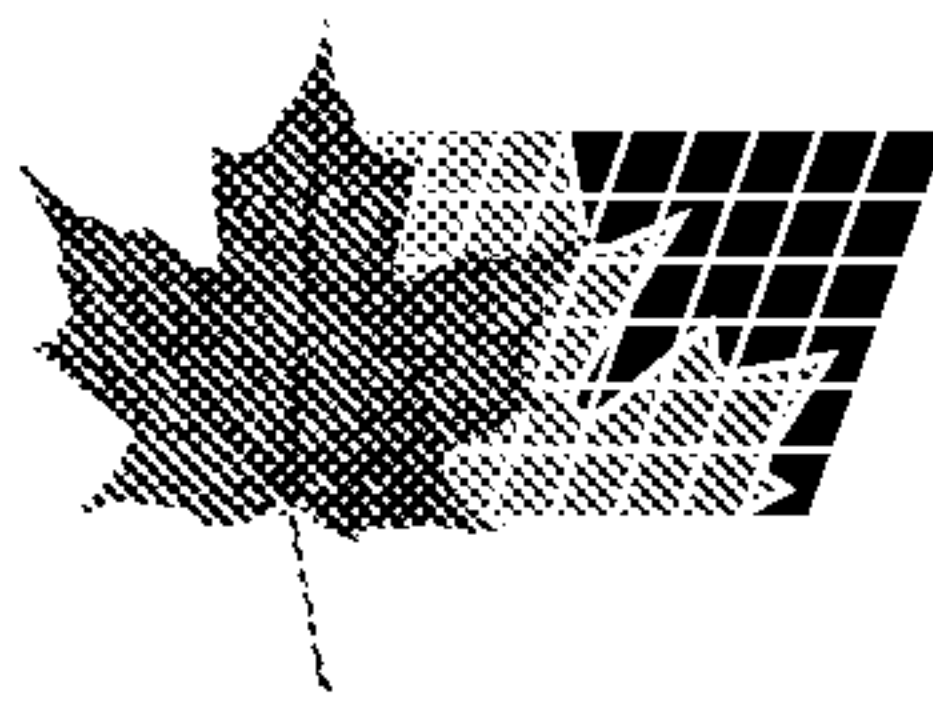
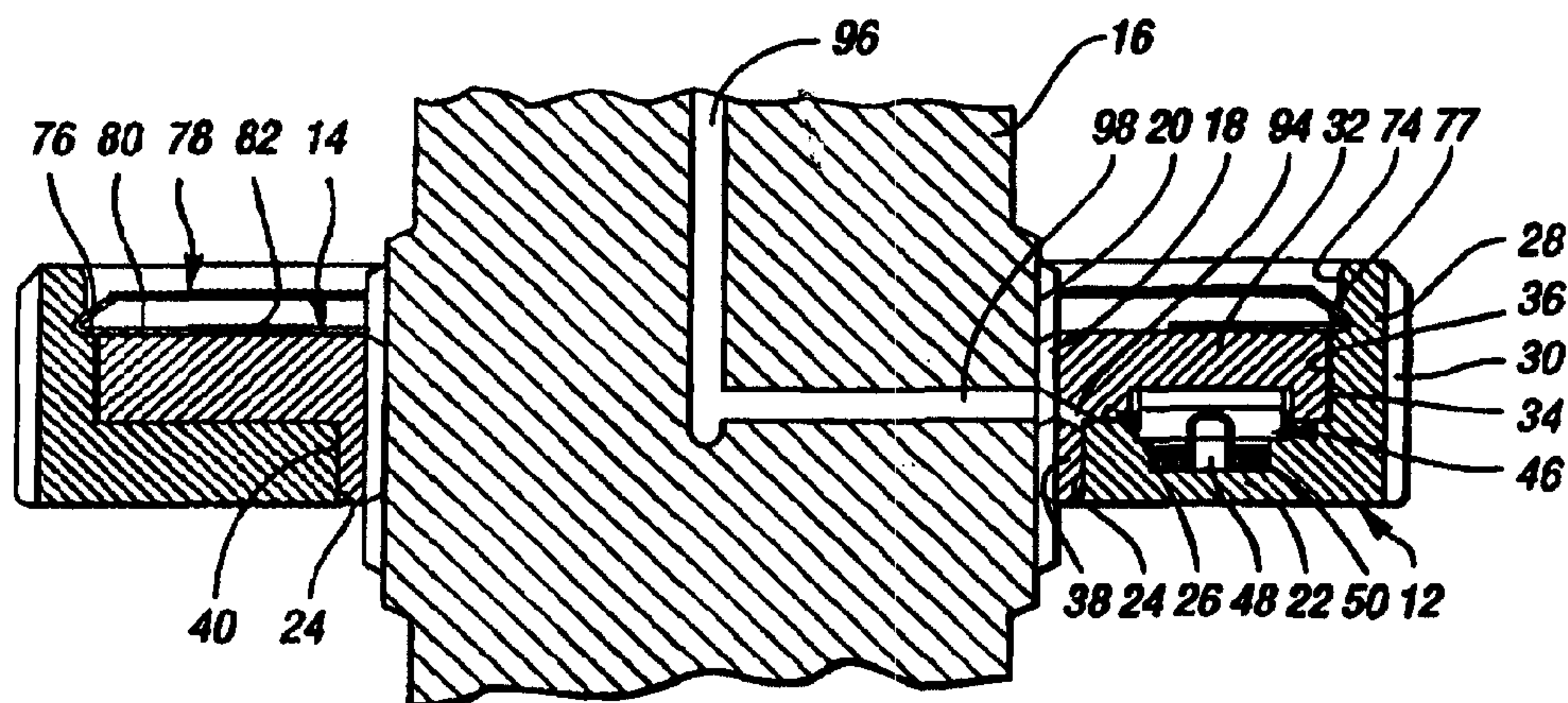




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(54) **EMBRAYAGE A ROUE LIBRE UNIDIRECTIONNEL**
(54) **ONE-WAY OVERRUNNING CLUTCH**



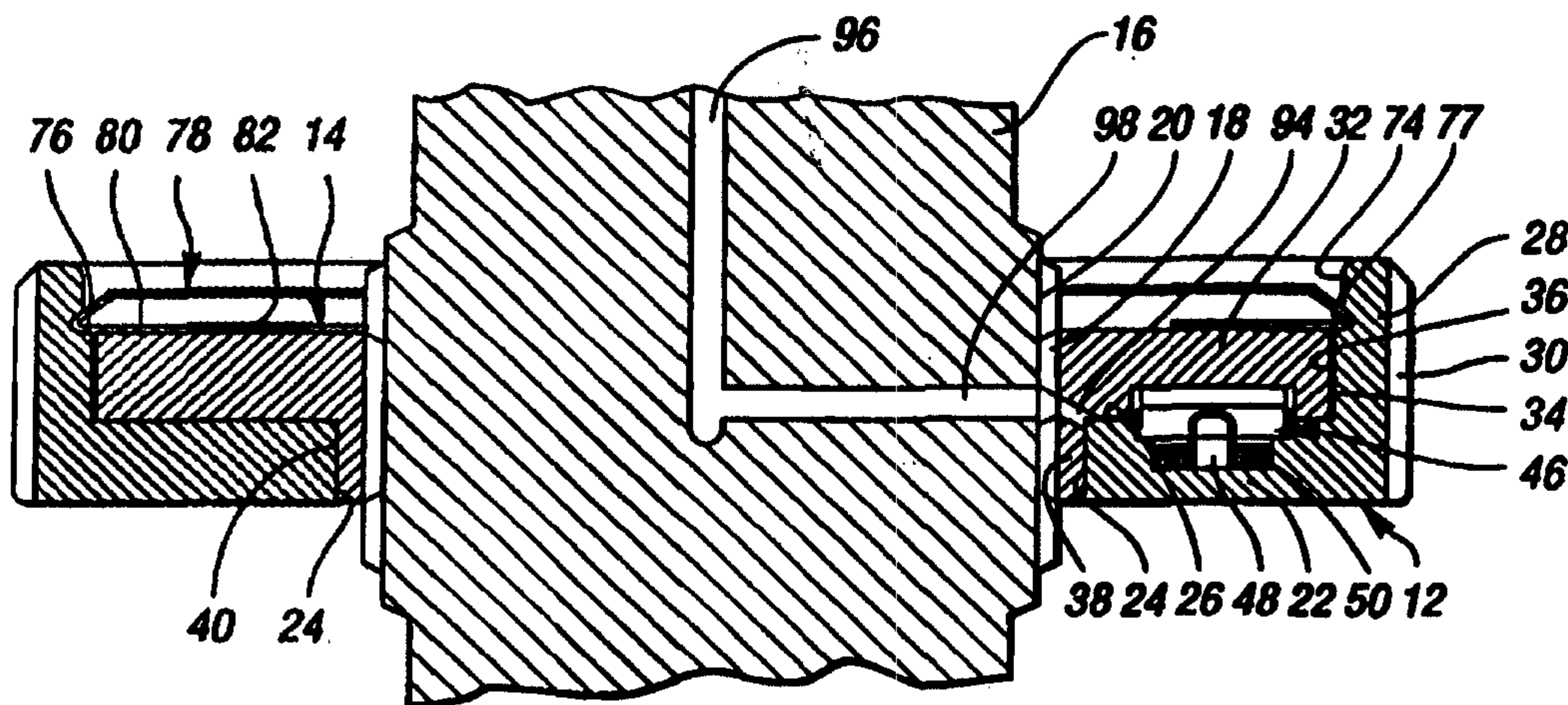
(57) L'invention porte sur un embrayage (10) à roue libre comportant un premier (12) et un deuxième (14) élément d'embrayage annulaire dont les surfaces des faces sont disposées en opposition, ainsi qu'au moins un cliquet rigide (46) placé entre elles et qui s'engage dans des cavités (62) en retrait lors de la rotation dans un sens, et se dégagent desdites cavités lors de la rotation dans le sens opposé. Un élément de retenue (78) maintenant l'embrayage en position d'accouplement contribue à former avec les éléments annulaires un réservoir de lubrifiant maintenant les cliquets dans un bain lubrifiant pendant le fonctionnement. L'élément de retenue forme un barrage au-dessus duquel le lubrifiant s'écoule depuis le réservoir vers un point radial de manière à garantir que les cliquets restent submergés pendant le fonctionnement.

(57) An overrunning clutch assembly (10) including first (12) and second (14) ring-shaped clutch members with face surfaces disposed in opposing relation and with at least one rigid strut (46) disposed therebetween for movement to engage recessed pockets (62) in the opposed surfaces upon rotation in one direction and for movement out of engagement with the pockets in at least one of the face surfaces upon relative rotation in the opposite direction. A retaining member (78) permanently retains the clutch in assembled relation and cooperates with the ring-shaped clutch members to form a lubricant reservoir maintaining the struts in a lubricant bath during operation. The retaining member forms a weir over which the lubricant flows from the reservoir at a radial location to assure that the struts remain submerged during operation.

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(21) International Application Number: PCT/US97/21925 (22) International Filing Date: 2 December 1997 (02.12.97) (30) Priority Data: 08/757,097 2 December 1996 (02.12.96) US (71) Applicant: MEANS INDUSTRIES, INC. [US/US]; 1860 S. Jefferson, Saginaw, MI 48601-2893 (US). (72) Inventors: REED, Martin, E.; 4318 Erlene Court, Chester, VA 23831 (US). HATCHER, William, J.; 4959 Stewart Lane, Disputanta, VA 23842 (US). KLECKER, Brian, D.; 8401 Rockvalley Lane, Chesterfield, VA 23838 (US). SINK, Danny, R.; 3900 Baldwin Road, Chester, VA 23831 (US). (74) Agents: DELEVIE, Hugo, A. et al.; Brooks & Kushman, 22nd floor, 1000 Town Center, Southfield, MI 48075 (US).		(81) Designated States: CA, JP, KR, MX, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>

(54) Title: ONE-WAY OVERRUNNING CLUTCH**(57) Abstract**

An overrunning clutch assembly (10) including first (12) and second (14) ring-shaped clutch members with face surfaces disposed in opposing relation and with at least one rigid strut (46) disposed therebetween for movement to engage recessed pockets (62) in the opposed surfaces upon rotation in one direction and for movement out of engagement with the pockets in at least one of the face surfaces upon relative rotation in the opposite direction. A retaining member (78) permanently retains the clutch in assembled relation and cooperates with the ring-shaped clutch members to form a lubricant reservoir maintaining the struts in a lubricant bath during operation. The retaining member forms a weir over which the lubricant flows from the reservoir at a radial location to assure that the struts remain submerged during operation.

ONE-WAY OVERRUNNING CLUTCH

BACKGROUND OF THE INVENTIONField of the Invention

5 This invention relates to one-way drive, overrunning clutch mechanisms, and more particularly to an improved lightweight, one-way clutch of simplified construction and high torque transmitting capability which is especially well adapted for high speed operation.

10 Description of the Prior Art

One-way drive overrunning clutch mechanisms, hereinafter generally referred to as clutches, or as overrunning clutches, are well known and widely used in a variety of applications ranging from low speed devices such as bicycle drives to high speed mechanisms such as automotive transmissions and torque converters. Commercial clutches employed in high speed automotive transmissions have in the past generally been of the sprag-type or the roller-ramp type, both of which depend on a wedging action to lock up, or to transmit torque between the driving and driven members of the clutch. The wedging action of these clutches produces extremely high stresses in component parts, and the clutches are relatively heavy and expensive to manufacture. Such clutches generally are considered the weakest link in an automatic transmission.

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Clutches are also known which employ rigid struts positioned between the driving and driven clutch members, or clutch plates, for pivotal movement between a driving position engaging shoulders defined by notches in the driving and driven clutch plates to transmit torque therebetween upon relative rotation in one direction and to permit overrunning, or free wheeling, upon relative rotation in the opposite direction. Clutches of this type are disclosed, for example, in U.S. Patent Nos. 5,070,978 and 5,449,057.

In the typical strut-type clutch, the individual struts are mounted for pivotal movement between a driving position in which opposed ends, or opposed edges of at least one strut engages a shoulder formed by notches in closely spaced, opposed faces of the driving and driven clutch plates upon rotation of the driving member in one direction and a retracted position in which the struts are out of engagement with at least one of the clutch plates when the driving member is rotated in the opposite direction relative to the driven member. The struts may be pivotally mounted on a carrier disposed between the clutch faces as in U.S. Patent No. 5,449,057, but in most commercial drives of this type, the struts are carried in a pocket in one clutch plate face with one end or edge continuously contacting a shoulder defined by the pockets. Whether supported by a

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carrier or mounted in a pocket in one of the clutch faces, the individual struts are continuously urged to a position to engage both clutch faces by a resilient member, typically a spring, to thereby lock
5 the two clutch plates together upon rotation of the drive member relative to the driven member in one direction. Upon relative rotation in the opposite, or overrunning direction, the spring members continue to urge the struts into contact with the clutch faces
10 and tend to urge the struts into each of the pockets as they are rotated, with the shape of the pockets camming the struts back as rotation continues.

As suggested in the above-mentioned U.S. Patent No. 5,449,057, the previous overrunning clutches used
15 in high speed transmission mechanisms have required a continuous supply of lubrication to assure that the struts, sprags, or rollers are continuously coated to minimize wear, particularly when the clutch is operated in the overrunning mode. When such clutches
20 are employed in mechanisms such as automatic transmissions containing a reservoir of lubricant which is continuously splashed throughout the interior of the mechanism by the various rotating components, this more or less random distribution of
25 lubricant has been relied upon to lubricate the clutches. It has been discovered, however, that such systems do not always provide adequate lubrication to

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minimize wear and to enable the most efficient operation, especially in the overrunning mode.

It has been shown that pivotal movement of the struts of strut-type clutches can be effectively
5 damped at high speeds by maintaining the struts submerged in a bath of lubricating oil so that they remain essentially stationary in the overrunning mode. This substantially eliminates rapid depression and expansion of the resilient spring members
10 engaging each strut as the strut passes over the respective recesses in the adjacent clutch face and thereby greatly increases the spring life by effectively eliminating fatigue failures. Further, by maintaining the struts substantially fully
15 submerged in a bath of lubricating oil during all high speed operations, direct metal-to-metal contact between the struts and clutch faces is avoided by the continuous coating of lubricant.

The above-mentioned U.S. Patent No. 5,070,978
20 discloses the concept of providing a housing, with seals between the housing and input shaft, to enclose the clutch plates. The sealed housing is filled with oil to assure continuous lubrication to "float" the two opposed clutch plates away from one another
25 during free wheeling or overrunning. This patent also seems to recognize, at column 8, lines 10 - 12, that filling the housing with oil may have an effect on strut movement during overrunning at high speed,

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although the patent also states that the struts
"hardly move at all" at high speeds even without
filling the housing with oil. The housing comprises
a generally cup-shaped, output shell having an open
5 end which is closed by a threaded closure plate. The
use of a separate housing and threaded closure
greatly increases the cost of the clutch, and
presents the potential for failure in the event of
the threading connector becoming loose during
10 prolonged use. Further, no provision is made for
replenishing the oil supply in the event of seal
failure, thereby presenting the potential for
excessive wear, overheating and eventual failure of
the clutch in the event of oil escaping from the
15 sealed housing. The sealed housing would act as a
shield effectively preventing splashed oil from
reaching the struts in the event of seal failures.
Further, the separate housing and threaded closure
greatly increases the overall weight and size of the
20 clutch assembly.

Accordingly, it is an object of the present
invention to provide an improved lightweight strut-
type overrunning clutch assembly having improved
means for assuring continuous lubrication for the
25 clutch components.

Another object is to provide such a clutch
assembly which assures that the movable struts are
continuously submerged in a reservoir of oil during

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high speed operation regardless of the attitude of the mechanism in which the clutch is used.

Another object is to provide such a clutch assembly having an improved lightweight retaining means retaining the clutch plates in assembled relation and providing an oil-tight joint with one of the clutch members and serving as a weir or dam to retain a reservoir of oil under pressure from centrifugal force between the clutch plates and enveloping the struts and spring members during high speed operation.

Another object is to provide such a clutch assembly including means for providing a continuous flow of oil through the clutch assembly during operation.

Another object is to provide such a clutch assembly which is less expensive to manufacture and which is highly reliable in operation.

SUMMARY OF THE INVENTION

The foregoing and other objects and advantages are achieved in accordance with the present invention in which a plurality of rigid struts are disposed between adjacent, opposed, relatively rotatable faces on a pair of clutch plates for pivotal movement between an engaged position in which at least one strut is rotated to a position engaging a shoulder on both clutch faces to thereby interlock the two clutch plates for rotation together about a common axis in

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one direction, and a disengage or overrunning position permitting free relative rotation of the clutch plates in the opposite direction. The first clutch plate has an axially extending outer rim portion and a radially inwardly extending integrally formed body portion at one end of the rim. The second clutch plate also has a substantially radially extending body portion having an outer periphery telescopingly received in the axially extending rim portion of the first clutch plate and preferably has an integrally formed axially extending inner hub telescopingly received in the inner periphery of the first clutch plate with the first and second clutch plates cooperating to define a cavity therebetween.

A plurality of struts are mounted in the cavity between the first and second clutch plates for pivotal movement between the engaged or driving position and a disengaged or overrunning position. In the preferred embodiment of the invention, the clutch faces are generally flat parallel annular clutch surfaces similar to the arrangement shown in the above-mentioned Patent No. 5,070,978 and in Figs. 15 - 27 of copending application Serial No. 08/382,070.

In the preferred embodiments, the annular rim on the first clutch plate member extends axially beyond the body of the second clutch plate member, and an inwardly directed annular groove is formed in the

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annular rim at a location outboard of but immediately adjacent to the radial body of the second clutch plate member. An annular retainer ring is rigidly fixed in the annular groove and overlying the surface of the second clutch plate member to firmly retain the first and second clutch plates in assembled relation. The retainer preferably is initially formed as a continuous annular ring of metal which has a body portion shaped into a generally frustoconical or Belleville washer configuration, and which is then press formed into a flat, planar configuration to expand its outer periphery into the annular groove and to overlie and engage the radially extending body portion of the second clutch plate.

15 The retaining ring groove and the outer peripheral portion of the retainer are dimensioned such that, upon installing the retainer, the groove engages and swages the retainer edge to conform to the groove geometry and form a fluid tight seal. The inner periphery of the retainer ring extends radially inward to a location at least substantially equal to the location of the radial innermost part of the rigid struts but outboard of the inner periphery of the body portion of the outer clutch plate. The radially inwardly extending body portion and the outer rim portion of the first clutch plate member and the retaining ring cooperate to form a generally toroidal, inwardly open enclosure or annular trough

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surrounding the cavity between the two clutch plate members and the outer peripheral portion of the second clutch plate member.

An oil supply passage is provided to deliver
5 lubricating oil into the cavity between the opposing clutch faces to provide lubrication for the component parts and to essentially fill the cavity between the clutch faces. Upon rotation of the clutch,
centrifugal force acting on the lubricating oil will
10 retain the oil in the toroidal space; thus, as soon as this space is filled with lubricating oil, it will remain filled and under pressure for so long as the clutch continues to rotate at a speed sufficient for the centrifugal force to overcome the force of
15 gravity, regardless of the orientation of the clutch.

Centrifugal force will cause the oil to flow between the outer periphery of the second clutch plate body and the first clutch plate rim, then along the retainer to flow over the edge of the retainer
20 which acts as a weir, assuring that the struts are continuously submerged in a body of pressurized lubricating oil. Preferably, the inner periphery or hub of the second clutch plate member and the outer rim of the first clutch plate member are formed with
25 splines, or gear teeth for cooperating with mating splines or gear teeth on a driving and driven member for the transfer of power upon rotation in one direction only. In a preferred embodiment, oil may

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be supplied through a drilled passage in a mounting shaft or gear to an annular oil ring communicating with the cavity between the first and second clutch faces as by a drilled oil passage formed in the
5 second clutch plate hub.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features and advantages of the invention will be apparent from the detailed description contained hereinbelow, taken in
10 conjunction with the drawings, in which:

Fig. 1 is an elevation view of a clutch assembly according to the present invention;

Fig. 2 is an exploded view of the clutch assembly shown in Fig. 1, with certain parts being
15 omitted for clarity;

Fig. 3 is a sectional view taken on line 3-3 of Fig. 1, with certain elements shown to a different scale for clarity;

Fig. 4 is an enlarged fragmentary sectional view
20 of a portion of the structure shown in Fig. 3;

Fig. 5 is a fragmentary sectional view taken on line 5-5 of Fig. 4;

Fig. 6 is a view similar to Fig. 5 and showing the clutch in an overrunning condition;

25 Fig. 7 is a perspective view, on an enlarged scale, of a rigid strut employed in the clutch;

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Fig. 8 is a sectional view showing the clutch in partially assembled relation with the rigid retainer in position to be installed;

Fig. 9 is a view similar to Fig. 8 and showing a die member for installing the rigid retainer;

Fig. 10 is a view similar to Fig. 9 showing the retainer partially installed;

Fig. 11 is a view of the fully assembled clutch with the die illustrated in final assembly position;

Fig. 12 is an enlarged fragmentary sectional view of an alternate embodiment of the invention with the seal in position to be installed;

Fig. 13 is a view similar to Fig. 4 and showing the clutch components of Fig. 12 in the fully assembled condition; and

Figs. 14 - 16 are fragmentary sectional views, each showing a further embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, a clutch assembly according to the present invention is indicated generally by the reference numeral 10 and includes an outer clutch member or clutch plate 12 and an inner clutch member or clutch plate 14. The clutch 10 is illustrated in Fig. 3 as mounted on a driven shaft 16 and supported against rotation thereon by gear teeth 18 on the inner periphery of inner plate 14, which gear teeth mate with splines 20 on the outer periphery of shaft 16.

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The outer, drive plate 12 includes a ring shaped body portion 22 having a cylindrical inner peripheral surface 24 and a planar, annular inner surface 26, and an outer rim portion 28 extending axially from planar inner surface 26. Gear teeth, or splines 30, are formed around the outer periphery of rim 28 for engaging with mating gear teeth on a drive gear, not shown.

The inner clutch member 14 also includes a generally ring shaped body portion 32 having a cylindrical outer peripheral surface 34 dimensioned to fit closely within the cylindrical inner surface 36 of rim 28 and has on its inner peripheral portion an axially extending hub 38 having an outwardly directed cylindrical surface 40 dimensioned to telescopingly receive the inner peripheral surface 24 of the outer clutch member 12. Body 32 also has a planar inner surface 42 disposed in closely spaced, parallel relation to the surface 26 when the clutch is assembled.

The planar inner surface 26 of driven clutch member 12 has a plurality of recesses 44 formed therein with each adapted to receive a strut or key 46. Each recess 44 further includes a secondary recess 48 for receiving a spring member 50.

As best seen in Fig. 7, the key 46 includes a rigid, generally rectangular body portion 52 with laterally extending wing portions 54 projecting one

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from each side edge 56 of the body adjacent one end thereof. The front end of body 52, i.e., the end opposite the end having wings 54 formed thereon, may be a substantially, flat planar surface inclined slightly with respect to the opposed planar surfaces of body 52, but preferably is slightly curved, as shown at 58 in Fig. 7. The back edge 60, i.e, the edge opposite and generally parallel to edge 58 is a flat planar surface inclined with respect to the faces of body 52 at an angle generally corresponding to the angle of inclination of the end 58. The angle of inclination of the edges 58, 60 corresponds to the maximum angle of inclination or movement of the key from the engaged or driving position projecting into a recess 44 as shown in Fig. 5 and the retracted or overrunning position withdrawn from the recess 44 as shown in Fig. 6.

The planar annular face 42 of clutch plate 14 is provided with a plurality of key-engaging notches 62 providing a ring of abutment faces or shoulders 64 in position to be engaged by the edge 58 of one of the keys 46 in the driving mode. Notches 62 may have a sloped or inclined rear portion 66. As stated above, the front end or edge 58 may be a flat planar surface but preferably is slightly arcuate, with the degree of curvature being exaggerated in Fig. 7 for illustrative purposes. When the edge 58 is arcuate, the shoulders or edges 64 will also be

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correspondingly curved so that, in the engaged position, the edges 58 and shoulders 64 will be in contact along the full length of edge 58. At the same time, the slightly arcuate configuration permits
5 sufficient adjustment or movement of the key, under load, to accommodate any slight misalignment which might occur due to manufacturing tolerances, thereby eliminating or minimizing stress concentrations which could be produced as a result of such misalignment.
10 Also, as seen in Figs. 5 - 7, the wings 54 preferably are provided with an inclined ramp portion 68 to permit free tilting of the key, under influence of the springs 50 to project the body 52 into a recess 44 as shown in Fig. 5. To facilitate the free flow
15 of lubricating oil into the recesses 44 and subrecesses 48, each recess 44 preferably includes a relief 70 and a similar relief 72 is preferably formed at one end of each subrecess 48.

As thus far described, the structure of the
20 clutch assembly, including the outer clutch member, the inner clutch member, the driving keys, and the resilient spring elements, may be substantially identical to that disclosed and described in
copending application Serial No. 08/382,070 with the
25 single exception of the preferred arcuate configuration of the key end surface 58 and the driving notch shoulder 64.

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As in the clutch assembly described in the above pending application, when the driving clutch plate 12 is rotated in the driving direction, i.e., to the right in Fig. 5, the spring 50 will urge the key 46
5 into the notch 62 so that the front edge 58 of one key 52 will engage the shoulder or abutment 64 of that notch 62. Resistance to movement of the driven clutch element 14 acting through the surface 58 and shoulder 64 will tend to cam the key into full
10 engagement with the shoulder, thereby assisting the spring 50 in projecting the key fully into the notch.

When the drive element 12 is rotated in the opposite direction, i.e., to the left in Fig. 6, or when the driven element 14 tends to rotate faster
15 than the driving element, the inclined surface 66 of notch 62 will cam the key back into the recess 44 to the overrunning position. In this overrunning condition shown in Fig. 6, it is desirable that the recesses 44, subrecesses 48, and notches 62 be
20 completely filled with a lubricating oil to dampen movement of the keys as successive notches 62 pass over the respective keys, thereby preventing the springs 50 from projecting the keys into the notches only to be driven back by impact with the inclined
25 ramp 66. In accordance with the present invention, this supply of pressurized oil completely submerging the body 52 of each key is assured during normal operation of the clutch.

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Referring now to Figs. 3 and 4, it is seen that the rim 28 of the outer clutch plate 12 is provided at its open end with a counterbore providing a cylindrical surface 74 having a diameter greater than the diameter of cylindrical surface 36 and terminating in a planar annular shoulder 76 lying in a plane parallel to the planar inner surface 26. A generally V-shaped annular groove or notch 77 is formed in the cylindrical wall 74 adjacent the shoulder 76, and a retaining element 78 is pressed into and forms a fluid-tight seal with the groove 77 around its entire periphery. In the preferred embodiment of the invention as shown in Figs. 1 - 11, the retaining element as initially formed (see Fig. 8) has a generally frustoconical ring-shaped body portion 80 having an annular inner peripheral edge 82 and a generally axially extending flange 84 integrally formed on its outer edge. The outer diameter of flange 82 is greater than the diameter of cylindrical surface 36 and slightly less than the diameter of cylindrical surface 74.

As shown in Figs. 8 - 11, the generally conical retainer 78 is initially positioned in the counterbore 74 with the cylindrical flange portion 84 adjacent the V-shaped groove 77 and with the frustoconical ring portion having its inner edge 82 projecting outwardly from the end of hub 38. The inner peripheral edge 82 of the retainer is then

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engaged by a shoulder 86 on an axially movable die element 88 which is moved downward to compress the retainer and form its major diameter outwardly and into the V-shaped groove 77. Final movement of the die 88 conforms the axially extending flange portion 84 of retainer 78 firmly into the groove 77 and shapes the body portion 80 into a planar, annular ring overlying the outer surface 90 of inner clutch member 14.

During press forming of the retainer 78, the inner peripheral edge is retained against radial shrinking by the shoulder 86 on die 88. Also, during the final movement of die 88, an annular notch 92 engages the end of flange 84 to swage the retainer to conform to the geometry of the groove 77 and form a fluid tight seal therewith.

The minor diameter of the retainer, in the installed position, extends radially inward to a position at least overlying the body portion 52 of the keys 46 but radially outboard of surface 24. Thus, the retainer 78, the rim 28, and the body 22 of the outer clutch member 12 define, in effect, a generally toroidal-shaped, annular cavity containing the keys 46, springs 50, the recesses 44 and subrecesses 48, as well as the notches 62 formed in the interface of the inner clutch plate 14.

Referring again to Figs. 3 and 4, it is seen that an oil supply passage 94 extends through the hub

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portion 38 and terminates at the intersection of surfaces 42 and 40. Oil, under pressure, may be supplied to the passage 94 through oil supply passages 96, 98 in shaft 16. Although in the static position as shown in Fig. 3, the planar surfaces 26 and 42 may be in direct contact, the clutch plates are dimensioned so as to provide some finite clearance between these surfaces during operation so that a film of oil will be present and oil can flow from passage 94 between these surfaces and into the recesses 44 and 48 and the notches 66. The separation of surfaces 26 and 42 is shown somewhat exaggerated in Figs. 4 - 6 to illustrate the oil flow passage. Also, a film of oil will be present between opposing cylindrical surfaces 24 and 40 as well as between cylindrical surfaces 34 and 36 to permit restricted flow and to provide lubrication and avoid direct metal-to-metal contact of these surfaces during operation.

During high speed operation, oil in the recesses and notches will surround the keys 46 and be pressurized both by centrifugal force and the pressure of oil flowing through passage 94 from passages 96, 98 and will cause a continuous flow of oil into and through these recesses and notches, and outwardly between surfaces 34 and 36 and along the opposing outer surface 90 of inner clutch member 14 and the inner surface 91 of the retainer 78. The

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inner peripheral edge 82 of retainer 78 extends along surface 86 to a position radially between the hub 38 and the radially inner portion of the body 52 of keys 46 and acts as a weir to permit a continuous
5 restricted outward flow of lubricating oil over edge 82 while maintaining the keys submerged in oil during operation.

Since the retainer 78 is rigidly and permanently fixed in the V-shaped groove 77, and forms a fluid
10 tight seal therewith, the clutch elements are continuously maintained in a fixed, spatial relation, with a continuous supply of lubricating oil to all opposing relatively moving surfaces during normal operation. The permanent, interlocked pressure-
15 formed joint between the retainer and the V-shaped notch assures against channeling of lubricating fluid and/or the loss of fluid as a result of improper fitting or loosening of conventional resilient snap ring or threaded retainers of the type employed in
20 the past.

The retaining element 78 is preferably initially stamped and formed from a flat sheet of a suitable steel material as an annular ring which is shaped into the frustoconical configuration having its
25 outermost peripheral edge portion rolled into a configuration to be pressure formed into and form a seal with the groove 77.

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While only a single oil passage 94 is shown in the drawings, it should be apparent that a plurality of such passages may be provided if desired. For example, a plurality of such oil passages may be provided at spaced intervals around the inner periphery of hub 38, with oil supply being provided to each from oil passage 96, 98 in shaft 16 communicating with an annular groove (not shown) extending around the shaft so that each such oil passage 94 will be in continuous communication with a supply of oil under pressure during operation. Alternatively, of course, multiple radially extending oil passages 98 might be provided, one in communication with each such passage 94.

In operation of a clutch constructed substantially as described above, with the inner and outer clutch members being formed from a transparent, thermoplastic material, it has been shown that lubrication filling the void space between the clutch members 12 and 14 and maintained under pressure produced from centrifugal force, will substantially completely dampen all movement of the struts 46 when the clutch is in the overrunning mode. A high speed camera operating at 20,000 frames per second used to photograph the keys when operating in the overrunning mode showed that no visibly discernible movement of the keys was present at speeds above about 150 rpm. In this experimental clutch formed from synthetic

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resin material, the outside diameter of the outer clutch member 12 was 6 inches, and the radial distance from the center of the shaft to the outside edge 56 of the keys was 2.5 inches.

5 Referring now to Figs. 12 and 13, an alternate embodiment of the invention will be described. In this embodiment, the driving and driven clutch elements, the struts and strut springs are substantially identical to that described above and
10 the same reference numerals are employed herein to designate similar parts. In this embodiment, however, the retainer is initially formed as a frustoconical ring 100 having a substantially uniform thickness throughout. The configuration of the
15 inwardly directed groove 102 formed in the counterbore portion of rim 28 has a more shallow V configuration than in the previously described embodiment. As shown in Fig. 13, the outer peripheral edge 104 of the retainer 100 is expanded
20 into the groove 102 and swaged into the configuration of the groove by the pressing movement forming the retainer into a substantially flat, planar ring in the manner described hereinabove. Once installed, the clutch assembly is permanently assembled, with
25 the inner peripheral edge thereof acting as a weir in the same manner described above.

Fig. 14 illustrates a modification of the structure shown in Figs. 12 and 13 in which the

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retaining element 110 is provided around its inner periphery with a reinforcing or stiffening bead, or flange 112 prior to being press formed into the assembled relation overlying the outer surface 90 of inner clutch member 14. The reinforcing bead 112 provides stiffness and dimensional stability of the retaining member 110 and tends to maintain the inner peripheral portion of the planar body of the retainer member in a more flat or plane condition after installation. It is understood that such a reinforcing bead or flange could readily be provided on the embodiment shown and described above with reference to Figs. 3 and 4.

Fig. 15 illustrates an embodiment wherein the retaining element 120 is in the form of a rigid, flat washer or ring which is fitted into the counterbore 74 of outer clutch member 12 to rest upon the shoulder 76. The outer clutch member 12 may be identical to that described above with respect to Figs. 3 and 4; however, as illustrated in Fig. 15, the V-shaped notch in the cylindrical wall of the counterbore is preferably eliminated. In this embodiment, the retaining ring 120 is rigidly retained in position overlying the outer surface 90 of inner clutch member 14 by a continuous bead 124 of the material formed from the body of outer retaining member 12 which is deformed by a known pressing operation in which force is applied to the end of

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member 12 adjacent the counterbore 74. As a further alternative, the bead 124 may be replaced with a succession of tabs (not shown) formed by a staking operation to deform metal from the body of clutch member 12 at spaced intervals around the periphery of the retainer 120. In this staked configuration, the outer diameter of the retainer 120 and the inner diameter of the counterbore are preferably dimensioned to provide a press fit with sufficient interference to form a reliable fluid seal to substantially prevent leakage of oil between the outer diameter of the retainer 120 and the counterbore formed in the end of member 12. A similar interference fit may also be employed where a continuous bead 124 of material is deformed as illustrated in Fig. 15.

A further modification of the invention is illustrated in Fig. 16 wherein the axially extending inner hub (designated at 38 in the embodiment illustrated in Figs. 3 and 4) has been eliminated. In this embodiment, outer and inner clutch members 132, 134, respectively, have their opposing inner faces formed with a tapered, or bevelled surface 134, 136, respectively, cooperating to provide a generally V-shaped annular channel 138 around the inner periphery of the clutch assembly. The channel 138 is positioned, in operation, in substantially opposed relation to the discharge outlet of the lubricant

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channel 98 in shaft 16 whereby, upon rotation of the assembly, lubricant discharged from channel 98 will either be discharged from outlet channel 98 under sufficient pressure or be propelled by its own
5 momentum and the influence of centrifugal force, into the channel 138. From the channel 138, oil flows under influence of centrifugal force between the opposing surfaces 26 and 42 and through the recesses 44, 48, and over the surfaces of the struts 52 to be
10 discharged over the inner periphery of the retaining member, acting as a weir, in the same manner described hereinabove.

The embodiment of Fig. 16 is illustrated as employing the retaining element of the same
15 configuration shown in Fig. 14. It is believed apparent, however, that any of the other configurations of the retaining element may be employed with this embodiment.

In each of the embodiments described above, the
20 two ring-shaped clutch members and the retaining means cooperate to form a generally toroidal, inwardly open enclosure or annular trough defining a lubricant flow path extending radially outward between the two clutch members and over the struts,
25 then radially inward between the second clutch member and the retaining member. The location of the inner periphery of the retaining member enables it to act as a weir for the discharge of lubricant to assure

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that the struts are continuously submerged during operation. The continuous flow of lubricant acts as a coolant and to flush any foreign matter from the clutch as well as to dampen movement of the struts in
5 the overrunning mode.

While preferred embodiments of the invention have been illustrated and described, it is believed apparent that various modifications might be made and it is therefore intended to include all of the
10 embodiments which would be apparent to one skilled in the art and which come within the spirit and scope of the invention.

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WHAT IS CLAIMED:

1 1. A one-way overrunning clutch assembly
2 comprising,

3 a first ring-shaped clutch member including a
4 first generally flat, annular body portion having a
5 cylindrical inner periphery and an outer periphery
6 defined by an annular rim projecting axially from one
7 side thereof, said rim having an inner cylindrical
8 surface,

9 a second ring-shaped clutch member having a
10 second generally flat, annular body portion having a
11 cylindrical outer surface and an inner annular
12 peripheral surface,

13 said second body portion having its cylindrical
14 outer surface telescopingly received in said inner
15 cylindrical surface of said rim whereby said first
16 and second ring-shaped clutch members have a common
17 central axis,

18 said first and second clutch members having face
19 surfaces disposed in spaced opposing relation to one
20 another, each said face surface having a plurality of
21 recesses formed therein to define strut abutment
22 shoulders at spaced intervals around the respective
23 opposing face surfaces,

24 at least one rigid strut having a body portion
25 pivotally supported for movement between a driving
26 position projecting into and engaging an abutment
27 shoulder defined by a notch in each said face surface

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28 to interlock the two clutch members for rotation
29 together in one direction and an overrunning position
30 out of contact with the abutment shoulders in at
31 least one of said face surfaces to permit free
32 relative rotation between said first and second
33 clutch members in the opposite direction,
34 resilient means engaging and continuously urging
35 each said at least one strut toward the driving
36 position,
37 an annular retaining member positioned within
38 said inner cylindrical surface of said annular rim,
39 said retaining member having a cylindrical outer
40 surface engaging and forming a fluid tight seal with
41 said cylindrical inner surface of said rim and an
42 annular retainer body portion having a first flat
43 surface overlying the outer flat surface of said
44 second clutch member, and
45 means permanently fixing said retaining member
46 on said rim to permanently retain the clutch in
47 assembled relation, said annular retainer body
48 portion extending inward from said groove and
49 terminating in an inner peripheral edge defining an
50 annular weir coaxial with said common axis and at a
51 location between the radially innermost portion of
52 said body portion of said at least one strut and
53 radially outward from said cylindrical inner
54 periphery of said first ring-shaped clutch member
55 whereby lubricating oil directed between said

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56 first and second ring-shaped clutch members at a
57 location adjacent their inner periphery during
58 rotation of said clutch assembly will be constrained
59 to flow in a path extending radially outward and over
60 said struts and resilient means, then radially inward
61 along said retaining member to be discharged over
62 said weir whereby said at least one strut is
63 continuously bathed by and submerged in the lubricant
64 flow.

1 2. The clutch assembly defined in claim 1
2 further comprising a counterbore formed in said rim,
3 said counterbore terminating in a shoulder spaced
4 axially from said face surface of said first clutch
5 member, said shoulder engaging said first flat
6 surface to axially fix said retaining member,
7 said means permanently fixing said retaining
8 member in said rim forming a fluid tight joint
9 therebetween.

1 3. The clutch assembly defined in claim 2
2 wherein said face surfaces are substantially flat,
3 planar inner surfaces of said body portion of said
4 first and said second clutch members.

1 4. The clutch assembly defined in claim 2
2 further comprising an annular groove formed in said
3 rim within said counterbore at a location adjacent
4 said shoulder, said retaining member having an outer
5 peripheral portion projecting into said groove and
6 forming a fluid tight seal therewith.

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1 5. The clutch assembly defined in claim 4
2 wherein said retaining member is initially formed
3 with a generally axially extending flange around its
4 outer peripheral edge portion and wherein said outer
5 peripheral portion is mounted in said groove by a
6 pressing operation which radially expands said
7 retaining member, said flange being deformed radially
8 inward by contact with said groove during the
9 pressing operation.

1 6. The clutch assembly defined in claim 5
2 wherein said retaining member further comprises a
3 reinforcing bead or flange formed around its inner
4 periphery.

1 7. The clutch assembly defined in claim 6
2 wherein said face surfaces are substantially flat,
3 planar inner surfaces of said body portion of said
4 first and said second clutch members.

1 8. The clutch assembly defined in claim 2
2 wherein said retaining means comprises a planar,
3 annular washer having an outer cylindrical surface
4 received within said counterbore and having one
5 planar surface engaging said shoulder, and wherein
6 said means permanently fixing said retaining member
7 comprises a portion of the material forming said rim
8 being deformed to engage said washer on a planar
9 surface thereof opposite said one planar surface to
10 thereby permanently retain said washer within said
11 counterbore.

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1 9. The clutch assembly defined in claim 8
2 wherein said annular washer has an outer cylindrical
3 surface forming an interference fit with the inner
4 cylindrical surface of said counterbore.

1 10. The clutch assembly defined in claim 1
2 wherein said face surfaces on said first and second
3 clutch members are substantially flat radial
4 surfaces, and wherein at least one of said clutch
5 members includes means defining an annular recess at
6 the inner peripheral edge of its face surface, said
7 annular recess defining a lubricant-receiving channel
8 communicating with the space between said opposing
9 face surfaces whereby oil supplied to said annular
10 recess will flow between said face surfaces under
11 influence of centrifugal force during operation of
12 the clutch assembly.

1 11. A one-way overrunning clutch assembly
2 comprising,

3 a first ring-shaped clutch member including a
4 first generally flat, annular body portion having a
5 cylindrical inner periphery and an outer periphery
6 defined by an annular rim projecting axially from one
7 side thereof, said rim having an inner cylindrical
8 surface,

9 a second ring-shaped clutch member having a
10 second generally flat, annular body portion having a
11 cylindrical outer surface and an inner periphery
12 defined by a hub projecting axially from one side

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13 thereof, said hub having an outer cylindrical
14 surface,

15 said first body portion having its cylindrical
16 inner periphery telescopingly received on said outer
17 cylindrical surface of said hub and said second body
18 portion having its outer surface telescopingly
19 received in said inner cylindrical surface of said
20 rim whereby said first and second clutch members
21 define an enclosed cavity therebetween,

22 said first and second clutch members having face
23 surfaces disposed in opposing relation to one another
24 in said cavity, each said face surface having a
25 plurality of recesses formed therein to define strut
26 abutment shoulders at spaced intervals around the
27 respective opposing face surfaces,

28 at least one rigid strut having a body portion
29 pivotally supported for movement between a driving
30 position projecting into and engaging an abutment
31 shoulder defined by a notch in each said face surface
32 to interlock the two clutch members for rotation
33 together in one direction and an overrunning position
34 out of contact with the abutment shoulders in at
35 least one of said face surfaces to permit free
36 relative rotation between said first and second
37 clutch members in the opposite direction,

38 resilient means engaging and continuously urging
39 each said at least one strut toward the driving
40 position,

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41 an inwardly directed annular groove formed in an
42 inner surface of said hub, and
43 an annular retaining member having an outer
44 peripheral portion swaged into and forming a fluid
45 tight seal with said groove and a flat annular
46 retainer body portion overlying the outer flat
47 surface of said second clutch member to permanently
48 retain the clutch in assembled relation, said annular
49 retainer body extending inward from said groove and
50 terminating in an inner peripheral edge at a location
51 between at least substantially the radially innermost
52 portion of said body portion of said at least one
53 strut radially outward from said cylindrical outer
54 surface of said hub.

1 12. The clutch assembly defined in claim 11
2 further comprising an oil passage formed in and
3 extending through said second clutch member and
4 communicating with said enclosed cavity at a location
5 radially inward from said inner peripheral edge of
6 said retaining member, whereby oil supplied to said
7 oil passage during operation of the clutch will flow
8 outwardly through said enclosed cavity and be
9 discharged over said inner peripheral edge under
10 influence of centrifugal force, said inner peripheral
11 edge of said retaining member acting as a weir to
12 control the volume of oil in said inner cavity during
13 such operation.

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1 13. The clutch assembly defined in claim 12
2 wherein said oil passages comprise a generally radial
3 passage extending through said hub.

1 14. The clutch assembly defined in claim 13
2 wherein said retaining member further comprises a
3 reinforcing bead or flange formed around its inner
4 periphery.

1 15. The clutch assembly defined in claim 15
2 wherein said face surfaces are substantially flat,
3 planar inner surfaces of said body portion of said
4 first and second clutch members.

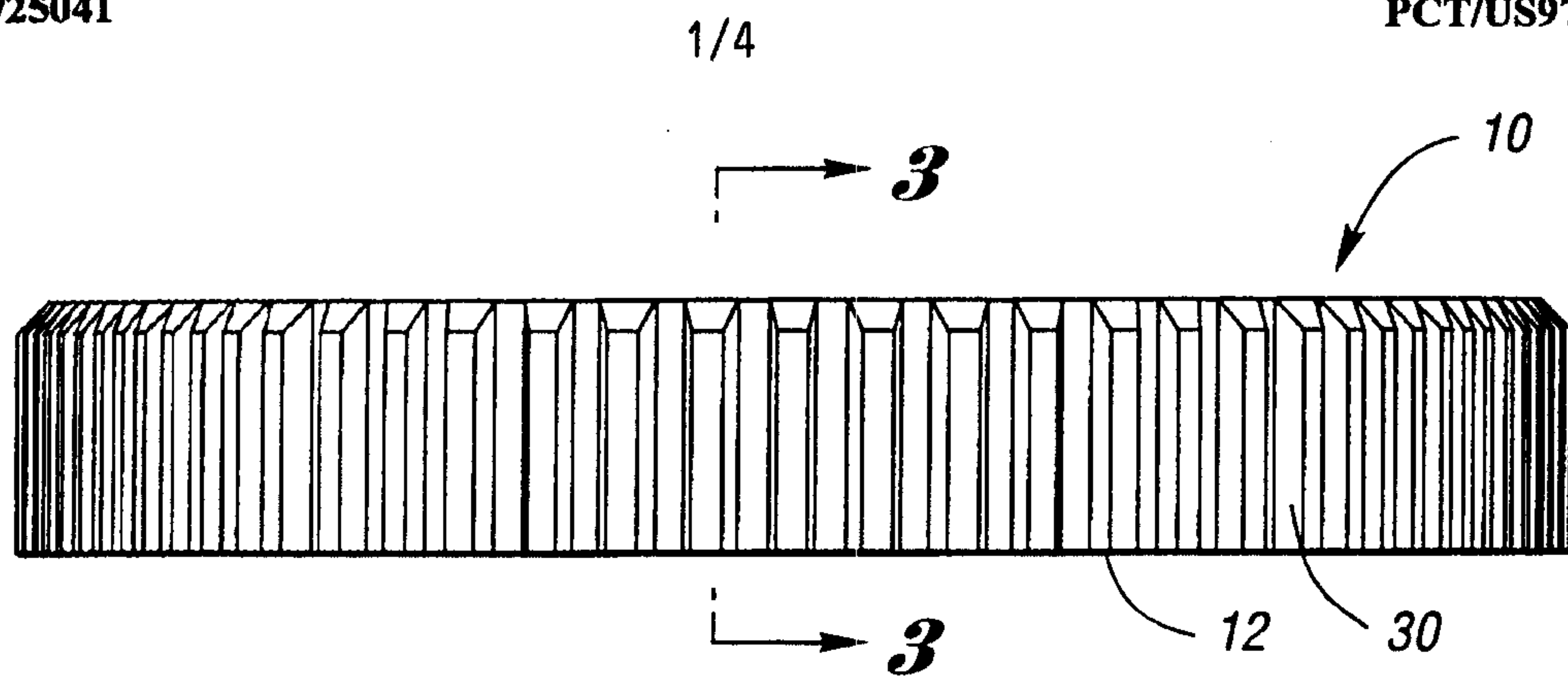
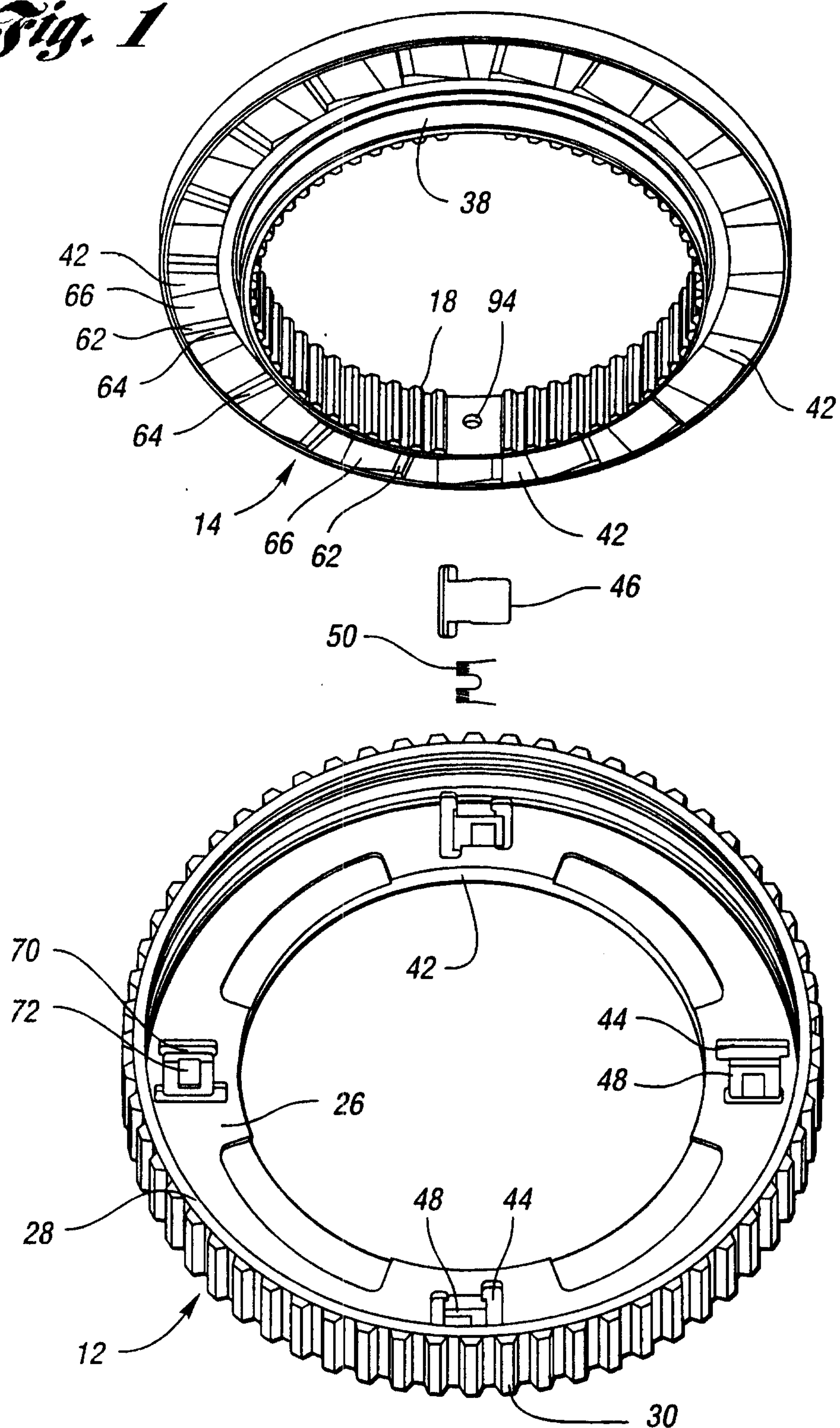
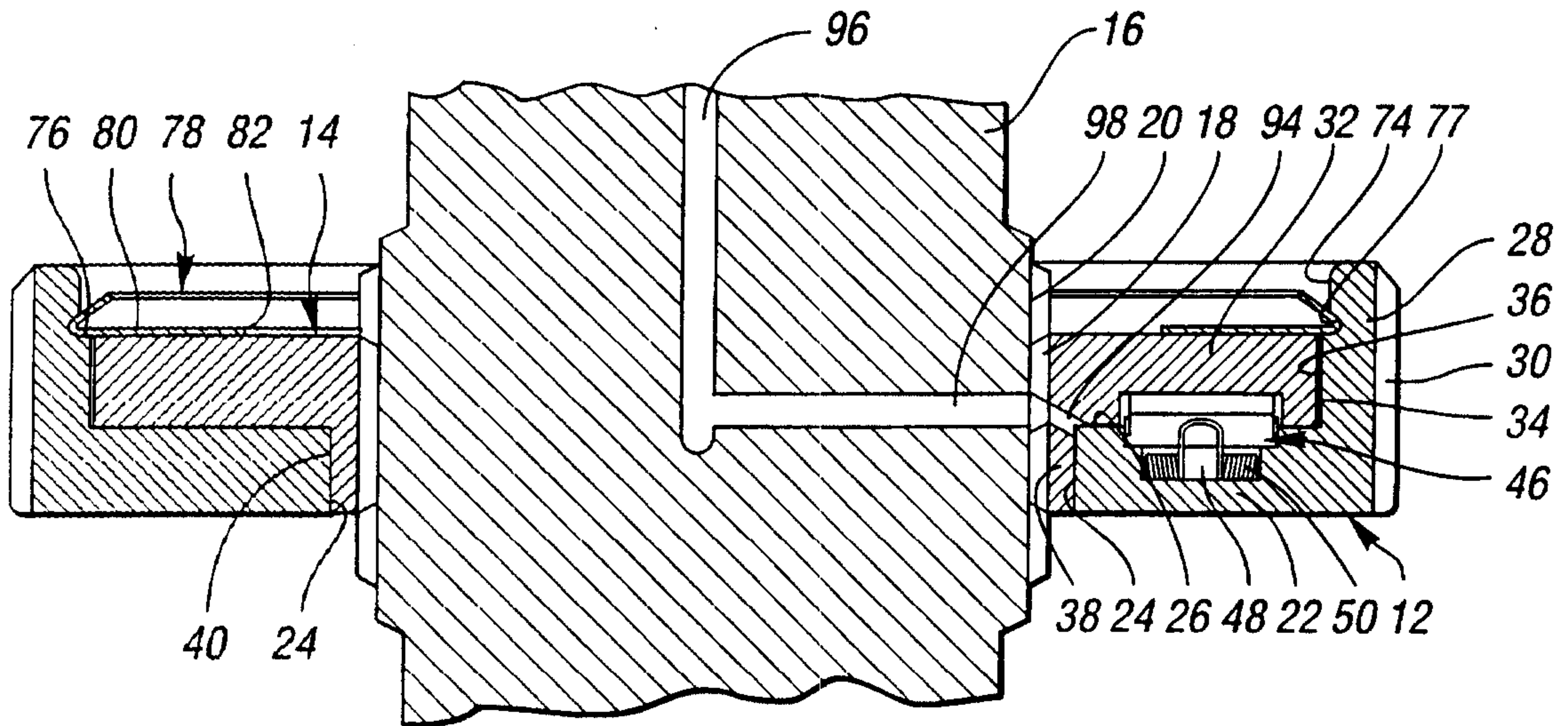
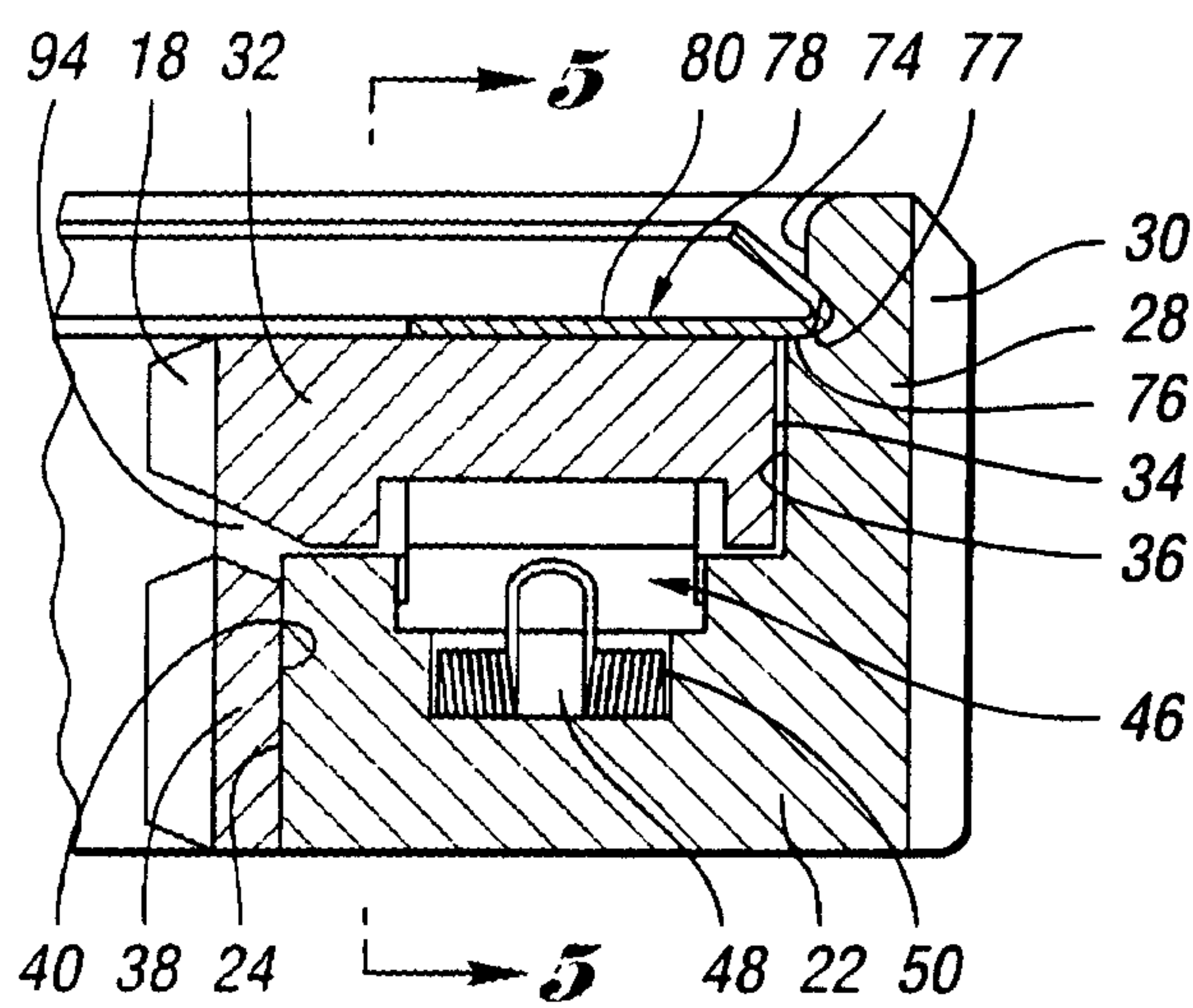
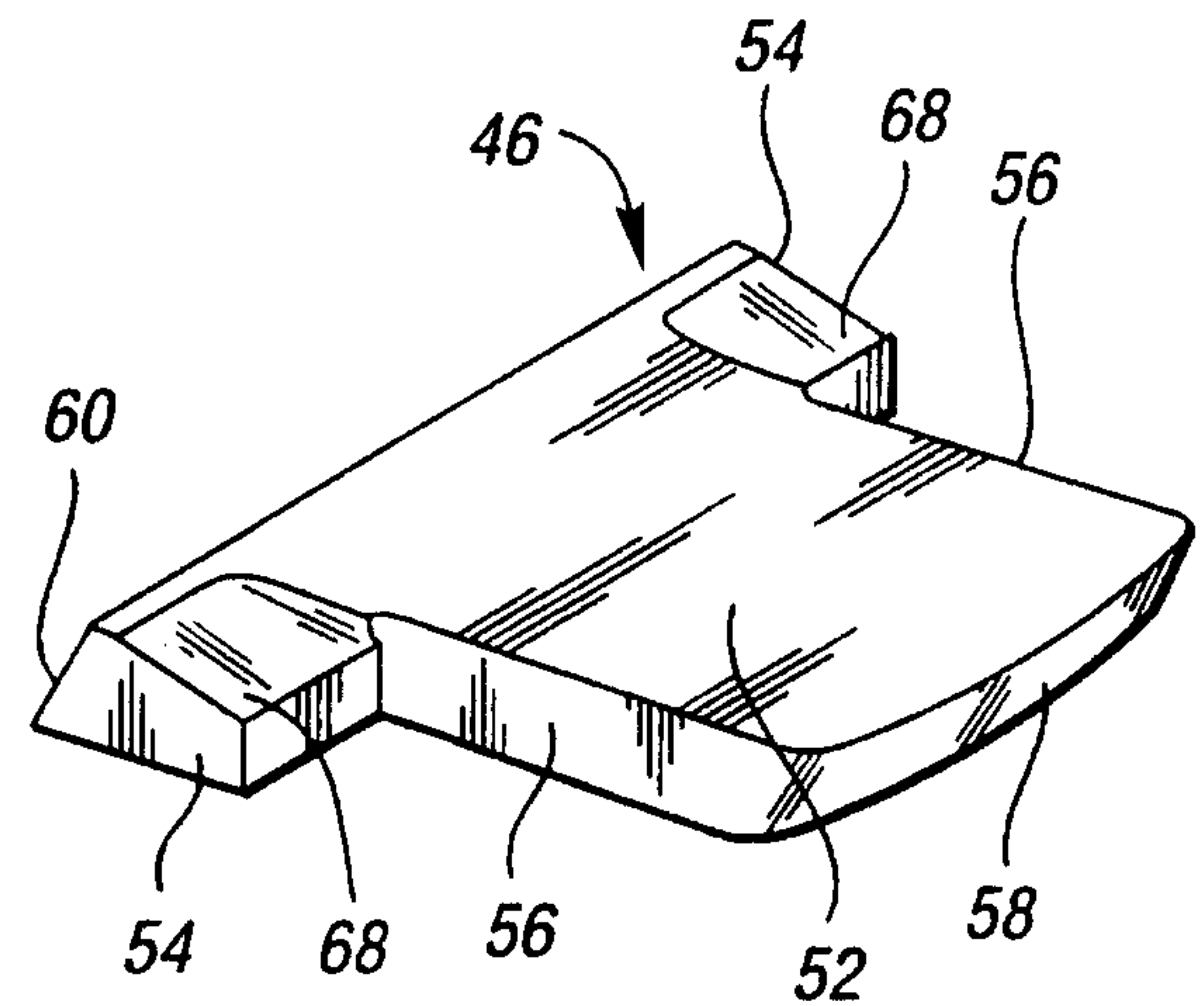
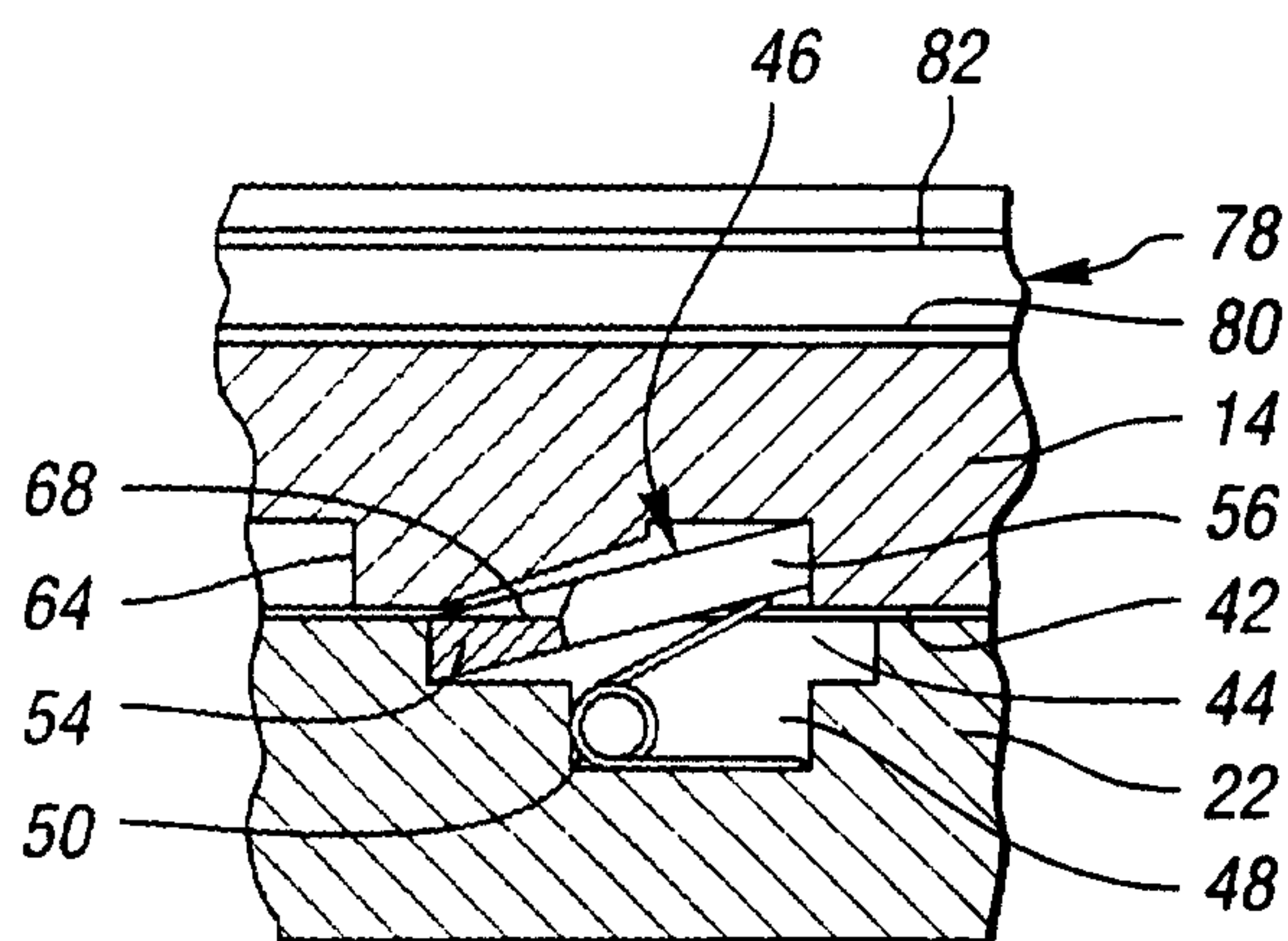
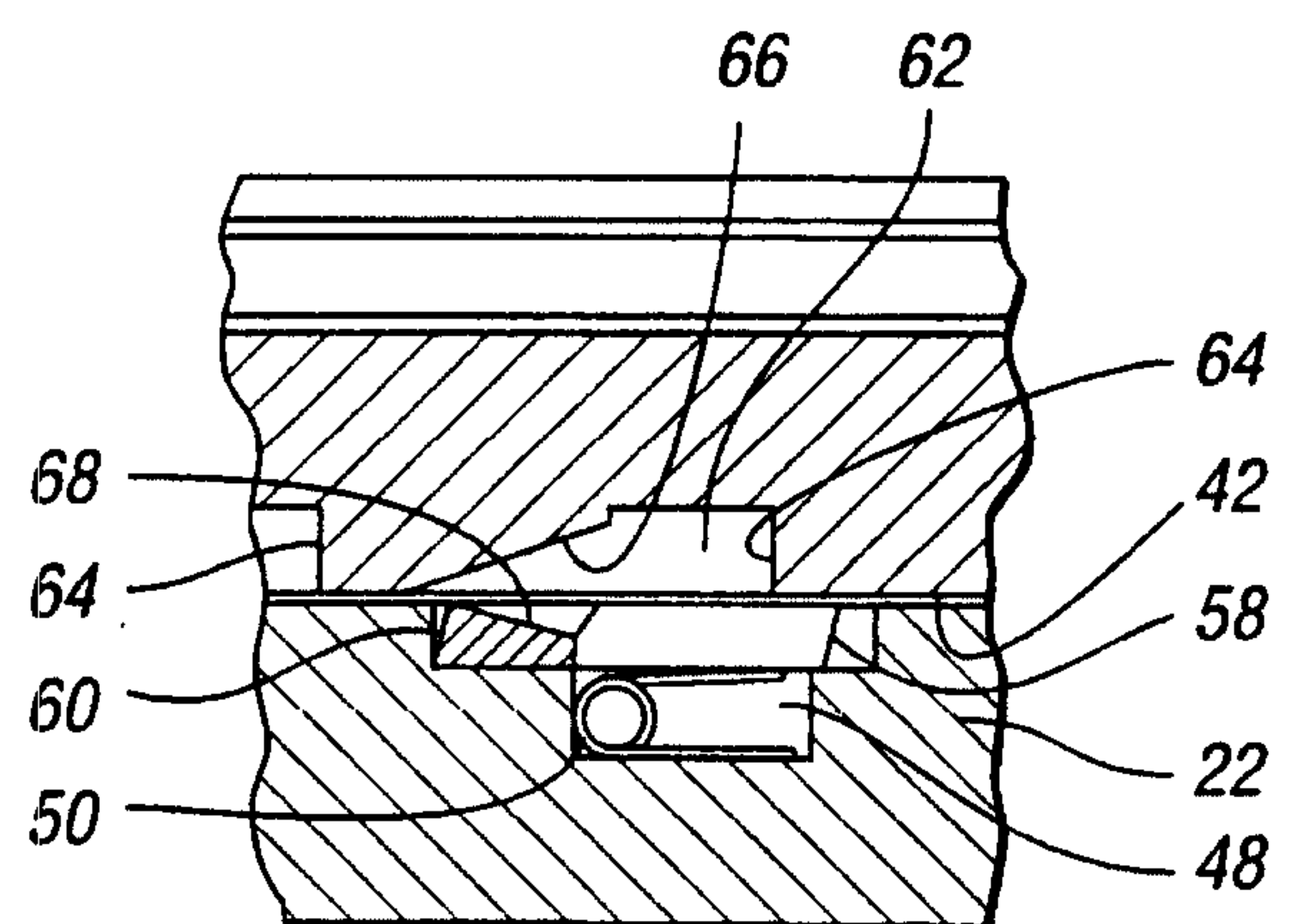
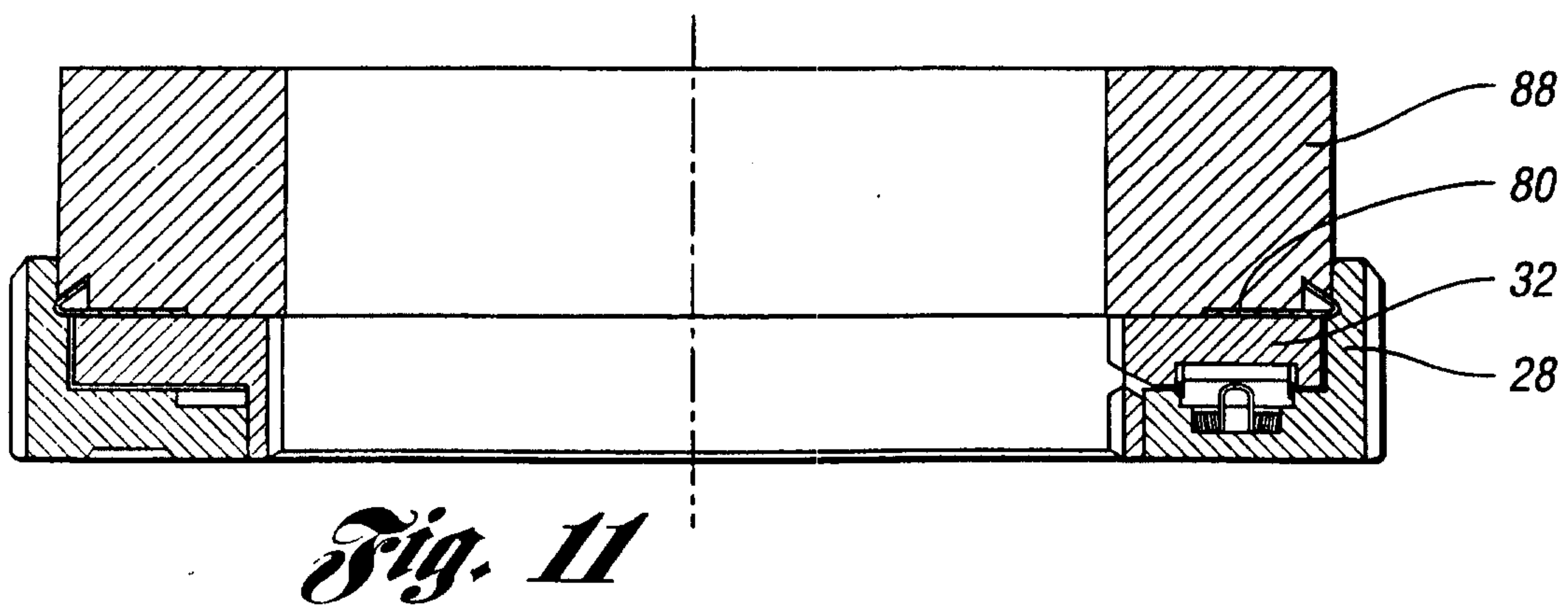
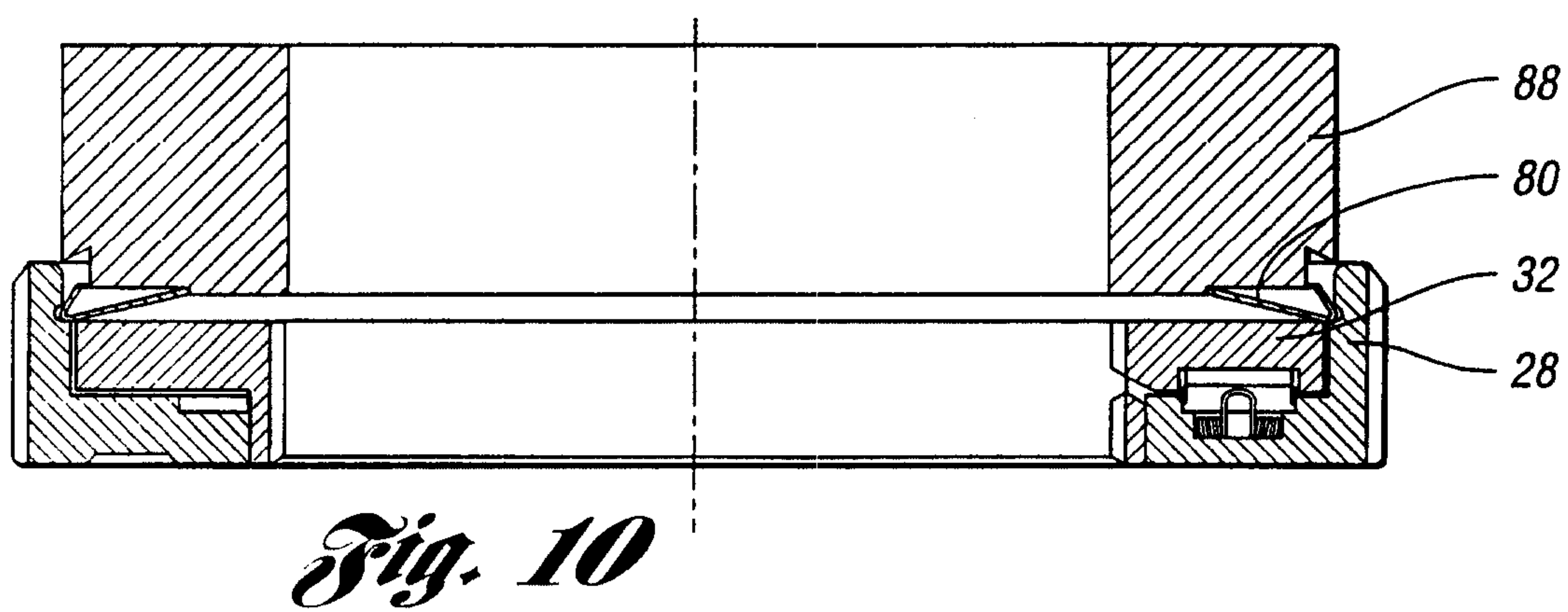
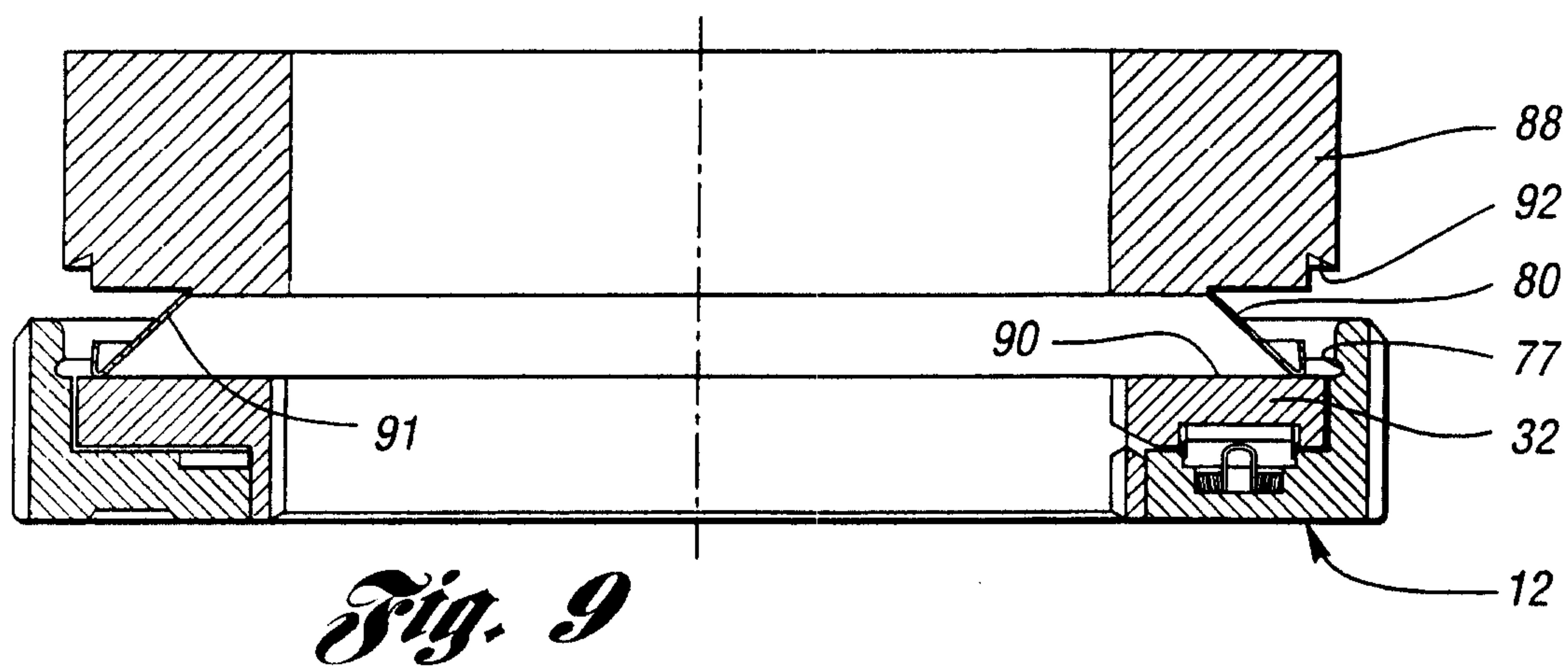
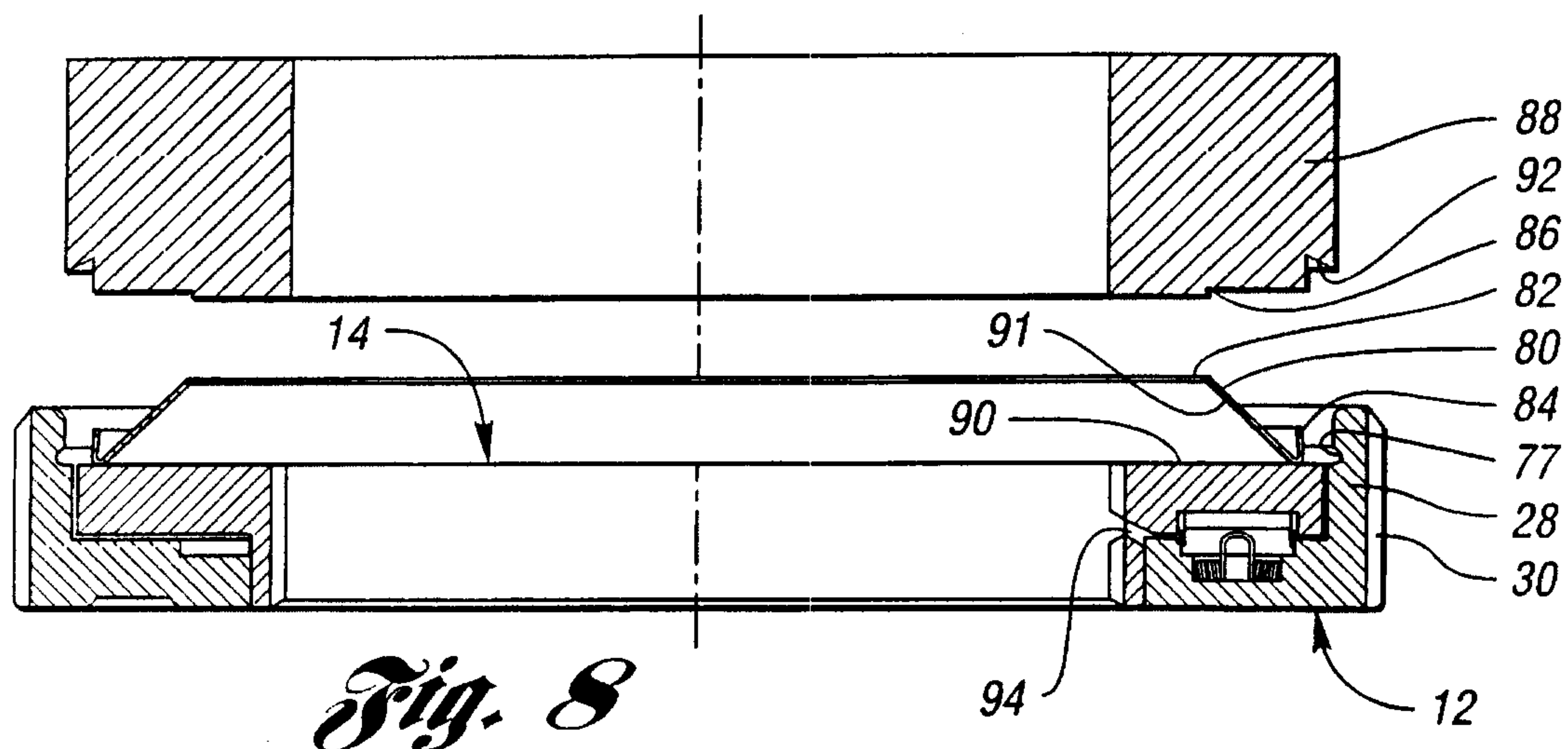


Fig. 1

Fig. 2



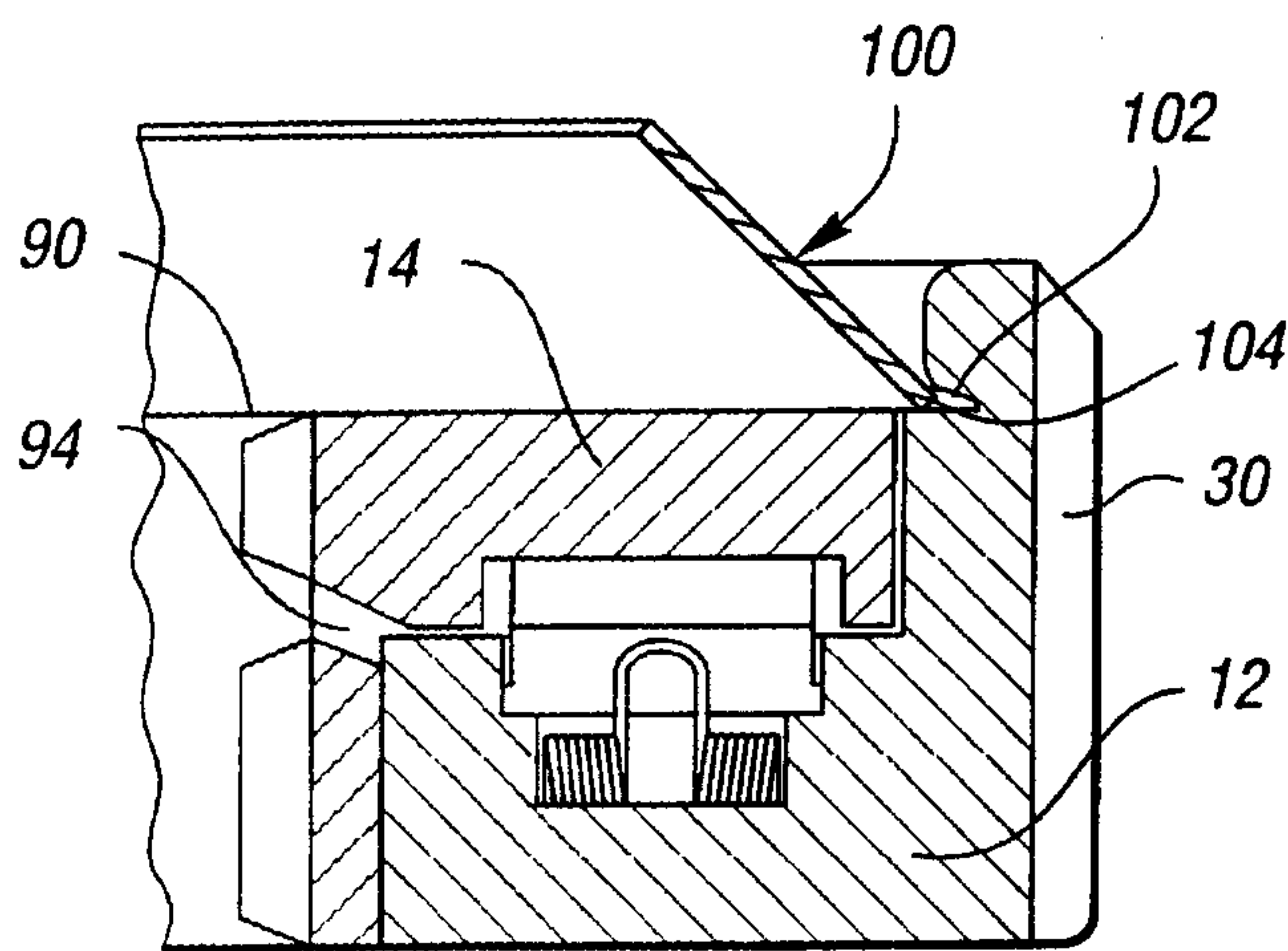
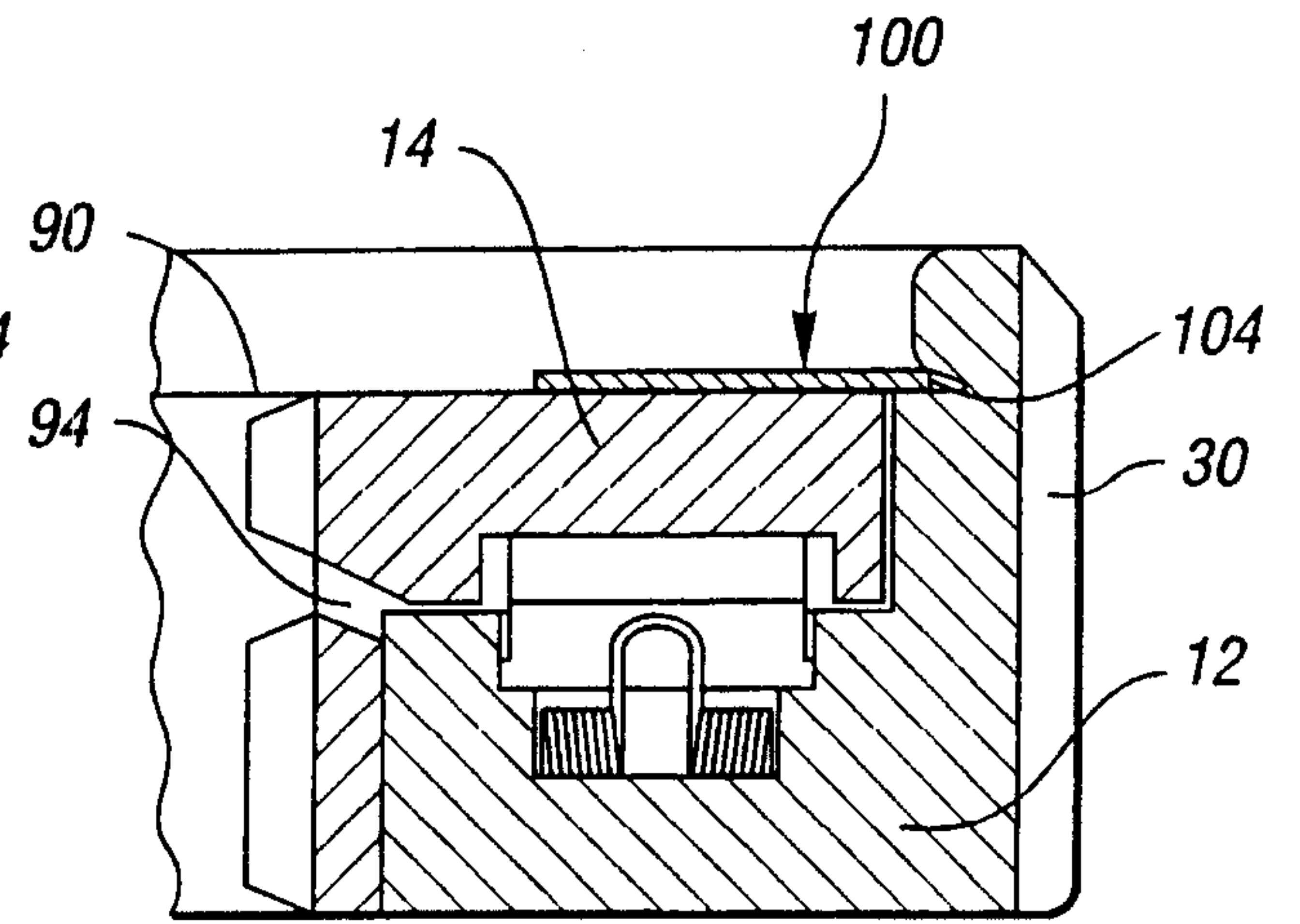
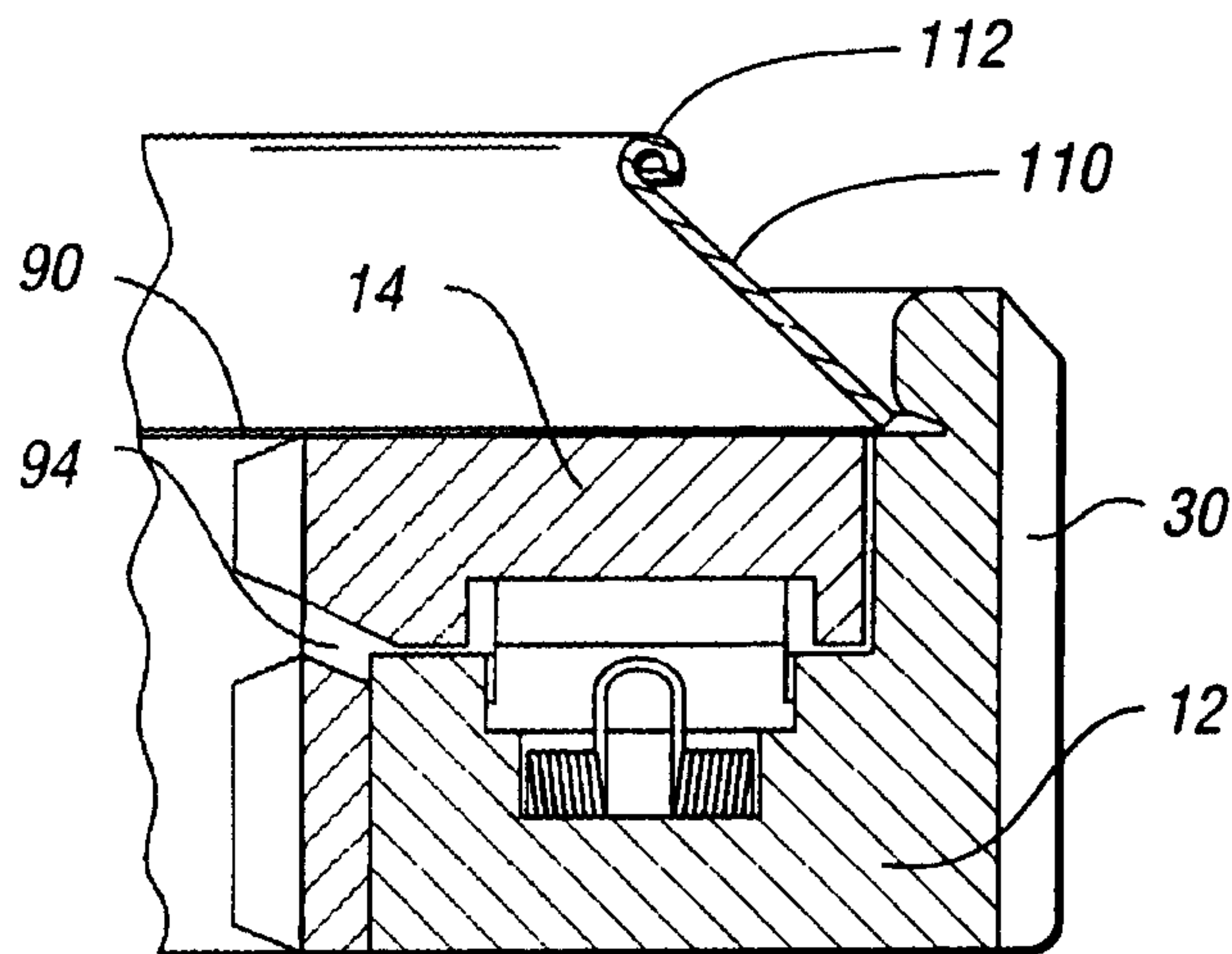
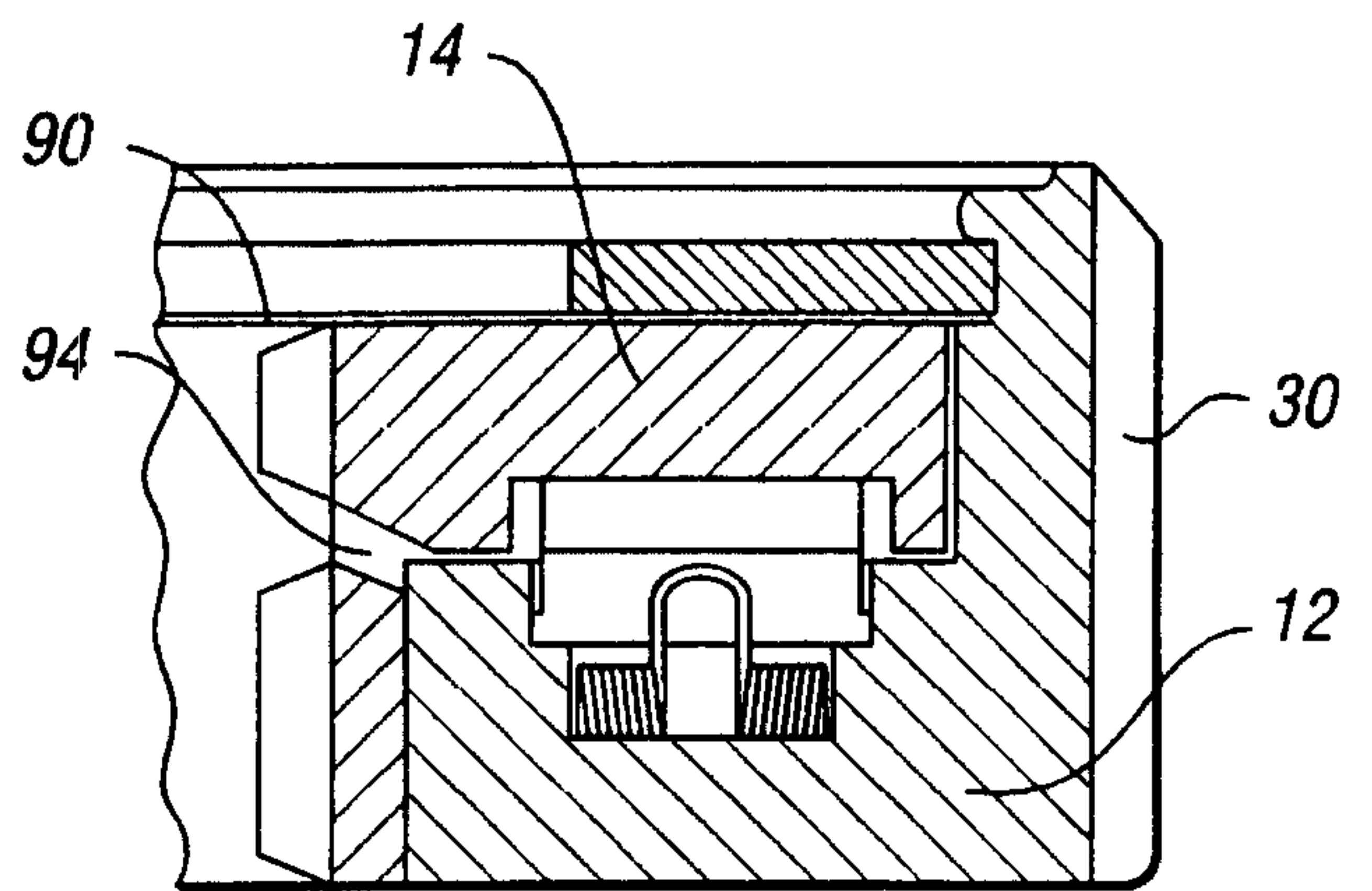
*Fig. 3**Fig. 4**Fig. 7**Fig. 5**Fig. 6*



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*Fig. 12**Fig. 13**Fig. 14**Fig. 15**Fig. 16*