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(71) Applicant: FEDERAL-MOGUL CORPORATION [US/US]; P.O. Box 1966, Detroit, MI 48235 (US).

(72) Inventors: ROMERO, Richard, A. ; 29258 Laurel Drive, Farmington Hills, MI 48331 (US). PAHIOS, Mark, G. ; 23920 Middlebelt, Apt. 3107, Farmington Hills, MI 48024 (US). COX, Jon, A. ; 5851 Oak Creek Lane, Brighton, MI 48116 (US).

(74) Agent: SHURUPOFF, Lawrence, J.; P.O. Box 1966, Detroit, MI 48235 (US).

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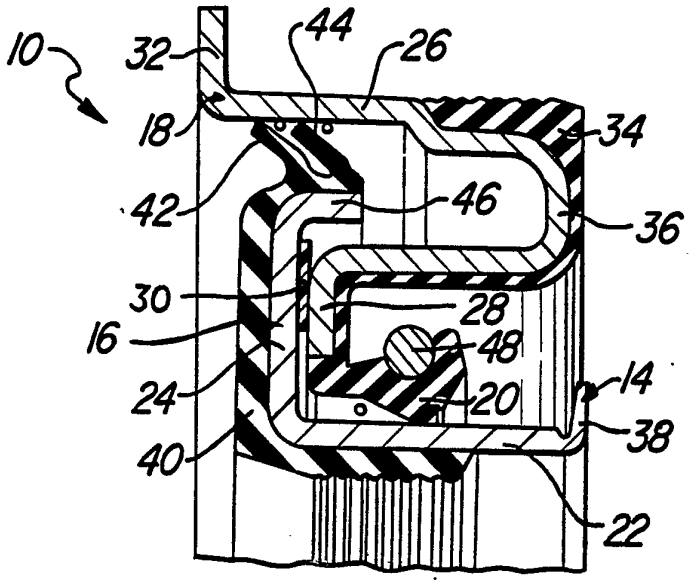

(57) Abstract

A two-piece radial lip seal (10) includes an inner seal case (16) unitized with an outer seal case (18). A wear resistant member (30) is provided between opposed radial flanges (24, 28) located on the inner and outer seal cases. The wear resistant member is preferably formed of a non-elastomeric material having a low coefficient of friction such as polytetrafluoroethylene. The wear resistant member limits the friction generated between the inner and outer seal cases during their relative rotation.

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LOW FRICTION RADIAL LIP SEAL

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates to radial lip seals and more particularly relates to seals which seal between two relatively rotatable machine elements.

Brief Description of the Background Art

Radial lip oil seals are used in numerous rotating machine applications including wheel hubs, shaft journals and anti-friction bearings. A particular form of a radial lip oil seal known as a unitized oil seal is preferred in certain applications because it protects the seal lips and minimizes the need for finishing the surfaces sealed by the unitized seal. A typical unitized radial lip seal includes relatively rotatable inner and outer metal elements or casings upon which elastomeric seal lips may be formed.

Unitized seals are often installed as a unit within a bore in a wheel hub. The wheel hub is then mounted over an axle around which the seal lip forms an annular sealing barrier. This mounting assembly generally involves some relative axial shifting of the inner and outer unitized seal elements. As the seal elements are axially shifted during installation, a significant axial load may be applied to the seal and may result in metal-to-metal, metal-to-rubber or rubber-to-rubber contact between the inner and outer elements. Such metal-to-metal contact can reduce seal life and cause an increase in torque required to rotate the seal as the inner and outer elements rub against one another. This condition can be aggravated by insufficient lubrication on the radial seal lip.

In order to prevent metal-to-metal contact, prior unitized seals have used axially-extending elastomeric bumpers or nibs for axially spacing the inner seal element from the outer seal element. However, upon assembly or mounting the unitized seal within a housing or mounting bore and over a shaft, the axially-directed mounting forces axially compress the bumpers and nibs between the inner and outer sealing elements. During the initial break-in period of the unitized seal, the nibs or bumpers on one seal element must be worn away to eventually provide clearance or minimal contact between the bumpers and a locating surface on the other seal element.

During the break-in period, the rubber nibs or bumpers generate significant resistance to rotation between the inner and outer sealing elements. This resistance must be overcome by increasing the torque applied between the sealing elements. Clearly, this increased resistance is undesirable from an efficiency viewpoint as energy is required to overcome the friction generated by the abrasion of the bumpers and nibs. Moreover, the heat generated by the friction can adversely affect the seal lip materials.

Because the nibs are initially compressed during installation, they subsequently expand axially during break-in thereby prolonging the time during which start-up torque must be increased to generate relative rotation between the shaft and bore being sealed. That is, as the nibs are worn away, they still maintain contact with the other seal element as they axially expand to relieve their compression. This prolongs the break-in period.

A typical example of a continuous unitized oil seal design is shown in U.S. Patent No. 3,510,138 to Bowen which discloses the concept of providing a hard rubber surface on a unitized oil seal to minimize squealing of new seals when a seal case binds against an elastomeric portion of an oil seal. The hard rubber washer is bonded to the elastomeric body of the seal.

If the seal of Bowen is assembled with excessive axial loading, the hard rubber washer will compress the elastomeric portion and result in increased torque being required to rotate the seal. Since the hard rubber washer is bonded to an elastomeric member, assembly of the seal is fairly complex and requires a difficult molding step.

U.S. Patent No. 4,667,968 to Nash, et al discloses an elastomeric radial lip seal wherein radially inwardly projecting unitizing nubs are provided to lock the inner and outer portions of the unitized seal together. The rubber nubs of Nash do not prevent metal-to-metal contact and the seal does not have low torque characteristics until the nubs are worn away to provide clearance between the unitized casings.

SUMMARY OF THE INVENTION

A radial lip seal having a low friction, non-elastomeric wear resistant member disposed between radially extending flanges of each casing element of a two-part seal is adapted for installation between first and second radially spaced relatively rotatable machine elements. A seal lip is retained by one of the seal cases to sealingly engage the other seal case. The wear resistant member may be loosely or fixedly disposed between the radially extending flanges to space them from one another. The wear resistant member acts as a thrust washer between the inner and outer seal cases along the radially extending flanges.

The wear resistant member is preferably a ring of non-elastomeric material having a low coefficient of friction. A particularly suitable material is filled or unfilled polytetrafluoroethylene. The wear resistant member may be either bonded or otherwise secured to one of the seal cases. Alternatively, the wear resistant member may be loosely retained between a pair of opposed radially extending seal case flanges.

In one embodiment, the wear resistant member may include a plurality of wear pads disposed at circumferentially spaced locations on one or both of the inner and outer seal cases. The wear pads may either be bonded or mechanically fastened to one or both of the radially-extending flanges.

A primary object of this invention is to provide an oil seal having low start-up torque requirements by reducing friction between relatively rotating seal elements or casings.

Another object is to provide an oil seal which is unaffected by variations in the axial alignment of the inner and outer portions of the seal casings which occur during installation of the seal.

Still another object is to prevent metal-to-metal contact between the inner and outer seal casings of a radial lip seal.

It is also an objective to provide an oil seal which runs at lower operating temperatures.

These and other objectives are achieved and problems are overcome according to the radial lip oil seal of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic cross-sectional view of a wheel bearing fitted with a seal assembly constructed according to the present invention;

Figure 2 is an enlarged fragmentary cross-sectional view of the radial lip seal of Figure 1;

Figure 3 is a fragmentary cross-sectional view of an alternate embodiment of a radial lip seal constructed in accordance with the present invention;

Figure 4 is a cross-sectional view of another embodiment of a radial lip seal constructed in accordance with the present invention;

Figure 5 is a fragmentary elevational view of a radial flange of a seal case constructed in accordance with yet another embodiment of the present invention; and

Figure 6 is a cross-sectional view taken along line 6-6 of Figure 5.

DETAILED DESCRIPTION

Referring now to Figure 1, a unitized radial lip seal 10 is located between a shaft 12 and a housing bore 14 for protecting an anti-friction bearing 11. The shaft 12 and bore 14 should be broadly construed to include two relatively rotatable machine elements. The radial lip seal 10 includes an inner metal case 16 and an outer metal case 18 which in combination support and protect a seal lip 20. In Figure 1, the seal lip 20 is connected to the outer seal case 18. If desired, the seal lip 20 may be attached to the inner case 16.

The inner case 16 includes a cylindrical wall 22 which encircles the shaft 12 and functions as a wear sleeve for the seal lip 20. The inner case 16 also includes a radially outwardly extending flange 24. The outer case 18 includes a cylindrical wall 26 which lines the inner surface of the bore 14 and may also function as a wear sleeve for an auxiliary lip. Outer case 18 also includes a radially inwardly extending flange 28.

A wear resistant anti-friction member 30 is disposed between the radially outwardly extending flange 24 and the radially inwardly extending flange 28. Wear resistant anti-friction member 30 may be fixed to the inner case 16 or outer case 18 or may be loosely held between the radially extending flanges 24 and 28. The wear resistant anti-friction member 30 is preferably formed as an annular polytetrafluoroethylene (PTFE) washer.

Referring now to Figure 2, the outer case 18 includes a locating flange 32 which is adapted to be abutted against the outer edge of the bore 14 when the outer case 18 is installed in the bore. An elastomeric lining 34 is molded over an axially-extending rib of the outer case 18. The elastomeric lining 34 is molded over the outer case and is advantageously formed in the same molding operation as the seal lip 20. A unitizing flange 38 is formed on the inner axial end of the cylindrical wall 22 for locking the inner and outer cases together after assembly.

An elastomeric lining 40 is molded on the inner case 16 which partially covers the radially inner side of the cylindrical wall 22 and the axially-outwardly facing surface of the radially-outwardly extending flange 24. The elastomeric lining extends to and forms first and second auxiliary seal lips 42 and 44 which are molded over an axial flange 46 at the outer end of the radially outwardly extending flange 24. A garter spring 48 is preferably provided to bias the seal lip 20 into sealing engagement with the cylindrical wall 22.

The unitized radial lip seal 50 is shown in Figure 3 as being installed between a shaft 52 and a bore 54 formed in a housing 56. The seal 50 includes an inner metal case 58 and an outer metal case 60 secured together in a unitized relationship.An elastomeric seal element 62 is molded onto the outer case 60 and defines a main lip 64 and an auxiliary lip 66. The main lip 64 and auxiliary lip 66 each engage the inner case 58.

The inner case 58 (Figure 3) includes a radially outwardly extending flange 68 which is connected to a cylindrical wall 70 via a frustoconical wall 72. The outer case 60 includes a radially outwardly extending flange 74 which is connected to the outer axial end of the cylindrical wall 76. A seal support flange 78 is connected to the inner axial end of the cylindrical wall 76 and extends radially inwardly toward the inner case 58.

A reversely turned flange 80 is formed at the radially outer edge of the radially outwardly extending flange 74. The reversely turned flange 80 is formed over the radially outwardly extending flange 68 after axially abutting the inner and outer cases 58 and 60 as seen in Figure 3.

A wear resistant member 82, which may be formed as a wafer of filled or unfilled polytetrafluorethylene (PTFE), is disposed between the radially outwardly extending flange 68 of the inner case 58 and the radially outwardly extending flange 74 of the outer case 60. The wear resistant member 82 prevents metal-to-metal contact between the flange 68 and the flange 74 and serves to reduce friction and torque transmitted through the flanges 68, 74. This also reduces the operating temperature of the seal and prolongs the useful life of the elastomeric seal lips.

Since the wear resistant member 82 is preferably formed of low friction PTFE, it reduces the amount of start-up torque required in the event that the inner and outer seal cases are axially misaligned when placed between the shaft 52 and the bore 54. The reversely turned flange 80 is connected to the flange 74 by an axially-extending flange 84 that provides axial and radial clearance for the flange 68 and the wear resistant member 82.

An elastomeric lining 86 is formed on the inner surface of the inner case 58. The elastomeric lining facilitates seating the inner case 58 on the shaft 52. In an alternative embodiment, an annular elastomeric cap 88 may be formed as part of the elastomeric lining 86. The cap 88 is formed across the interior opening in the inner case 58 in a manner similar to that of a tear away cap on a bottle. Frequently, when a seal is assembled within a bore in a housing and before insertion of a shaft in the housing, separately formed caps or plugs are used to keep foreign materials out of the housing. The elastomeric cap 88 is circumferentially weakened at 89 adjacent the elastomeric lining 86 so that the cap 88 may be cut or torn away without damaging the seal.

Another embodiment of the invention is shown in Figure 4 as unitized radial lip seal 90. The seal 90 includes an inner case 92 and a two-part outer case 94. The two-part outer case 94 includes a clamping ring 96 and a clamped ring 98. A PTFE seal wafer 100 and a resilient gasket ring 102 are secured in the two-part outer case 94 by the clamping ring 96 engaging and axially squeezing the clamped ring 98. The PTFE seal wafer 100 includes a seal lip 104 which engages with the cylindrical wall 106 of the inner case 92. The PTFE seal wafer 100 may include hydrodynamic surface elements or formations to aid in sealing, as is well known in the art.

A radially outwardly extending flange 108 is formed on the axially outer end of the inner case 92. A cylindrical wall 110 of the clamping ring 96 includes a radially inwardly extending flange 112 on the axially outer end thereof. A wear resistant member 114, preferably formed as a ring of PTFE, is trapped between the radially inwardly extending flange 112 and the radially outwardly flange 108.

An elastomeric shaft liner 116 is bonded to the inner surface of the cylindrical wall 106. The shaft liner 116 extends across the axially extending outer surface of the radially

outwardly extending flange 108 and terminates in an auxiliary seal lip 118. An elastomeric bore liner 120 is bonded to the cylindrical wall 110 of the clamping ring 96 and aids in locking the unitized radial lip seal 90 within a bore.

Referring now to Figure 5, a plurality of wear pads 122 are circumferentially spaced about a radially extending surface 124 of a seal case. The wear pads 122 function in the same manner as the ring of PTFE material which forms the wear resistant member of the previous embodiments. If spaced wear pads are used, less PTFE material is required.

The wear pads 122 are secured to the radially-extending flange 124 by bonding with suitable adhesives or secured through a hole in the radially-extending surface, as shown in Figure 6. A mechanical locking element 128 may be formed on one end of a projection 129. The mechanical locking element may be formed as an enlarged area of the projection 129 or may be formed after insertion by heat staking or otherwise deforming the projection 129.

Because the PTFE ring does not experience significant axial compression during installation, and because of PTFE's low coefficient of friction, start-up torque requirements are lowered compared to prior unitized seal designs which used axially-extending elastomeric bumbers to axially space the seal case members from one another. PTFE, which is not elastomeric, does not compress as much as the elastomeric materials previously used to separate unitized seal case members from one another. Therefore, PTFE does not expand as much as prior elastomers during break-in. This leads to a shorter break-in period and more accurate operating tolerances between the seal case members since less axial compression results in less uncontrolled relative spacing between the seal members during seal installations.

Specifically, the axial spacing of the inner and outer seal case elements having rubber or elastomeric spacers or bumbers is dependent upon the degree of axial compression of the spacers which in turn is dependent upon the axial force applied during installation. As installation forces vary from one application to another, so may the resulting spacing between the unitized seal case members. This variance is negligible when a relatively rigid spacer such as a rigid plastic spacer of PTFE or the like is used according to the present invention.

To those skilled in the art to which this invention relates, many changes in construction and engineering applications of the invention will suggest themselves without departing from the scope of the invention. The scope of the invention is defined by the following claims and should not be limited by the preceding descriptions of specific embodiments of the invention. More particularly, any two-piece seal whether unitized or non-unitized, which may be subject to axial contact forces may be fitted with a low friction PTFE ring to achieve the advantages discussed above.

WHAT IS CLAIMED IS:

1. A radial lip seal (10) for sealing between first (12) and second (14) relatively rotatable machine elements said seal comprising an inner seal case (16) having a first radially extending flange (24), said inner seal case (16) being adapted to be installed over the first machine element (12); an outer seal case (18) having a second radially extending flange (28), said outer seal case (18) being adapted to be installed into a bore formed in the second machine element (14); a seal lip (20) retained by one of said inner and outer seal cases (16, 18) to sealingly engage the other of said seal cases (18, 16); characterized by a wear resistant member (30) disposed between the first and second (28) radially extending flanges spacing them from one another, said wear resistant member (30) being effective to act as a thrust washer and to reduce friction generated between said first (24) and second (28) radially extending flanges.

2. The seal (10) of claim 1 wherein said wear resistant member (30) comprises a ring of polytetrafluoroethylene.

3. The seal (10) of claim 2 wherein said wear resistant member (30) is unattached to either of said inner (16) and outer (18) seal cases and is retained between said first (24) and second (28) radially extending flanges.

4. The seal (10) of claim 1 wherein said wear resistant member (30) is bonded to one of said inner (16) and outer (18) seal cases.

5. The seal (10) of claim 1 wherein said wear resistant member (30) comprises a plurality of wear pads (122) disposed at circumferentially spaced locations.

6. The seal (10) of claim 5 wherein said wear pads (122) are bonded to one of said inner (16) and outer (18) seal cases.

7. The seal (10) of claim 6 wherein said wear pads (122) are mechanically fastened through holes formed in one of said inner (16) and outer (18) seal cases.

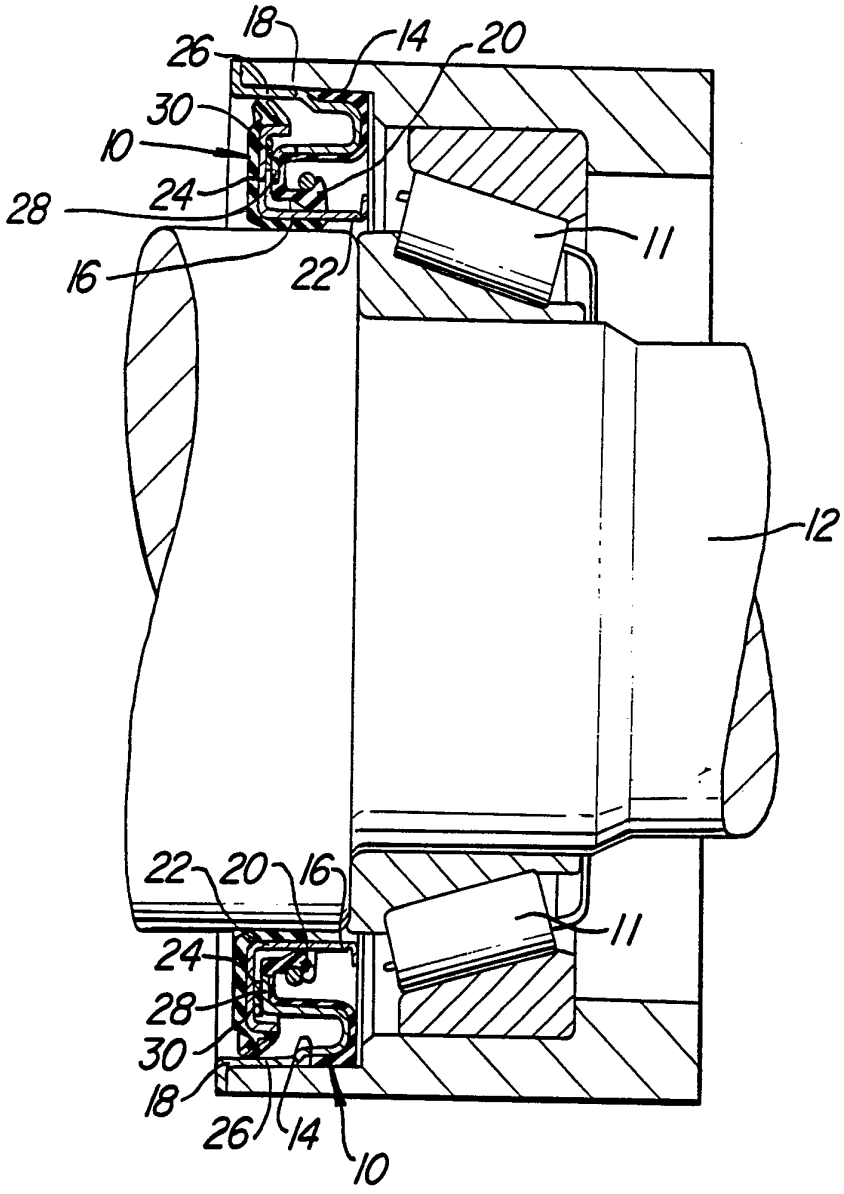
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Fig-1

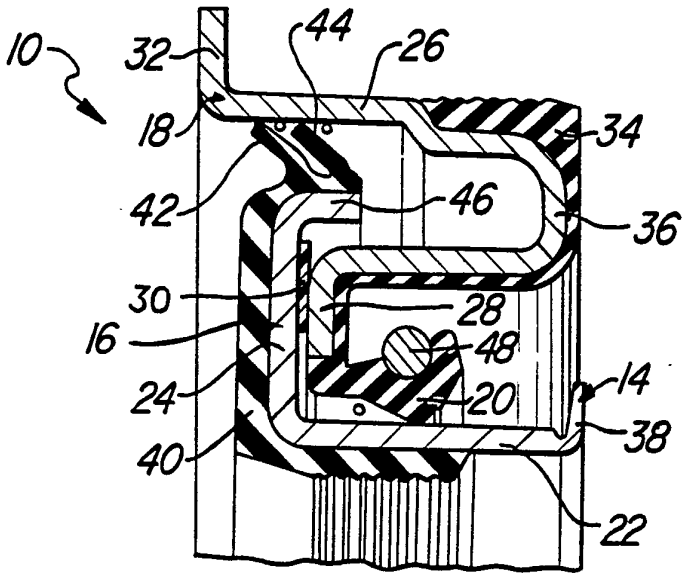
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Fig-2

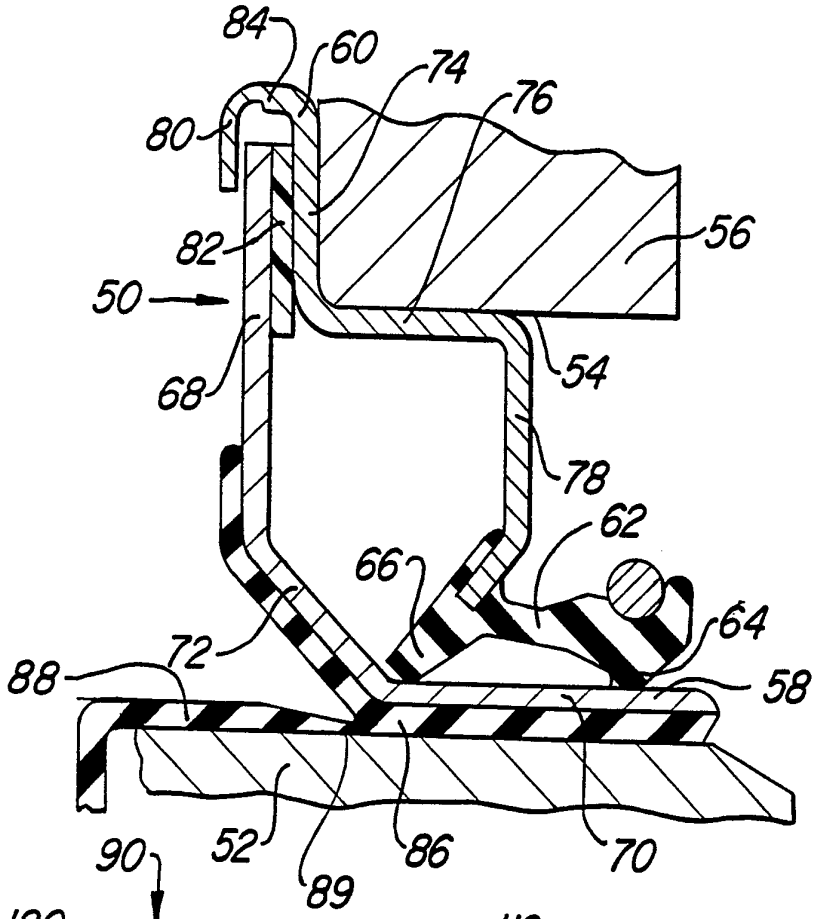

Fig-3

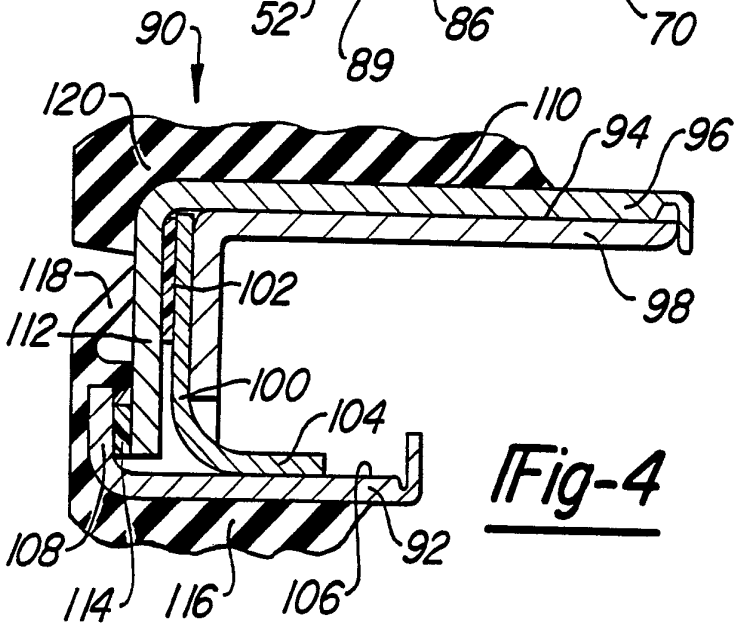

Fig-4

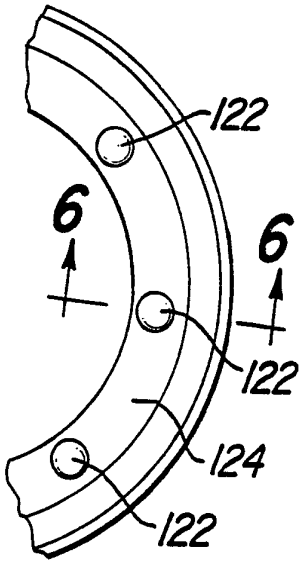

Fig-5

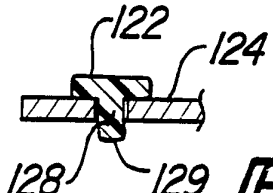

Fig-6

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 90/00178

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: F 16 J 15/32

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	F 16 J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	GB, A, 1300590 (HANSSON et al.) 20 December 1972 see figures 5,8; page 3, lines 20-31	1-3
X	DE, A, 3445561 (KACO) 3 July 1986 see figures; page 10, line 15 - page 11, line 11	1
A		3,5
A	US, A, 3156474 (NELSON) 10 November 1964 see figures; column 2, lines 40-60	5

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8th May 1990	0 8 JUIN 1990
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MISS T. TAZELAAR

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9000178 SA 34122

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 1300590	20-12-72	None	
DE-A- 3445561	03-07-86	None	
US-A- 3156474		None	