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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,332,896**

(86) 1999/06/30
(87) 2000/01/06

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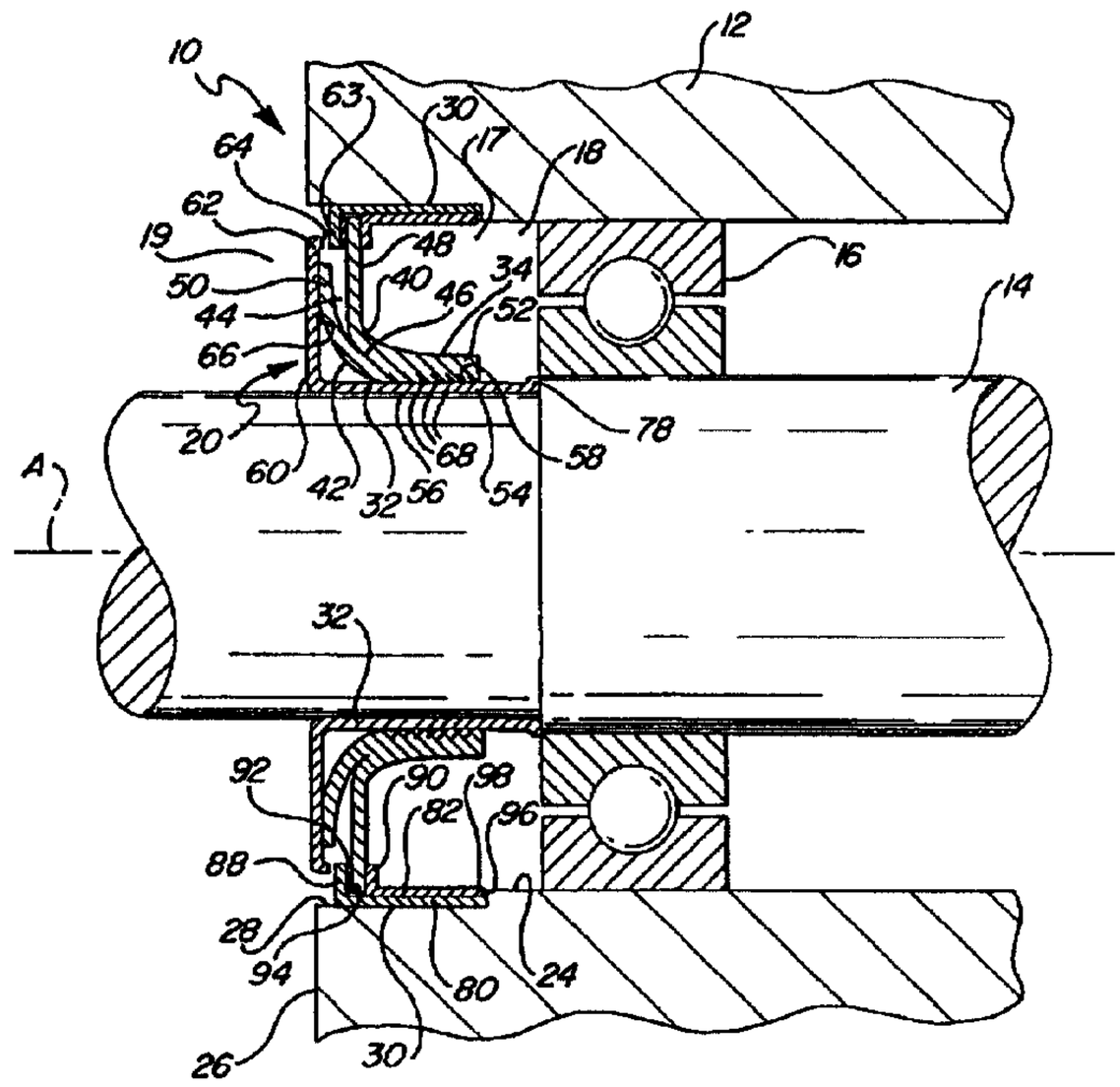
(51) Int.Cl.[6] F16J 15/32
(30) 1998/06/30 (09/107,117) US

(54) **JOINT INTEGRE ETANCHE A L'HUILE ET PROCEDE DE FABRICATION CORRESPONDANT**

(54) **UNITIZED OIL SEAL AND METHOD OF MANUFACTURE**



(57) Selon cette invention, un ensemble intégré (20, 220, 320, 420) de joint étanche à l'huile comprend un disque d'étanchéité (34, 234, 334, 434) qui est fendu le long de son bord externe de manière à délimiter une paire de sections fendues dont l'une (48, 248, 348, 438) est fixée à un élément de support annulaire externe (30, 230, 330, 430) et soutient l'autre section fendue (50, 250, 350, 450) ainsi qu'une section non fendue (52, 252, 352, 452) en les mettant en prise de manière étanche avec les surfaces d'étanchéité correspondantes d'une gaine d'usure (32, 232, 332, 432), et ce de façon à ne pas laisser passer les contaminants et à retenir le lubrifiant, respectivement, de sorte que ce dernier ne s'échappe de l'ensemble intégré (20, 220, 320, 420) de joint étanche à l'huile.

(57) A unitized oil seal assembly (20, 220, 320, 420) has a sealing disk (34, 234, 334, 434) that is split along its outer edge to define a pair of split sections, one of which (48, 248, 348, 438) is fixed to an outer annular carrier member (30, 230, 330, 430) and supports the other split section (50, 250, 350, 450) and an unsplit section (52, 252, 352, 452) in sealing engagement with corresponding sealing surfaces of a wear sleeve (32, 232, 332, 432) to exclude contaminants and retaining lubricant, respectively, from passing by the seal assembly (20, 220, 320, 420).

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : **F16J 15/32** — **A1**

(11) International Publication Number: **WO 00/00763**

(43) International Publication Date: 6 January 2000 (06.01.00)

(21) International Application Number: PCT/US99/14948

(22) International Filing Date: 30 June 1999 (30.06.99)

(30) Priority Data:
09/107,117 30 June 1998 (30.06.98) US

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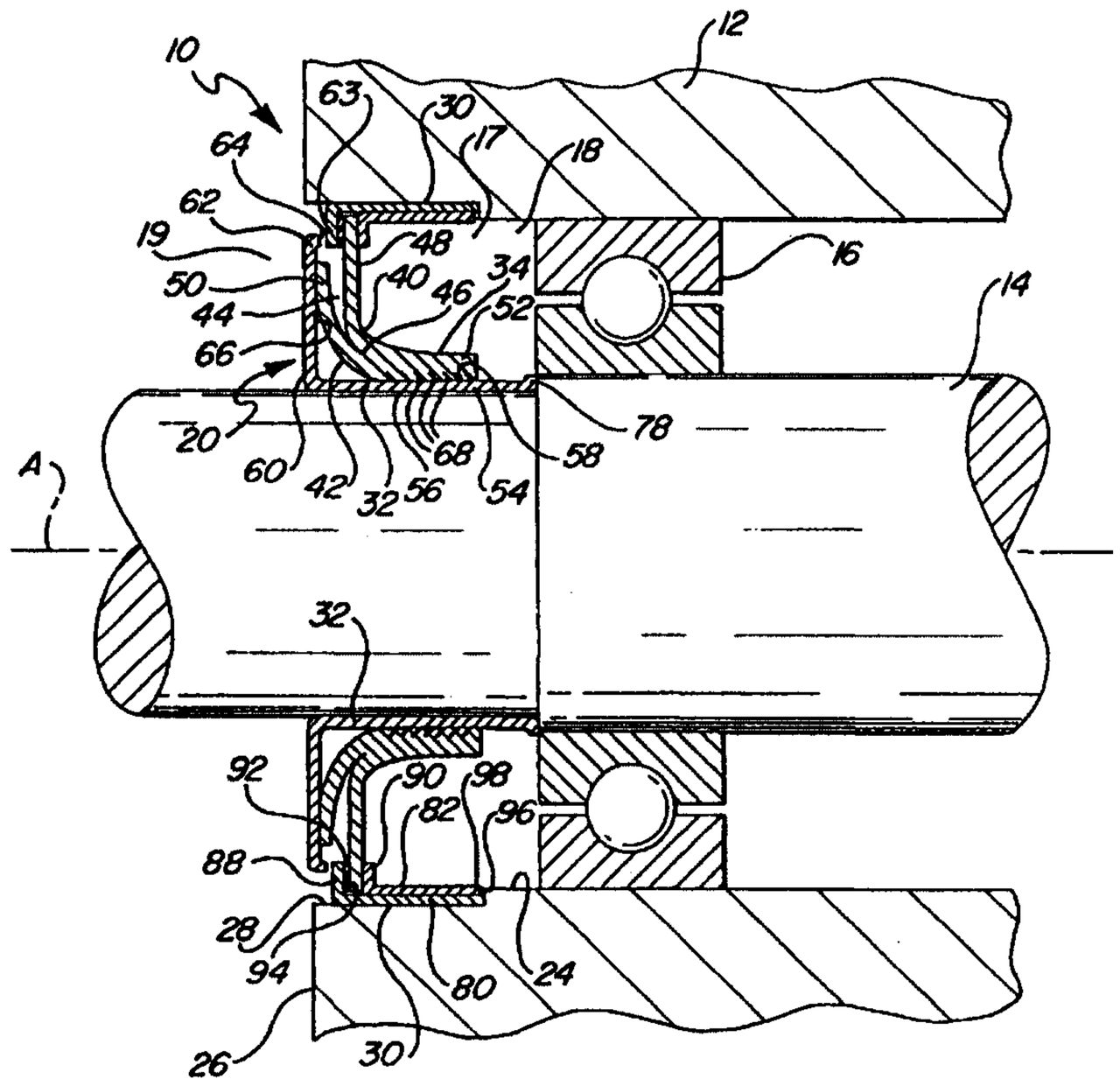
(81) Designated States: CA, JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: UNITIZED OIL SEAL AND METHOD OF MANUFACTURE

(57) Abstract

A unitized oil seal assembly (20, 220, 320, 420) has a sealing disk (34, 234, 334, 434) that is split along its outer edge to define a pair of split sections, one of which (48, 248, 348, 438) is fixed to an outer annular carrier member (30, 230, 330, 430) and supports the other split section (50, 250, 350, 450) and an unsplit section (52, 252, 352, 452) in sealing engagement with corresponding sealing surfaces of a wear sleeve (32, 232, 332, 432) to exclude contaminants and retaining lubricant, respectively, from passing by the seal assembly (20, 220, 320, 420).



UNITIZED OIL SEAL AND METHOD OF MANUFACTURE

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates generally to oil seals of the type having a carrier, a wear sleeve, and a sealing disk unitized in a single assembly, and more particularly to such seals wherein the sealing disk component has a pair of annular sealing lips that engage the wear sleeve in such manner that one of the lips retains lubricant on one side of the seal and the other lip excludes contaminants on the other side of the seal.

2. Related Prior Art

Unitized oil seals are commonly used in various mechanical devices wherever one component rotates in a bearing relative to an adjacent stationary component. The seal operates to close an annular space between the components in order to retain lubricant on the bearing side of the seal and exclude contaminants on the exterior side of the seal, to protect the bearing.

U.S. Patent No. 4,484,752, which is owned by the assignee of the present invention and its disclosure incorporated herein by reference, discloses a unitized oil seal assembly having a pair of discrete sealing disks fixed side-by-side on the carrier to provide a pair of annular sealing lips that sealingly engage the wear sleeve. One lip serves as the oil-retaining seal and the other lip serves as the contaminant-excluding seal. While such oil seal assemblies perform satisfactorily, the requirement for

two sealing disk elements adds cost and complexity to the manufacture of such assemblies. When fully assembled with the wear sleeve, the lips of the disks are bent in opposite axial directions. Special care must be taken to support the lips during assembly to assure that the lips maintain their oppositely bent orientation, further complicating the manufacture of such seal assemblies.

U.S. Patent No. 5,462,287 discloses an oil seal having a single disk element whose inner free edge is split into two relatively thinner annular lip sections that serve as the oil-retaining and contaminant-excluding lips of the seal assembly. Splitting the inner free edge of the disk necessarily decreases the effective thickness of the oil-retaining lip, which may not be desirable in some applications where the oil-retaining lip is subject to wear. Additionally, the disclosed seal assembly utilizes the split side of the oil-retaining lip as the working surface in contact with the wear sleeve, making it more difficult to provide the usual hydrodynamic grooves or formations on the working surface of the oil-retaining lip. Special care must be taken to assure that the lip sections are bent in opposite axial directions, which adds cost and complexity to the assembly process and makes the root of the split prone to possible tensile forces and premature wear or tearing.

U.S. Patent No. 5,615,894 discloses a non-unitized oil seal having a single sealing disk whose inner free edge is split to provide oil-retaining and contaminant-excluding lip portions. Special dies and

forming steps are required to emboss hydrodynamic ribs on the contacting surfaces of both lip sections, which adds to the cost and complexity of the manufacture of such seals. The lip sections are also bent in opposite axial directions, and thus this seal assembly shares the same draw backs as those described previously.

Other unitized oil seal assemblies are known to include a PTFE sealing disk element having a conical configuration rather than the usual flat wafer configuration. The conical disk is bonded to the carrier by an annular rubber mounting collar. The collar encircles the disk at a location between its ends and supports the ends in sealing engagement with the wear sleeve to serve as the oil-retaining and contaminant-excluding lips of the seal. Such conical sealing disks are costly in comparison to traditional flat wafers and add to the complexity of making such seals, as does the need for the rubber mounting collar.

SUMMARY OF THE INVENTION AND ADVANTAGES

According to a first aspect of the invention, a unitized oil seal assembly is provided having a rigid annular carrier member, a rigid annular wear sleeve formed with a primary sealing surface and a secondary sealing surface, and an annular sealing disk fabricated of a single piece of polymeric material having radially opposed edges. The assembly is characterized by the sealing disk including an annular circumferentially extending split dividing one edge of the disk into a pair

of adjacent first and second split sections joined at the root of the split to an integral unsplit section at the opposite edge of the disk. The first split section is fixed to the carrier member and supports the unsplit section and the second split section in sealing engagement with the primary and secondary sealing surfaces of the wear sleeve.

Mounting the disk by one of its split sections has the advantage of providing a full thickness unsplit section which preferably would serve as the oil-retaining lip of the seal assembly. Such mounting of the disk has the further advantage of enabling the second split section to be automatically positioned in opposite axially extending relation to the split section in response to assembling the wear sleeve with the sealing disk and carrier. Such eliminates a step in the assembly process of having to orient the oil-retaining and contaminant-excluding sealing lips in opposite directions, thereby simplifying the construction and manufacture of such seal assemblies and reducing the cost involved.

Another advantage of the invention is that the unsplit section and second split section can be supported in such manner that they engage the wear sleeve on a common outer surface of the sealing disk. This enables hydrodynamic formations to be formed according to conventional practice and further supports the root of the split in compression rather than tension, thereby lessening the opportunity for weakening or tearing of the sealing disk.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other advantages and features of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Figure 1 is a schematic, fragmentary cross-sectional view of a device in which a unitized seal assembly of the invention is installed;

Figure 2 is an elevational view of a sealing element only constructed according to the invention;

Figure 3 is an enlarged sectional view taken generally along lines 3-3 of Figure 2;

Figure 4 is an enlarged sectional view of a seal assembly constructed according to a first embodiment of the invention embodying the sealing element of Figures 2 and 3;

Figure 5 is an enlarged sectional view of an alternative embodiment of a seal assembly constructed according to the invention;

Figure 6 is an enlarged fragmentary sectional view of a sealing element only constructed according to an alternative embodiment of the invention;

Figure 7 is an enlarged sectional view of a seal assembly constructed according to another embodiment of the invention incorporating the sealing element of Figure 6; and

Figure 8 is an enlarged sectional view of a further embodiment of a seal assembly constructed according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a mechanical device generally at 10 having a stationary component 12 and a rotatable component 14. The rotatable component 14 is journaled by a bearing 16 for rotation about an axis A of the component 14 relative to the stationary component 12. Lubrication, such as oil or grease, is present in an annular clearance gap or space 18 between the components 12, 14 and provides needed lubrication to the bearing 16.

A unitized oil seal assembly 20 constructed according to the invention is disposed within the gap 18 and functions to prevent the lubricant from escaping the gap 18 on a bearing or oil side 17 of the seal assembly 20 facing the bearing16 and to exclude harmful contaminants such as dust, dirt, and in some cases, harmful liquids or gases on an opposite exterior side 19 of the seal assembly 20 from entering the gap 18 past the seal assembly 20.

It is to be understood that the seal assembly 20 may be used in conjunction with any of a number of devices 10 in which one component 14 rotates relative to another adjacent component 12 and there is a need to seal an annular gap 18 between the components 12,14 to contain a

lubricant on one side of the seal and exclude contaminants on the other side. By way of example, the device 10 schematically shown in Figure 1 may comprise an internal combustion engine wherein the stationary component 12 comprises a stationary case or housing of the engine and the rotatable component 14 comprises a shaft, such as a crank shaft, that extends through an opening 24 in one end 26 of the housing 12. The seal assembly 20 is mounted within an annular recess 28 of the housing 12 and encircles the shaft 14 to effectively close the gap 18.

The seal assembly 20 includes a rigid annular case or carrier member 30, a rigid annular wear sleeve 32, and an annular sealing disk 34 fixed to the carrier member 30 and sealingly engaging the wear sleeve 32. The carrier member 30 and wear sleeve 32 may be fabricated of conventional, structurally rigid materials such as stamped steel components according to conventional practice. The sealing disk 34 comprises a thin, annular wafer fabricated from a single, unitary piece of polymeric material, and preferably a polytetrafluoroethylene (PTFE) based material which may include suitable fillers. The PTFE material is preferably of the type commonly used in seal applications and is not new per se. It will be appreciated that other materials suitable for seal applications, such as elastomers, could also be used.

The sealing disk 34 in its relaxed state has a generally flat ring configuration, including a radially outer edge portion 36, a radially inner edge portion 38, and axially opposite first and second faces 40, 42,

respectively. The inner edge portion 38 encircles a central opening 43 of the disk 34 to receive the wear sleeve 32.

The sealing disk 34 is formed with an annular circumferentially extending split 44 that commences at one of the edges and extends radially toward the other edge. In the illustrated embodiment of Figures 1-4, the split 44 commences at the outer edge portion 36 of the disk and extends therefrom toward the inner edge portion 38 and terminates at a base or root 46 of the split located intermediate the edges 36, 38. The split 44 divides the outer edge region 36 of the disk 34 into axially adjacent first and second annular split sections 48, 50, that are free at their radially outer ends and are joined to an integral unsplit inner edge section 52 of the sealing disk 34 at a root 46 of the sealing disk 34.

The disk 34 of the first embodiment of Figure 1-4 has a generally uniform thickness, such that the thickness of the unsplit section 52 is relatively greater than that of the thicknesses of either of the split sections 48, 50. Preferably, one of the split sections 48 has a radial length that is relatively greater than that of the other split section 50 for purposes of mounting the disk 34 to the carrier member 30 in a manner to be described below.

As best shown in Figure 4, the wear sleeve 32 has a generally cylindrical barrel or body 54 with an inner surface 56 and an outer surface 58. The inner surface 56 is sized for an interference fit on the shaft 14 such that the wear sleeve 14 rotates with the shaft 14 about the axis A.

The outer surface 58 is finished to provide a suitable primary or main sealing surface 58 for the wear sleeve 32.

The wear sleeve 32 is formed with an integral annular flange or collar 60 provided on the axially outer end of the wear sleeve 32. The flange 60 extends radially outwardly of the body 54 to a free end portion 62 thereof and preferably beyond a radially inner edge 63 of the carrier member 30. The free end portion 62 is preferably turned axially inwardly toward the carrier member 30 and is spaced axially therefrom by an annular clearance gap 64. An axially inner face 66 of the flange 60 defines a secondary sealing surface 66 of the wear sleeve 32 disposed adjacent to and extending transversely, and preferably perpendicular to, the main sealing surface 58.

According to a characterizing feature of the invention, one of the split sections 48 of the sealing disk 34 is fixed to the carrier member 30 and the other split section 50 and the unsplit section 52 are supported in sealing engagement with the secondary and primary sealing surfaces 66, 58, respectively, of the wear sleeve 32. As shown best in Figure 4, the unsplit section 52 is bent or curled away from the mounted split section 48 axially inwardly toward the oil side 17 of the seal assembly 20 causing the side 42 of the unsplit section 52 to lay down against the main sealing surface 58 of the wear sleeve 32 to serve as an oil-retaining lip of the seal assembly 20. The unsplit section 52 is formed on its contacting side 42 with a plurality of hydrodynamic formations 68, which may comprise a

series of helically disposed flutes, cuts, embossments or other type well known to the art and which are typically provided on the contacting surface of oil-retaining lips to provide hydrodynamic pumping action that assists in retaining the lubricant on the oil side 17 of the seal assembly 20 during operation of the device 10.

As also shown in Figure 4, bending the unsplit section 52 axially toward the oil side 17 of the seal assembly 20 cups the first face 40 of the sealing disk 34 giving it a generally concave profile. The inward cupping of the first face 40 of the sealing disk 34 exerts an outward convex bowing force on the opposing face 42. Such outward bowing force causes the split 44 to open or separate somewhat, thereby biasing the outer free edge of the other split section 50 away from the mounted split section 48 axially opposite the unsplit section 52 toward the exterior or air side 19 of the seal assembly 20 and into sealing engagement with the secondary sealing surface 66 of the wear sleeve flange 60 to serve as the contaminant-excluding lip seal of the assembly 20.

The split section 50 is likewise curled or bent so as to lay down against the sealing surface 66 and sealingly engage the wear sleeve 32 on the same face side 42 of the disk 34 as that of the unsplit section 52. In other words, mounting the sealing disk 34 by one of its split sections 48 enables the remaining split section 50 and the unsplit section 52 to engage the wear sleeve 32 on a common side or face of the sealing disk (in the illustrated example, the second face 42). This has the advantage of

placing the root 46 of the split 44 in compression during service of the seal assembly 20. Any radial or axial movements between the wear sleeve 32 and carrier member 30 would act to further close the split 44, thus isolating the root 46 of the split 44 from tension forces that would tend to tear or prematurely wear the sealing disk at the root 46. It will be appreciated that the split or cut sides 72, 74 of the split sections 48, 50 do not seal against the wear sleeve 32, and are spaced therefrom.

The split section 50 has a radial length that is relatively shorter than the radial length of the mounted split section 48. The shorter length enables the split section 50 to deflected outwardly into engagement with the sealing surface 66 while avoiding interference with the carrier 30.

According to a method of making the oil seal assembly 20, the sealing disks 34 are preferably cut from an elongate tubular billet of PTFE. In practice, to make an individual disk 34, the hydrodynamic grooves 68 are first cut into the radially inner edge portion of the end face of the billet. The split 44 is then cut into the outer diameter of the billet and the end face is cut to form the relatively shorter split section 50. The individual disk 34 is then cut from the billet and the process repeated to form additional disks.

The split section 48 of the disk 34 is then fixed to the carrier 30. As illustrated in Figure 4, the disk 34 is preferably clamped to the carrier 30. For this purpose, the carrier 30 is formed with an outer case portion 80 and an inner case portion 82 each having a cylindrical body 84,

86 and each terminating at their axially outer ends thereof in radially inwardly extending mounting flanges 88, 90. The flange 88 of the outer case portion 82 carries and annular resilient mounting gasket 92 on an axially inward surface thereof opposite the flange 90. The outer free end of the split section 48 is disposed in a gap 94 between the facing surfaces of the mounting gasket 92 and the flange 90 and clamped in place by means of an axial compressive force urging the mounting flange 90 constantly toward engagement with the mounting gasket 92. Such clamping force is applied and then permanently retained by rolling an axially inner end 96 of the case portion 80 about the inner edge 98 of the case portion 82, so as to clamp and retain the split section 48 of the sealing disk 34 securely between the mounting flanges 88, 90.

The wear sleeve 32 is then assembled with the carrier 30 and disk 34 by extending the body 54 of the sleeve 32 axially through the central opening 43 of the disk 34 from the exterior side 19 thereof. The unsplit section 52 is engaged by the sleeve 32 and is bent thereby axially inwardly in the direction of insertion as the sleeve 32 is extended through the disk 34 so as to lay down and seal against the primary sealing surface 58 of the sleeve 32. Such bending of the unsplit section 52 forces the unclamped second split section 50 axially outwardly away from the unsplit section 52 toward and into self-biased sealing engagement with the secondary sealing surface 66 of the flange 60 of the wear sleeve 32, as illustrated. It will thus be appreciated that the simple action of extending

the sleeve 32 through the sealing disk 34 automatically sets the unsplit oil-retaining lip 52 and the split contaminant-excluding lip 50 of the sealing disk 34 in proper sealing engagement with the sealing surfaces 58, 66 of the wear sleeve 32, without need for an additional step in the process or use of special tools or fixtures.

The wear sleeve 32 is retained against axial inward disconnection from the assembly 20 by confrontation between the flange 60 of the wear sleeve 32 and the flange 88 of the carrier 30. The wear sleeve is further retained against axial outward disconnection from the assembly by means of a radially outwardly extending retaining lip 78 formed on the axially inner end of the wear sleeve 32. Urging the wear sleeve 32 axially outwardly causes the lip 78 to confront the free edge of the unsplit section 52 of the sealing disk 34, thereby limiting the outward axial movement of the wear sleeve 32.

Figure 5 illustrates an alternative embodiment of the invention, wherein like reference numerals are used to represent corresponding features to the first embodiment, but are offset by 200. The construction of the seal assembly 220 is identical to that of the first embodiment, except the split section 248 is bonded rather than clamped to the carrier member 230. The carrier member 230 has a single outer case portion 280 and lacks the inner case portion 82 of the first embodiment. An elastomeric body 100 is bonded to the carrier 230 and split section 248, thereby securing the sealing disk 234 to the carrier 230. The elastomeric

body 100 may comprise rubber or other material compatible with both the metal carrier member 230 and the PTFE sealing disk 234.

Figures 6 and 7 illustrate yet a further embodiment of the invention, wherein the same reference numerals are used to represent corresponding features to the first embodiment, but are offset by 300. The sealing disk 334 is formed such that the unsplit section 352 has the same thickness as the split sections 348, 350. The thinner unsplit section 352 is relatively more flexible than that of the relatively thicker unsplit section 52 of the first embodiment and consequently may exert lower contact pressure against the wear sleeve 32. An outer elastomeric member 102 is fabricated of rubber or the like and is bonded to the carrier member 330. The member 102 includes a supplemental contaminant exclusion lip 104 disposed in the gap 364. The lip 104 acts to further exclude dust and other contaminants from entering the seal assembly 320.

Figure 8 illustrates still a further embodiment of the invention wherein the same reference numerals are used to represent corresponding features to the first embodiment, but are offset by 400. The assembly 420 includes an elastomeric supplemental contaminant exclusion lip 106 bonded to the flange 460 of the wear sleeve 432 and sealingly engaging the flange 488 of the carrier member 430 to close the clearance gap 464. The lip 106 operates in the same manner as the lip 104 of the previous embodiment to exclude contaminants from entering the seal assembly 420.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims wherein parenthetical reference numerals are merely for convenience and are not in any way to be limiting, the invention may be practiced as otherwise than as specifically described.

What is claimed is:

1. A unitized oil seal assembly comprising:

a rigid annular carrier member (30, 230, 330, 430);

a rigid annular wear sleeve (32, 232, 332, 432) having a primary sealing surface (58, 258, 358, 458) and a secondary sealing surface (66, 266, 366, 466); and

characterized by an annular sealing disk (32, 232, 332, 432) fabricated of a single piece of polymeric material having radially opposed edges and a circumferential split (44, 244, 344, 444) along one of said edges extending radially toward the other of said edges and terminating at a root (46, 246, 346, 446) of said split (44, 244, 344, 444) intermediate said edges, said split (44, 244, 344, 444) dividing said one edge into a pair of first (48, 248, 348, 448) and second (50, 250, 350, 450) annular split sections joined at said root (46, 246, 346, 446) to an integral unsplit section (52, 252, 352, 452) at said other edge of said disk (34, 234, 334, 434), said first split section (48, 248, 348, 448) being fixed to said carrier member (30, 230, 330, 430) and supporting said unsplit section (52, 252, 352, 452) and said second split section (50, 250, 350, 450) in sealing engagement with said primary (58, 258, 358, 458) and said secondary (66, 266, 366, 466) sealing surfaces of said wear sleeve (32, 232, 332, 432).

2. The assembly of claim 1 further characterized by said opposed edges of said disk (34, 234, 334, 434) comprising radially outer and inner edges thereof, and said split (44, 244, 344, 444) being provided in said outer edge.

3. The assembly of claim 1 further characterized by said disk (34, 234, 334, 434) including opposed faces and said second split section (50, 250, 350, 450) and said unsplit section (52, 252, 352, 452) engaging said sealing surfaces (66, 266, 366, 466; 58, 258, 358, 458) of said wear sleeve (32, 232, 332, 432) along a common one of said faces of said disk (34, 234, 334, 434).

4. The assembly of claim 1 further characterized by said unsplit section (52, 252, 352, 452) being bent axially away from said first split section (48, 248, 348, 448) along said wear sleeve (32, 232, 332, 432) toward an oil side (19, 219, 319, 419) of said assembly, and said second split section (50, 250, 350, 450) being bent away from said first split section (48, 248, 348, 448) in a direction opposite said unsplit section (52, 252, 352, 452).

5. The assembly of claim 1 further characterized by said unsplit section (52, 252, 352, 452) having a thickness relatively greater than the thicknesses of each of said split sections (48, 248, 348, 448; 50, 250, 350, 450).

6. The assembly of claim 1 further characterized by said unsplit section (52, 252, 352, 452) including hydrodynamic formations (68, 268, 368, 468).

7. The assembly of claim 1 further characterized by said wear sleeve (32, 232, 332, 432) including a generally cylindrical body (54, 254, 354, 454) defining said primary sealing surface (58, 258, 358, 458), and a flange (60, 260, 360, 460) extending radially from said body (54, 254, 354, 454) and having an axially inner surface (66, 266, 366, 466) disposed transverse to said primary sealing surface (58, 258, 358, 458) and defining said secondary sealing surface (66, 266, 366, 466) of said wear sleeve (32, 232, 332, 432).

8. The assembly of claim 7 further characterized by said second split section (50, 250, 350, 450) being spaced radially from said unsplit section (52, 252, 352, 452) when engaging said sealing surfaces (66, 266, 366, 466; 58, 258, 358, 458).

9. The assembly of claim 1 further characterized by said sealing disk (34, 234, 334, 434) being fabricated of polytetrafluoroethylene based material.

10. The assembly of claim 1 further characterized by said root (46, 246, 346, 446) of said split (44, 244, 344, 444) being supported in compression.

11. The assembly of claim 1 further characterized by said first split section (48, 248, 348, 448) having a radial length relatively greater than the radial length of said second split section (50, 250, 350, 450).

12. The assembly of claim 1 further characterized by including an auxiliary exclusion lip (104, 106) disposed within an annular gap (364, 464) between said carrier member (330, 430) and said wear sleeve (332, 432) adjacent said second split section (350, 450).

13. A unitized oil seal assembly comprising:

a rigid annular carrier member (30, 230, 330, 430);

a rigid annular wear sleeve (32, 232, 332, 432) disposed radially adjacent said carrier member (30, 230, 330, 430) having a body (54, 254, 354, 454) with a cylindrical outer primary sealing surface (58, 258, 358, 458), and a flange (60, 260, 360, 460) extending radially outwardly of said body (54, 254, 354, 454) and having an axially inwardly facing secondary sealing surface (66, 266, 366, 466); and

characterized by an annular sealing disk (34, 234, 334, 434) fabricated of a single piece of polymeric material having radially inner and outer edges and axially opposed side faces, said outer edge of said disk (34, 234, 334, 434) formed with a circumferentially extending split (44, 244, 344, 444) dividing said outer edge into a first (48, 248, 348, 448) and second (50, 250, 350, 450) annular split sections and joined at a root (46, 246, 346, 446) of said split (44, 244, 344, 444) to an integral unsplit section (52, 252, 352, 452) at said inner edge of said disk (34, 234, 334, 434), said first split section (48, 248, 348, 448) being fixed to said carrier member (30, 230, 330, 430) and supporting said unsplit section (52, 252, 352, 452) in axially bent sealing engagement with said primary sealing surface (58, 258, 358, 458) of said wear sleeve (32, 232, 332, 432) to provide an oil-retaining lip of said assembly and supporting said second split section (50, 250, 350, 450) in axially bent sealing engagement with said secondary sealing surface (66, 266, 366, 466) to provide a

contaminant-excluding lip of said assembly, said second split section (50, 250, 350, 450) extending away from said unsplit section (52, 252, 352, 452) and said second split section (50, 250, 350, 450) and said unsplit section (52, 252, 352, 452) engaging said sealing surfaces (52, 252, 352, 452; 52, 252, 352, 452) of said wear sleeve (32, 232, 332, 432) on a common one of said axially opposite faces of said sealing disk (34, 234, 334, 434).

14. The assembly of claim 13 further characterized by said disk (34, 234, 334, 434) being fabricated of polytetrafluoroethylene based material.

15. A mechanical device having a stationary component (12), a rotary component (14) journaled by said stationary component (12), and a unitized oil seal assembly (20, 220, 320, 420) closing an annular space (18, 218, 318, 418) between said components (12, 14) to retain lubricant on an oil side (17, 217, 317, 417) of said seal assembly (20, 220, 320, 420) and to exclude contaminants on an air side (19, 219, 319, 419) of said seal assembly (20, 220, 320, 420), said seal assembly (20, 220, 320, 420) including an annular carrier member (30, 230, 330, 430) mounted on one of said components, a wear sleeve (32, 232, 332, 432) mounted on the other of said components, and a polymeric sealing disk (34, 234, 334, 434) fixed to said carrier member (30, 230, 330, 430) and sealingly engaging said wear sleeve (32, 232, 332, 432), and characterized by:

said annular sealing disk (34, 234, 334, 434) having radially opposed edges and a circumferential split (44, 244, 344, 444) along one of said edges extending radially toward the other of said edges and terminating at a root (46, 246, 346, 446) of said split (44, 244, 344, 444) intermediate said edges, said split (44, 244, 344, 444) dividing said one edge into a pair of first (48, 248, 348, 448) and second (50, 250, 350, 450) annular split sections joined at said root (46, 246, 346, 446) to an integral unsplit section (52, 252, 352, 452) at said other edge of said disk (34, 234, 334, 434), said first split section (48, 248, 348, 448) being fixed to said carrier member (30, 230, 330, 430) and supporting said unsplit section (52, 252, 352, 452) and said second split section (50, 250, 350,

450) in sealing engagement with primary (58, 258, 358, 458) and secondary (66, 266, 366, 466) sealing surfaces of said wear sleeve (32, 232, 332, 432).

16. A method of making a unitized oil seal assembly comprising:

preparing a sealing disk (34, 234, 334, 434) fabricated of polymeric material having radially inner and outer edges and axially opposite faces; and

characterized by a) splitting the outer edge of the disk (34, 234, 334, 434) to form first (48, 248, 348, 448) and second (50, 250, 350, 450) annular split sections at the outer edge thereof joined at a root (46, 246, 346, 446) of the split (44, 244, 344, 444) to an integral unsplit section (52, 252, 352, 452) at the inner edge thereof, b) fixing the first split section (48, 248, 348, 448) to an outer annular carrier member (30, 230, 330, 430), and c) extending a generally cylindrical body (54, 254, 354, 454) of a wear sleeve (32, 232, 332, 432) through a central opening (43, 243, 343, 443) in the disk (34, 234, 334, 434) thereby engaging the unsplit section (52, 252, 352, 452) and bending it axially away from the first split section (48, 248, 348, 448) in the direction of extension whereupon the unsplit section (52, 252, 352, 452) is caused to seal about the body (54, 254, 354, 454) of the wear sleeve (32, 232, 332, 432) and define an oil-retaining lip of the assembly, and in response to such bending of the unsplit section (52, 252, 352, 452), automatically deflecting the second split section (50, 250, 350, 450) away from the unsplit section (52, 252, 352, 452) toward and into self-biasing sealing

engagement with a flange (60, 260, 360, 460) of the wear sleeve (32, 232, 332, 432) to provide a contaminant-excluding lip of the assembly.

17. The method of claim 16 further characterized by fabricating the sealing disk (34, 234, 334, 434) from polytetrafluoroethylene based material.

18. The method of claim 16 further characterized by supporting the root (46, 246, 346, 446) of the split (44, 244, 344, 444) in compression.

19. The method of claim 16 further characterized by supporting the second split section (50, 250, 350, 450) and the unsplit section (52, 252, 352, 452) such that a common one of the axial faces of the sealing disk (34) sealingly engages the wear sleeve (32, 232, 332, 432).

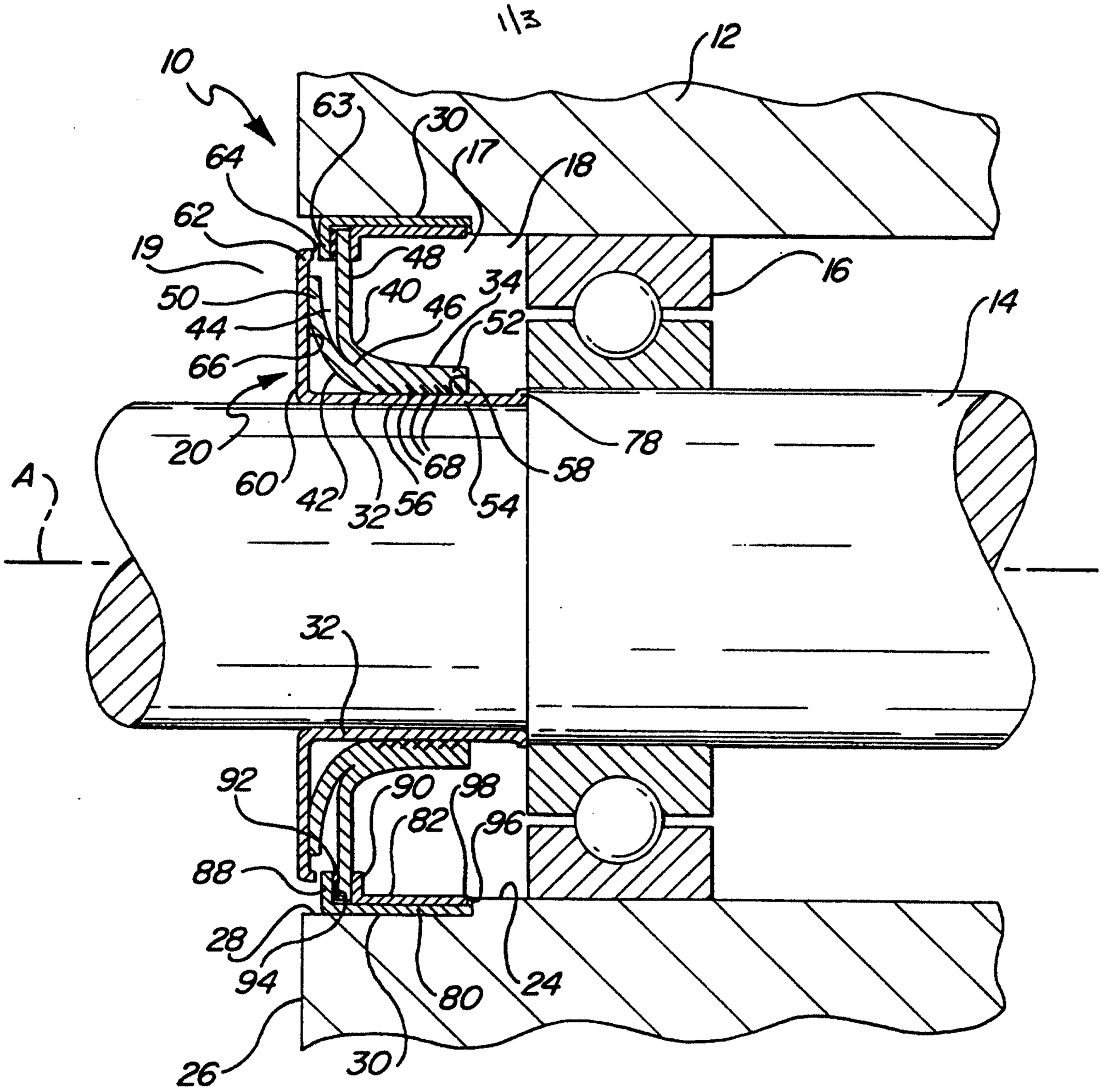

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FIG-1

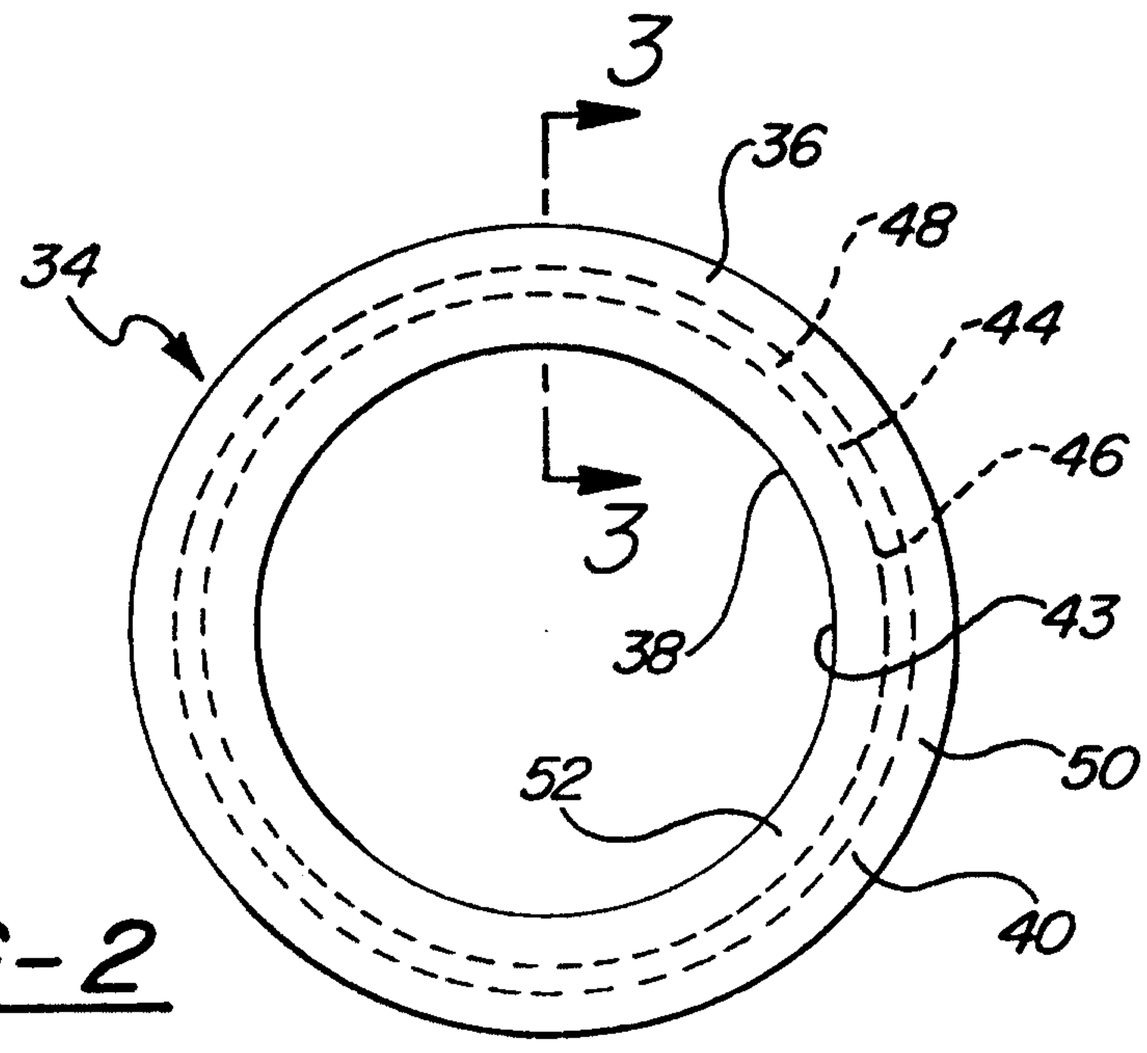
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FIG-2

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FIG-3

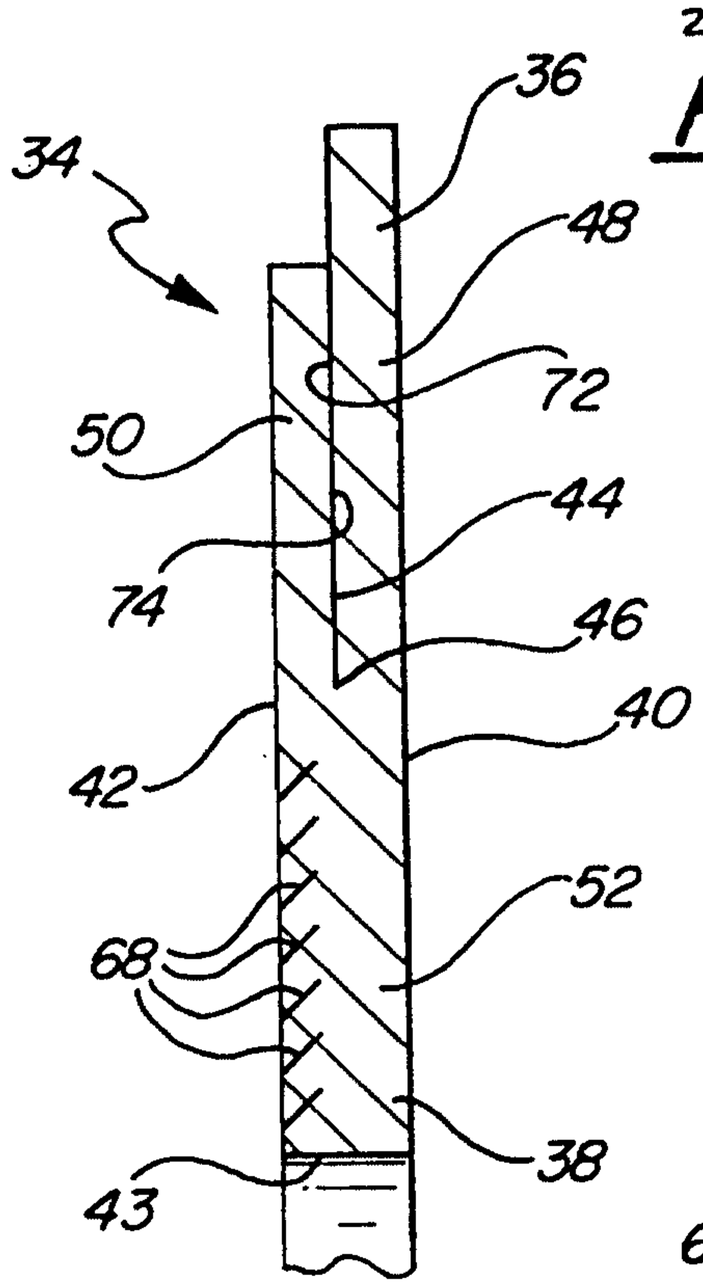
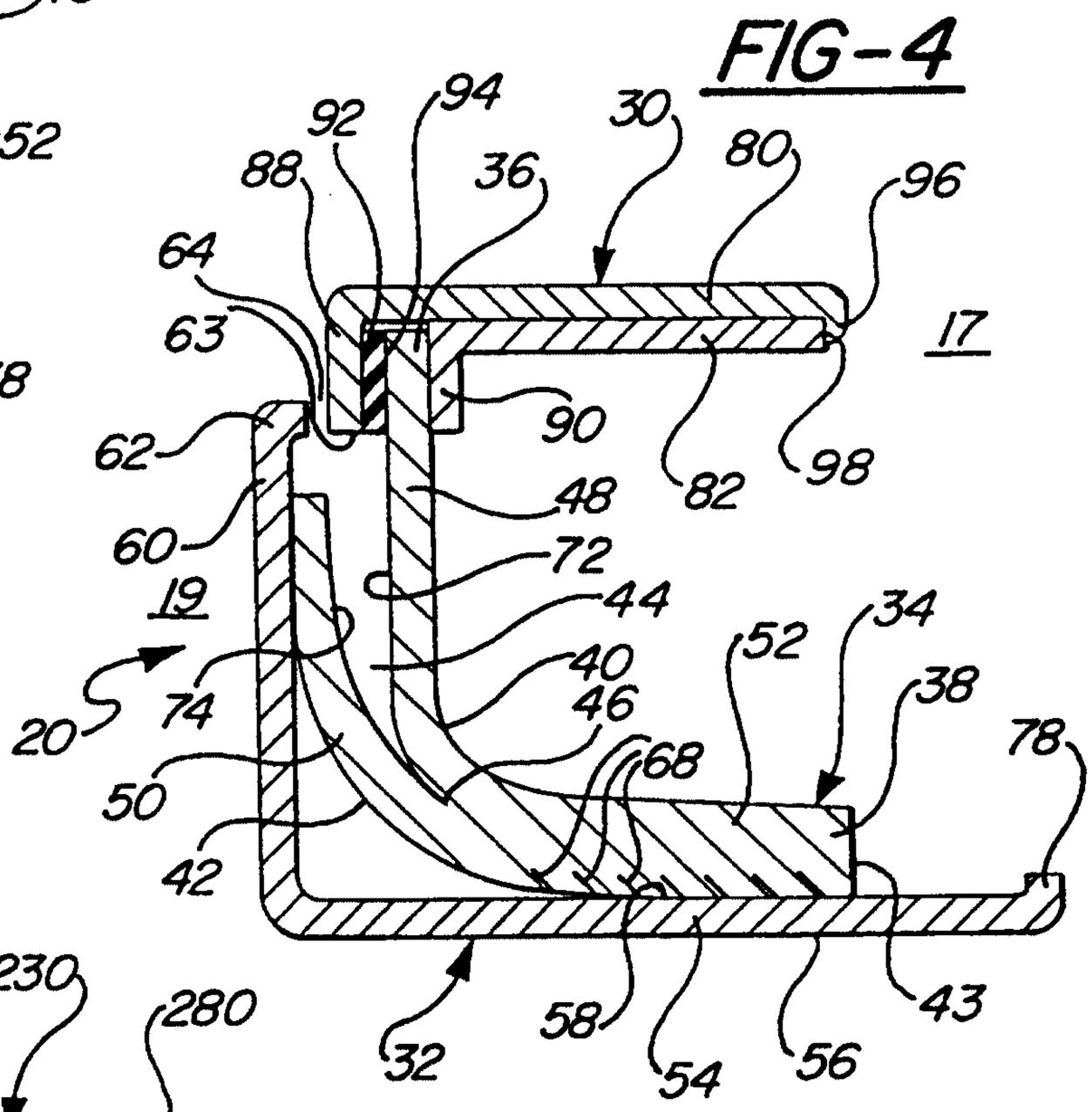


FIG-4



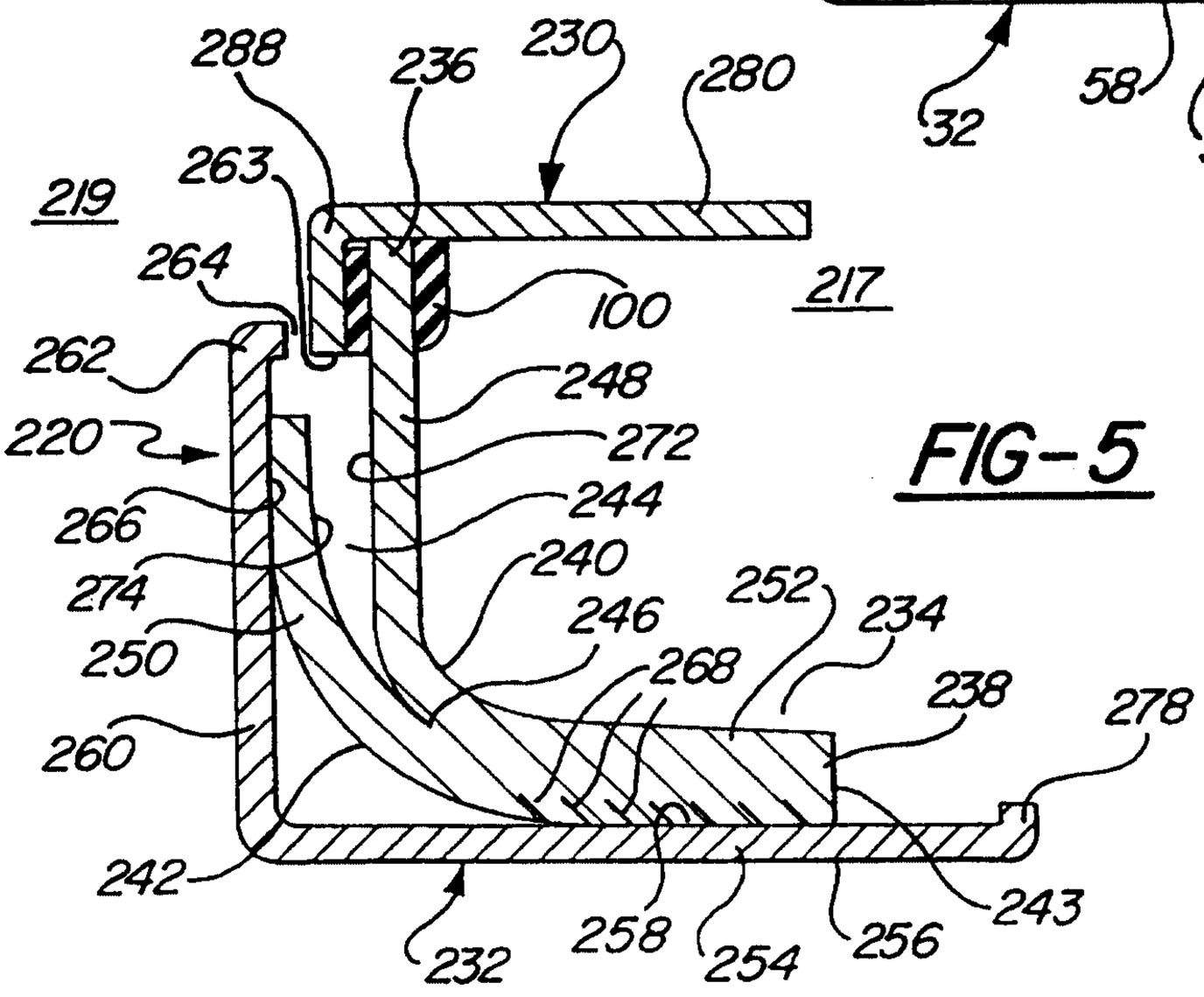


FIG-5

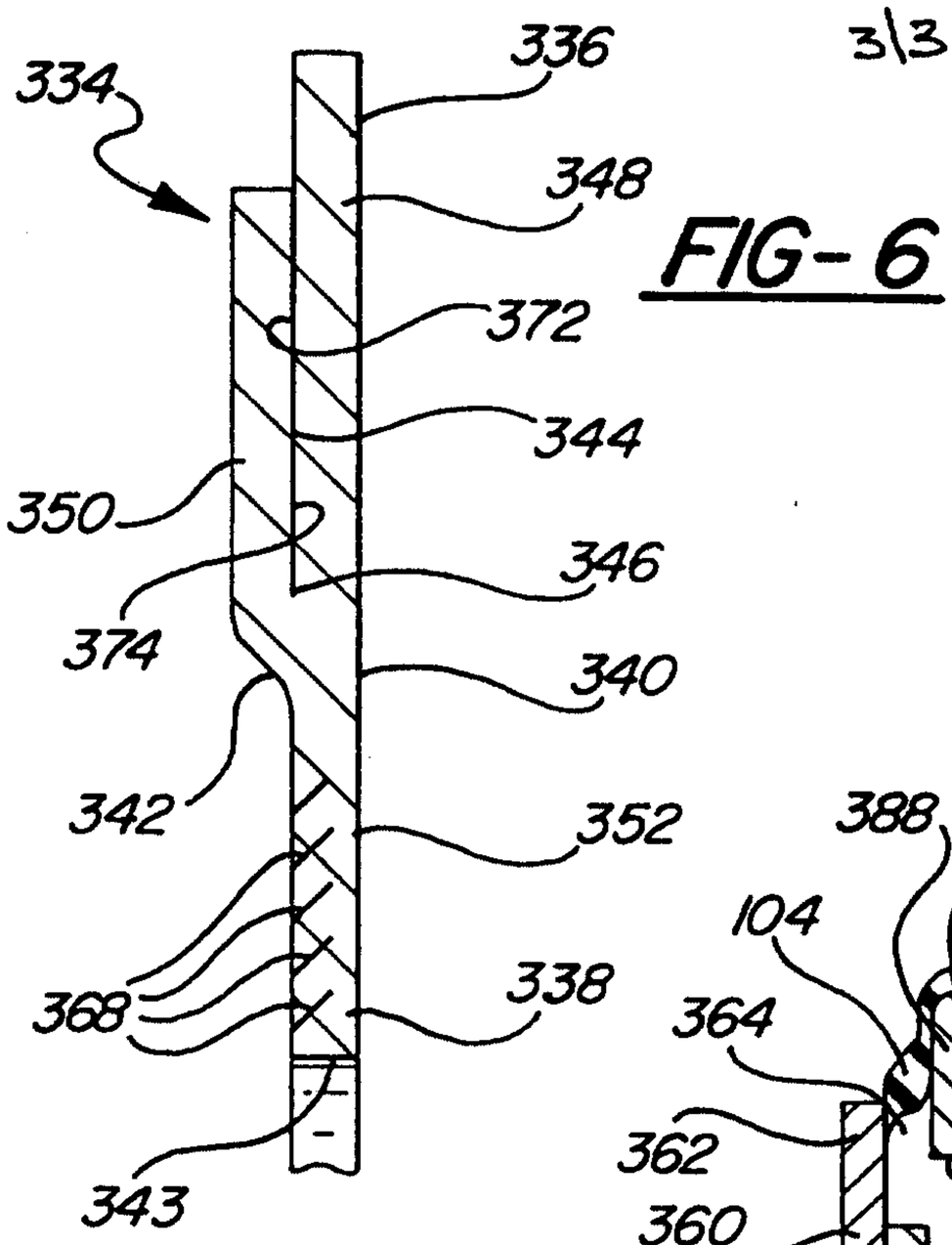


FIG-6

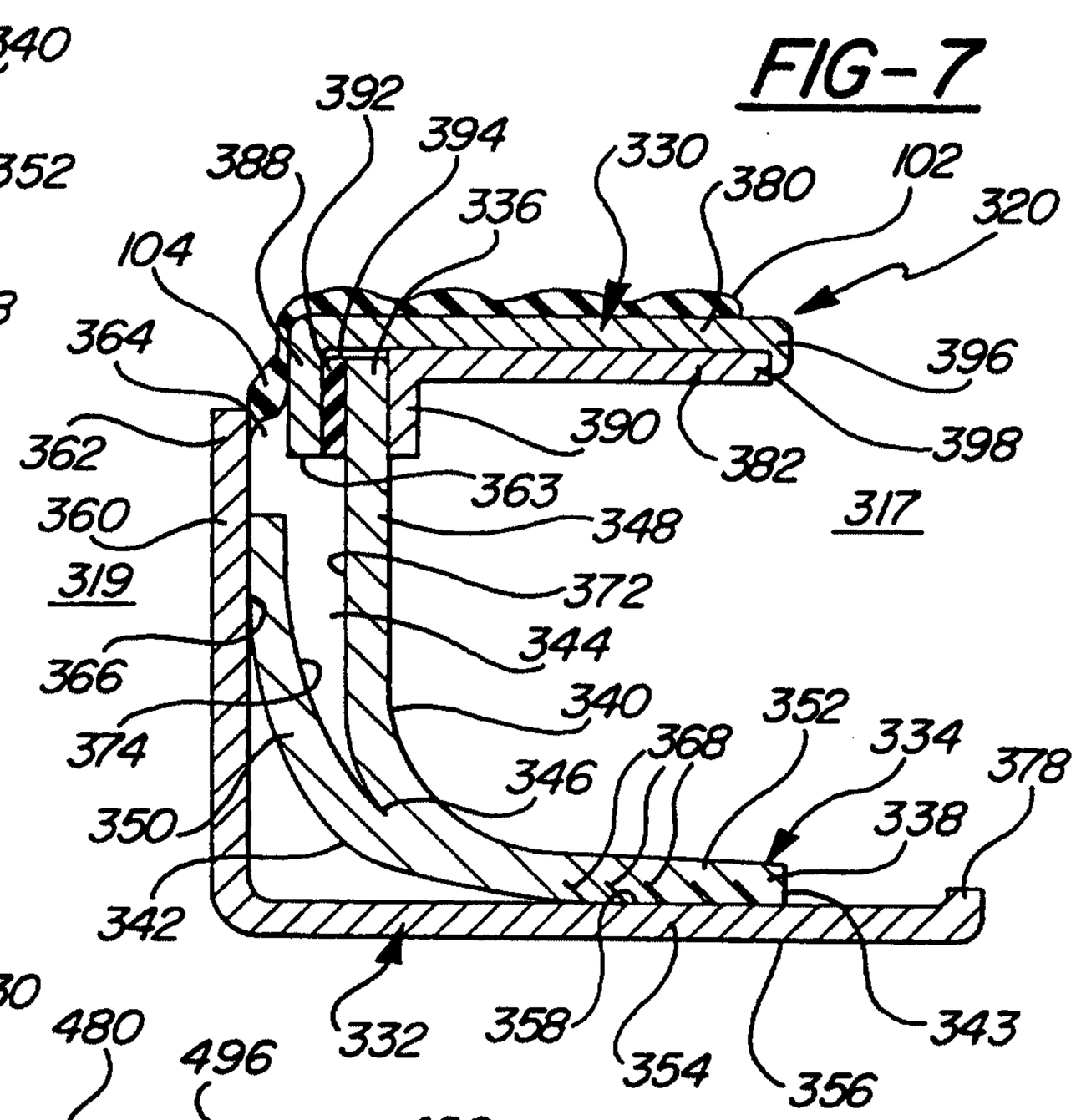


FIG-7

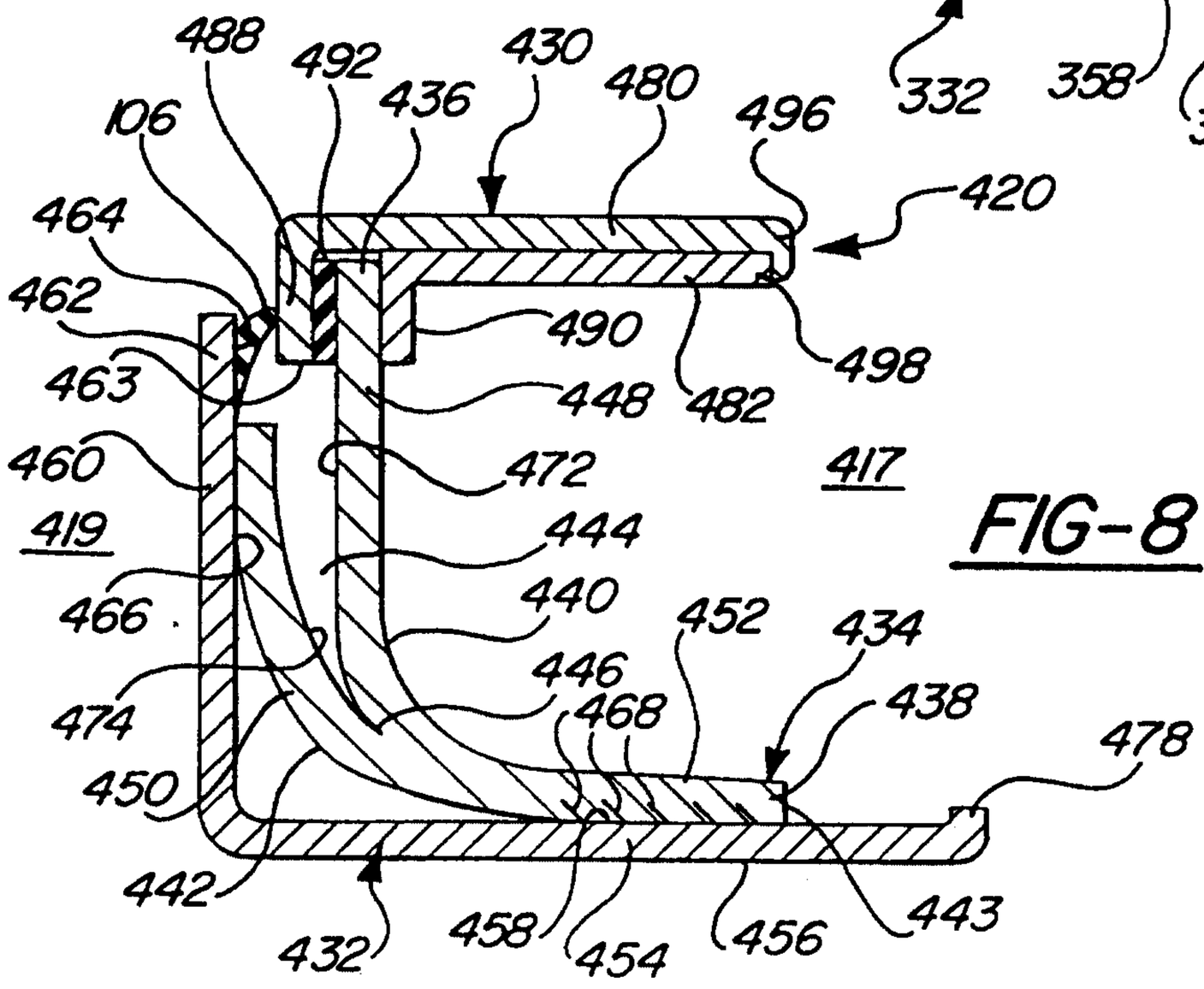
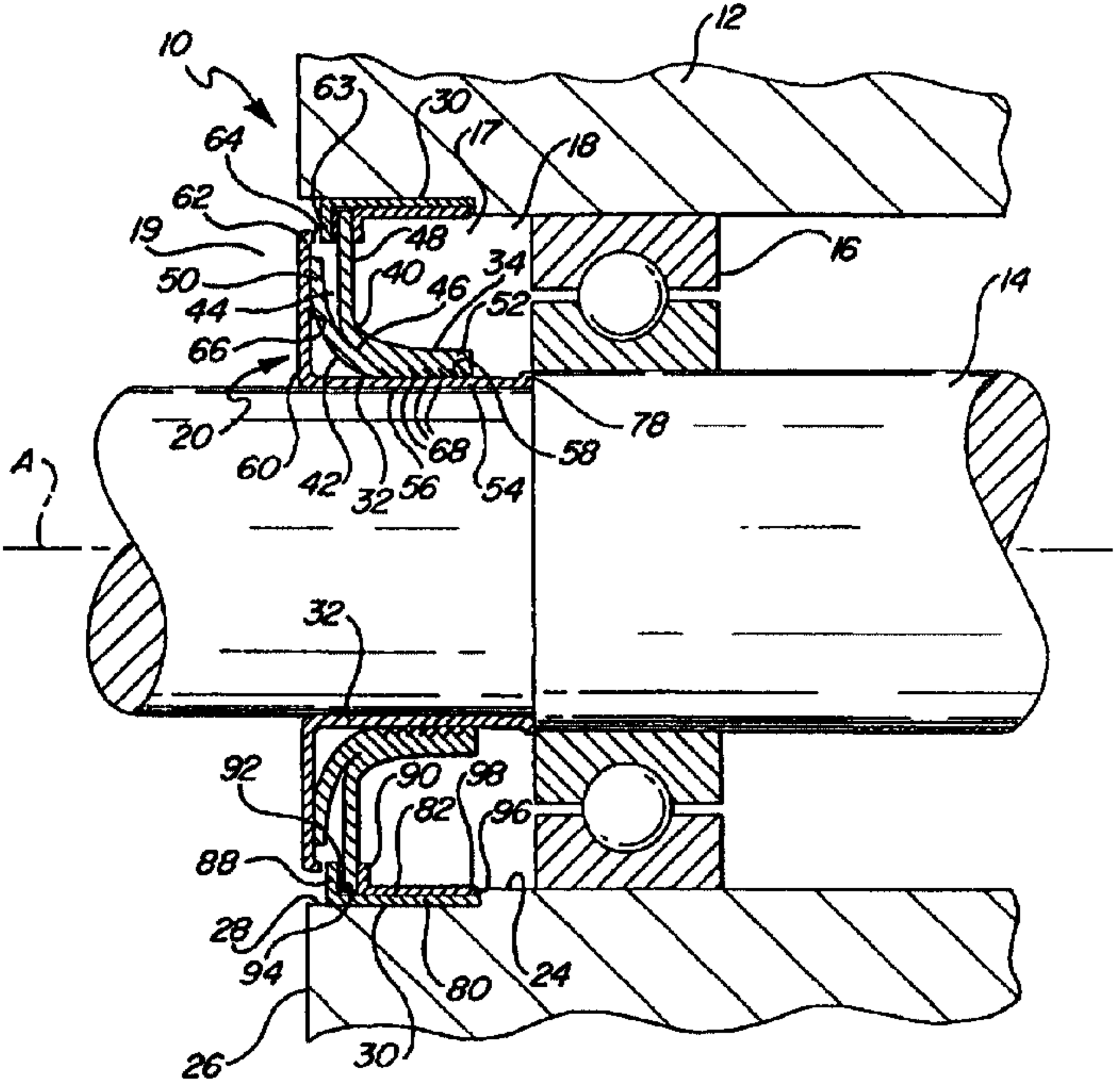


FIG-8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