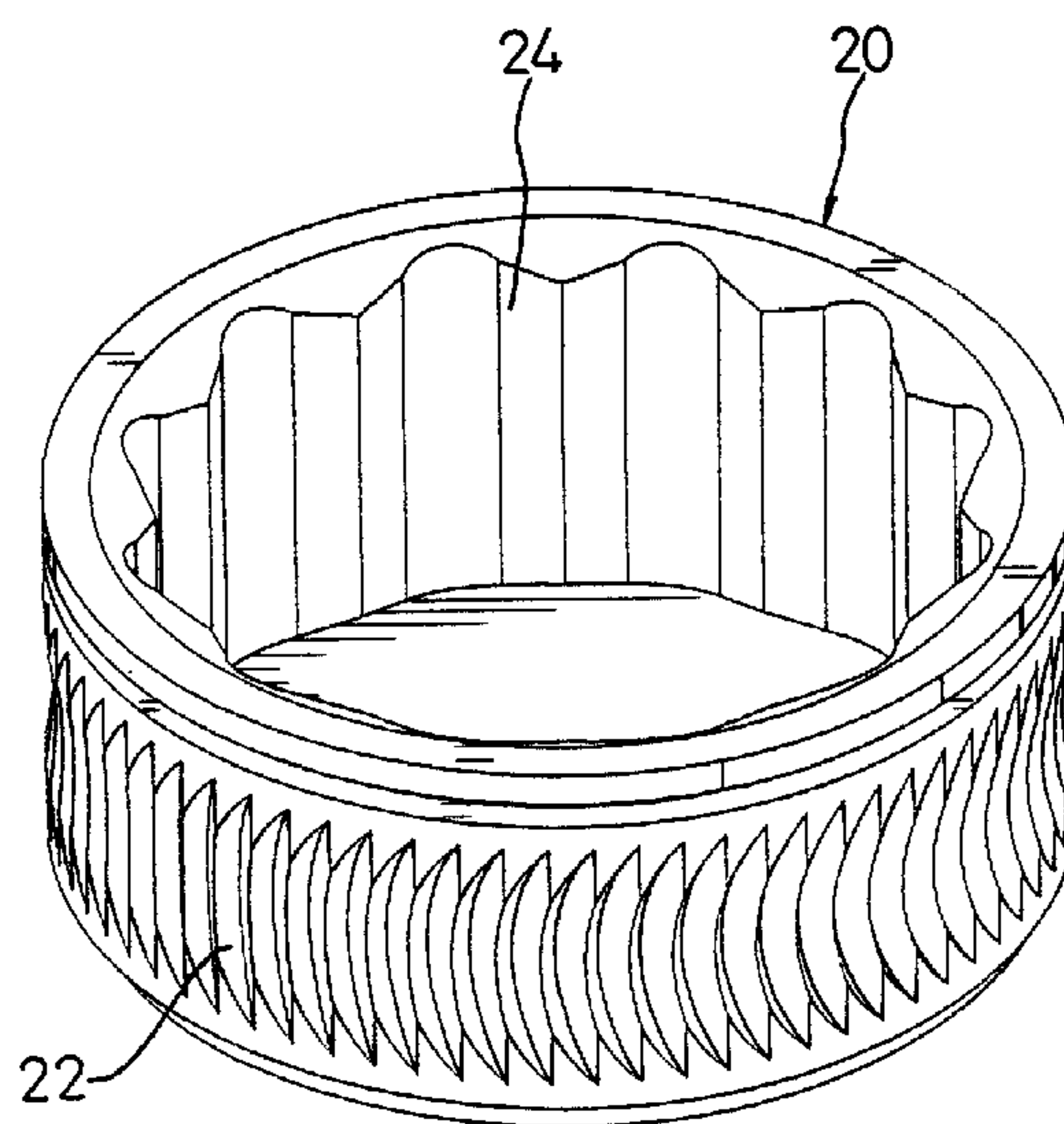
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(54) **ROUE A ROCHET AVEC DENTURE CONCAVE ARQUEE
ASYMETRIQUE OU DENTURE CONCAVE NON ARQUEE ET
OUTILS A ROCHET AVEC UNE TELLE ROUE A ROCHET**

(54) **RATCHET WHEEL WITH ASYMMETRIC ARCUATE
CONCAVE TEETH OR NON-ARCUATE CONCAVE TEETH
AND RATCHETING TOOLS WITH SUCH RATCHET WHEEL**



(57) A ratchet wheel includes an outer periphery. The outer periphery includes a number of arcuate concave teeth each having two sides and an intersection of the two sides. The ratchet wheel includes a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions, thereby forming asymmetric arcuate concave teeth to provide improved structural strength and improved torque. In another embodiment, the concave teeth are non-arcuate to reduce the formation time for the teeth, thereby reducing the production cost.

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Abstract of the Disclosure

A ratchet wheel includes an outer periphery. The outer periphery includes a number of arcuate concave teeth each having two sides and an intersection of the two sides. The ratchet wheel includes a center, a line from the center to the intersection dividing an angle between the two sides into two unequal portions, thereby forming asymmetric arcuate concave teeth to provide improved structural strength and improved torque. In another embodiment, the concave teeth are non-arcuate to reduce the formation time for the teeth, thereby reducing the production cost.

1 **RATCHET WHEEL WITH ASYMMETRIC ARCUATE CONCAVE TEETH OR**
2 **NON-ARCUATE CONCAVE TEETH AND RATCHETING TOOLS WITH SUCH**
3 **RATCHET WHEEL**

4 **Background of the Invention**

5 **1. Field of the Invention**

6 The present invention relates to a ratchet wheel with asymmetric arcuate concave teeth
7 or non-arcuate concave teeth. The present invention also relates to a ratcheting tool, e.g., a ring
8 spanner having a box end in which the ratchet wheel is mounted. The ratchet wheel with
9 asymmetric arcuate concave teeth provides improved structural strength and improved torque.
10 The ratchet wheel with non-arcuate concave teeth is easy to form and thus reduces the
11 production cost.

12 **2. Description of the Related Art**

13 A wide variety of spanners and wrenches have heretofore been provided. Ring spanners
14 are the best choice for driving fasteners (e.g., nuts, bolt heads, etc) in a limited space that is
15 uneasy to access and difficult to operate all kinds of ratcheting tools. Nevertheless,
16 conventional ring spanners have low driving torque. Ratchet type ring spanners have been
17 proposed to solve this problem. A ratchet wheel is mounted in the box end of a ring spanner
18 for driving fasteners at high torque. It is, however, found that, the structural strength of the
19 ratchet wheel is weak, as an outer periphery of the ratchet wheel is processed to form a
20 plurality of arcuate teeth with a considerable depth.

21 Figs. 11 through 13 of the drawings illustrate a conventional ratchet wheel 1 mounted in
22 a box end (not shown) of a ring spanner (not shown) and having an inner periphery 4 for
23 driving a fastener (not shown) and an outer periphery having a plurality of arcuate concave
24 teeth 3. Referring to Fig. 12, each arcuate concave tooth 3 is formed by means of feeding a
25 cutter 2 along a direction transverse to a radial direction (see line OR). The resultant concave
26 tooth 3 has a depth "d" and two sides that intersect at point "R". The line OR divides the angle
27 α defined by the two sides of the arcuate concave tooth 3 into two equal portions (usually

1 45° for each portion). As illustrated in Fig. 12, each arcuate concave tooth 3 is machined to
2 have a considerable depth “d” that adversely affects the structural strength of the ratchet wheel
3 1, as the remaining wall thickness “t” of the ratchet wheel 1 is relatively small. As a result, the
4 driving torque provided by the ratchet wheel for driving the fastener is limited.

5 Figs. 14 through 16 of the drawings illustrate a conventional ratchet wheel 5 mounted in
6 a box end 9a (Fig. 17) of a ring spanner 9 (Fig. 17) and having an inner periphery 8 for driving
7 a fastener (not shown) and an outer periphery having a plurality of arcuate concave teeth 6.
8 Referring to Fig. 15, each arcuate concave tooth 6 is formed by means of feeding a cutter 7
9 along a radial direction. The resultant arcuate concave tooth 6 has a depth “d” and two sides
10 that intersect at point “R”. The line OR divides the angle β defined by the two sides of the
11 concave tooth 6 into two equal portions (usually 45° for each portion). As illustrated in Fig. 15,
12 each arcuate concave tooth 6 is machined to have a considerable depth “d” that adversely
13 affects the structural strength of the ratchet wheel, as the remaining wall thickness “t” of the
14 ratchet wheel 5 is relatively small. As a result, the driving torque provided by the ratchet
15 wheel for driving the fastener is limited. Such structure has been disclosed in U.S. Patent No.
16 5,533,427 to Chow issued on Jul. 9, 1996, which is incorporated herein for reference. A
17 further drawback of this conventional ratchet wheel is the low production rate for forming the
18 arcuate concave teeth by cutting.

19 The present invention is intended to provide an improved ratchet wheel that mitigates
20 and/or obviates the above problems.

21 Summary of the Invention

22 It is a primary object of the present invention to provide an improved ratchet wheel has
23 asymmetric arcuate concave teeth for providing improved structural strength and improved
24 torque.

25 It is another object of the present invention to provide an improved ratchet wheel that
26 has non-arcuate concave teeth to allow higher production rate, as the non-arcuate concave
27 teeth can be formed by means of roll squeezing method, investment casting, or molding. The

1 non-arcuate concave teeth may be symmetric or asymmetric. The ratchet wheel with non-
2 arcuate concave teeth may bear higher torque during ratcheting (i.e., tightening or loosening a
3 fastener).

4 The present invention also provides a ratcheting tool, e.g., a spanner, equipped with a
5 ratchet wheel in accordance with the present invention. In an embodiment of the invention, the
6 spanner has a box end for receiving a ratcheting wheel with asymmetric arcuate concave teeth.
7 In another embodiment of the invention, the spanner has a box end for receiving a ratcheting
8 wheel with non-arcuate asymmetric concave teeth. In a further embodiment of the invention,
9 the spanner has a box end for receiving a ratcheting wheel with non-arcuate symmetric
10 concave teeth.

11 Other objects, advantages, and novel features of the invention will become more
12 apparent from the following detailed description when taken in conjunction with the
13 accompanying drawings.

14 **Brief Description of the Drawings**

15 Fig. 1 is a perspective view of a ratchet wheel with asymmetric arcuate concave teeth in
16 accordance with the present invention;

17 Fig. 2 is a side view of the ratchet wheel in accordance with the present invention;

18 Fig. 3 is a top view of the ratchet wheel in accordance with the present invention,
19 illustrating formation of asymmetric arcuate concave teeth in an outer periphery of the ratchet
20 wheel;

21 Fig. 4 is a top view of a box end of a ring spanner equipped with the ratchet wheel in
22 accordance with the present invention;

23 Fig. 5 is a sectional view taken along line 5-5 in Fig. 4;

24 Fig. 6 is a top view, in an enlarged scale, of the ratchet wheel in accordance with the
25 present invention, wherein position of symmetric concave teeth formed according to prior art
26 is illustrated to show difference therebetween;

1 Fig. 7a is a perspective view of a pawl for cooperating with the asymmetric arcuate
2 concave teeth of the ratchet wheel in accordance with the present invention;

3 Fig. 7b is a top view of the pawl in Fig. 7a;

4 Fig. 7c is a side view of the pawl in Fig. 7a;

5 Fig. 8a is a perspective view of a conventional pawl for cooperating with the arcuate
6 concave teeth of the ratchet wheel in Fig. 14;

7 Fig. 8b is a top view of the pawl in Fig. 8a;

8 Fig. 8c is a side view of the pawl in Fig. 8a;

9 Fig. 9 is an enlarged fragmentary view illustrating operation of the pawl and the
10 asymmetric arcuate concave teeth of the ratchet wheel in accordance with the present
11 invention;

12 Fig. 10 is a schematic force diagram of the asymmetric arcuate concave tooth of the
13 ratchet wheel in accordance with the present invention;

14 Fig. 11 is a perspective view of a ratchet wheel according to prior art;

15 Fig. 12 is a top view of the ratchet wheel in Fig. 11;

16 Fig. 13 is a side view of the ratchet wheel in Fig. 11;

17 Fig. 14 is a perspective view of another ratchet wheel according to prior art;

18 Fig. 15 is a top view of the ratchet wheel in Fig. 14;

19 Fig. 16 is a side view of the ratchet wheel in Fig. 14;

20 Fig. 17 is a top view of a box end of a ring spanner equipped with the ratchet wheel in
21 Fig. 14;

22 Fig. 18 is an enlarged fragmentary view illustrating operation of the conventional pawl
23 and the symmetric arcuate concave teeth of the conventional ratchet wheel in the ring spanner
24 Fig. 17;

25 Fig. 19 is a schematic force diagram of the ratchet wheel in Fig. 14;

26 Fig. 20 is a sectional view taken along line 20-20 in Fig. 17;

1 Fig. 21 is a perspective view of a ratchet wheel with non-arcuate concave teeth in
2 accordance with the present invention;

3 Fig. 22 is a side view of the ratchet wheel in Fig. 21;

4 Fig. 23 is a top view of a box end of a ring spanner equipped with the ratchet wheel in
5 Fig 21;

6 Fig. 24 is a sectional view taken along line 24-24 in Fig. 23;

7 Fig. 25 is a top view of the ratchet wheel in Fig. 21, wherein position of symmetric
8 concave teeth formed according to prior art is illustrated to show difference therebetween;

9 Fig. 26a is a perspective view of a pawl for cooperating with the non-arcuate concave
10 teeth of the ratchet wheel in Fig. 23;

11 Fig. 26b is a top view of the pawl in Fig. 26a; and

12 Fig. 26c is a side view of the pawl in Fig. 26a.

13 **Detailed Description of the Preferred Embodiments**

14 Referring to Figs. 1 through 9 and initially to Figs. 1 through 3, a ratchet wheel 20 in
15 accordance with the present invention generally includes an inner periphery 24 for driving a
16 fastener (not shown) and an outer periphery having a plurality of arcuate concave teeth 22.
17 Referring to Fig. 3, each arcuate concave tooth 22 is formed by means of feeding a cutter 26
18 along a direction transverse to a radial direction (see line OR). The resultant concave tooth 22
19 has a depth "d₁" and two sides RA and RB that intersect at point "R". The line OR divides the
20 angle θ defined by the two sides RA and RB of the concave tooth 22 into two unequal
21 portions (e.g., 30° and 60°, 40° and 50°, etc). Namely, every tooth 22 thus formed is
22 "asymmetric", or the two sides for each teeth 22 is not equal, which is the most important
23 feature of this embodiment of the present invention. As illustrated in Fig. 3, each concave
24 tooth 22 is machined to have a depth "d₁" that will not adversely affect the structural strength
25 of the ratchet wheel, as the remaining wall thickness "t₁" of the ratchet wheel 20 is still
26 relatively large. As a result, the ratchet wheel 20 may bear a relatively large driving torque for
27 driving the fastener.

1 Difference in the depth of the tooth 22 of the ratchet wheel 20 of the present invention
2 and the depth of the tooth 6 of conventional ratchet wheel 5 (Fig. 14) is illustrated in Fig. 6.
3 Namely, the remaining wall thickness "t₁" of the ratchet wheel 20 of the present invention is
4 greater than the remaining wall thickness "t" of conventional ratchet wheel 5 that has the same
5 size as the ratchet wheel 20. Referring to Figs. 4 and 17, the narrowest wall thickness (t₁ =
6 1.01 mm in Fig. 4 for a ratchet wheel having an outer diameter of 25.76 mm) of the ratchet
7 wheel 20 of the present invention is almost twice as the narrowest wall thickness (t = 0.51 mm
8 in Fig. 17 for a ratchet wheel having an outer diameter of 25.76 mm) of conventional ratchet
9 wheel 5. Thus, the structural strength and the driving torque of the ratchet wheel of the present
10 invention are both improved.

11 Referring to Fig. 4, the ratchet wheel 20 in accordance with the present invention is
12 rotatably mounted in a box end 38 of a ring spanner 40. A web area 39 between the box end
13 38 and a handle 42 of the ring spanner 40 includes a compartment 36 for receiving a pawl 30.
14 Figs. 7a through 7c illustrate the pawl 30. The pawl 30 includes a plurality of teeth 31 that are
15 formed complimentary to the curvatures of the asymmetric arcuate concave teeth 22. An end
16 33 of the pawl 30 is attached to an end of an elastic member 32 the other end of which is
17 received in a cavity 34 defined in a wall 36a defining the compartment 36, best shown in Fig.
18 4. Fig. 17 illustrates a conventional arrangement of a ratchet type ring spanner 9 that has a box
19 end 9a for rotatably receiving the ratchet wheel 5. A web area (not labeled) of the ring spanner
20 9 includes a compartment 10 for receiving a pawl 11. Figs. 8a through 8c illustrate the pawl 11.
21 The pawl 11 includes a plurality of teeth 11a that are formed complimentary to the curvatures
22 of the symmetric arcuate concave teeth 6. An end (not labeled) of the pawl 11 is attached to an
23 end of an elastic member 12 the other end of which is received in a cavity 10a defined in a
24 wall 10b defining the compartment 10, best shown in Fig. 17. Figs. 8a, 8b, 8c, and 17 are
25 illustrated for comparison purpose. In addition, difference in the wall thickness of the ratchet
26 wheel 20 of the present invention and the wall thickness of conventional ratchet wheel 5 can
27 also be clearly seen in Fig. 6 and by means of comparing Fig. 5 with Fig. 20.

1 In use of the ring spanner equipped with the ratchet wheel 20 in accordance with the
2 present invention, referring to Fig. 9, the angle δ between a force N normal to the operative
3 side P and the tangent T to the intersection I between the pawl 30 and the wall 36a defining
4 the compartment 36 is smaller than that in the prior art ratchet wheel (see Fig. 18). As a result,
5 the pawl 30 in Fig. 9 is reliably pushed toward the wall 36a defining the compartment 36 and
6 thus provides a reliable engagement between the teeth 22 of the ratchet wheel 20 and the teeth
7 31 of the pawl 30. If the angle δ reaches 90° , the pawl moves toward the central area of the
8 ratchet wheel and thus results in an undesired "sliding" effect, as there is no horizontal force
9 imparted to move the pawl toward the wall 36a of the compartment 36. Thus, the ratchet
10 wheel 20 and the pawl 30 in accordance with the present invention provides an engagement
11 reliable than that between the conventional ratchet wheel 5 and the pawl 11 and thus less
12 likely to "slide". The spanner with the ratchet wheel/pawl combination in accordance with the
13 present invention can be used in a relatively small space and can be operated in a convenient
14 manner. More specifically, the spanner is allowed to rotate in a reverse direction without
15 disengaging the box end from the fastener when the spanner is stopped by an obstacle during
16 ratcheting. And the spanner is then ready for next ratcheting movement. This is very
17 convenient and timesaving.

18 Referring to Figs. 9 and 10, when the operative side P of the tooth 22 of the ratchet
19 wheel 20 in accordance with the present invention is subjected to a force F during ratcheting,
20 the area filled by the pawl 30 for bearing such force F is $2/1.732 h^2$. Referring to Fig. 19, for a
21 conventional ratchet wheel 5, when either operative side P of the tooth 6 of the ratchet wheel 5
22 is subjected to a force F, the area filled by the pawl 11 for bearing such force F is h^2 which is
23 smaller than that provided by the ratchet wheel/pawl combination in accordance with the
24 present invention. Namely, the ratchet wheel 20 with asymmetric arcuate concave teeth 22
25 provides a higher torque for ratcheting (i.e., tightening or loosening a fastener such as a nut or
26 bolt head).

1 Referring to Figs. 21 and 22, in a second embodiment of the ratchet wheel in accordance
2 with the present invention, the ratchet wheel (now designated by 50) includes an inner
3 periphery 54 for driving a fastener (not shown) and an outer periphery having a plurality of
4 non-arcuate concave teeth 52. The non-arcuate concave teeth 52 is formed by means of roll
5 squeezing method, investment casting, or molding, which is quicker than formation by cutter.
6 Each non-arcuate concave tooth 52 may be trapezoidal, triangular, or any other shape that
7 results from formation other than cutting. The production cost for the ratchet wheel 50 with
8 non-arcuate concave teeth 52 in accordance with the present invention is largely reduced, as
9 the production time for the non-arcuate concave teeth 52 is relatively short. In addition, the
10 non-arcuate concave teeth 52 may be symmetric or asymmetric. When the ratchet wheel 50
11 has non-arcuate symmetric concave teeth 52, the resultant structure provides a driving torque
12 approximately the same as that provided by the conventional ratchet wheel 5 with symmetric
13 arcuate concave teeth 6. When the ratchet wheel 50 has non-arcuate asymmetric concave teeth
14 52 configured similar to teeth 22, the resultant structure provides a higher driving torque than
15 that provided by the conventional ratchet wheel 5 with symmetric arcuate concave teeth 6.

16 Referring to Fig. 23, the ratchet wheel 50 in accordance with the present invention may
17 be rotatably mounted in a box end 38 of a ring spanner 40. A web area 39 of the ring spanner
18 40 includes a compartment 36 for receiving a pawl 60. Figs. 26a through 26c illustrate the
19 pawl 60. The pawl 60 includes a plurality of teeth 61 that are formed complimentary to the
20 curvatures of the non-arcuate concave teeth 52. An end 62 of the pawl 60 is attached to an end
21 of an elastic member 32 the other end of which is received in a cavity 34 defined in a wall 36a
22 defining the compartment 36, best shown in Fig. 23. A detail comparison between the
23 conventional pawl 11 illustrated in Figs. 8a through 8c, the pawl 30 of the first embodiment of
24 the present invention illustrated in Figs. 7a through 7c, and the pawl 60 of this embodiment
25 illustrated in Figs. 26a through 26c would be appreciated. In addition, difference in the wall
26 thickness of the ratchet wheel 50 of the present invention and the wall thickness of

1 conventional ratchet wheel 5 can also be clearly seen in Fig. 25 and by means of comparing
2 Fig. 24 with Fig. 20.

3 According to the above description, it is appreciated that the ratchet wheel with
4 asymmetric arcuate concave teeth in accordance with the present invention provides a higher
5 torque for operation and has improved structural strength as having a thicker wall in the
6 ratchet wheel. The engagement between the ratchet wheel with asymmetric arcuate concave
7 teeth and the pawl with asymmetric arcuate concave teeth is more reliable. The ratchet wheel
8 with non-arcuate concave teeth in accordance with the present invention reduces the
9 production cost for the ratchet wheel. The ratchet wheel with non-arcuate concave teeth also
10 provides a higher torque for operation when the non-arcuate concave teeth is asymmetric. A
11 spanner with the ratchet wheel/pawl combination in accordance with the present invention can
12 be used in a relatively small space. Nevertheless, the ratchet wheel/pawl combination in
13 accordance with the present invention is not limited to be used in the box end of a ring spanner.
14 Namely, the ratchet wheel/pawl combination may be used in other ratcheting tools such as
15 ratchet wrenches.

16 Although the invention has been explained in relation to its preferred embodiment, it is
17 to be understood that many other possible modifications and variations can be made without
18 departing from the spirit and scope of the invention as hereinafter claimed.

1 **What is claimed is:**

2 1. A ratchet wheel comprising an outer periphery, the outer periphery including a plurality of
3 asymmetric arcuate concave teeth each having two sides and an intersection of the two sides,
4 the ratchet wheel including a center, a line from the center to the intersection dividing an angle
5 between the two sides into two unequal portions.

6 2. The ratchet wheel as claimed in claim 1, further comprising an inner periphery for driving a
7 fastener.

8 3. A ratchet wheel comprising an outer periphery, the outer periphery including a plurality of
9 asymmetric non-arcuate concave teeth each having two sides and an intersection of the two
10 sides, the ratchet wheel including a center, a line from the center to the intersection dividing an
11 angle between the two sides into two unequal portions.

12 4. The ratchet wheel as claimed in claim 3, further comprising an inner periphery for driving a
13 fastener.

14 5. The ratchet wheel as claimed in claim 3, wherein said asymmetric non-arcuate concave
15 teeth are not formed by cutting.

16 6. The ratchet wheel as claimed in claim 3, wherein said asymmetric non-arcuate concave
17 teeth are formed by roll squeezing.

18 7. The ratchet wheel as claimed in claim 3, wherein said asymmetric non-arcuate concave
19 teeth are formed by investment casting.

20 8. The ratchet wheel as claimed in claim 3, wherein each said asymmetric non-arcuate concave
21 tooth is trapezoidal.

22 9. The ratchet wheel as claimed in claim 3, wherein each said asymmetric non-arcuate concave
23 tooth is of a shape formed as a result of formation other than cutting.

24 10. A ratchet wheel comprising an outer periphery, the outer periphery including a plurality of
25 symmetric non-arcuate concave teeth each having two sides and an intersection of the two
26 sides, the ratchet wheel including a center, a line from the center to the intersection dividing an
27 angle between the two sides into two equal portions.

- 1 11. The ratchet wheel as claimed in claim 10, further comprising an inner periphery for driving
2 a fastener.
- 3 12. The ratchet wheel as claimed in claim 10, wherein said symmetric non-arcuate concave
4 teeth are not formed by cutting.
- 5 13. The ratchet wheel as claimed in claim 10, wherein said symmetric non-arcuate concave
6 teeth are formed by roll squeezing.
- 7 14. The ratchet wheel as claimed in claim 10, wherein said symmetric non-arcuate concave
8 teeth are formed by investment casting.
- 9 15. The ratchet wheel as claimed in claim 10, wherein each said symmetric non-arcuate
10 concave tooth is trapezoidal.
- 11 16. The ratchet wheel as claimed in claim 10, wherein each said symmetric non-arcuate
12 concave tooth is of a shape formed as a result of formation other than cutting.
- 13 17. A ratcheting tool comprising:
- 14 a handle and an end connected to the handle, the end including a hole, a compartment
15 being defined in an area between the handle and the end;
- 16 a ratchet wheel rotatably mounted in the hole of the end, the ratchet wheel comprising
17 an outer periphery, the outer periphery including a plurality of asymmetric arcuate concave
18 teeth each having two sides and an intersection of the two sides, the ratchet wheel including a
19 center, a line from the center to the intersection dividing an angle between the two sides into
20 two unequal portions;
- 21 a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the
22 pawl comprising a plurality of teeth corresponding to the asymmetric arcuate concave teeth of
23 the ratchet wheel; and
- 24 means for biasing the pawl toward a wall defining the compartment.
- 25 18. The ratcheting tool as claimed in claim 17, further comprising an inner periphery for
26 driving a fastener.
- 27 19. A ratcheting tool comprising:

1 a handle and an end connected to the handle, the end including a hole, a compartment
2 being defined in an area between the handle and the end;

3 a ratchet wheel comprising an outer periphery, the outer periphery including a plurality
4 of asymmetric non-arcuate concave teeth each having two sides and an intersection of the two
5 sides, the ratchet wheel including a center, a line from the center to the intersection dividing an
6 angle between the two sides into two unequal portions. ;

7 a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the
8 pawl comprising a plurality of teeth corresponding to the asymmetric non-arcuate concave
9 teeth of the ratchet wheel; and

10 means for biasing the pawl toward a wall defining the compartment.

11 20. The ratcheting tool as claimed in claim 19, wherein the ratchet wheel further comprises an
12 inner periphery for driving a fastener.

13 21. The ratcheting tool as claimed in claim 19, wherein said asymmetric non-arcuate concave
14 teeth are formed by roll squeezing.

15 22. The ratcheting tool as claimed in claim 19, wherein each said asymmetric non-arcuate
16 concave tooth is of a shape formed as a result of formation other than cutting.

17 23. A ratcheting tool comprising:

18 a handle and an end connected to the handle, the end including a hole, a compartment
19 being defined in an area between the handle and the end;

20 a ratchet wheel comprising an outer periphery, the outer periphery including a plurality
21 of symmetric non-arcuate concave teeth each having two sides and an intersection of the two
22 sides, the ratchet wheel including a center, a line from the center to the intersection dividing an
23 angle between the two sides into two equal portions;

24 a pawl slidably mounted in the compartment and engaged with the ratchet wheel, the
25 pawl comprising a plurality of teeth corresponding to the symmetric non-arcuate concave teeth
26 of the ratchet wheel; and

27 means for biasing the pawl toward a wall defining the compartment.

1 24. The ratcheting tool as claimed in claim 23, wherein the ratchet wheel further comprises an
2 inner periphery for driving a fastener.

3 25. The ratcheting tool as claimed in claim 23, wherein said symmetric non-arcuate concave
4 teeth are formed by roll squeezing.

5 26. The ratcheting tool as claimed in claim 23, wherein each said symmetric non-arcuate
6 concave tooth is of a shape formed as a result of formation other than cutting.

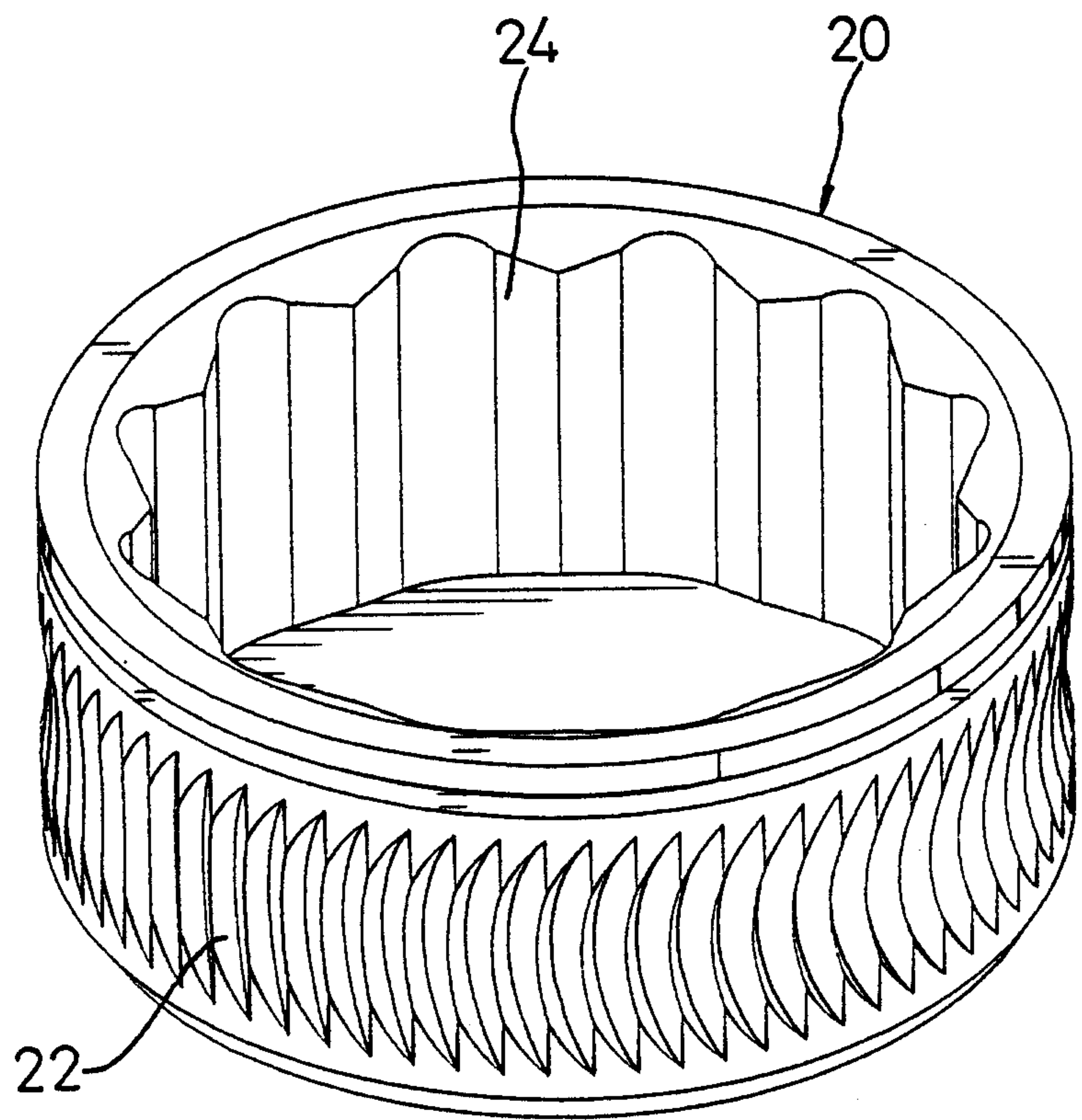


Fig. 1

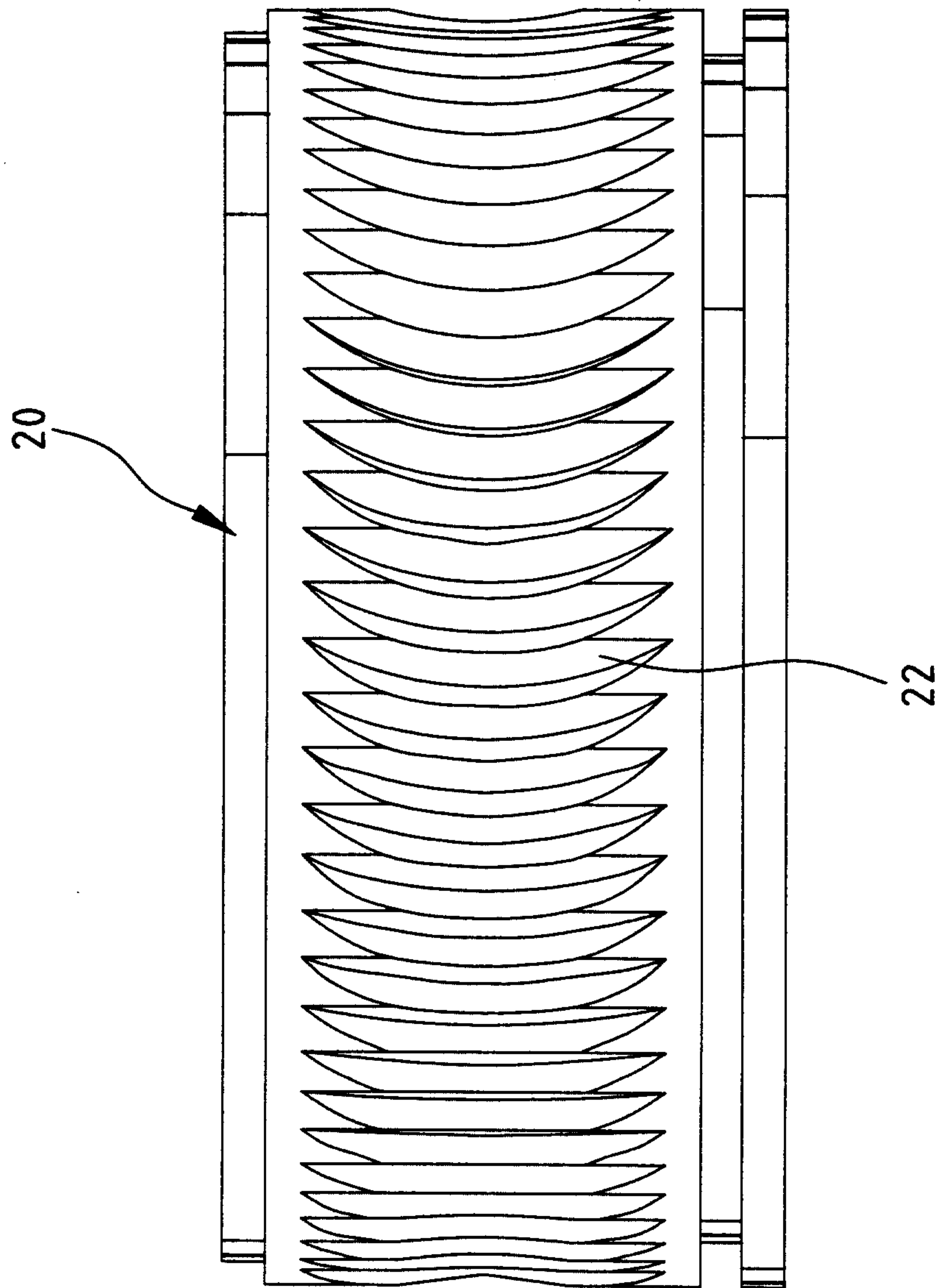


Fig. 2

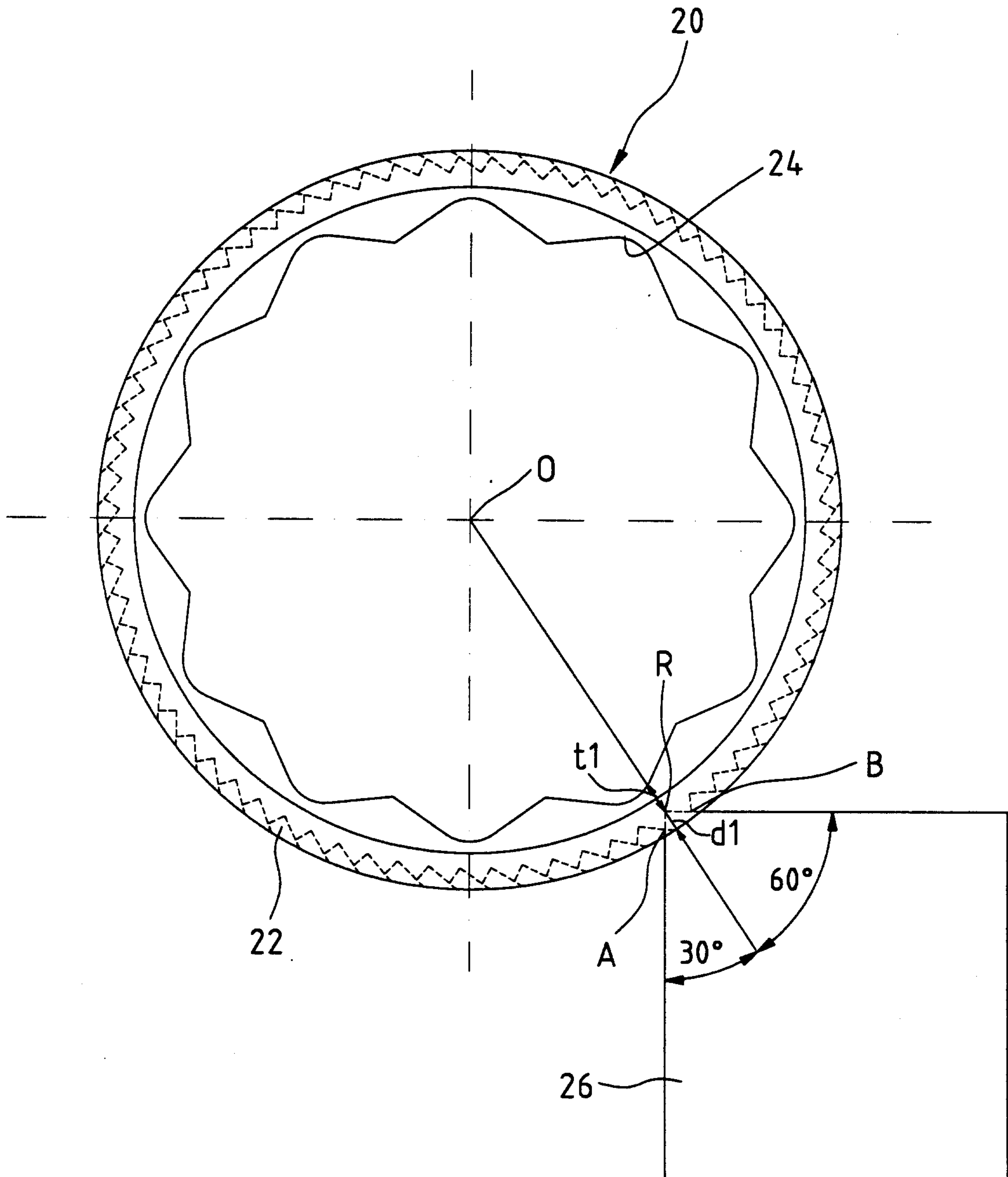


Fig. 3

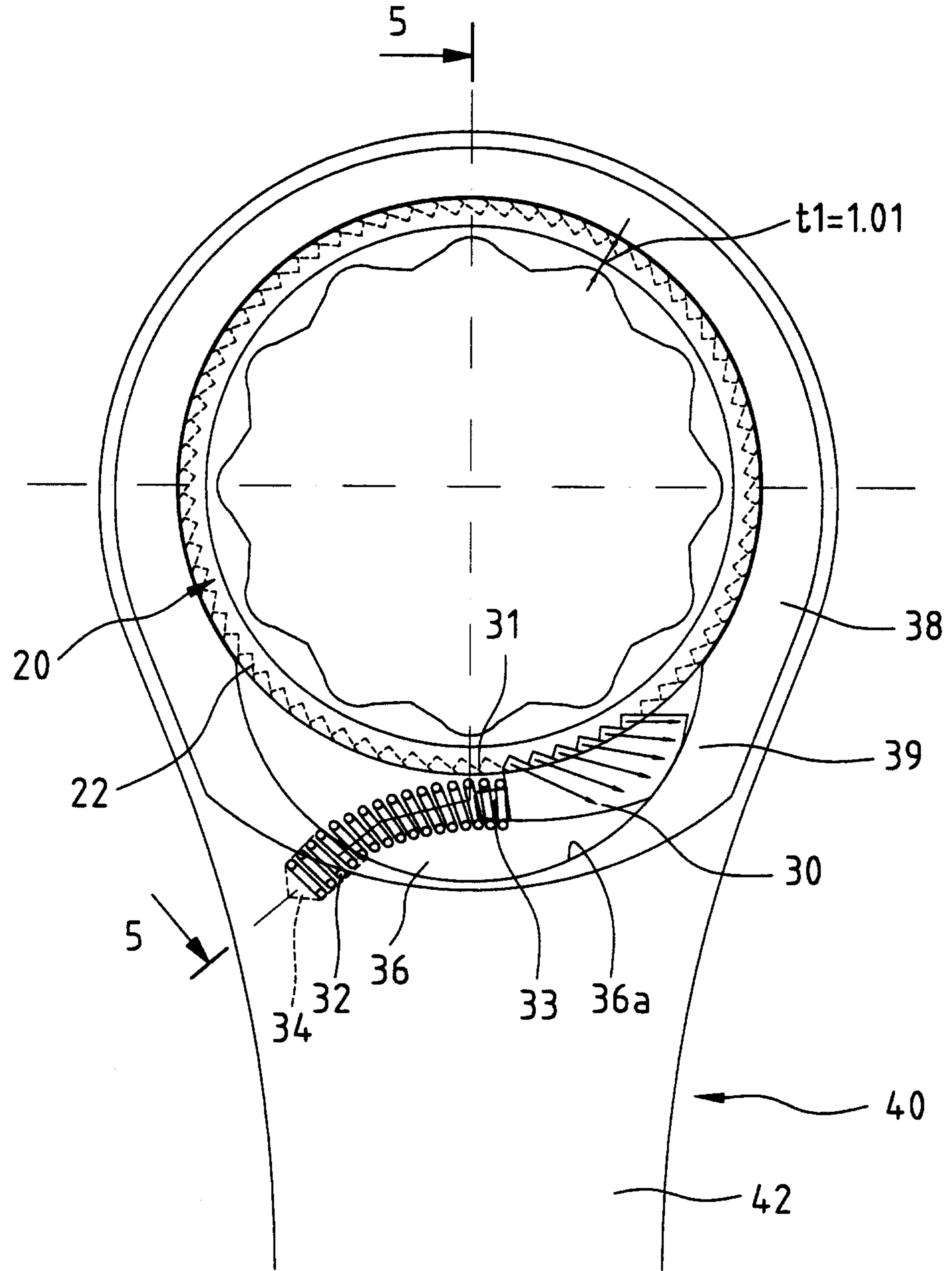


Fig. 4

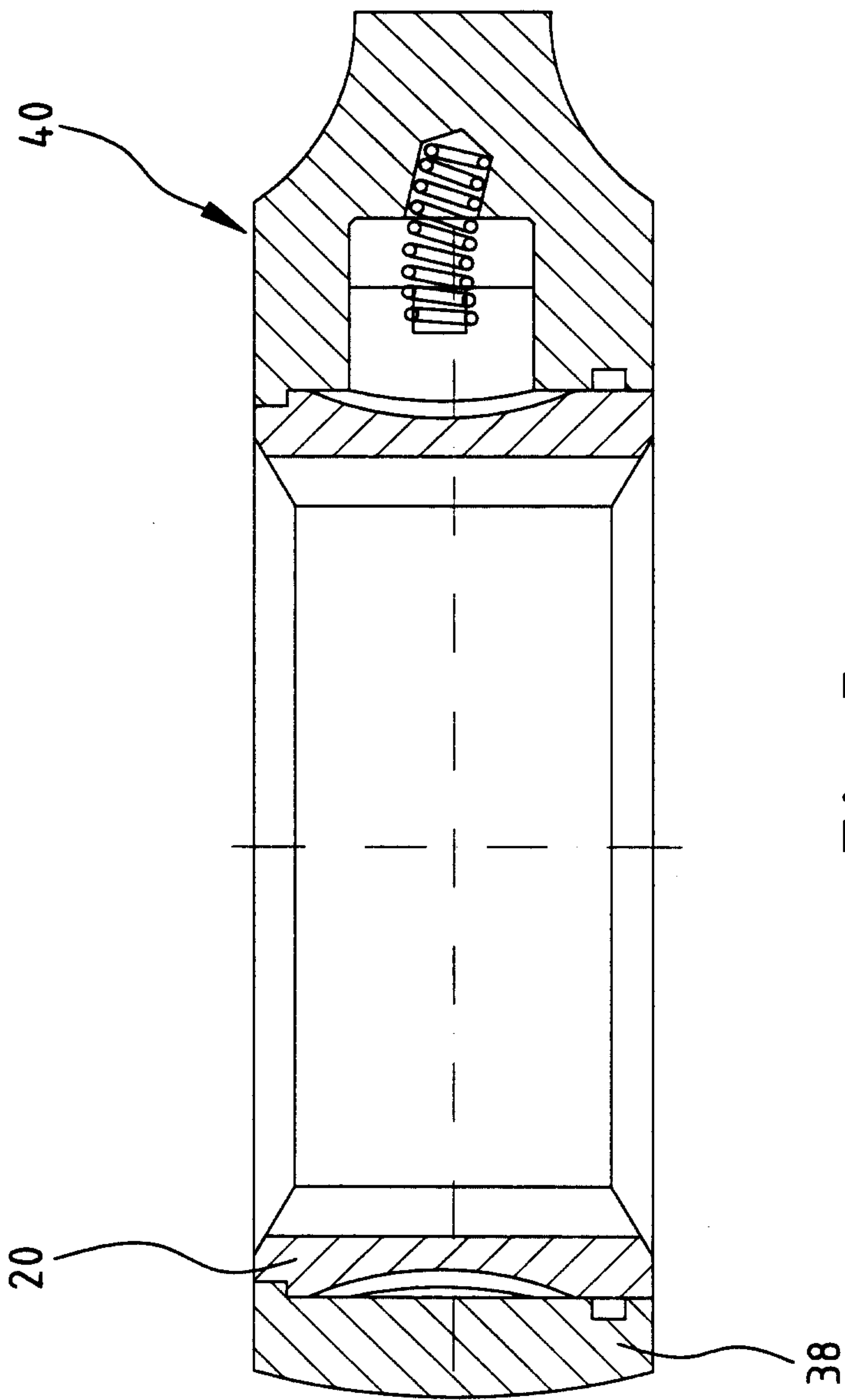


Fig. 5

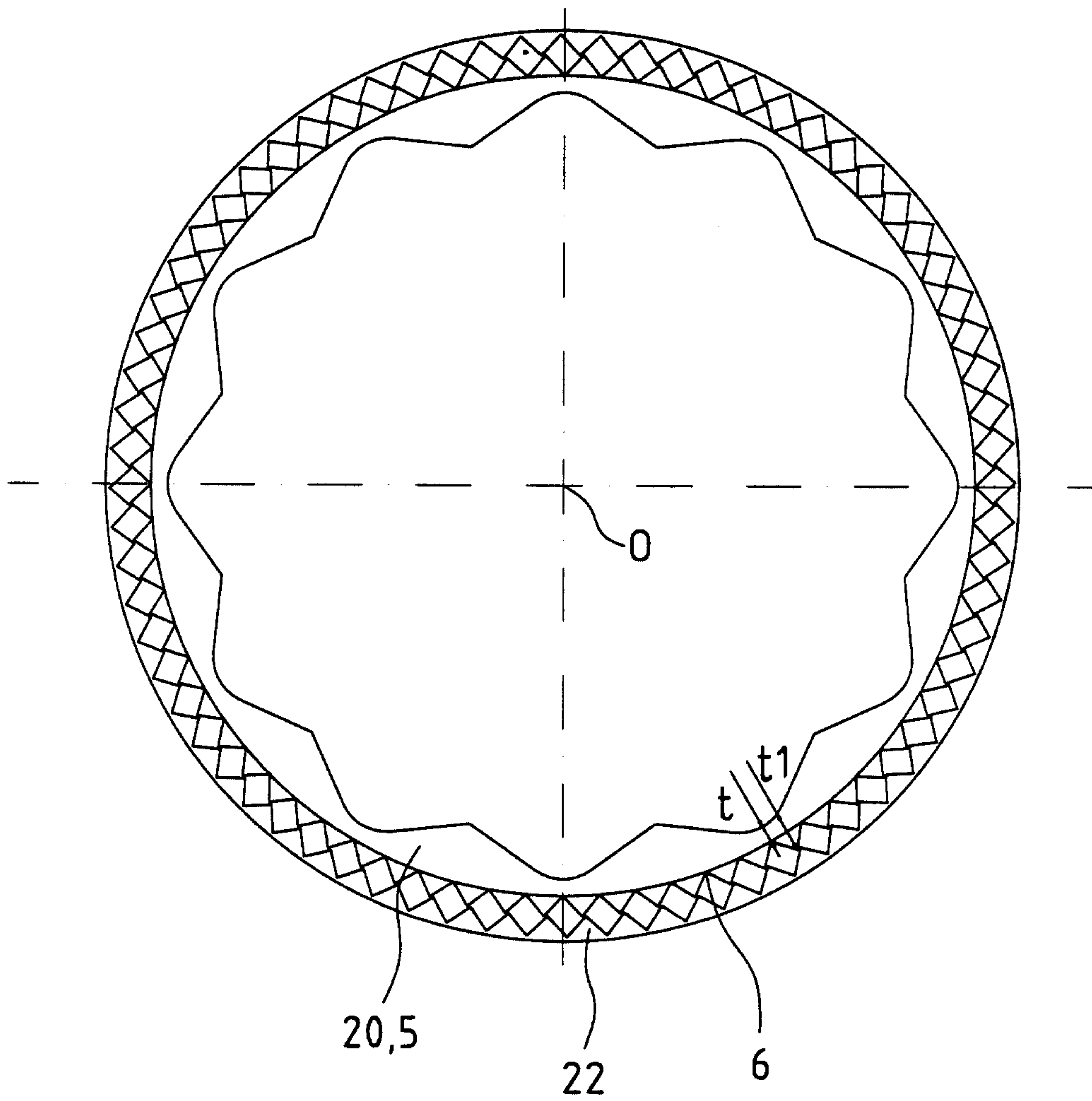


Fig. 6

Fig. 7a

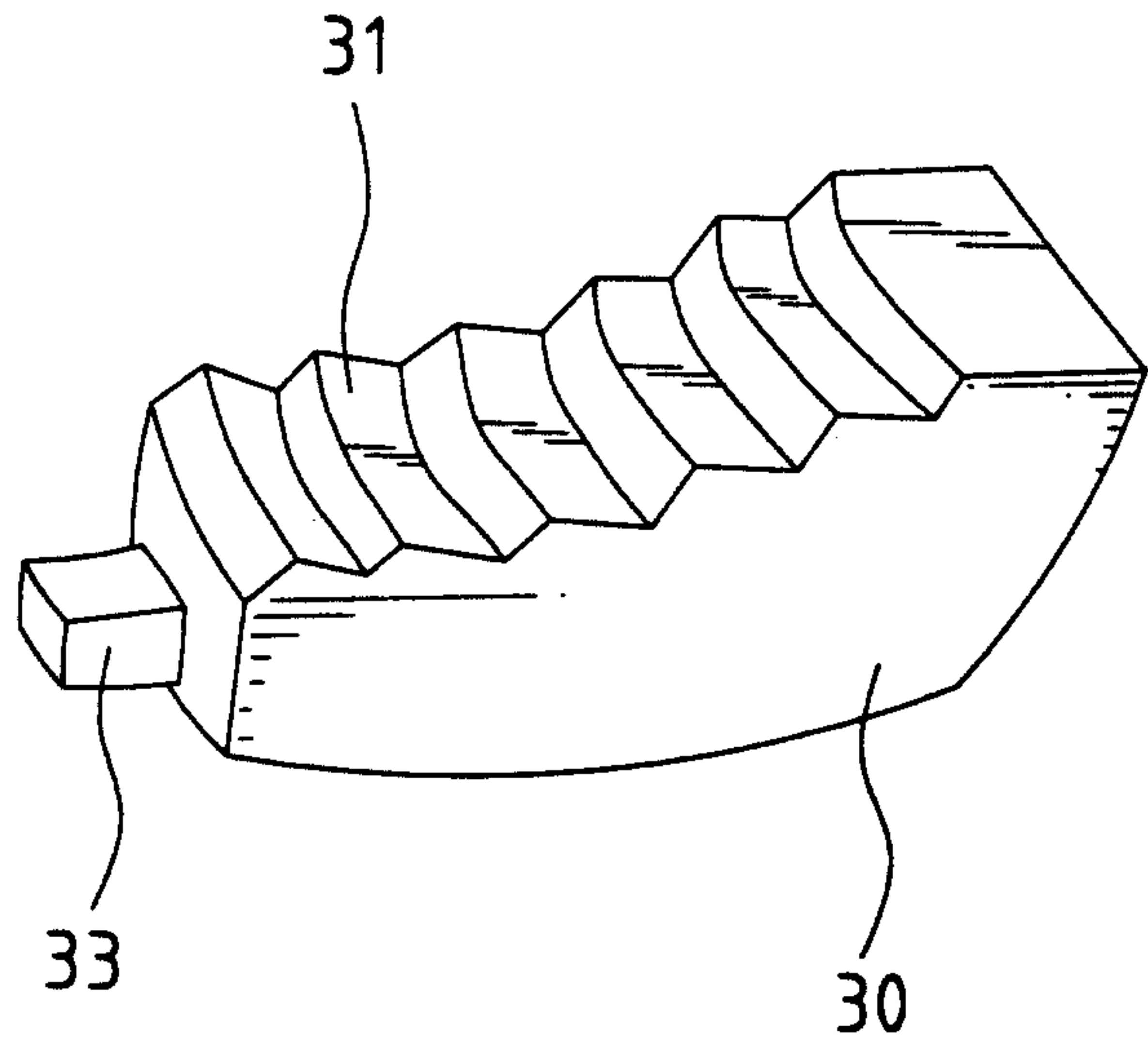


Fig. 7b

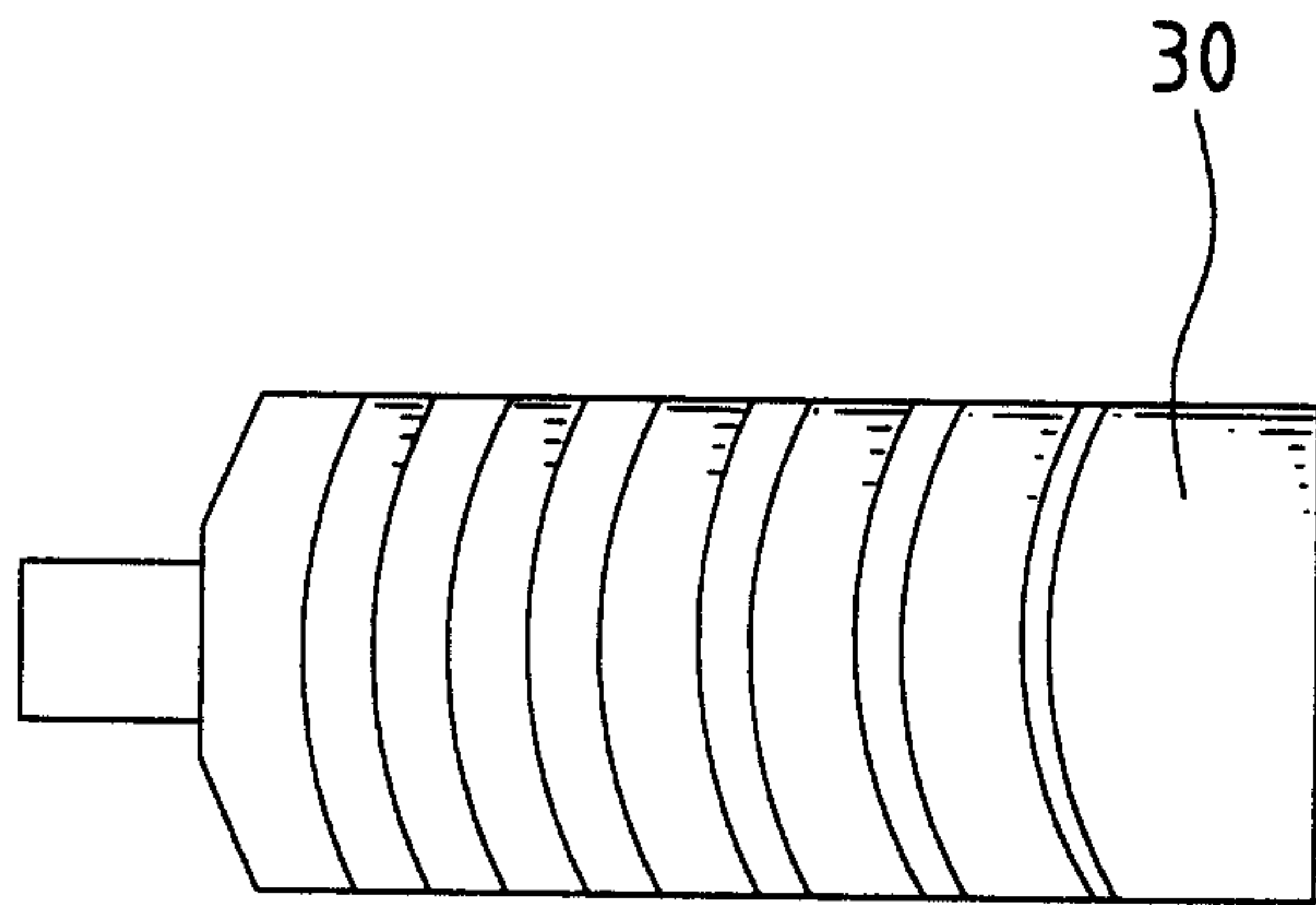


Fig. 7c

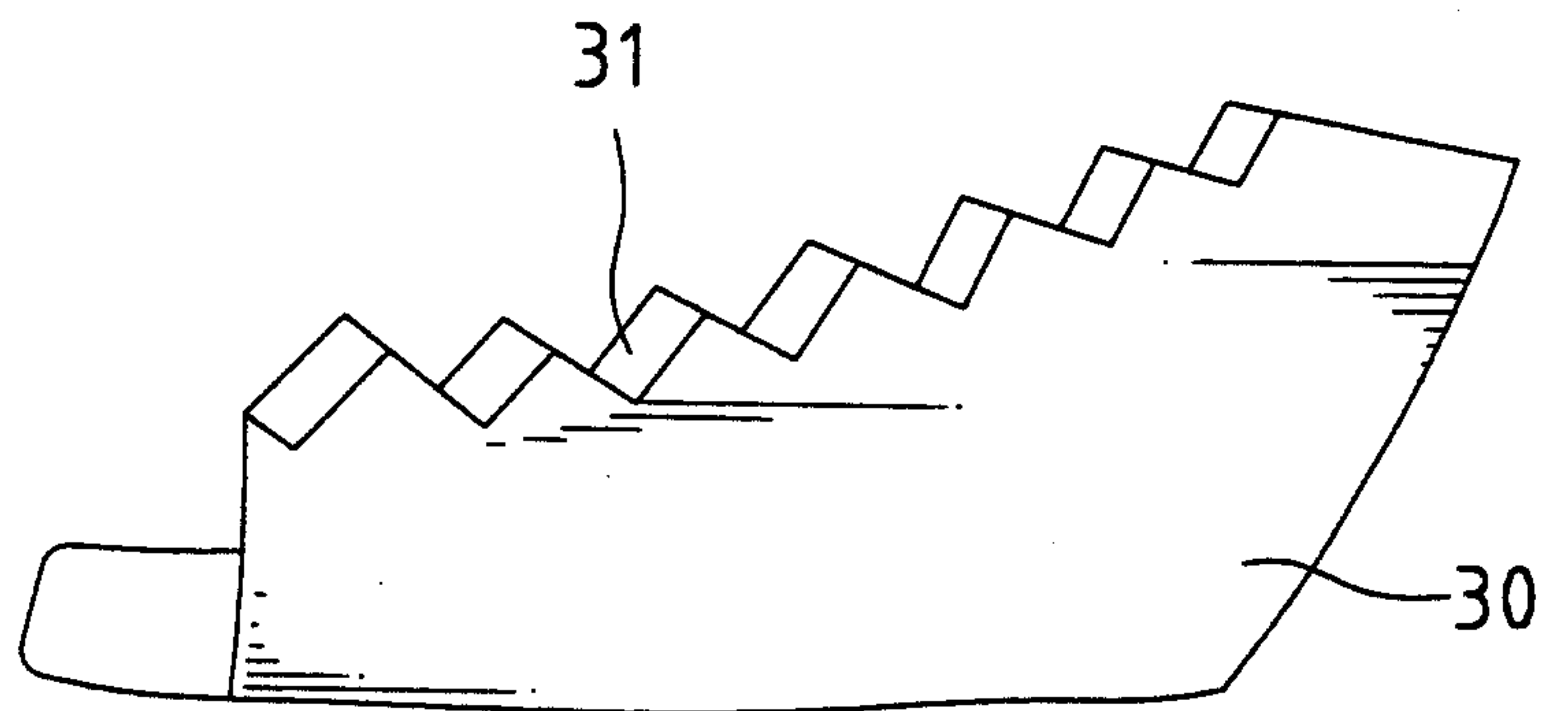


Fig. 8a
PRIOR ART

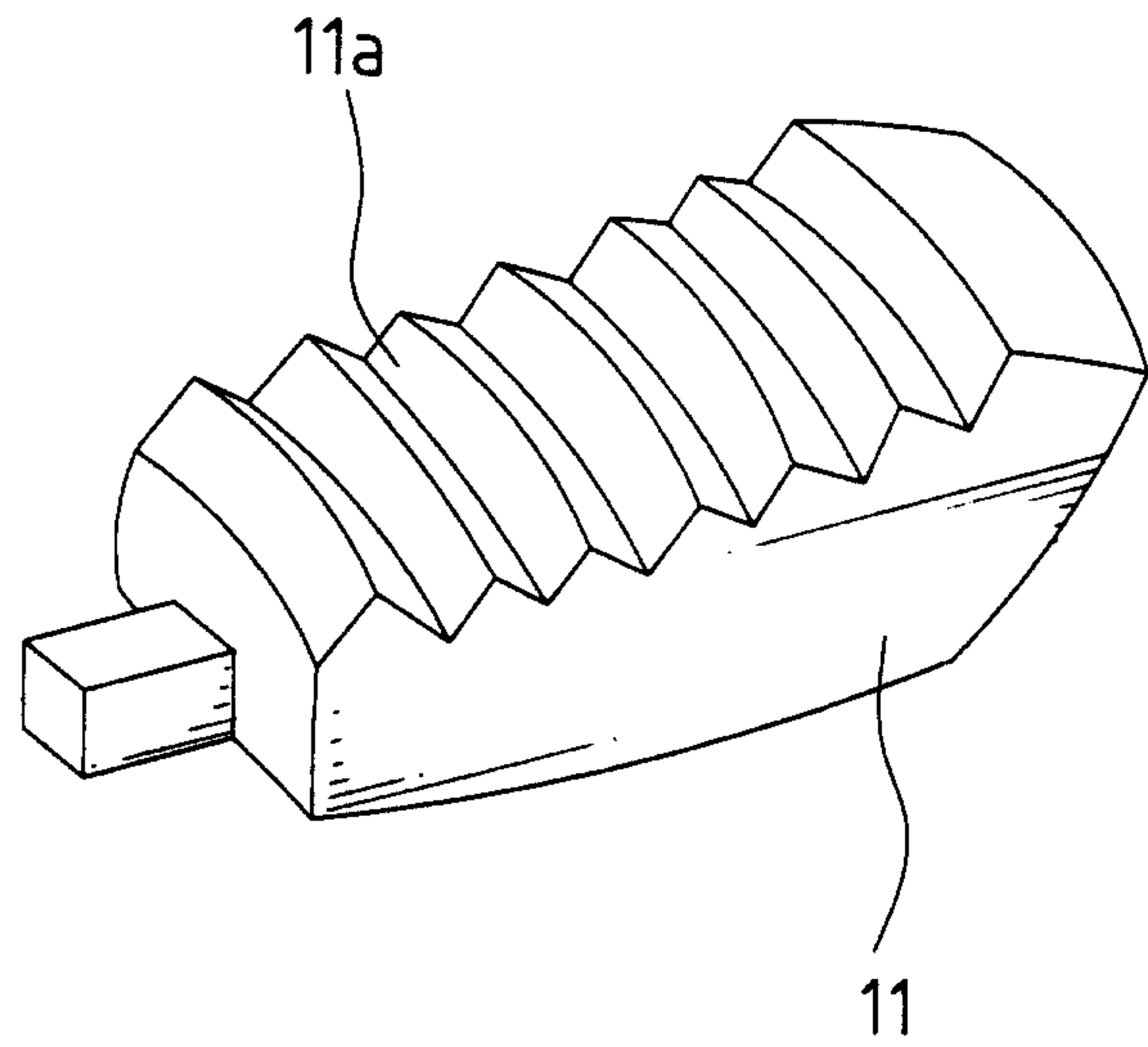


Fig. 8b
PRIOR ART

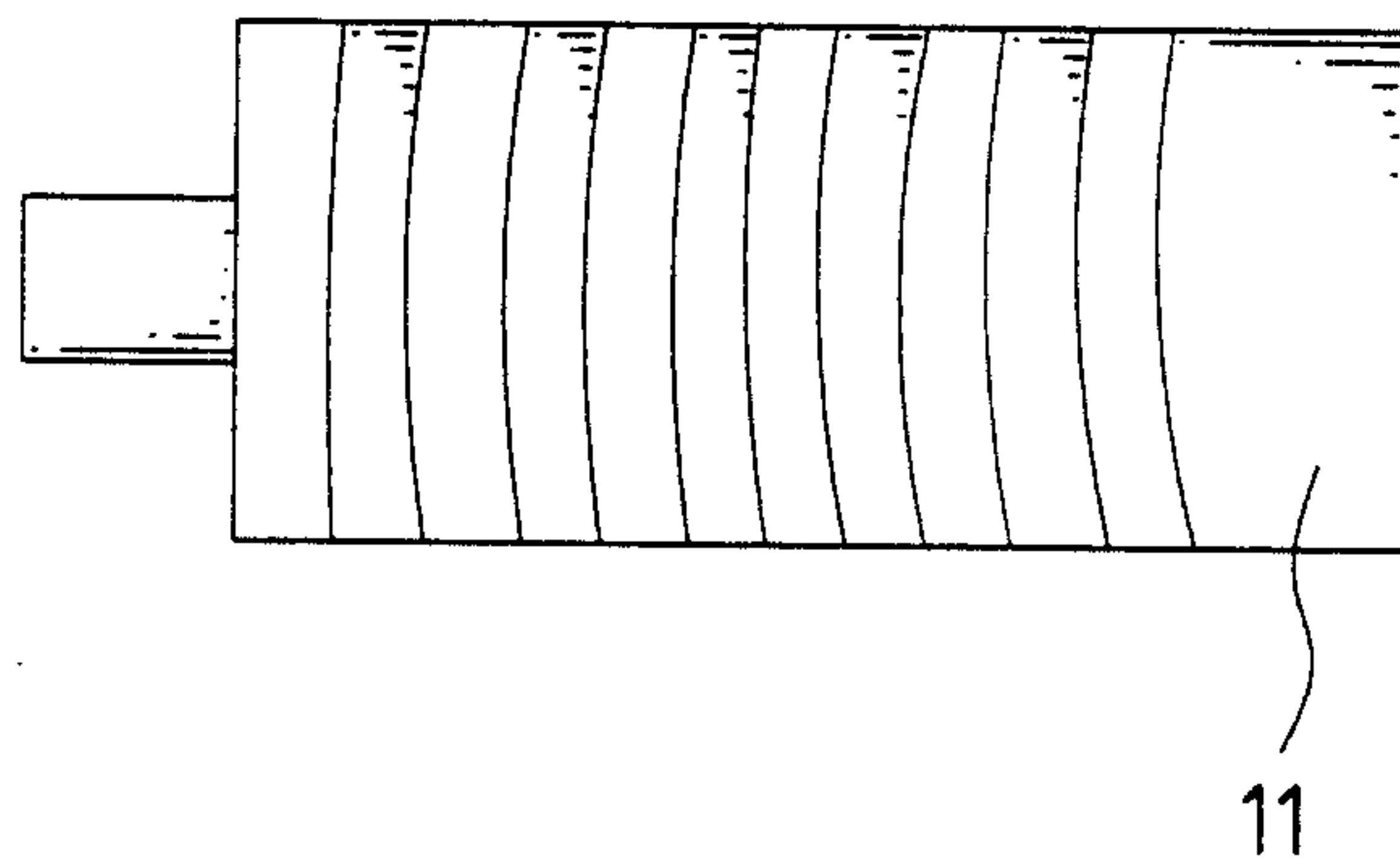
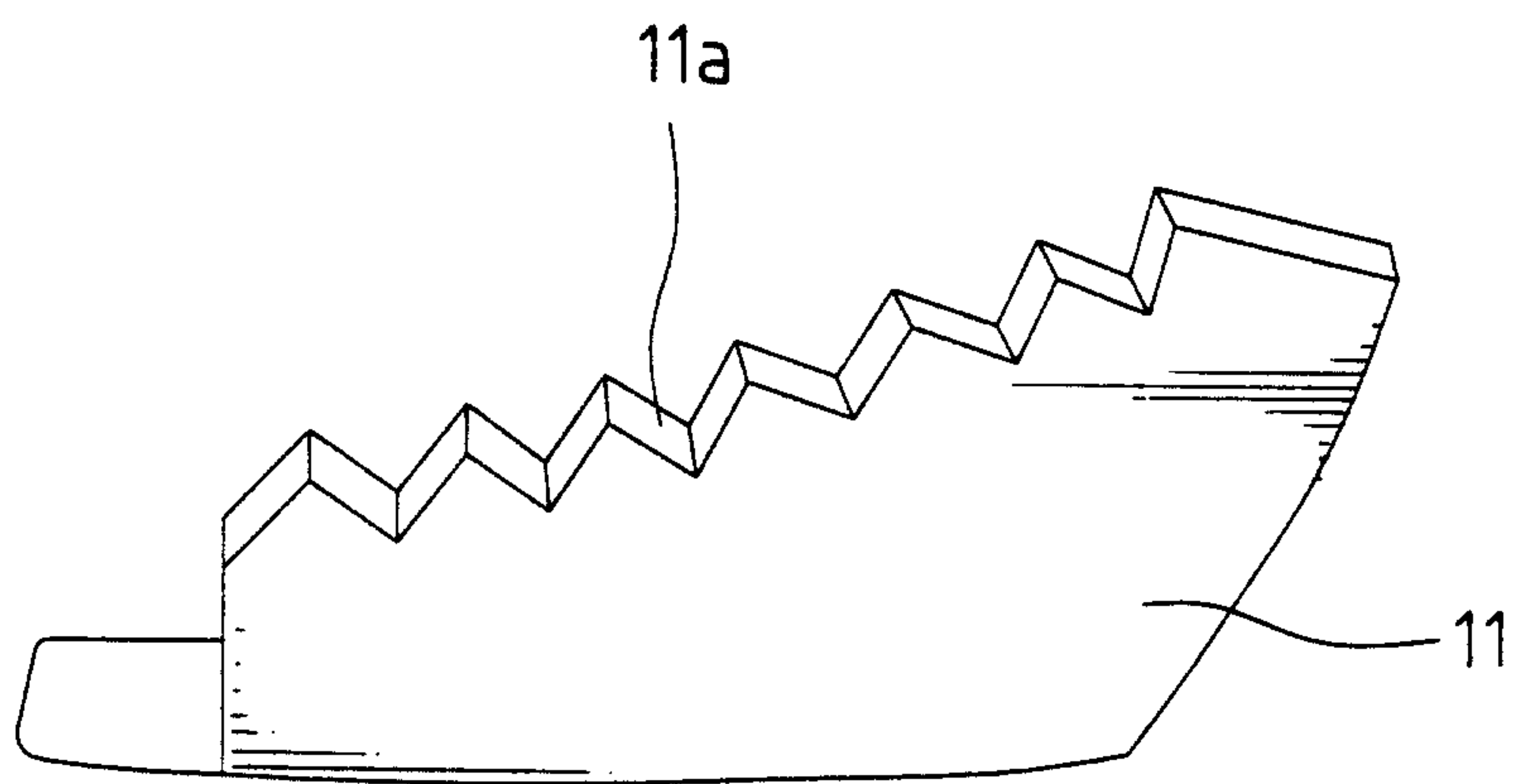


Fig. 8c
PRIOR ART



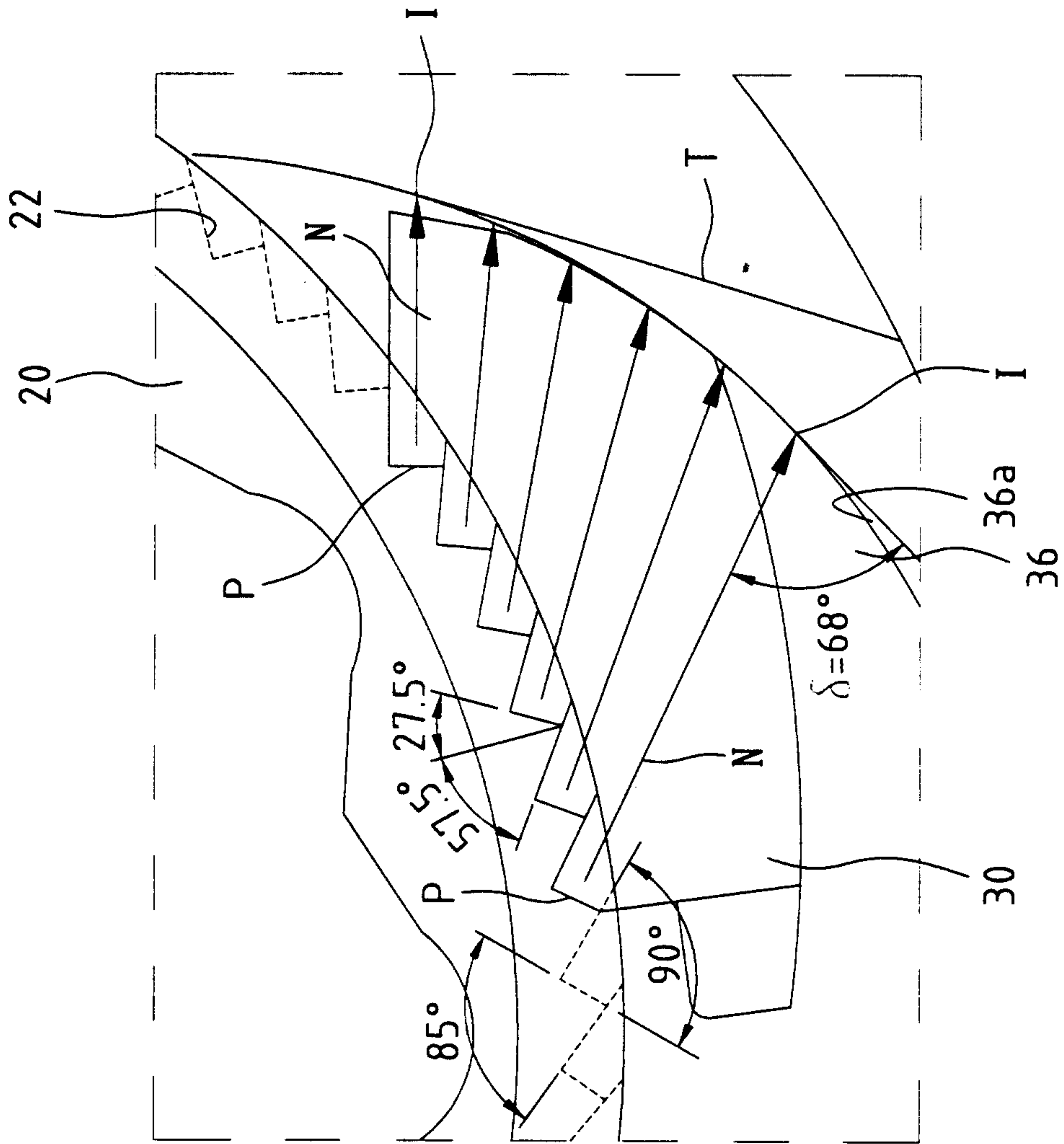


Fig. 9

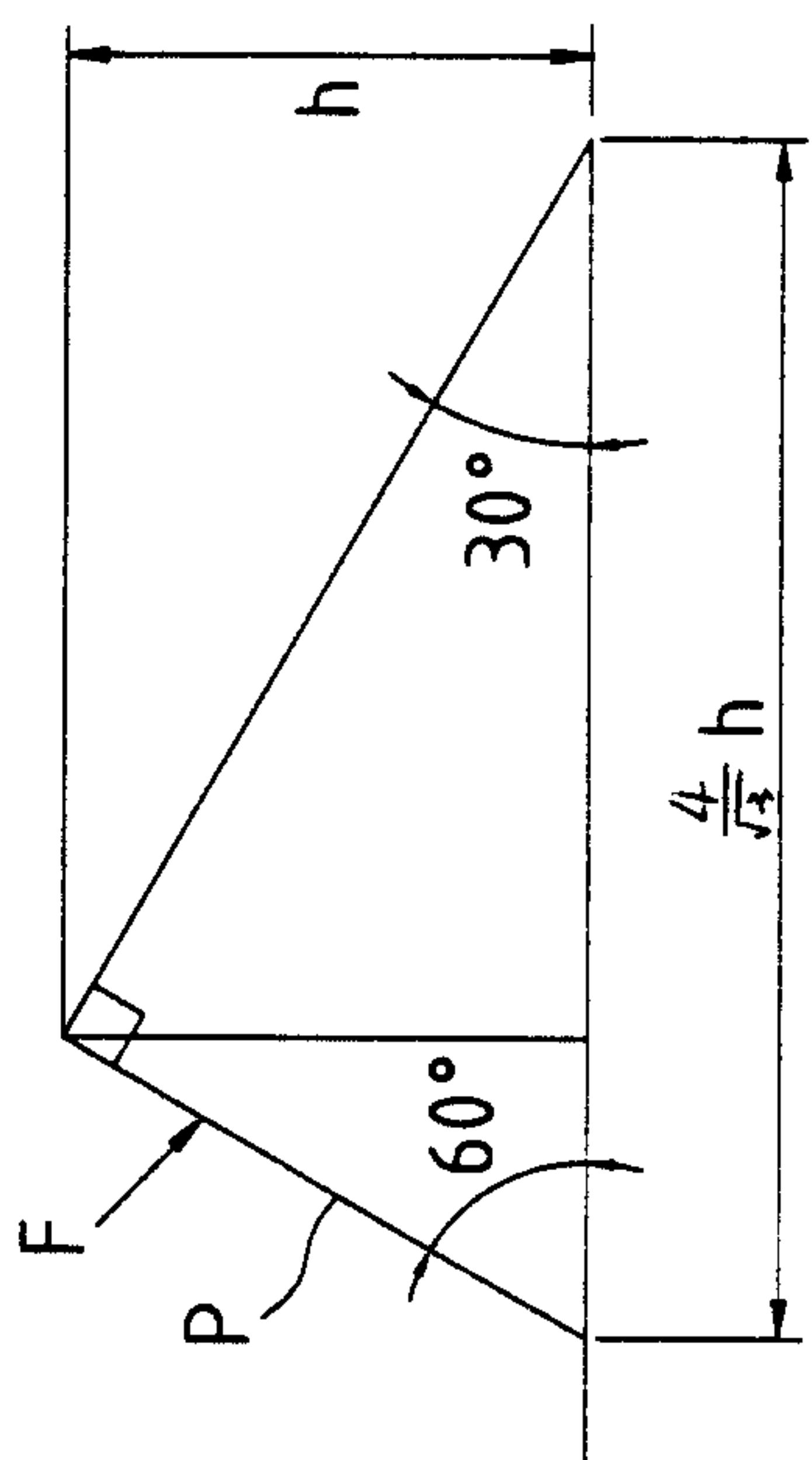


Fig. 10

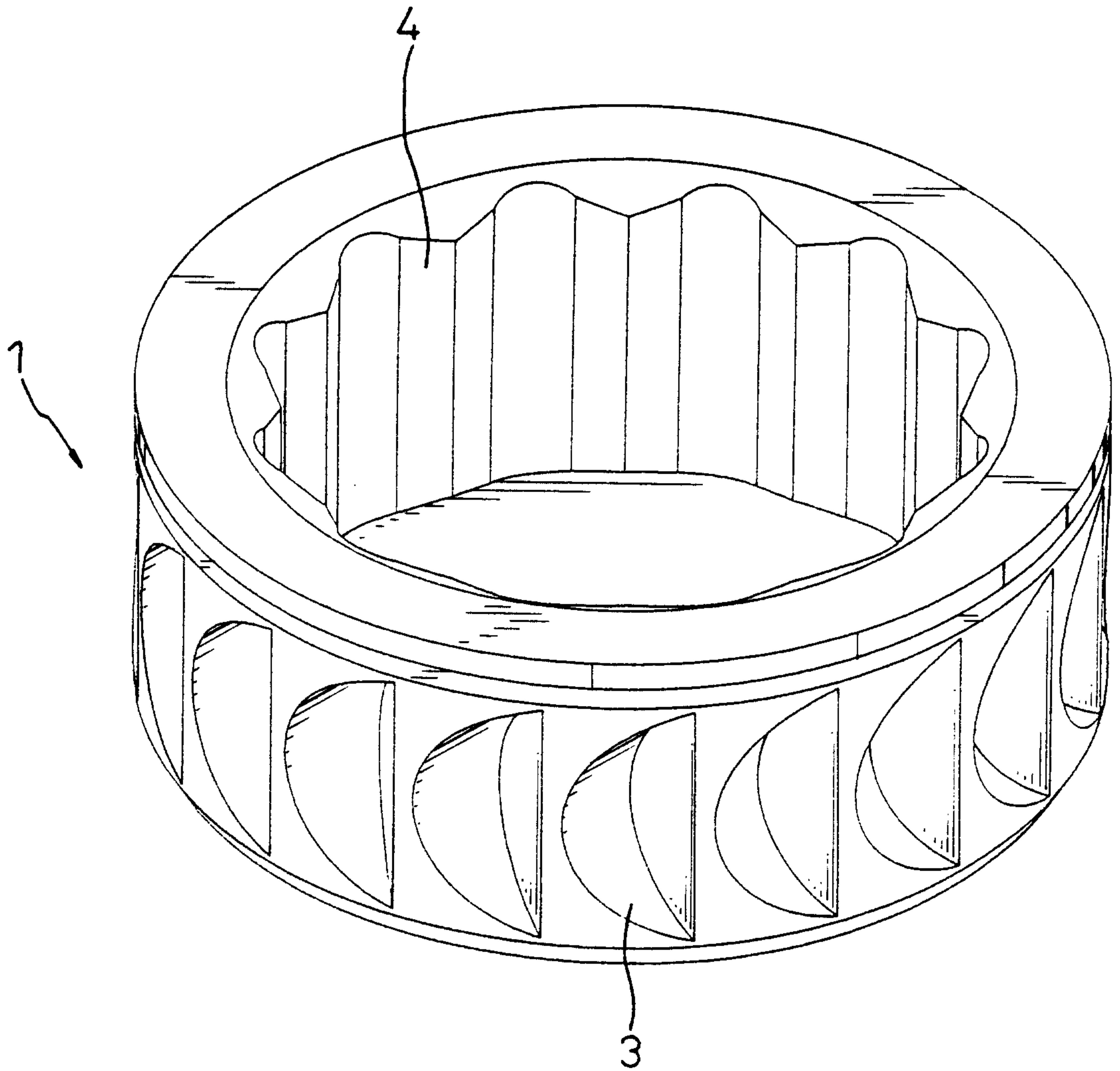


Fig. 11
PRIOR ART

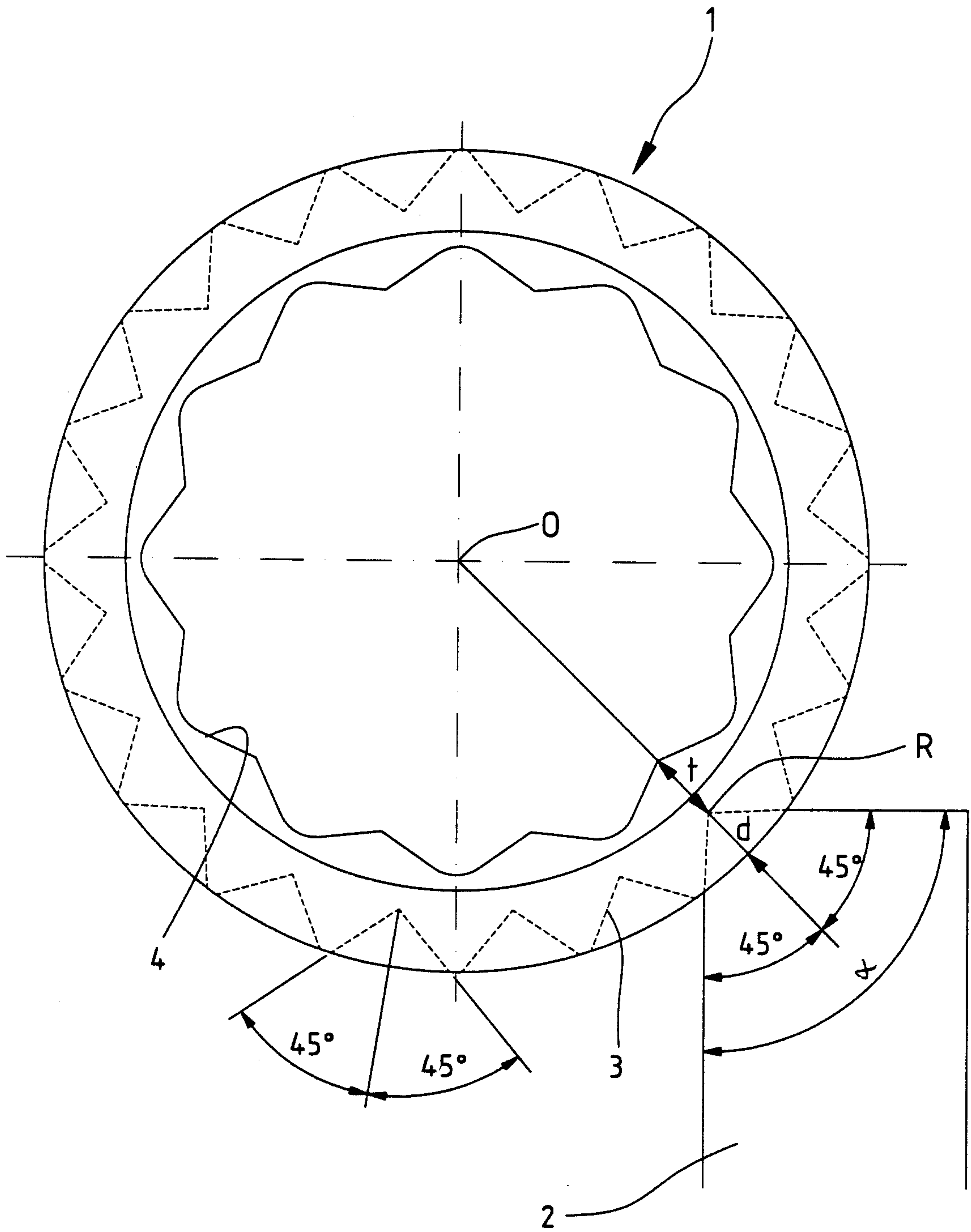


Fig. 12
PRIOR ART

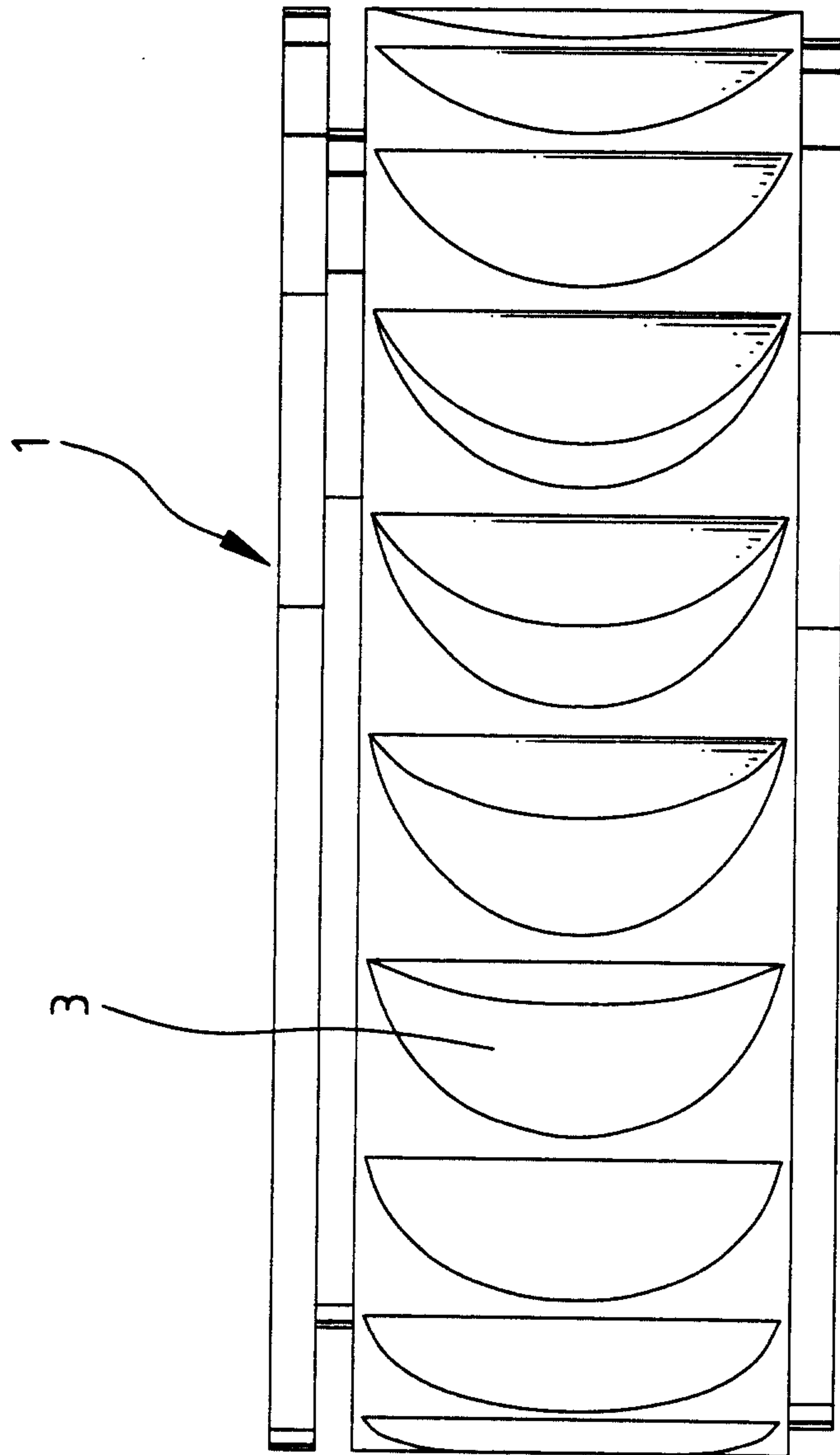


Fig. 13
PRIOR ART

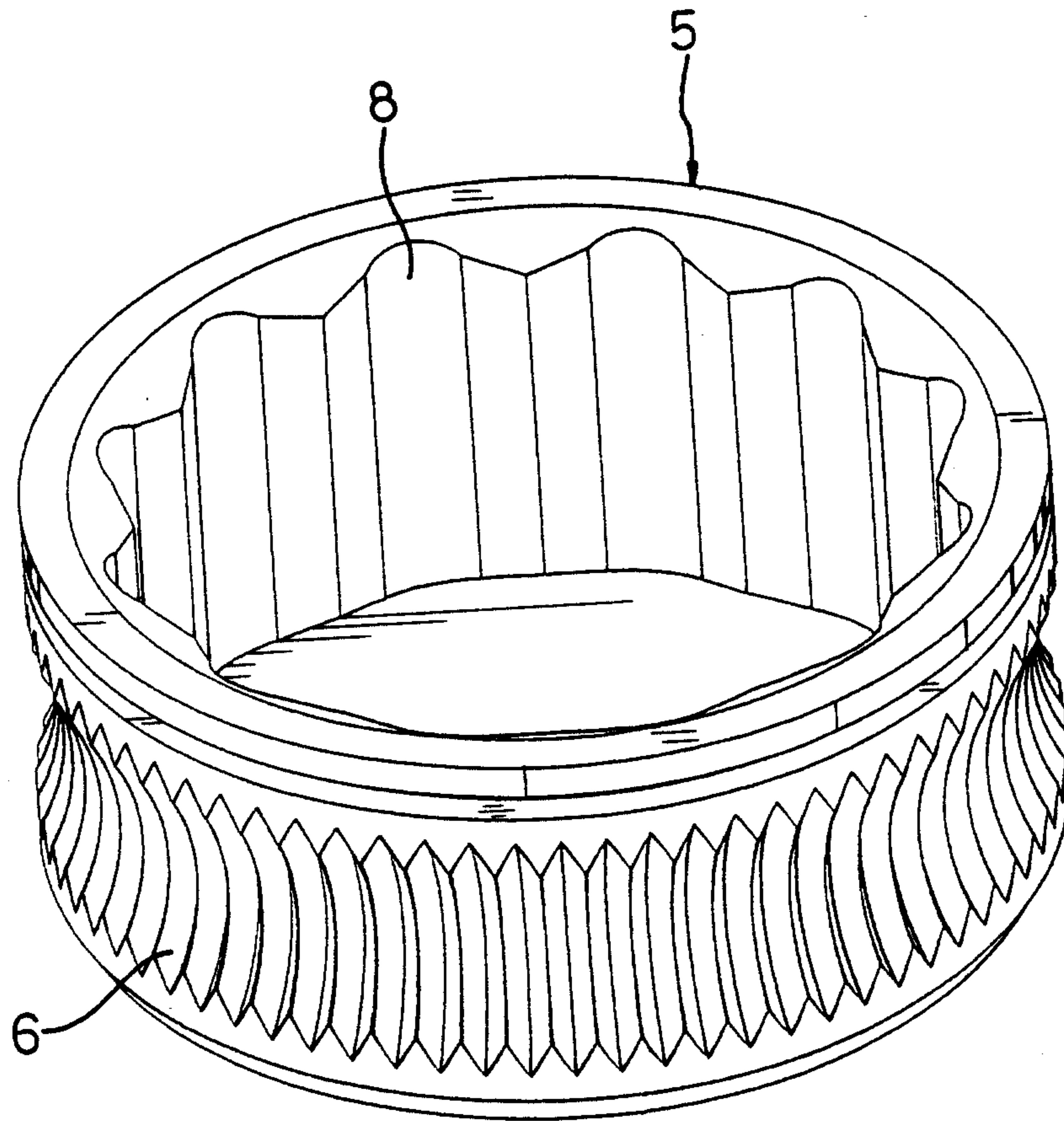


Fig. 14
PRIOR ART

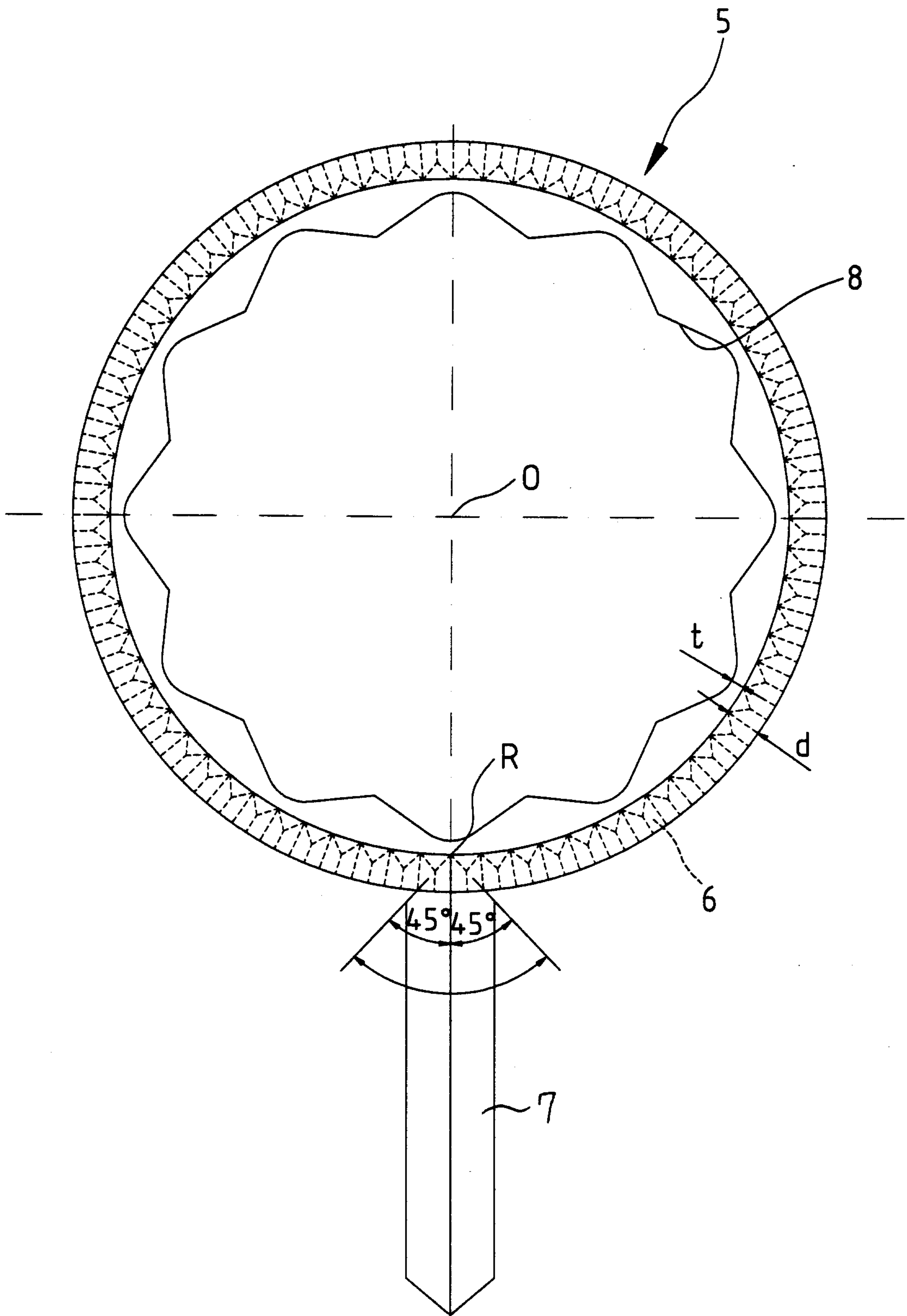


Fig. 15
PRIOR ART

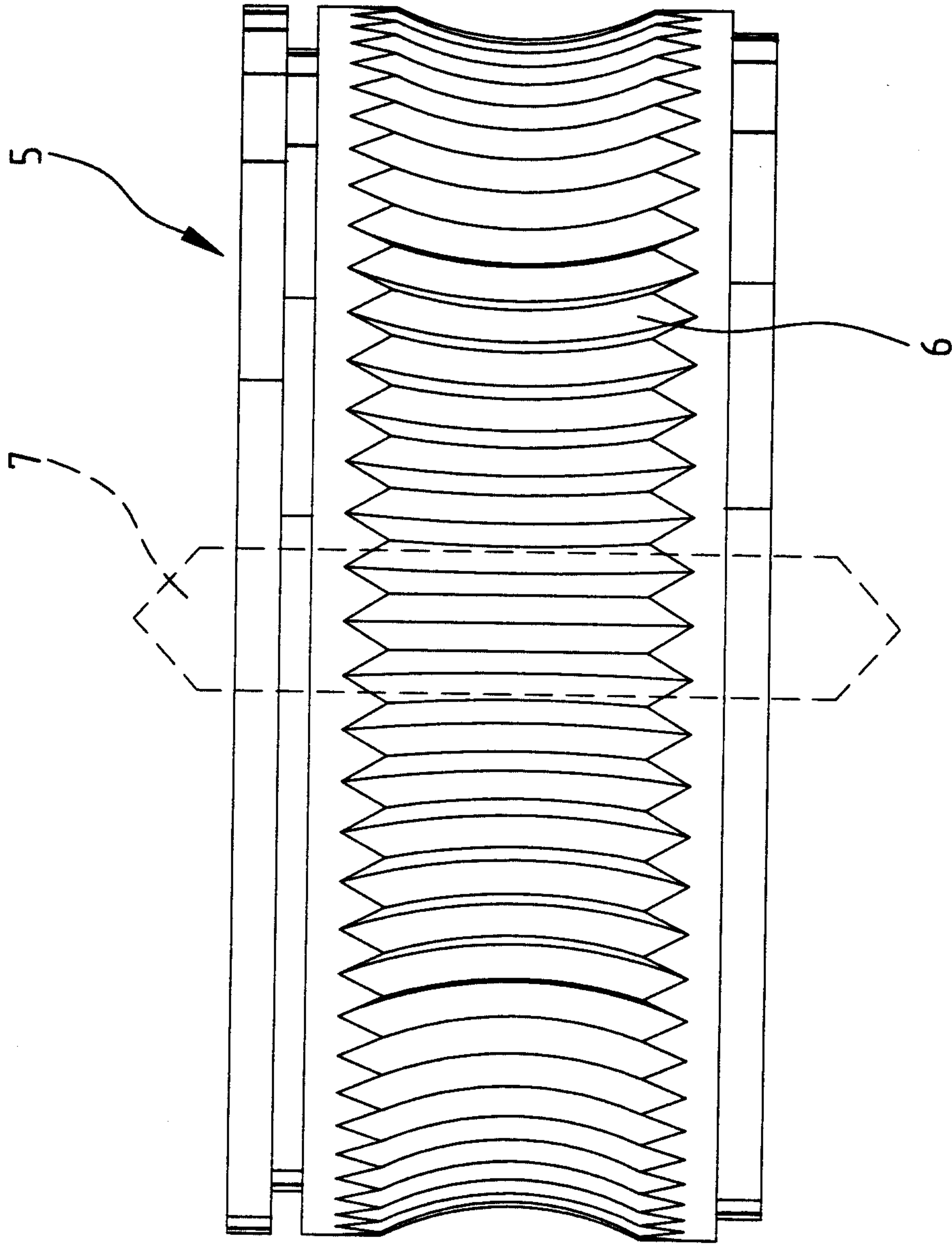


Fig. 16
PRIOR ART

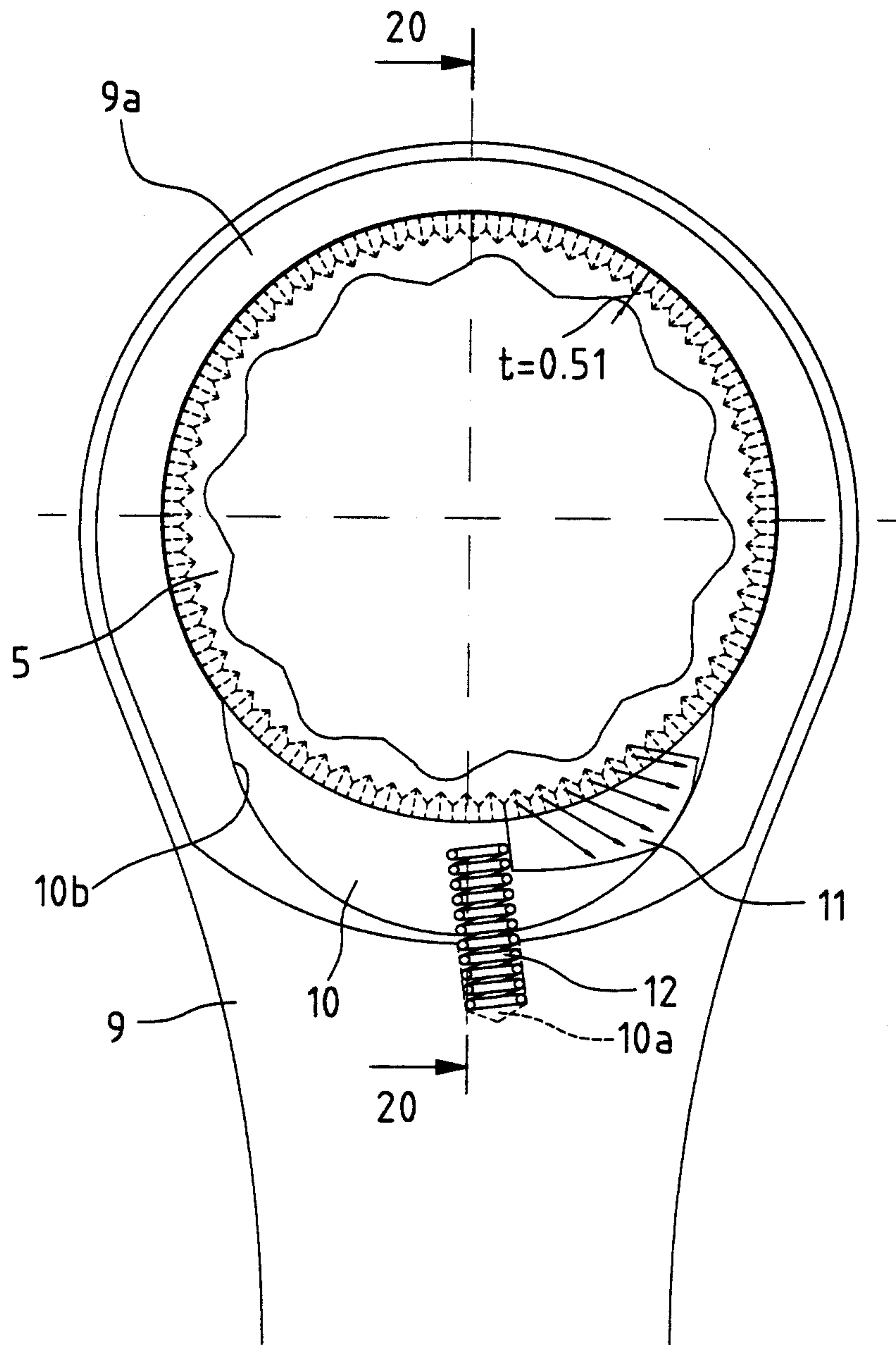


Fig. 17
PRIOR ART

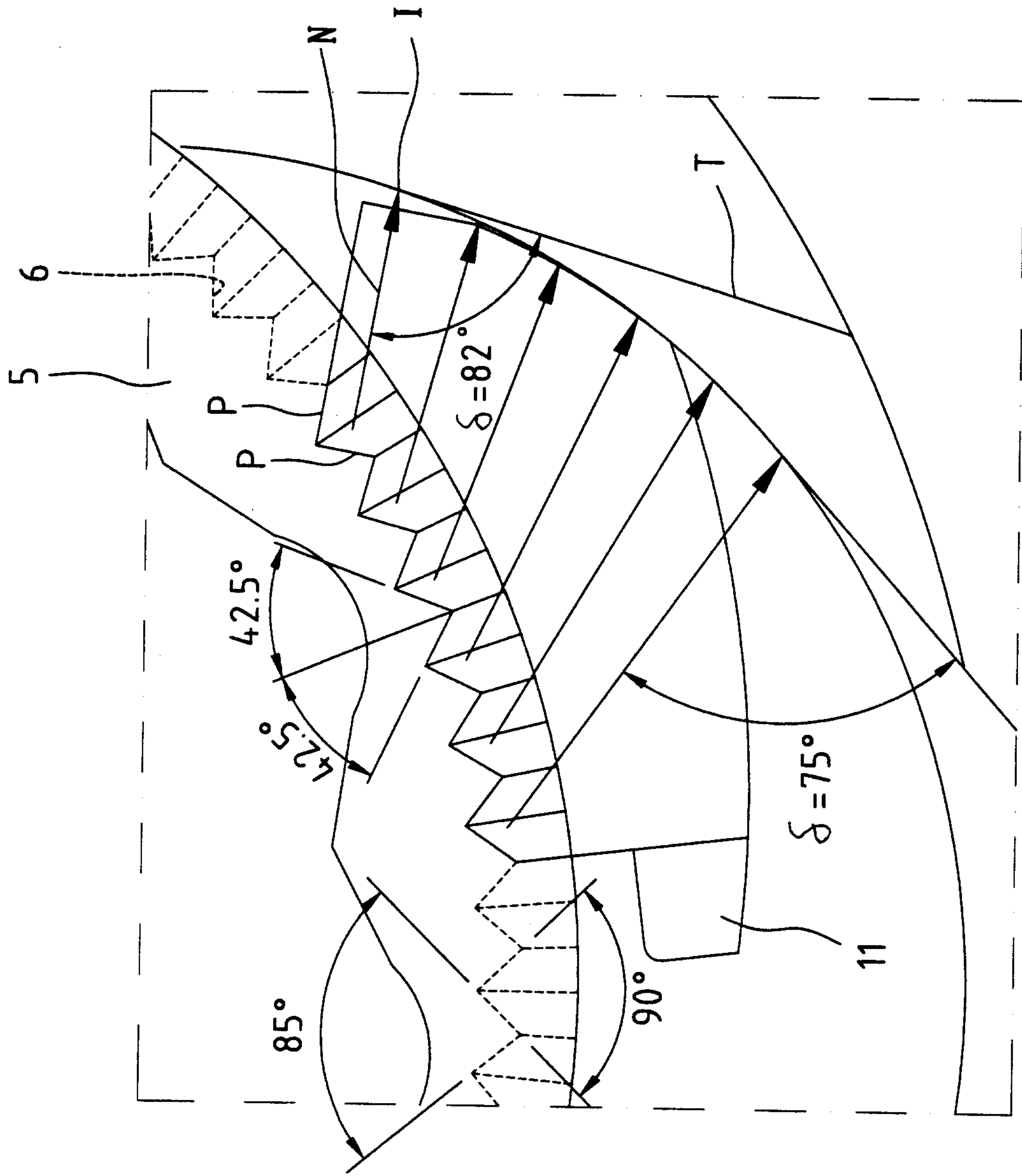


Fig. 18
PRIOR ART

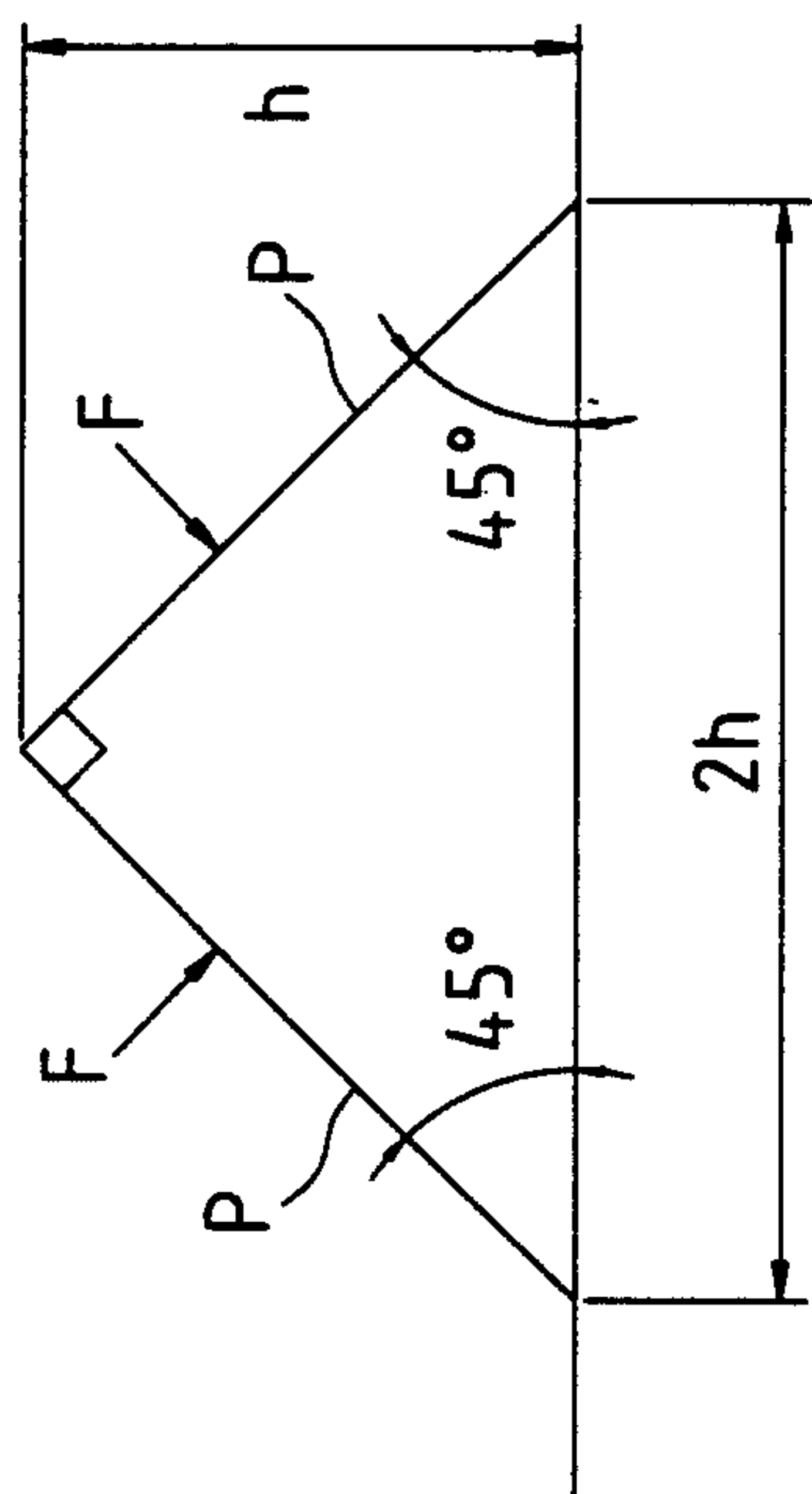


Fig. 19
PRIOR ART

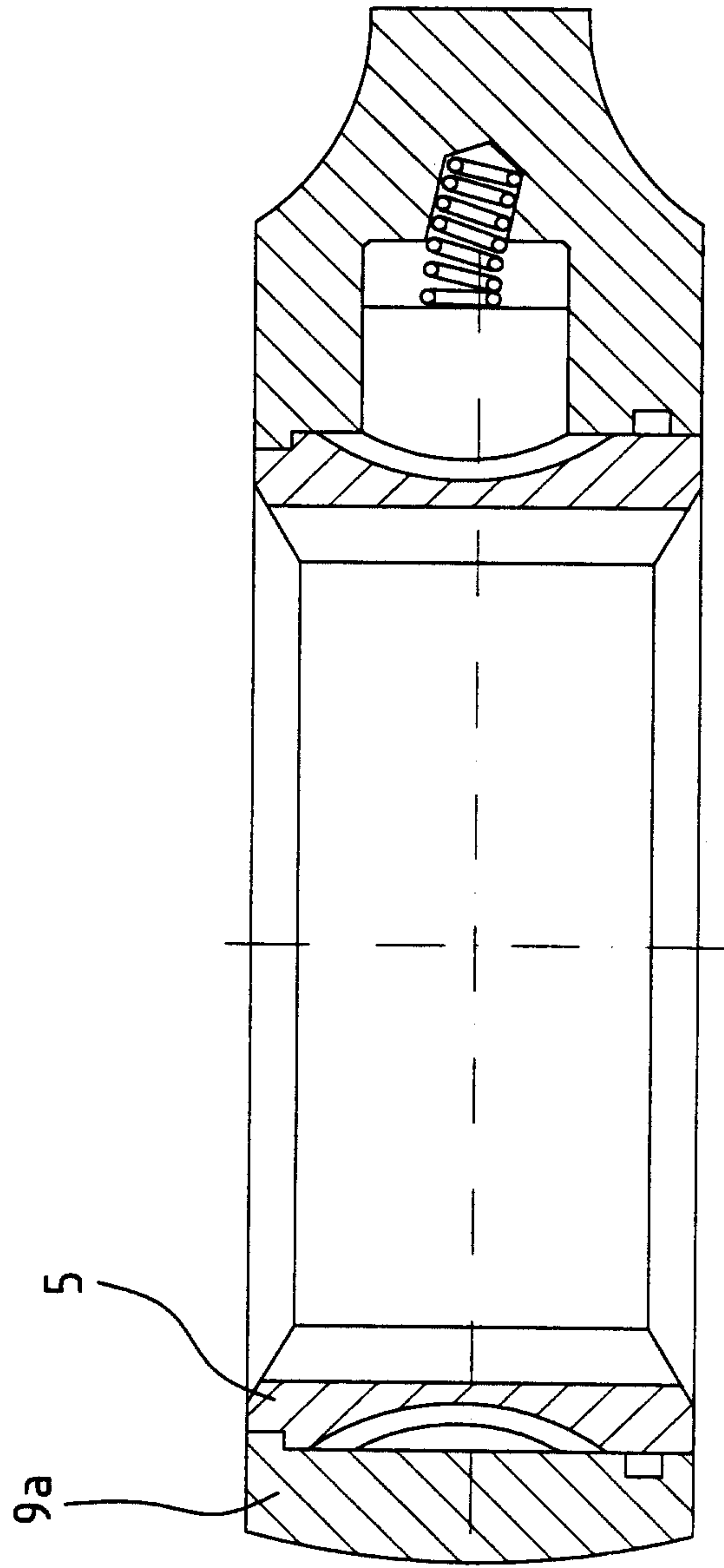


Fig. 20
PRIOR ART

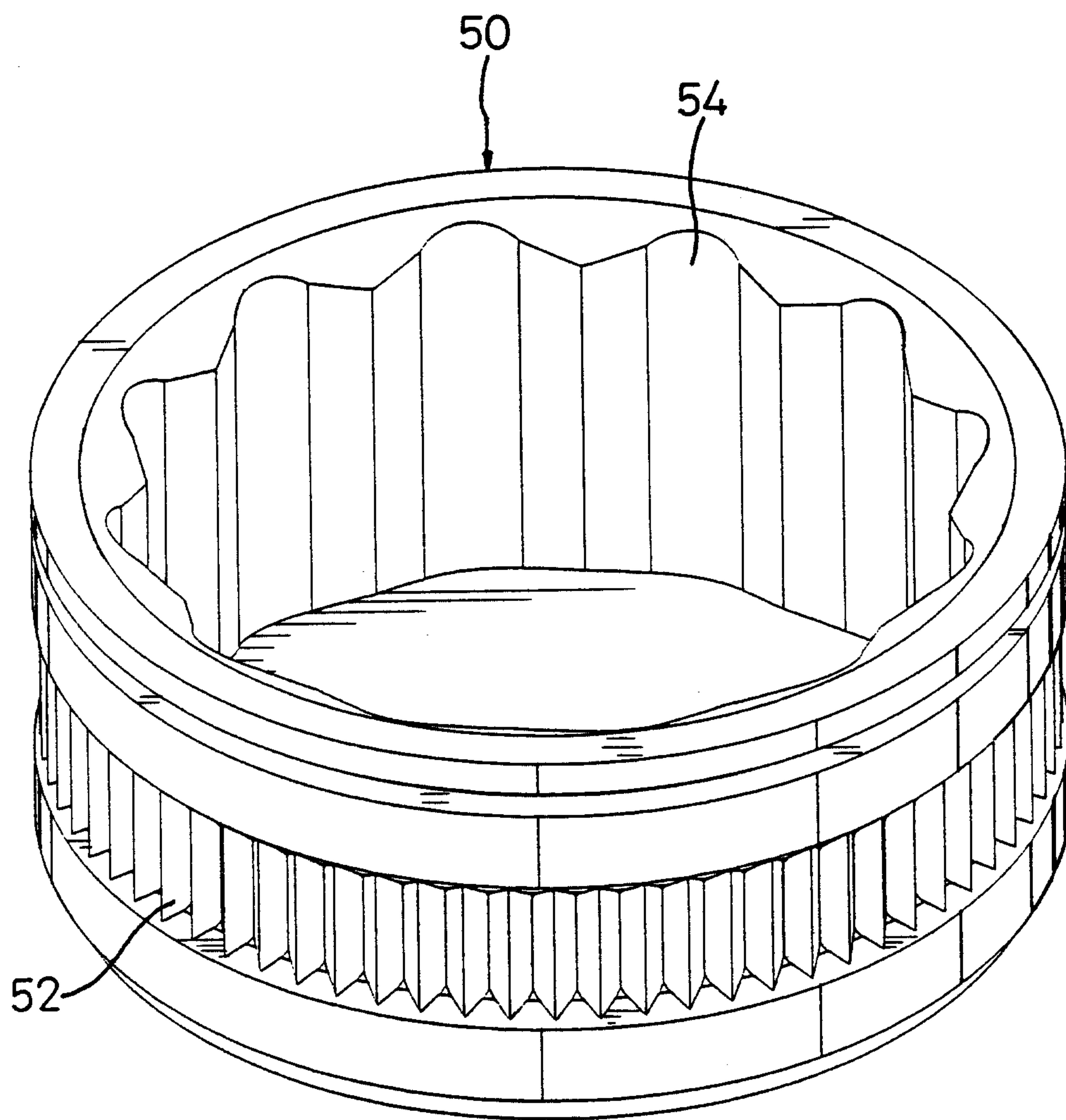


Fig. 21

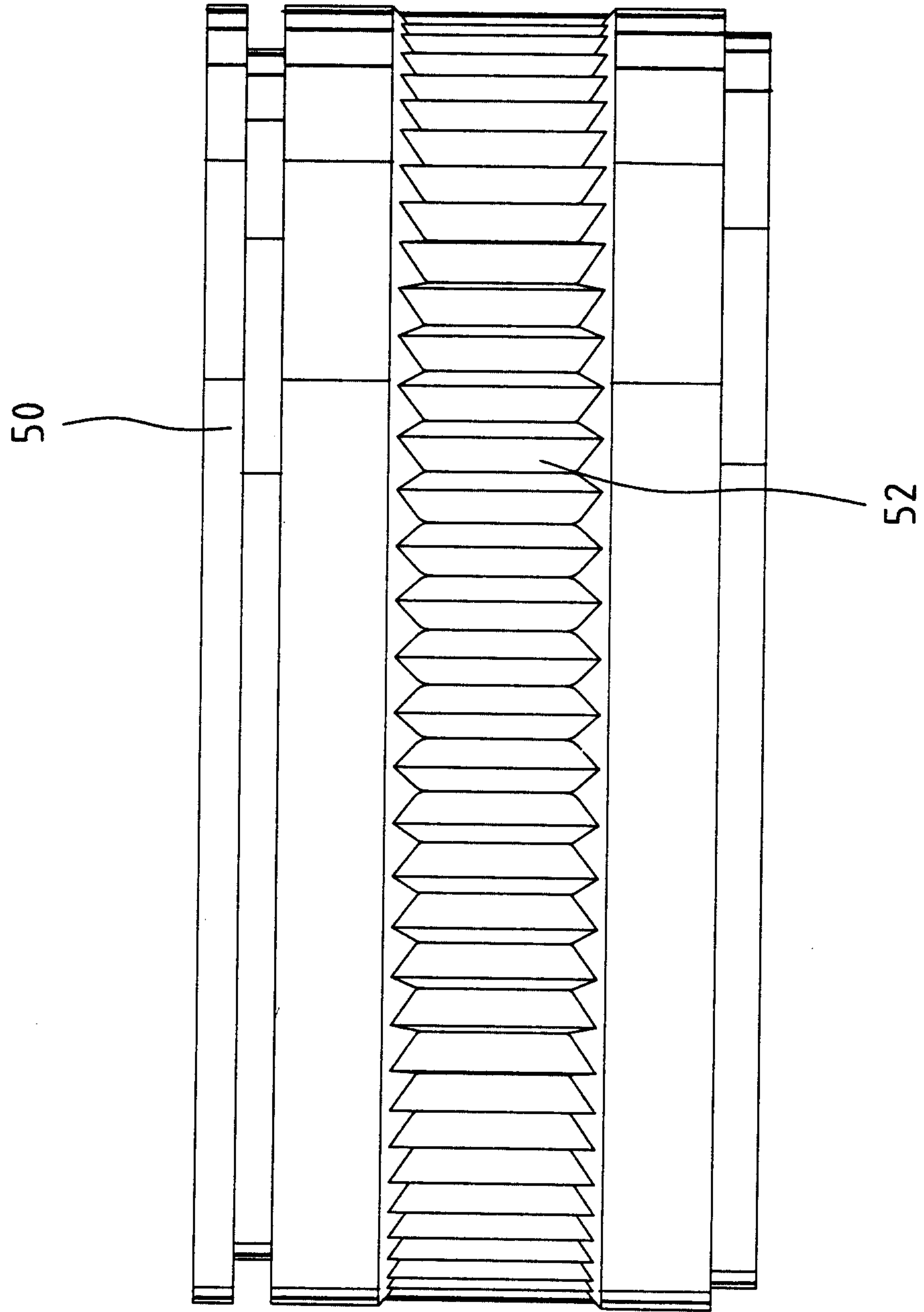


Fig. 22

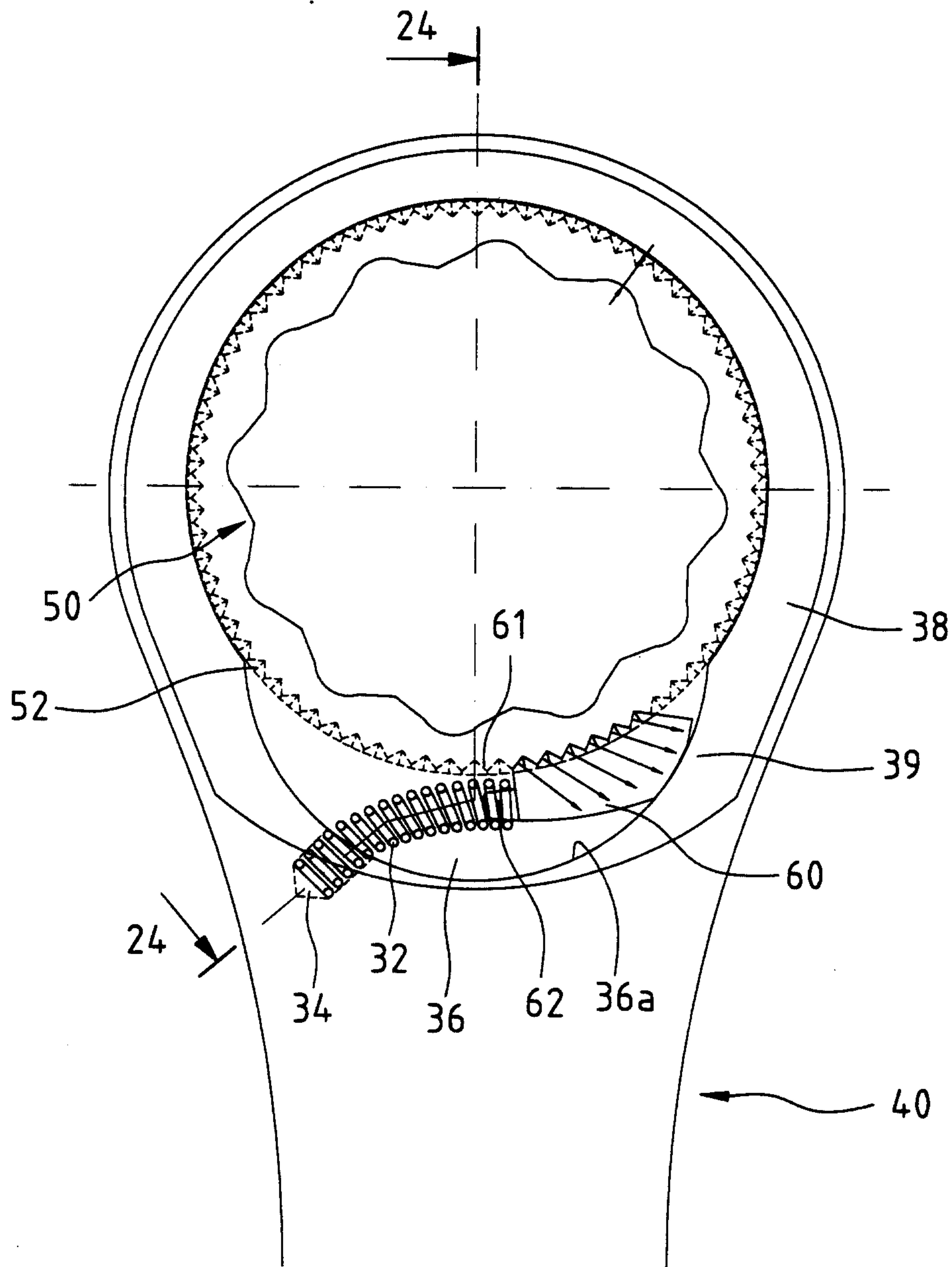


Fig. 23

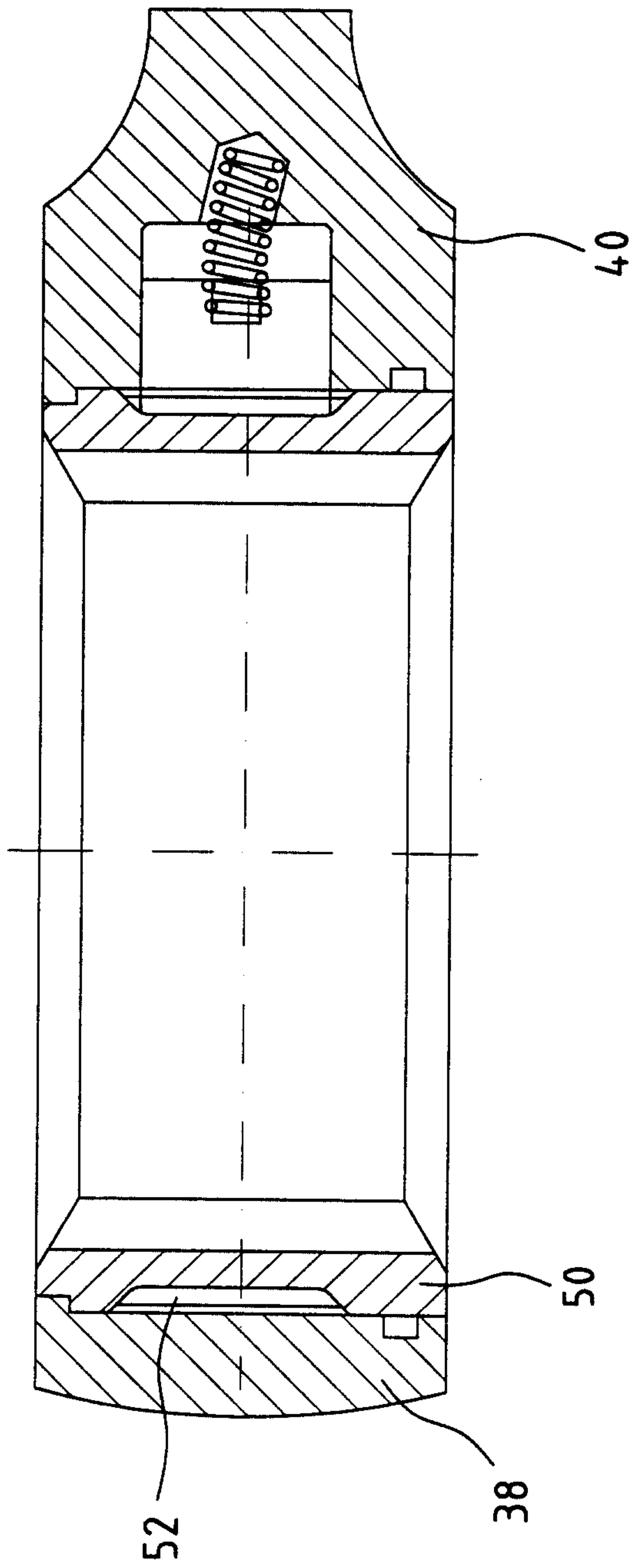


Fig. 24

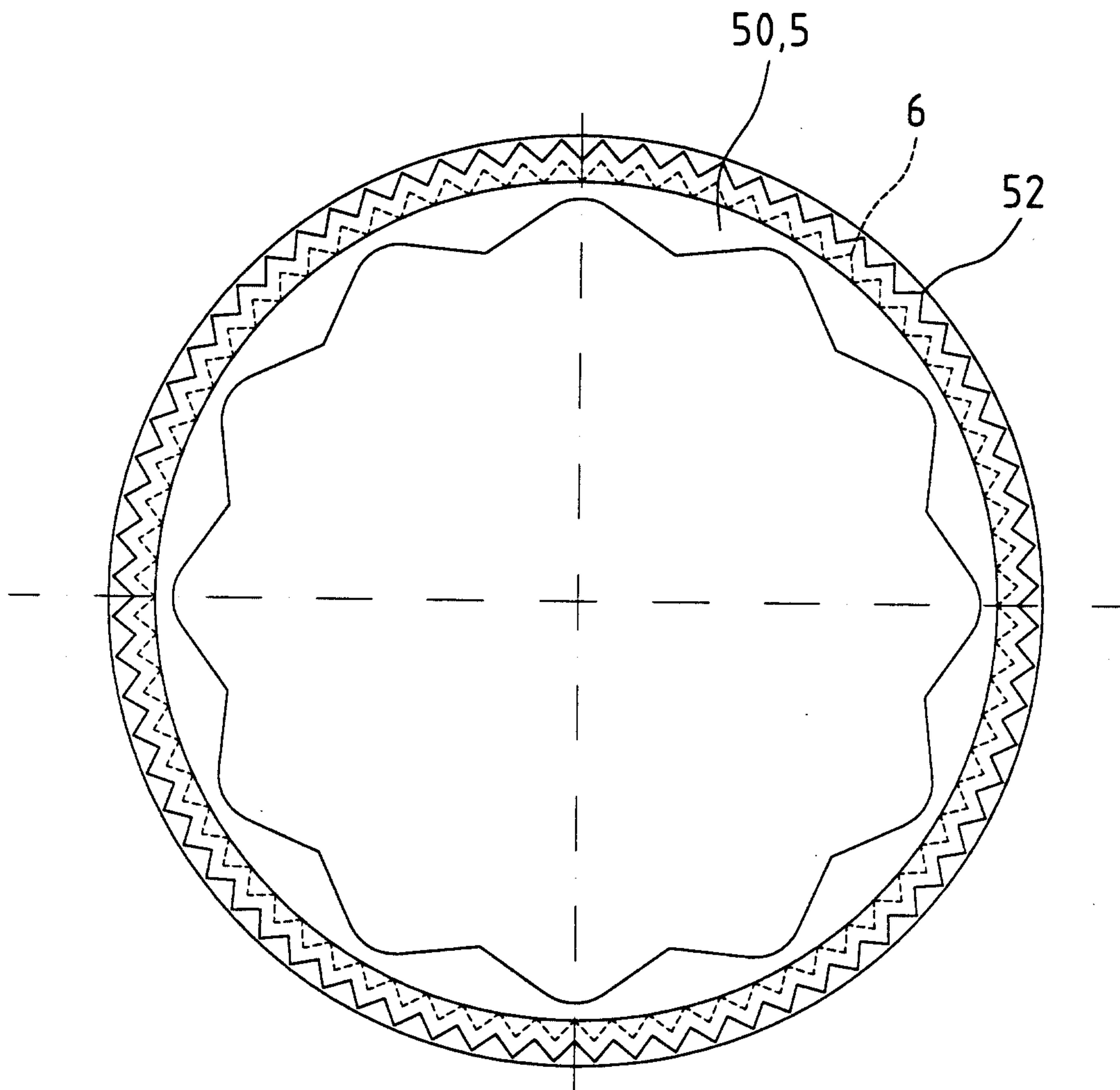


Fig. 25

Fig. 26a

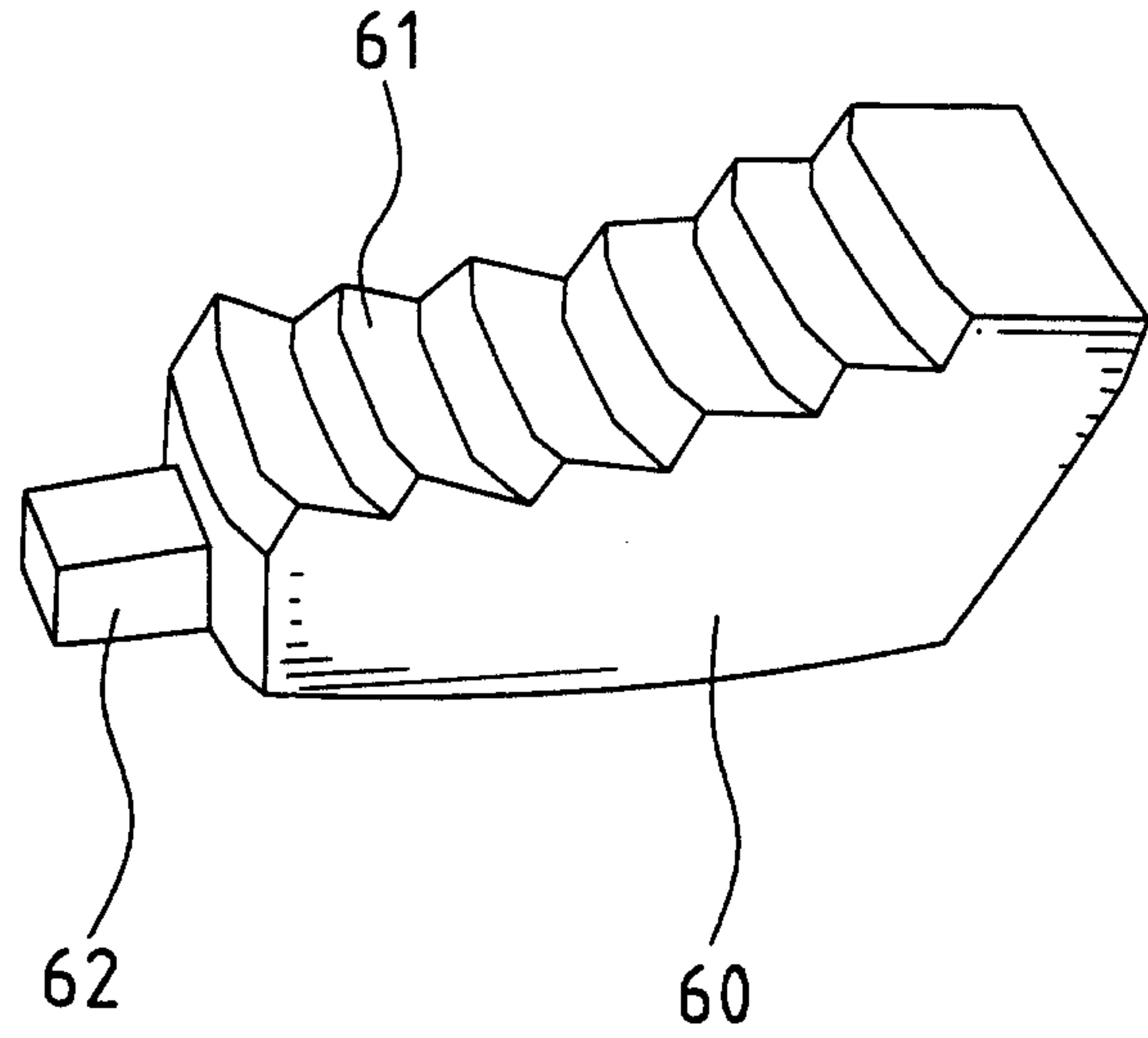


Fig. 26b

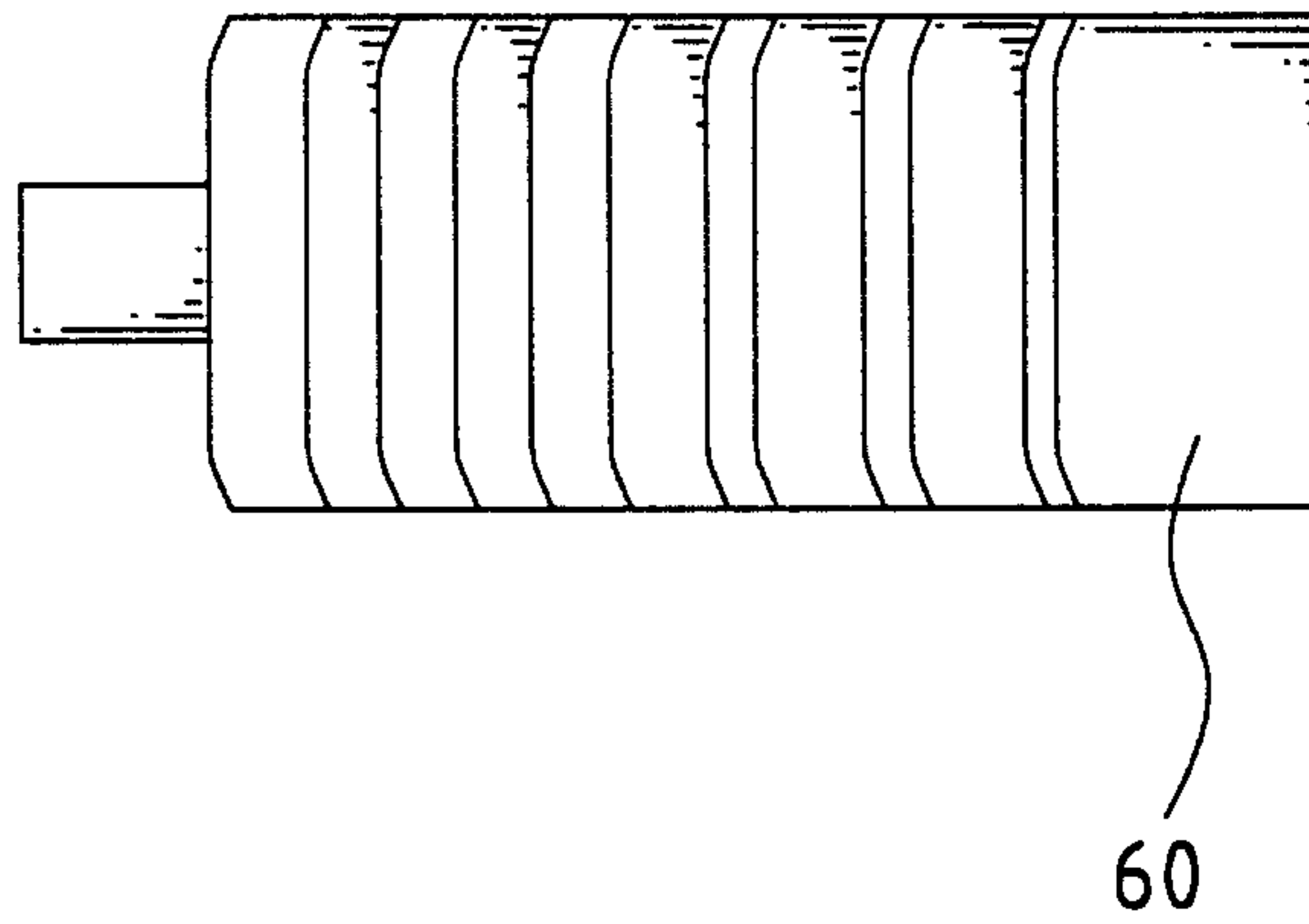


Fig. 26c

