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(72) Inventor: **Yamashina, Yoshiyuki**
Kashiwara-shi, Osaka (JP)

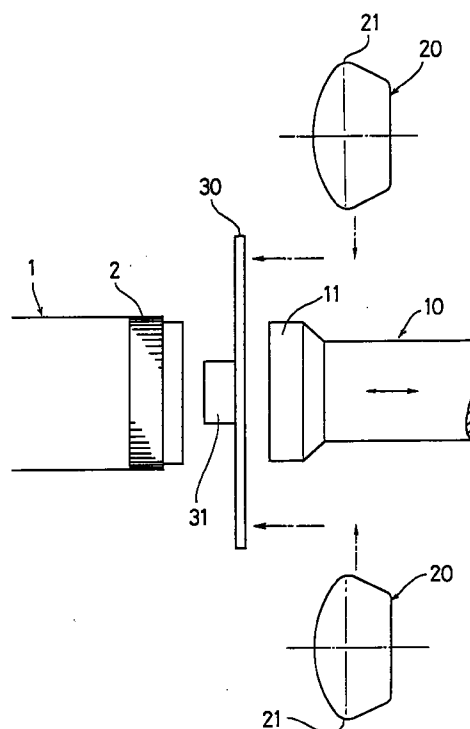
(71) Applicant: **Samtech Corporation**
Kashiwara-shi, Osaka (JP)

(74) Representative: **Glawe, Delfs, Moll & Partner**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) Method of manufacturing toothed transmission element

(57) A blank is clamped between a mandrel formed with a plurality of axial teeth on its outer periphery and a tailstock member arranged so as to be movable toward and away from one end of the mandrel. The blank is rotated together with the mandrel and the tailstock member. The radial positions of a plurality of forming rollers arranged around the tailstock member are adjusted. The forming rollers are moved in the direction of axis of the mandrel, thereby pressing the outer peripheral portion of the blank against the outer peripheral surface of the mandrel to spread the outer peripheral portion of the blank in the axial direction of the mandrel.

FIG. 1



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Description

This invention relates to a method of manufacturing a toothed transmission element including a cylindrical portion having a plurality of axial teeth formed at least on the inner periphery thereof.

An automatic transmission which utilizes the driving force transmitted from a torque converter to actuate a planetary gear type transmission is usually equipped with a hydraulic clutch in the torque transmission path between the torque converter and the planetary gear type transmission.

Such a clutch is usually a multiple disk friction clutch. Fig. 11 shows a clutch drum of a conventional clutch of this type.

The clutch drum 50 shown comprises an end plate 51 and a cylindrical portion 52 extending from the outer edge of the end plate 52. The cylindrical portion 52 has a plurality of axial teeth 53 in its inner periphery to guide the axial movement of friction disks 54.

If such a clutch drum 50 is formed by cutting, a long time is needed to manufacture such a drum and thus the yield is low. Also, the clutch drum thus formed tends to be low in strength because fiber flows are cut.

An object of this invention is to provide a simple and efficient method of manufacturing a toothed transmission element such as a clutch drum.

According to this invention, there is provided a method of manufacturing a toothed transmission element comprising the steps of clamping a blank between a mandrel formed with a plurality of axial teeth on the outer periphery thereof and a tailstock member arranged so as to be movable toward and away from one end of the mandrel, rotating the blank together with the mandrel and the tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around the tailstock member, and moving the forming rollers in the direction of axis of the mandrel, whereby pressing the outer peripheral portion of the blank against the outer peripheral surface of the mandrel to spread the outer peripheral portion of the blank in the axial direction of the mandrel.

According to the second invention, there is provided a method of manufacturing a toothed transmission element comprising the steps of clamping a blank having an outer peripheral portion between a tailstock member and a mandrel in the form of a stepped shaft comprising a large-diameter portion and a small-diameter portion, the small-diameter portion being formed with a plurality of axial teeth on the outer periphery thereof, rotating the blank together with the mandrel and the tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around the tailstock member, each forming roller comprising a truncated conical portion having an arcuate surface along the edge of the larger end face thereof, and cylindrical portion provided on the larger end face of the truncated conical portion, and moving the forming rollers in the direction of axis of the mandrel, whereby the cylindrical portion of the blank is

pressed radially inward by the arcuate surfaces on the truncated conical portions of the forming rollers to spread it axially until the cylindrical portion abuts the end face of the large-diameter portion of the mandrel.

According to the third invention, there is provided a method of manufacturing a toothed transmission element comprising the steps of clamping a blank having an outer cylindrical portion between a tailstock member and a mandrel in the form of a stepped shaft comprising a large-diameter portion and a small-diameter portion formed with a plurality of axial teeth on the outer periphery thereof, the large-diameter portion having a cylindrical portion provided along the edge of the end face and formed with a plurality of axial teeth on the inner periphery thereof, rotating the blank together with the mandrel and the tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around the tailstock member, each forming roller having the shape of a truncated cone having an arcuate surface along the edge of the larger end face, and moving the forming rollers in the direction of axis of the mandrel, whereby the cylindrical portion of the blank is pressed radially inward to spread it axially until the cylindrical portion abuts the end face of the large-diameter portion of the mandrel.

According to this invention, a transmission element is formed by plastic working, i.e. by spreading a rotating blank in radial and axial directions of the mandrel by pressing the forming rollers. The transmission element thus formed shows high strength because fiber flows are not cut. Also, it can be formed efficiently.

Such a transmission element may be formed in a cold or warm environment.

Other features and objects of the present invention will become apparent from the following description made with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view of the forming device used for the method according to this invention;

Figs. 2A and 2B are views showing steps of forming from a blank;

Fig. 3 is a partially cutaway perspective view of a transmission element formed using the abovementioned forming device;

Fig. 4 is a sectional view of a different blank;

Figs. 5A and 5B are views of a different forming device showing the states before and after the blank have been formed;

Fig. 6 is a partially cutaway perspective view of a transmission element formed using the forming device of Fig. 5;

Fig. 7 is a sectional view of a different forming device;

Fig. 8 is a partially cutaway perspective view of a transmission element formed using the forming device of Fig. 7;

Figs. 9A and 9B are views of another forming device showing the states before and after the blank have been formed;

Fig. 10 is a partially cutaway perspective view of a transmission element formed using the forming device of Fig. 9; and

Fig. 11 is a sectional view of a conventional clutch drum.

Figs. 1 and 2 show a first embodiment of this invention. As shown in the figures, a forming device comprises a mandrel 1, a tailstock member 10 aligned with the mandrel 1, and a plurality of forming rollers 20 arranged around the tailstock member 10.

Axial teeth 2 are formed at equal intervals on the outer periphery of the mandrel 1.

The tailstock member 10 is movable toward and away from the mandrel 1 and has a disk-shaped head 11 at the end near the mandrel 1.

The forming rollers 20 have an arcuate surface 21 on the outer periphery thereof. They are radially movable toward and away from the tailstock member 10 and also axially movable together with the tailstock member relative to the mandrel 1.

The forming rollers 20 may be arranged at equal intervals in a single plane perpendicular to tailstock member 10 or may be arranged at equal intervals but offset from one another in the direction of axis of the tailstock member 10.

Blanks 30 to be worked with this forming device include a disk-shaped blank 30 having a boss portion 31 as shown in Fig. 1, and a blank 30 comprising a boss portion 31 and an outer cylindrical portion 32 as shown in Fig. 4.

The inner diameter of the cylindrical portion 32 is larger than the diameter of the circle circumscribing the teeth 5 of the mandrel 1.

The blank 30 shown in Fig. 1 is clamped between the mandrel 1 and the tailstock member 10 as shown in Fig. 2A and rotated in one direction. Then, after positioning the forming rollers 20 so that the diameter D1 of the circle inscribing the arcuate surfaces 21 is equal to the outer diameter of the end product, the forming rollers 20 are moved axially toward the mandrel 1. The outer-diameter portion of the blank 30 is thus bent along the outer edge of the mandrel 1 by being pushed by the end faces of the forming rollers 20 and also pressed against the outer periphery of the mandrel 1 and stretched by the arcuate surfaces 21 of the forming rollers. Fig. 3 shows the end product thus formed, i.e. a transmission element 40 having teeth 42 on the inner periphery of its cylindrical portion 41.

When forming the transmission element 40, the forming rollers 20 move in the direction of axis of the mandrel 1 while rotating about their own axes by contact with the blank 30. Thus, it is possible to form an end product having no scratches on the surface. Moreover, since the toothed transmission element is formed by plastic working, it is of higher quality and strength.

In order to form the transmission element shown in Fig. 3 using the blank 30 shown in Fig. 4, the cylindrical portion 32 is pressed against the outer periphery of the

mandrel 1 with the forming rollers 20 while stretching this portion 32 in the direction of axis of the mandrel 1.

Figs. 5A and 5B show a second embodiment of this invention. The mandrel 1 of this embodiment is a stepped shaft comprising a large-diameter portion 3 and a small-diameter portion 4 formed at one end of the large-diameter portion 3. A plurality of axial teeth 5 are formed at equal intervals on the outer periphery of the small-diameter portion 4.

The forming rollers 20 each comprise a truncated conical portion 22 and a cylindrical portion 23 formed on the larger end face of the truncated conical portion 22. An arcuate surface 24 is formed on the outer edge of the larger end face of the truncated conical portion 22.

The blank 30 is clamped between the mandrel 1 and the tailstock member 10 and rotated in one direction together with the mandrel 1 and the tailstock member 10. Then, after adjusting the radial position of the forming rollers 20 relative to the tailstock member 10, the roller 20 are moved in the direction of axis of the mandrel 1. Thus, the cylindrical portion 32 of the blank 30 is pushed radially inward by the arcuate surfaces 24 of the forming rollers 20, so that the cylindrical portion is pressed against the small-diameter portion 4 and at the same time spread in the axial direction of the small-diameter portion 4.

As shown in Fig. 5B, when the cylindrical portion is spread until its end abuts the shoulder of the large-diameter portion 3, the end of the cylindrical portion 32 is bent radially outward, forming a flange portion 33.

The cylindrical portions 23 of the forming rollers 20 further deform the flange portion 33 to form its outer circumferential surface.

Then, the burr 34, i.e. the portion extending into the space between the outer periphery of large-diameter portion 3 of the mandrel 1 and the cylindrical portions 23 of the forming rollers 20, is removed with a lathe or the like. Fig. 6 shows a transmission element 40 thus formed having teeth 42 on the inner periphery of the cylindrical portion 41 and a flange 43 on the outer periphery.

As shown in Fig. 7, a plurality of axial protrusions 6 may be formed on the end face of the large-diameter portion 3 of the mandrel. A flanged transmission element 40 formed using this mandrel is shown in Fig. 8. It has radial grooves 44 in the end face of the flange 43. These grooves 44 are used as passages for lubricating oil.

Figs. 9A and 9B show a third embodiment of this invention. The mandrel 1 in this embodiment is a stepped shaft comprising a large-diameter portion 3 and a small-diameter portion 4 provided on one end of the large-diameter portion 3. A plurality of axial teeth 5 are formed at equal intervals on the outer periphery of the small-diameter portion 4.

On the other hand, the large-diameter portion 3 has a cylindrical portion 7 extending axially from the end face thereof. A plurality of axial teeth 8 are formed at

equal intervals on the inner periphery of the cylindrical portion 7.

The forming rollers 20 are movable radially toward and away from the tailstock member 10. They have the shape of a truncated cone having an arcuate surface 25 along the edge of the larger end face.

The blank 30 is clamped between the mandrel 1 and the tailstock member 10 and rotated in one direction together with the mandrel 1 and the tailstock member 10. Then, after adjusting the radial position of the forming rollers 20 relative to the tailstock member 10, the rollers 20 are moved in the direction of axis of the mandrel 1. Thus, the cylindrical portion 32 of the blank 30 is pushed radially inward by the arcuate surfaces 25 of the forming rollers 20, so that the cylindrical portion is pressed against the small-diameter portion 4 and at the same time spread in the axial direction of the small-diameter portion 4.

When the cylindrical portion 32 is spread until its end abuts the end face of the large-diameter portion 3, the end of the cylindrical portion 32 is bent radially outward, forming a flange portion 33.

The flange portion 33 is pressed against the inner periphery of the cylindrical portion 7 of the mandrel 1.

Any excess material of the blank moves into the space between the forming rollers 20 and the end face of the cylindrical portion 7, forming a burr 34.

The burr 34 is removed with a lathe or the like. Fig. 10 shows a transmission element 40 thus formed. It has teeth 42 and 45 on the inner periphery of the cylindrical portion 41 and on the outer periphery of the flange 43, respectively.

Claims

1. A method of manufacturing a toothed transmission element comprising the steps of clamping a blank between a mandrel formed with a plurality of axial teeth on the outer periphery thereof and a tailstock member arranged so as to be movable toward and away from one end of said mandrel, rotating said blank together with said mandrel and said tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around said tailstock member, and moving said forming rollers in the direction of axis of said mandrel, whereby pressing the outer peripheral portion of said blank against the outer peripheral surface of said mandrel to spread the outer peripheral portion of said blank in the axial direction of the mandrel.
2. A method of manufacturing a toothed transmission element comprising the steps of clamping a blank having an outer peripheral portion between a tailstock member and a mandrel in the form of a stepped shaft comprising a large-diameter portion and a small-diameter portion, said small-diameter portion being formed with a plurality of axial teeth on the outer periphery thereof, rotating said blank

together with said mandrel and said tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around said tailstock member, said each forming roller comprising a truncated conical portion having an arcuate surface along the edge of the larger end face thereof, and cylindrical portion provided on the larger end face of said truncated conical portion, and moving said forming rollers in the direction of axis of said mandrel, whereby said cylindrical portion of said blank is pressed radially inward by said arcuate surfaces on said truncated conical portions of said forming rollers to spread it axially until said cylindrical portion abuts the end face of said large-diameter portion of said mandrel.

3. A method of manufacturing a toothed transmission element as claimed in claim 2, wherein said mandrel has a plurality of radial protrusions formed on the end face of said large-diameter portion thereof.
4. A method of manufacturing a toothed transmission element comprising the steps of clamping a blank having an outer cylindrical portion between a tailstock member and a mandrel in the form of a stepped shaft comprising a large-diameter portion and a small-diameter portion formed with a plurality of axial teeth on the outer periphery thereof, said large-diameter portion having a cylindrical portion provided along the edge of said end face and formed with a plurality of axial teeth on the inner periphery thereof, rotating said blank together with said mandrel and said tailstock member, adjusting the radial positions of a plurality of forming rollers arranged around said tailstock member, said each forming roller having the shape of a truncated cone having an arcuate surface along the edge of the larger end face, and moving said forming rollers in the direction of axis of said mandrel, whereby said cylindrical portion of said blank is pressed radially inward to spread it axially until said cylindrical portion abuts the end face of said large-diameter portion of said mandrel.

FIG. 1

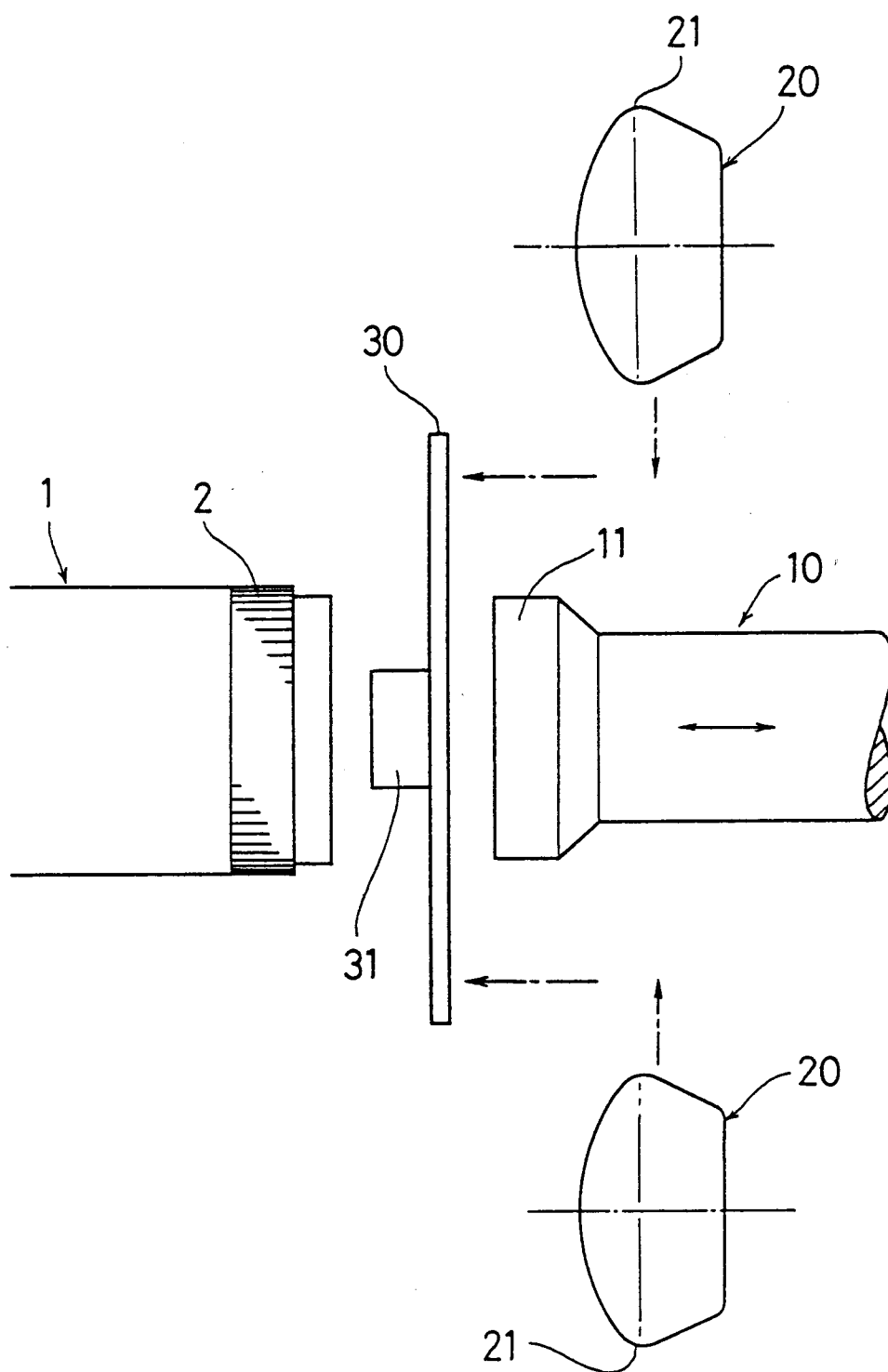


FIG. 2A

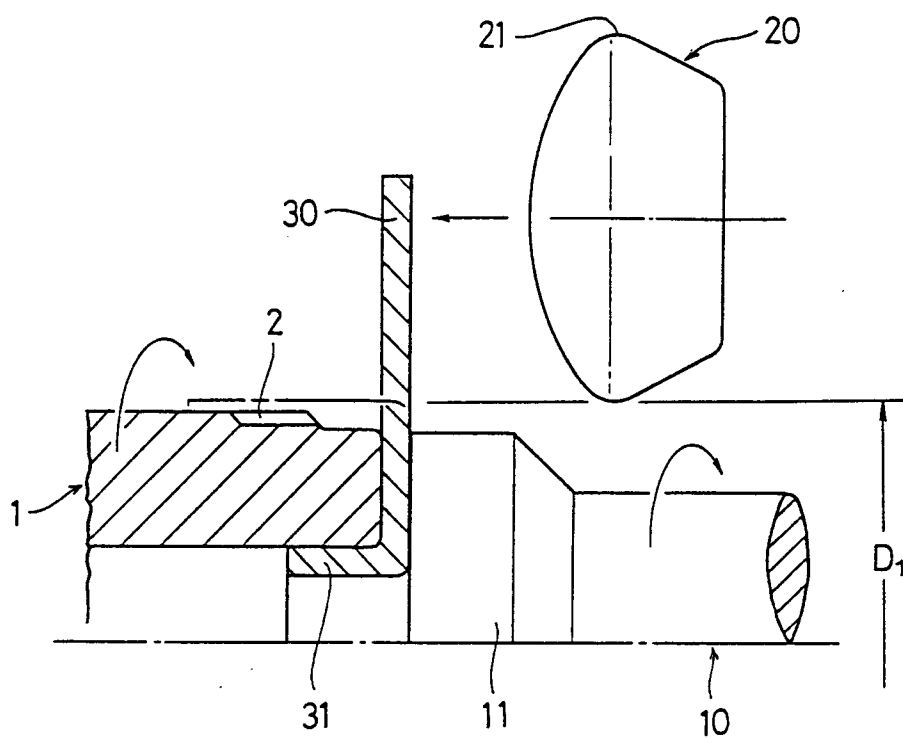


FIG. 2B

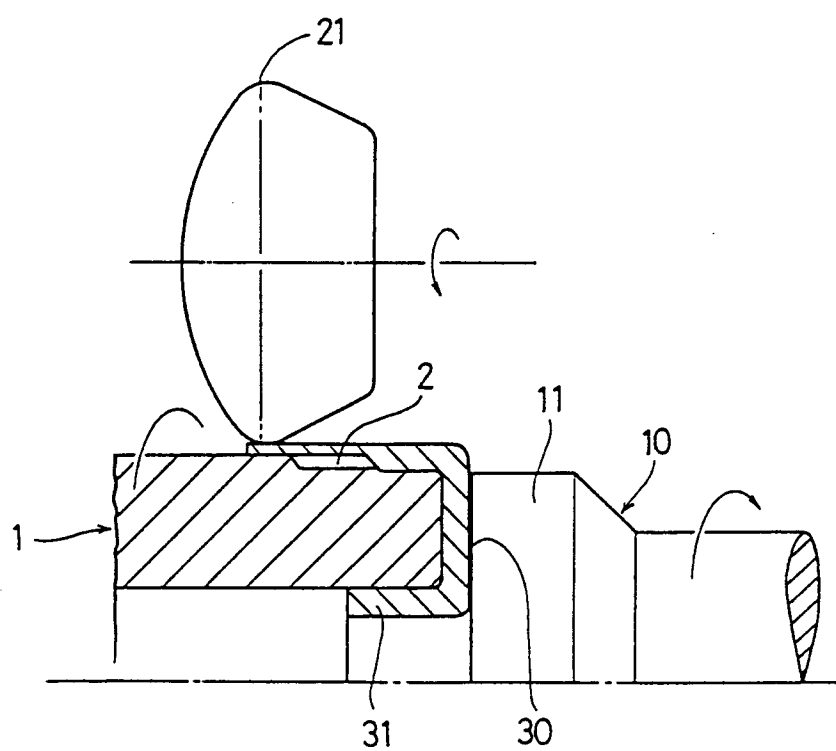


FIG. 3

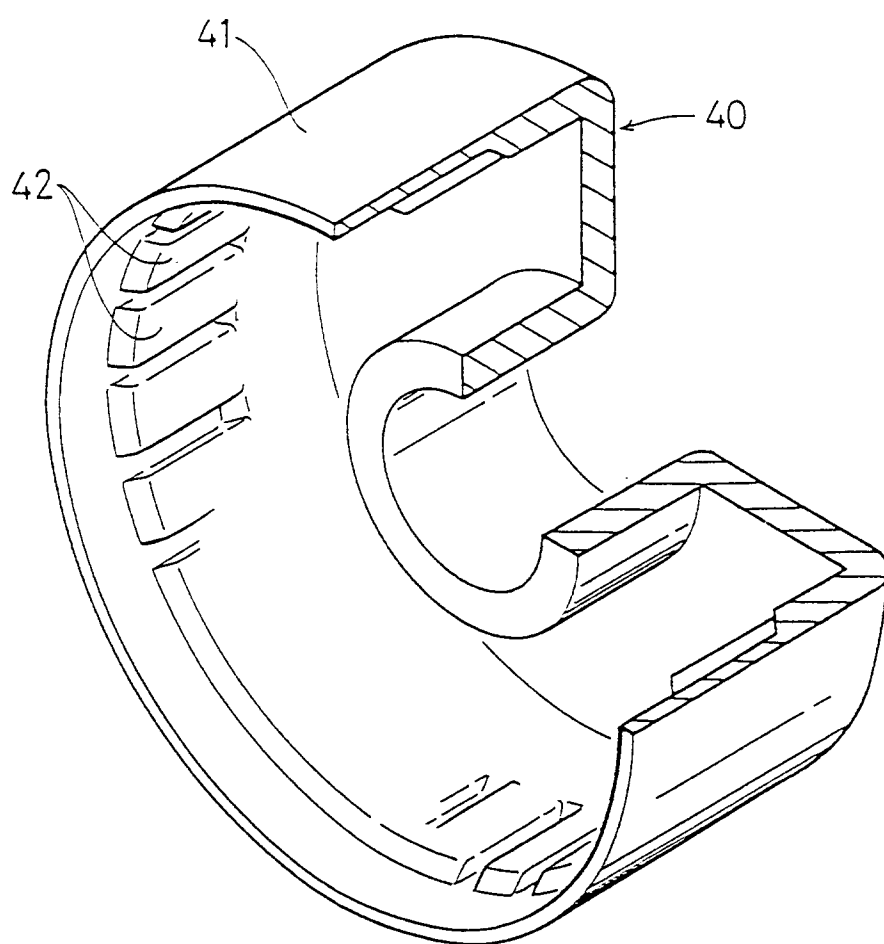


FIG. 4

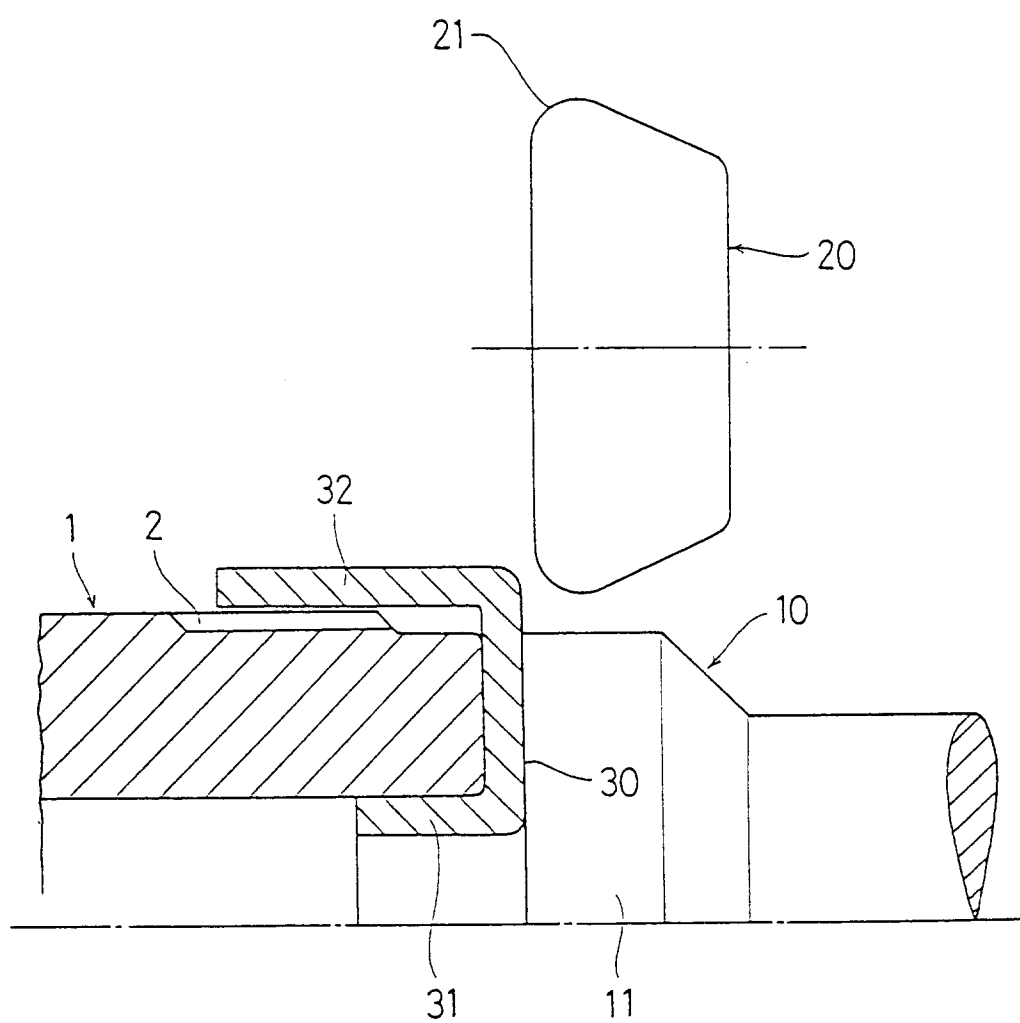


FIG. 5A

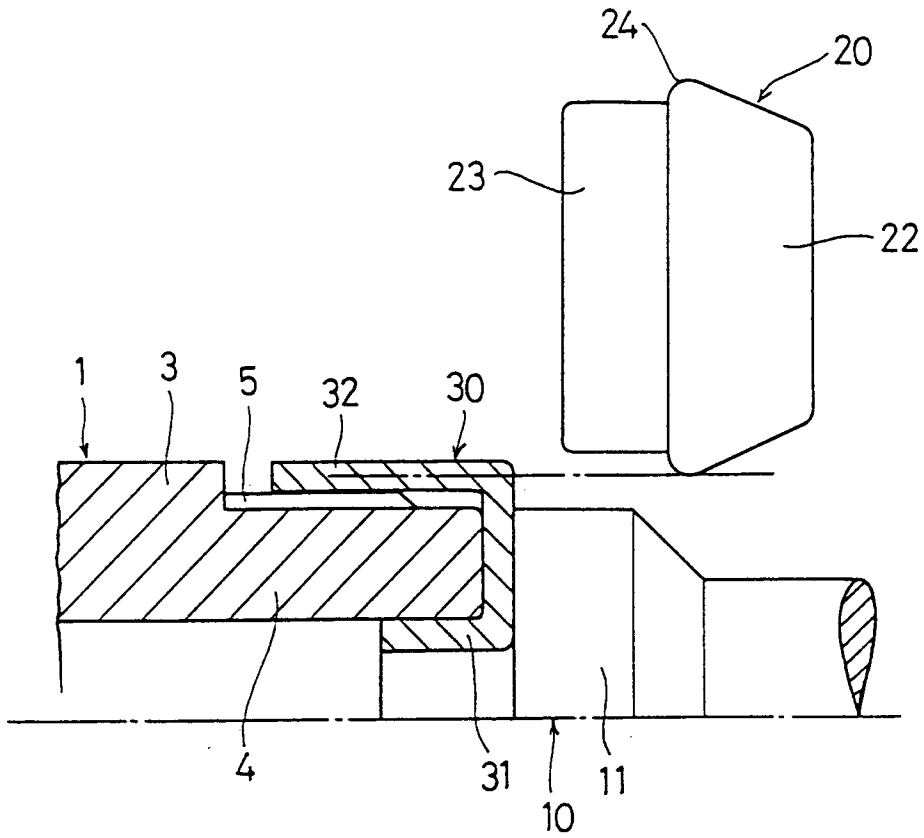


FIG. 5B

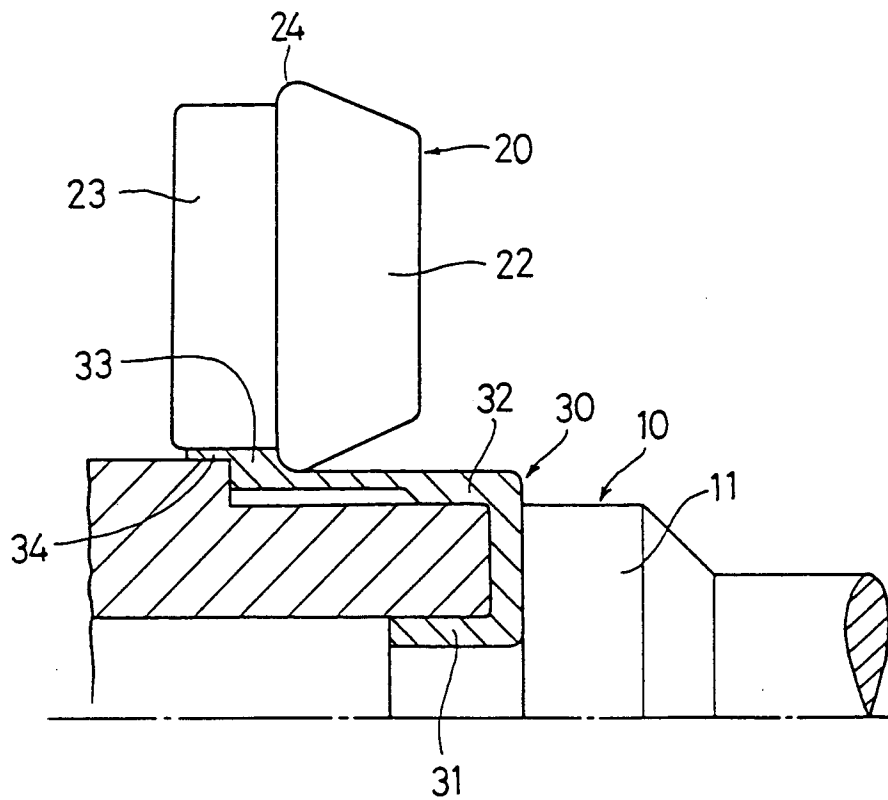


FIG. 6

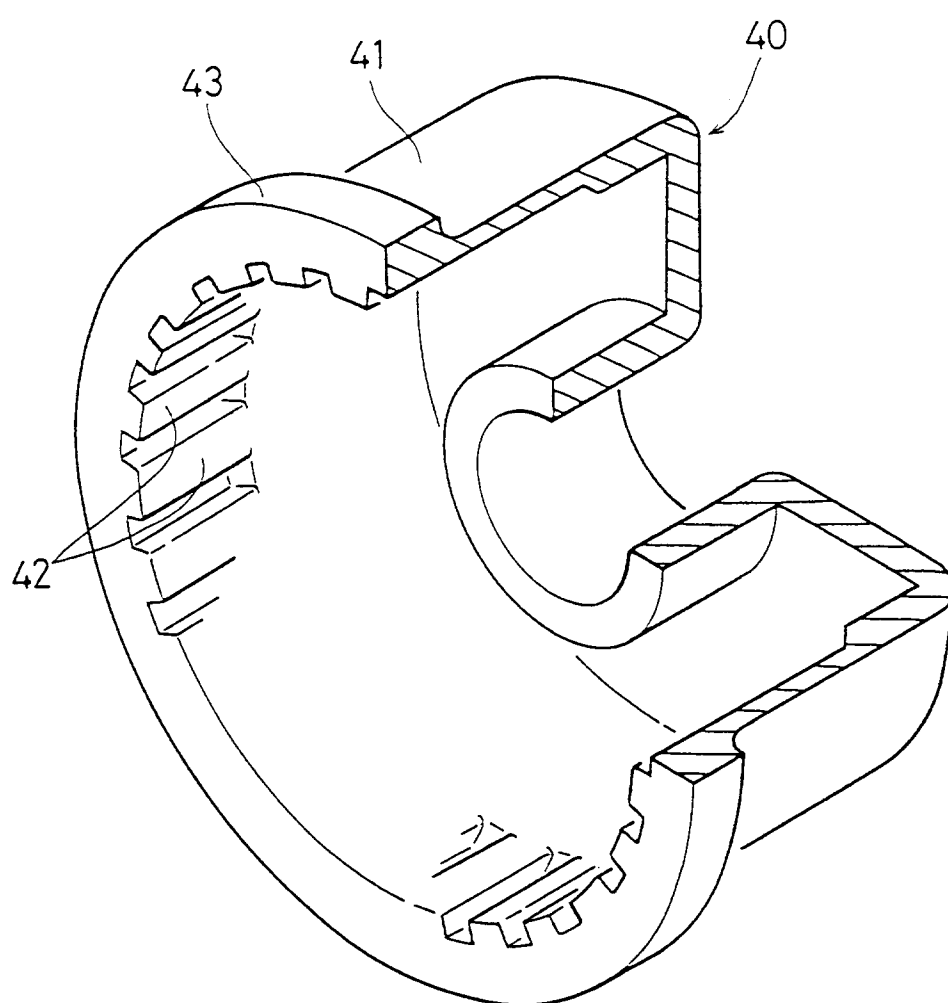


FIG. 7

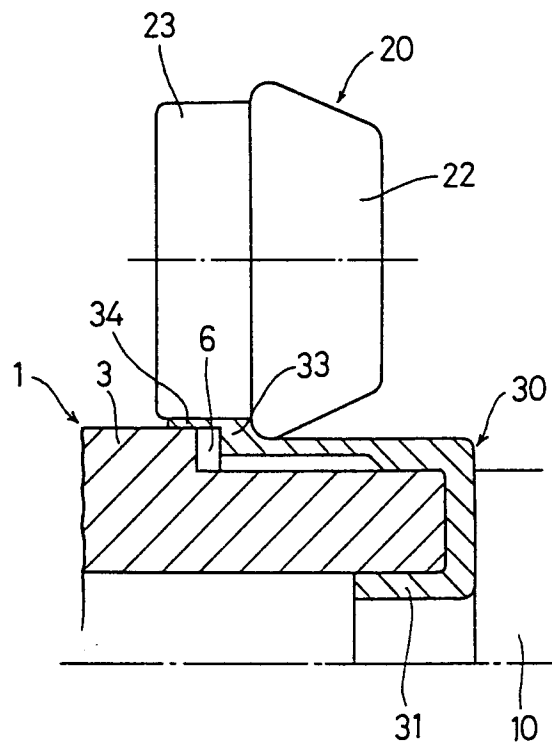


FIG. 8

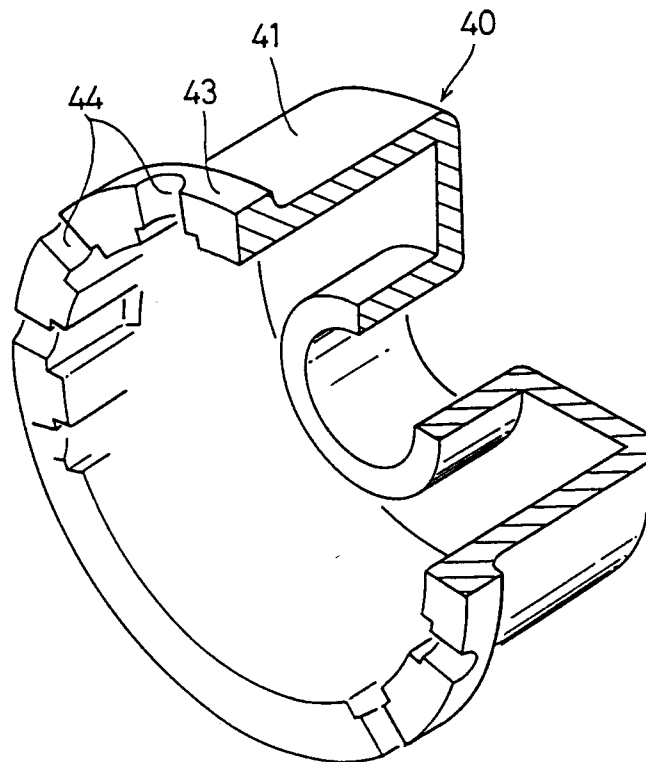


FIG. 9A

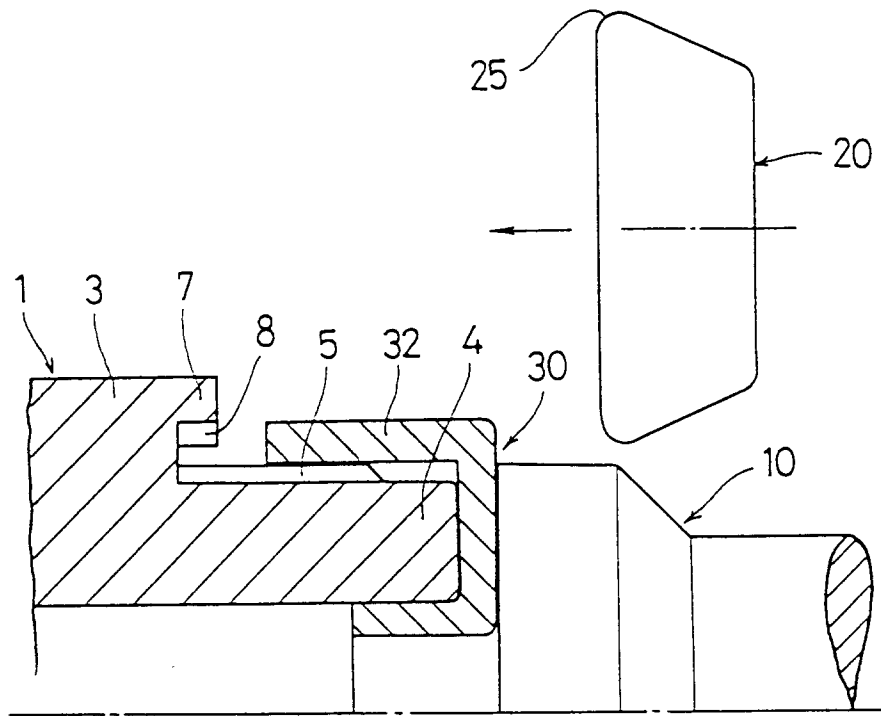


FIG. 9B

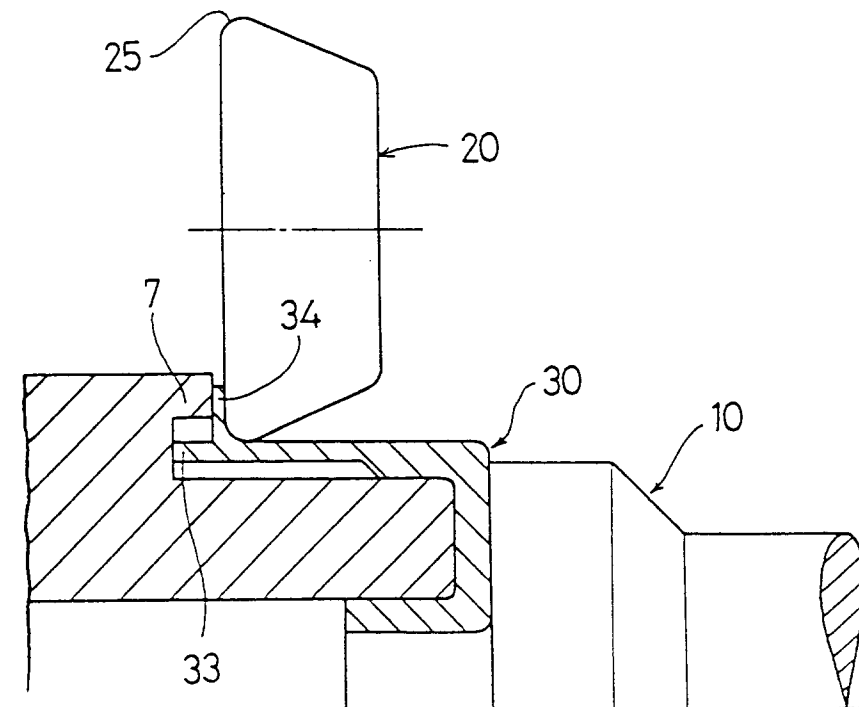


FIG. 10

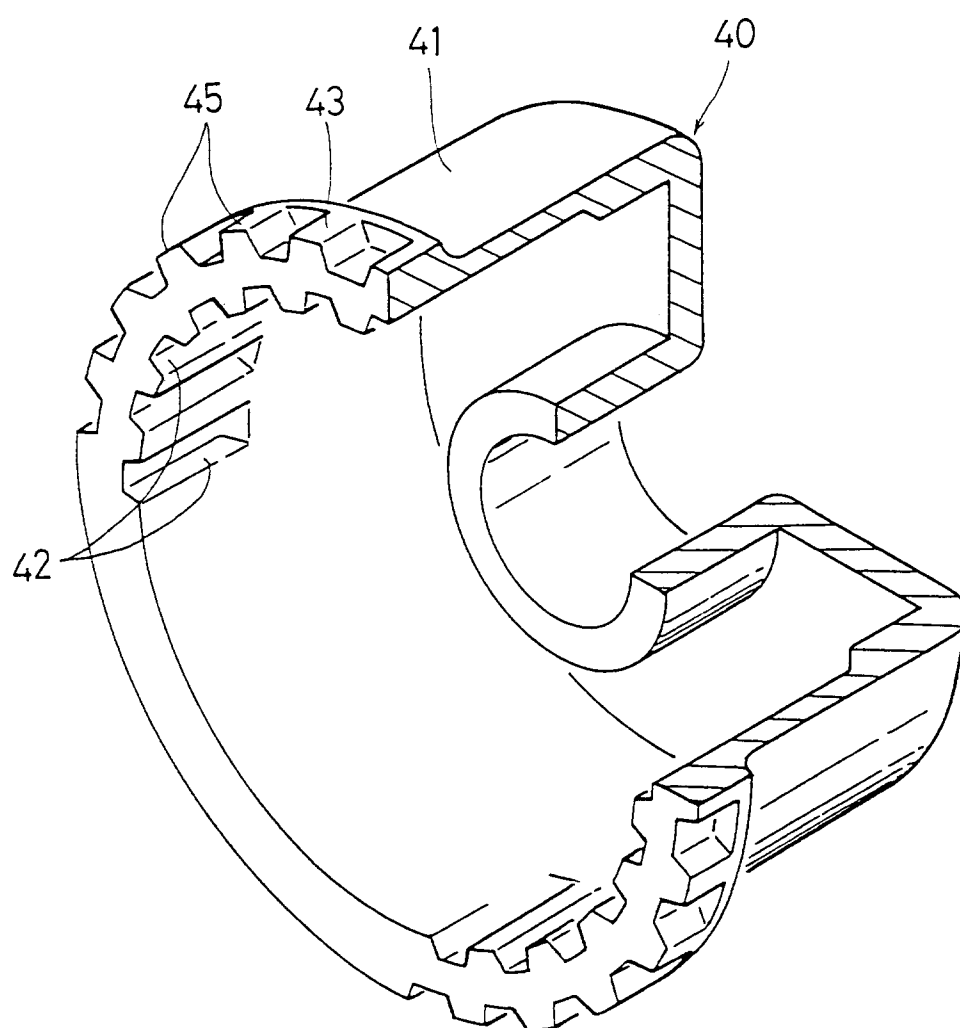
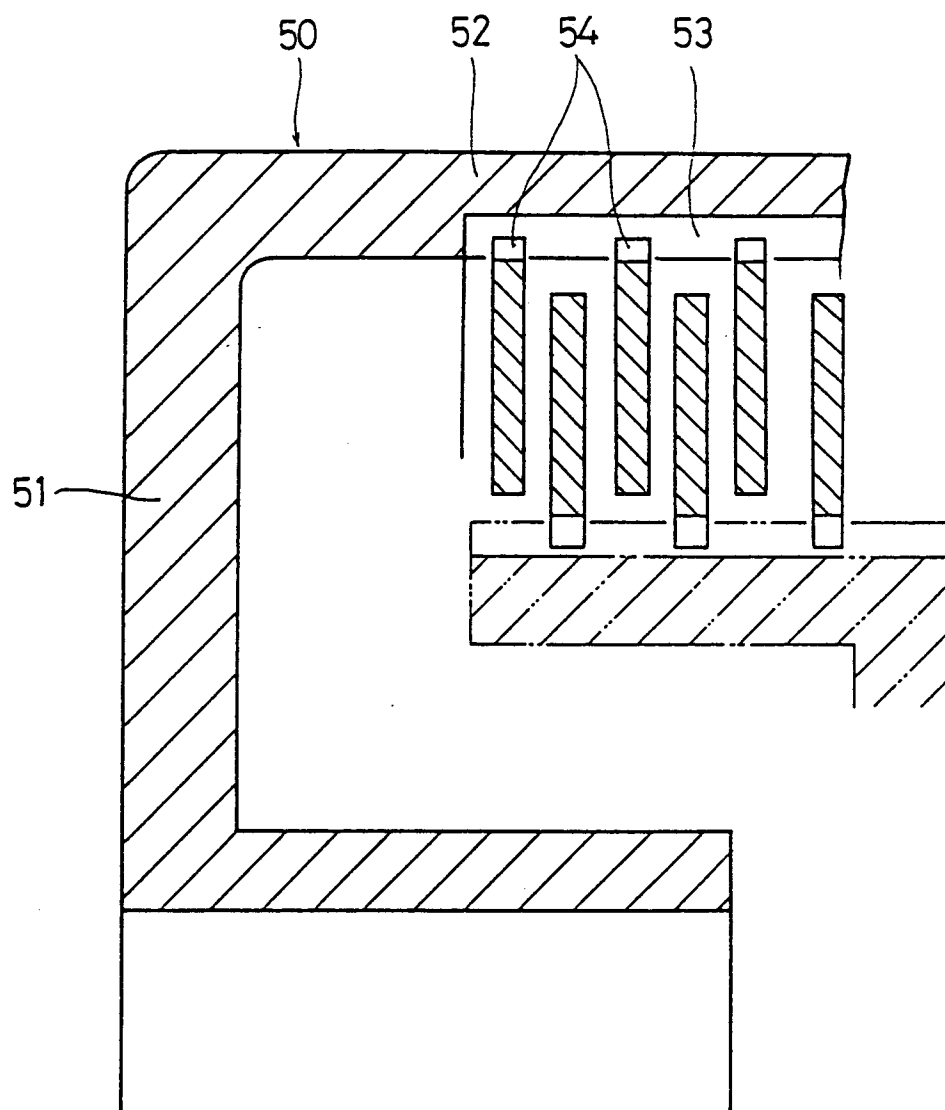


FIG. 11





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 5204

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 605 916 (GENERAL MOTORS) * the whole document *	1-3	B21D53/28 B21H5/00 B21H5/02
A	---	4	
X	EP-A-0 568 779 (WF-MASCHINENBAU UND BLECHFORMTECHNIK) * the whole document *	1	
A	---	2,4	
X	DE-A-39 31 599 (WF-MASCHINENBAU UND BLECHFORMTECHNIK) * the whole document *	1	
A	---	2,4	
X	EP-A-0 639 415 (HERZING + SCHROTH) * column 2 - column 4; figures 8-12 *	1	
A	---	2,4	
A	DE-A-42 40 613 (LEIFELD) * the whole document *	1-4	
A	DE-A-43 14 558 (LEIFELD) * the whole document *	4	
A	DE-B-12 87 549 (VEB ZENTRALE ENTWICKLUNG UND KONSTRUKTION) * the whole document *	4	B21D B21H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 6 September 1995	Examiner Rosenbaum, H
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