



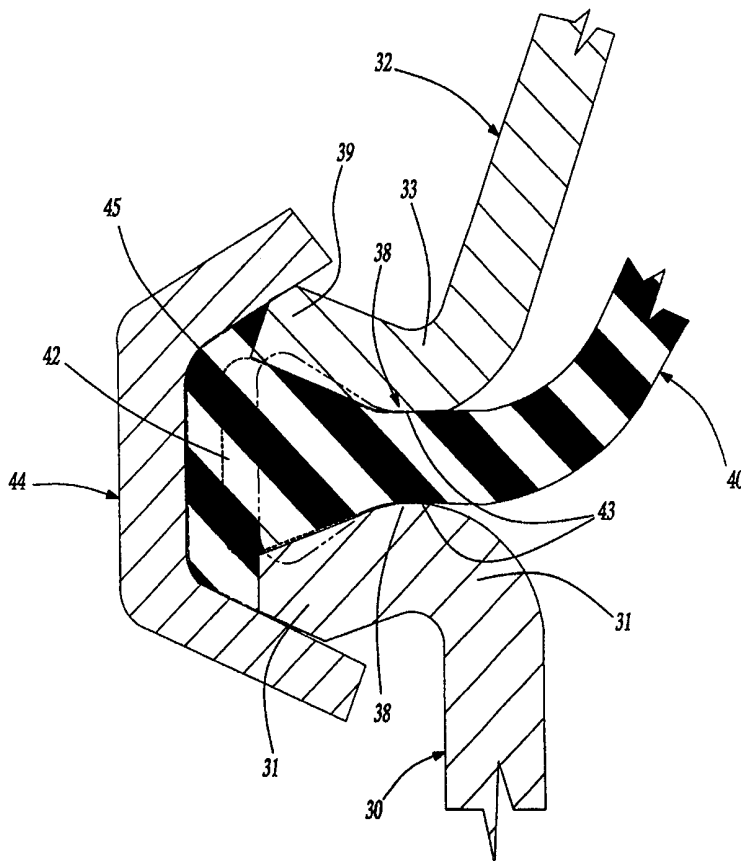
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: EASY FIT DIAPHRAGM

(57) Abstract

The present invention provides a brake actuator assembly including a housing (30) having a generally radial annular flange portion (41) and a cover (32) having a generally radial annular flange portion generally co-axially aligned with the generally radial annular flange portion of the housing (30). A cup-shaped flexible diaphragm (40) having an outer radial rim portion is disposed between the generally radial annular flange portions of the housing (30) and the cover (32). A retaining element generally surrounds and compresses the generally annular flange portions of the housing (30) and the cover (32) against the rim portion (41) of the flexible diaphragm (40). The rim portion of the diaphragm includes a wedge-shaped edge portion (42) and co-axially aligned flats on opposite sides of the rim portion (41) adjacent to the wedge-shaped edge portion (42) aligning the flange portions of the housing (30) and the cover (32). In another embodiment, a flexible brake diaphragm includes a cup-shaped flexible diaphragm having an outer radial annular rim portion. The rim portion of the diaphragm includes a wedge-shaped edge portion and co-axially aligned flats (43) on opposite sides of the rim portion adjacent to the wedge-shaped edge portion (42).



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EASY FIT DIAPHRAGM

The present invention relates generally to
braking systems and, more specifically, to fluid-
operated brake actuators such as air brake actuators.

BACKGROUND OF THE INVENTION

Fluid-operated braking systems such as air brake
systems have long been used to control the movement of
motor vehicles in a safe and effective manner. In
particular, air brakes are commonly used on commercial
vehicles, such as trucks which typically have large
gross vehicle weights. The considerable inertial mass
of these heavy-duty vehicles in combination with the
high speeds at which they travel require a braking
system which responds rapidly with substantial braking
power. One system component which is instrumental in
the operation of air brake systems is the brake
actuator. The brake actuator provides the force
necessary when braking a vehicle. Commercial air
brake actuators can actuate the normal surface brakes
as well as parking/emergency brakes. The brake
actuators, also known as spring brakes, typically have
a network of air chambers defined by one or more
diaphragms and/or pistons and a plurality of springs
which operate to provide the appropriate braking
action in response to inputs by the vehicle driver.
In the event an air braking system loses pressure, the
brake actuator automatically engages the vehicle
brakes.

In brake actuators of this type, the diaphragms
are typically flexible, cup-shaped and have an outer
radial rim which is received and compressed between
flange portions of a housing and cover. Such
diaphragms are generally formed of a rubber material

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with a fibrous reinforcement disposed therein. Diaphragms are often molded in an ovoid shape making it somewhat difficult to align and assemble the diaphragm in the brake actuator housing. The
5 difficulties in assembly can often lead to leakage of the seal established between the diaphragm and the flange portions of the housing and cover. Great care is taken in the manufacture of the brake actuators in order to test for leaking actuator assemblies,
10 identify leaking brake actuators assemblies, and to eliminate leaking brake actuator assemblies. If the brake actuator assembly leaks, the brake actuator may fail.

In this type of brake actuator assembly, it is
15 important during assembly that the rim portion of the flexible diaphragm be properly seated and aligned prior to being compressed between the opposed radial flanges of the housing and the cover. During assembly the flexible diaphragm must be coaxially aligned with
20 the radial flanges of the opposed housing members. However, due to the ovoid shape of typical diaphragms as received from the manufacturer and curvature of the surfaces of the opposed radial flanges, alignment of the diaphragm and housing is difficult, thereby
25 increasing the potential for leakage.

Additionally, the thickness of radial rim portion of the diaphragm causes difficulty in the assembly of the brake actuator. The thickness of the rim portion of the diaphragm requires that the housing and cover
30 be placed in compression against the diaphragm during assembly in order to facilitate the application of a band clamp which holds the housing and cover in sealing engagement with the diaphragm.

Accordingly, it would be both advantageous and
35 desirable to have a diaphragm which can more easily be positioned and seated during assembly of the brake

actuator to reduce the amount of leaking brake
actuator assemblies and which also aids in the
assembly process by eliminating the step of
compressing together the housing and the cover in
5 order to attach and fasten the band clamp.

SUMMARY OF THE INVENTION

In accordance with the present invention, a brake
actuator assembly is provided which includes a housing
10 having an open end and a generally radial annular
flange portion surrounding the open end, a cover
having a generally radial annular flange portion
generally coaxially aligned with the generally radial
annular flange portion of the housing, a cup-shaped
15 flexible diaphragm having an outer radial annular rim
portion located between the generally radial annular
flange portions of the housing and the cover, and an
annular clamp which may be separate or integral with
one of the housing members generally surrounding and
20 compressing the generally radial annular flange
portions of the housing and cover against the rim
portion of the flexible diaphragm. The rim portion of
the diaphragm includes a wedge-shaped edge portion and
co-axially aligned flats on opposite sides of the rim
25 portion adjacent the wedge-shaped edge portion which
aligns the flange portions of the housing and the
cover.

Also in accordance with the present invention,
there is disclosed a flexible brake diaphragm which
30 includes a cup-shaped flexible diaphragm having an
outer radial annular rim portion. The outer annular
rim portion of the diaphragm includes a wedge-shaped
edge portion and co-axially aligned flats on opposite
sides of the rim portion adjacent to the wedge-shaped
35 edge portion.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the
5 accompanying drawings wherein:

FIGURE 1 is a cross-sectional side elevational view of one embodiment of the brake actuator of the present invention;

10 FIGURE 2 is a top view of the brake actuator shown in Figure 1 illustrating a clamp band having two retaining bolts;

FIGURE 3 is a cross-sectional side elevational view of a preferred embodiment of the diaphragm of the present invention;

15 FIGURE 4 is an enlarged view of the rim portion of the diaphragm as shown in Figure 3;

FIGURE 5 is a cross-sectional view of the rim portion of the diaphragm resting on a flange portion of the service housing;

20 FIGURE 6 is a cross-sectional side elevational view of the rim portion of the diaphragm disposed within the service chamber assembly including a clamp ring; and

25 FIGURE 7 is a partial cross-sectional side elevational view of an alternative embodiment of the brake actuator of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

30 Referring to Figure 1 of the drawings, in one embodiment of the present invention, a brake actuator 20 is shown generally, illustrated here as a single-diaphragm air brake actuator. The brake actuator 20 includes a service chamber assembly 22 having a push
35 rod 24 attached to a service side piston 26. The service chamber assembly 22 includes a service housing

30 and a service housing cover 32 which define a non-pressure chamber 28 which encloses a return spring 36. Conventional mounting bolts 34 and a yoke assembly 35 are also shown. Other brake actuator assemblies may
5 be suitable in the present invention.

As will be understood by those skilled in the art, fluid actuated or "air brakes" of this nature are controlled by the movement of one or more flexible diaphragms and rigid piston plates which combine to
10 form a movable wall when actuated by air pressure differentials created in the various chambers of the brake actuator 20.

The brake actuator 20 is equipped with a flexible, cup-shaped, and generally circular diaphragm
15 40 having a peripheral annular flange 41 including an expanded outside diameter portion or simply expanded portion 42 in the nature of an integral O-ring or the like. The diaphragm 40 forms a hermetic or air-tight seal by the compression of the expanded portion 42 at
20 the interface of the service housing 30 and the service housing cover 32. The diaphragm 40 is formed of a resilient material such as rubber, neoprene, fabric-center reinforced neoprene or the like. In order to obtain this compression of the expanded
25 portion 42 and to attached the service housing 30 to the service housing cover 32, a clamp ring 44 is positioned over an annular flange portion 31 of the service housing 30 and an annular flange portion of the service housing cover 32.

Referring to Figure 2, the clamp ring 44 is shown
30 in greater detail having two semi-circular portions 50 and 52. Each semi-circular portion 50,52 having tabs or ears 54 through which clamp retaining bolts 56 are inserted to tighten the clamp ring 44 in position by
35 tightening retaining nuts 58 on the clamp retaining bolts 56. That is, the clamp ring 44 secures the

service housing 30 to the service housing cover 32 and compresses the expanded portion 42 of the diaphragm 40 forming an air-tight seal. A one-piece, single-bolt clamp of this type is also well known in the art and can be utilized with the present invention.

5 Referring again to Figure 1, in the normal service brake mode, air is injected under pressure through an inlet 60 causing the diaphragm 40 and service side piston 26 to move downwardly. It will be understood that the diaphragm 40 and the service side piston 26 form a second movable wall which is air-pressure responsive. The downward movement of this second movable wall causes the push rod 26 to thrust out from the service housing 30 to set the vehicle
10 brakes.

15 Referring to Figure 3, the diaphragm 40 is shown in greater detail. The diaphragm 40 is generally cup-shaped and includes an annular radial flange 41 having an expanded portion 42 and co-axially disposed flats 43 located adjacent to the expanded wedge-shaped portion 42.

20 Referring to Figure 4, the annular flange 41 of the diaphragm 40 is shown in greater detail. The expanded portion 42 of the annular flange 41 is generally wedge-shaped at its outer portion. Adjacent to the wedge-shaped expanded portion 42 of the annular flange 41 are disposed co-axially aligned flat portions 43 on opposite sides of the annular flange 41. The flats 43 preferably have a minimum flat
25 radius or width of approximately 0.030 inches but may be as large as necessary depending upon the dimensions of the diaphragm. Preferably, the width of the flat 43 ranges from approximately 0.030 inches to approximately 0.075 inches. The flats 43 allow the
30 diaphragm 40 to be more easily and accurately seated between the radial flanges 31 and 33.

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Referring to Figure 5, the annular flange 41 of the diaphragm 40 is shown seated on the radial flange 31 of the service housing 30. Preferably, the opposed flanges 31,33 of the service housing 30 and the service housing cover 32, respectively, are U-shaped in cross-section opening outwardly. The opposed flanges 31 and 33 include a flange engagement portion 38 which engages the flat portions 43 on the annular flange 41. In other words, the U-shaped flange portions 31 and 33 engage the flats 43 of the annular flange 41 at the apogees of the U-shaped region. The portion of the U-shaped flanges 31 and 33 which is aligned with the flats 43 of the annular flange 41 is also referred to as the "locus." Each radial flange 31 and 33 also includes an outer leg 39 which receives and compresses the wedge-shaped expanded portion 42 of the diaphragm 40 during applications of the clamp ring 44.

Referring to Figure 6, the diaphragm 40 is shown disposed between the annular flanges 31 and 33 including the clamp ring 44 disposed thereon. The flats 43 of the annular flange 41 are disposed directly adjacent to the flange engagement portion 38 or apogees of the flanges 31 and 33. As force is applied to the annular flanges 31 and 33 by the clamp ring 44, the wedge-shaped expanded portion 42 of the annular flange 41 is received and compressed by the outer legs 39 of the radial flanges 31 and 33 to fill a generally U-shaped space 45 between the clamp band 44 and the housing members 30 and 32 as shown in Figure 6. The wedge-shaped expanded portion 42 is compressed to such a degree that it completely fills the space 45 between the clamp band 44 and the housing members 30 and 32 to form a "hydraulic lock." The hydraulic lock reduces the incidence of brake actuator 20 leakage and also reduces creep or "run-out" of the

diaphragm 40 which is a particular problem when the diaphragm 40 is not accurately aligned during assembly.

5 The flexible diaphragm 40 of this invention will thus naturally and accurately seat the flat 43 on the apogee of the U-shaped flange 31 of the service housing 30, even when the diaphragm 40 is initially ovoid when received from the mold. Therefore, the person assembling the diaphragm 40 on the service housing 30 does not have to adjust the location of the diaphragm 40 on the service housing 30 or hold the diaphragm 40 in place during assembly of the cover 32. Similarly, the U-shaped flange 33 of the cover 32 will naturally nest and accurately seat on the opposed flat 43 on the diaphragm rim portion 41 prior to receipt of the clamp ring 44, resulting in a very accurate alignment of the service housing 30, diaphragm 40, and cover 32 which is very important to avoid leakage around the diaphragm 40 following assembly. Finally, 15 the accuracy of the alignment is not likely to be disturbed or displaced during clamping of the flanges 31,33 because the components are nested and are therefore not easily displaced. Because the clamping force is applied on the flats 43, if the diaphragm 40 is not properly aligned on the service housing 30 during assembly, the wedge-shaped portion 42 of the outer flange 41 can be engaged by the U-shaped flanges 31 and 33 to align the diaphragm 40. If the diaphragm 40 is not completely aligned, more of the wedge-shaped portion 42 will be squeezed out at that point creating an adequate seal and essentially self-align the diaphragm 40 between the U-shaped flanges 31 and 33. 20 25 30

Another feature of the diaphragm 40 of the present invention is that by reducing the thickness of the annular flange portion 41 at the flats 43, the clamp band 44 is more easily assembled on the housing 35

30 and housing cover 32 without the necessity for compressing together the housing 30, diaphragm 40, and housing cover 32 prior to applying the clamp band 44. However, it should be understood, that the clamp band 44 will compress the annular flange portion 41 of the diaphragm 40 as the clamp retaining bolts 56 of the clamp band 44 are tightened.

In an alternative embodiment of the present invention and referring now to Figure 7 of the drawings, a double diaphragm brake actuator assembly 80 is shown generally. Like elements are designated using the same reference numerals as in the embodiment shown in Figures 1 through 6. Also, it is to be understood that while the present invention is described in connection with a specific type of brake actuator and has been illustrated with reference to both a single diaphragm brake actuator and a double diaphragm brake actuator, other fluid brake actuators may be made in accordance with the present invention such as piston type brake actuators, without regard to the type of brakes, cam, disc, or wedge, actuated by the brake actuator and with or without external tube breather systems. The present invention is adaptable to virtually any brake actuator wherein a diaphragm is compressed between a first housing and housing cover or a service housing and a flange case or the like and all of these devices are intended to come within the scope of the present invention.

The double diaphragm air brake actuator 80 includes a service chamber assembly 22 and a spring chamber assembly 82. The spring chamber assembly 82 includes a spring side diaphragm 86 having an expanded portion 88 which is in the nature of an integral O-ring or the like. A spring side piston 90 and a power spring 92 are disposed within the spring chamber assembly 82. An annular retaining member 83 disposed

on the spring chamber assembly 82 provides a tamper-resistant closure or attachment of the head 85 of the spring chamber assembly 82 to the flange case 84. The retaining member 83 in this embodiment is in the nature of a circular channel clamp which receives flange 94 thereby causing the compression of the expanded portion 88 of the diaphragm 86.

The present invention has been described in an illustrative manner. It is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

CLAIMS**WHAT IS CLAIMED IS:**

1. A brake actuator including a housing having
5 an open end and a generally radial annular flange
portion surrounding said open end, a cover having a
generally radial annular flange portion generally
coaxially aligned with said generally radial annular
10 flange portion of said housing, a cup-shaped flexible
diaphragm having an outer radial annular rim portion
located between said generally radial annular flange
portions of said housing and said cover, and a
retainer element generally surrounding and compressing
15 said generally radial annular flange portions of said
housing and said cover against said rim portion of
said flexible diaphragm, said rim portion of said
diaphragm including a wedge-shaped edge portion and
co-axially aligned flats on opposite sides of said rim
20 portion adjacent said wedge-shaped edge portion
aligning said flange portions of said housing and said
cover.

2. The brake actuator defined in Claim 1,
25 wherein said generally annular flange portions of said
housing and said cover each include a U-shaped portion
in cross section opening outwardly having a diaphragm
engagement portion engaging and compressed against
said flats on said rim portion of said flexible
diaphragm.

30

3. The brake actuator defined in Claim 2,
wherein said U-shaped portions of said housing and
said cover each include an outer leg which receives
35 and compresses therebetween said wedge-shaped edge
portion of said flexible diaphragm.

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4. The brake actuator defined in Claim 3, wherein said annular clamp includes an annular U-shaped portion comprising an axial portion surrounding said flange portions of said housing and said cover and opposed axial portions overlying said flange portions of said housing and said over, said radial portions of said annular clamp compressing said rim portion of said flexible diaphragm to substantially fill said U-shaped portion of said clamp.

10

5. The brake actuator defined in Claim 1, wherein said clamp is a separate element.

6. The brake actuator defined in Claim 1, wherein said retainer element includes an annular clamp.

15

7. The brake actuator defined in Claim 1, wherein said retaining element is integral with either said housing or cover flange portions.

20

8. A brake actuator including a housing having an open end and a generally radial annular flange portion surrounding said open end, a cover having a generally radial annular flange portion generally co-axially aligned with said generally radial annular flange portion of said housing, a cup-shaped flexible diaphragm having an outer radial annular rim portion located between said generally radial annular flange portions of said housing and said cover, and a retainer element generally surrounding and compressing said generally radial annular flange portions of said housing and said cover against said rim portion of said flexible diaphragm, said rim portion of said diaphragm including a wedge-shaped edge portion and co-axially aligned flats on opposite sides of said rim

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portion adjacent said wedge-shaped edge portion aligning said flange portions of said housing and cover, said generally annular flange portions of said housing and said cover each including a U-shaped portion in cross-section opening outwardly having an engagement portion engaging and compressed against said flats on said rim portion of said flexible diaphragm.

5
10 9. The brake actuator defined in Claim 8, wherein said U-shaped portions of said housing and said cover each include an outer leg which receives and compresses therebetween said wedge-shaped edge portion of said flexible diaphragm.

15 10. The brake actuator defined in Claim 9, wherein said annular clamp includes an annular U-shaped portion comprising an axial portion surrounding said flange portions of said housing and said cover and opposed axial portions overlying said flange portions of said housing and said cover, said radial portions of said annular clamp compressing said rim portion of said flexible diaphragm to substantially fill said U-shaped portion of said clamp.

25 11. The brake actuator defined in Claim 8, wherein said clamp is a separate element.

30 12. The brake actuator defined in Claim 8, wherein said retainer element includes an annular clamp.

35 13. A flexible brake diaphragm comprising a cup-shaped flexible diaphragm having an outer radial annular rim portion, said rim portion of said diaphragm including a wedge-shaped edge portion and

co-axially aligned flats on opposite sides of said rim portion adjacent said wedge-shaped edge portion.

5 14. A flexible brake diaphragm as set forth in claim 13, wherein said flats each have a length of at least 0.030 inches.

10 15. A flexible brake diaphragm as set forth in claim 13, wherein said flats each have a length ranging from approximately 0.030 inches to approximately 0.075 inches.

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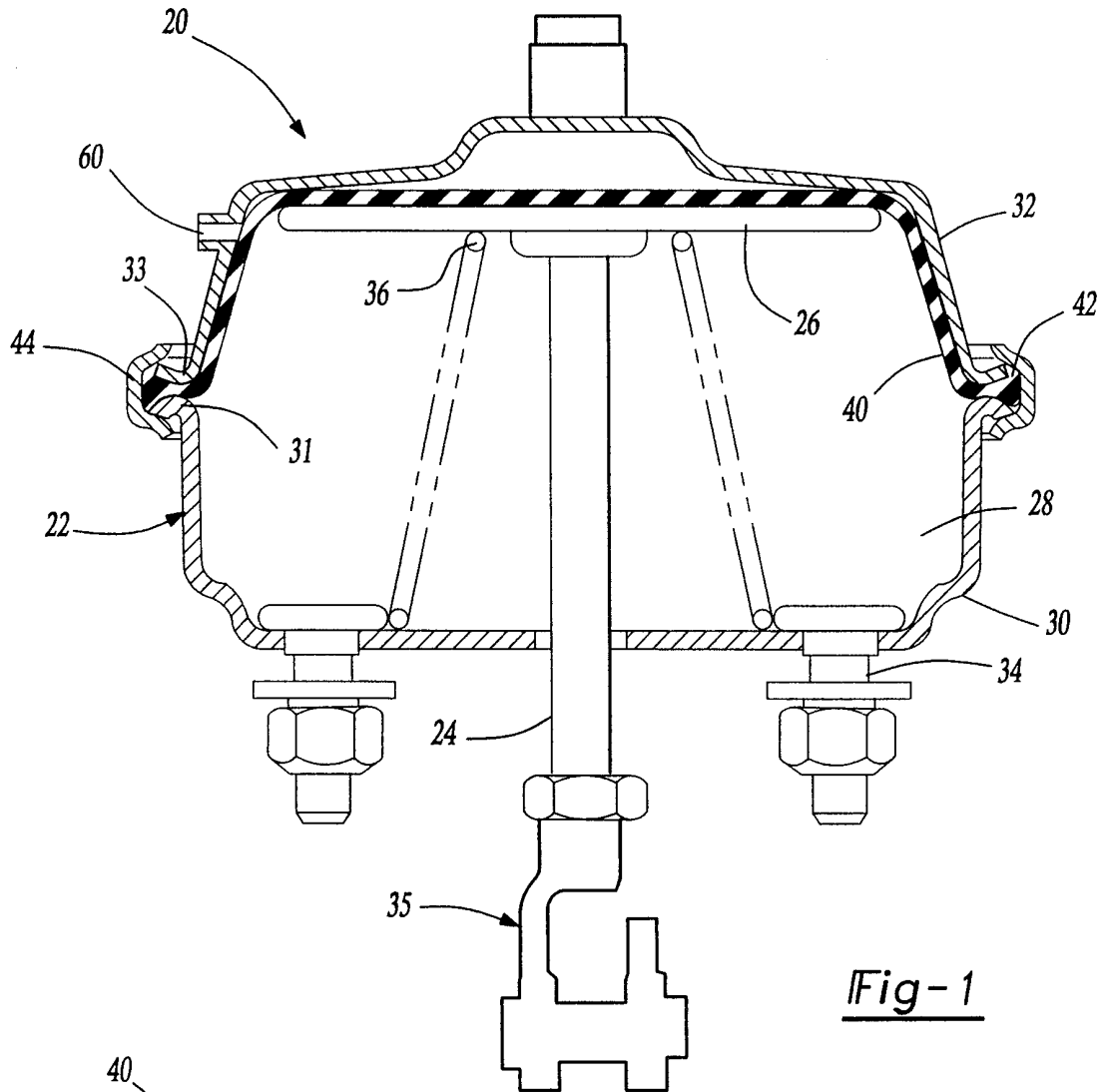


Fig-1

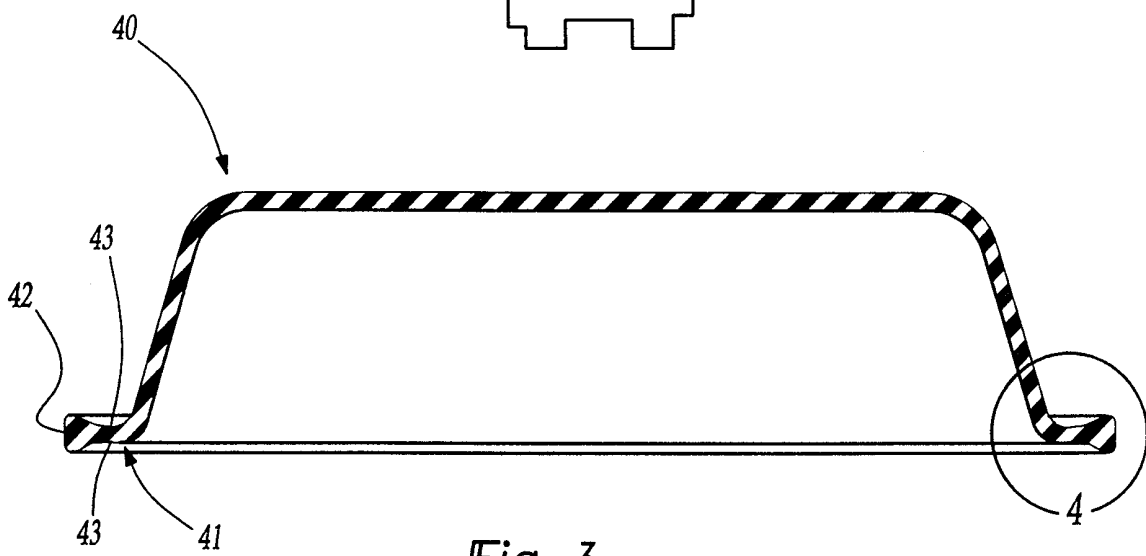


Fig-3

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Fig-2

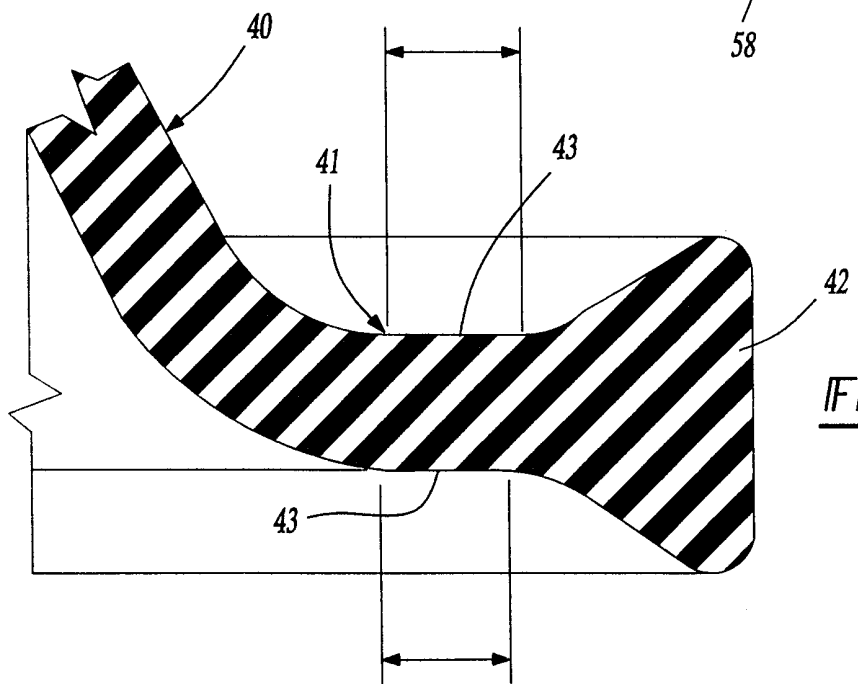
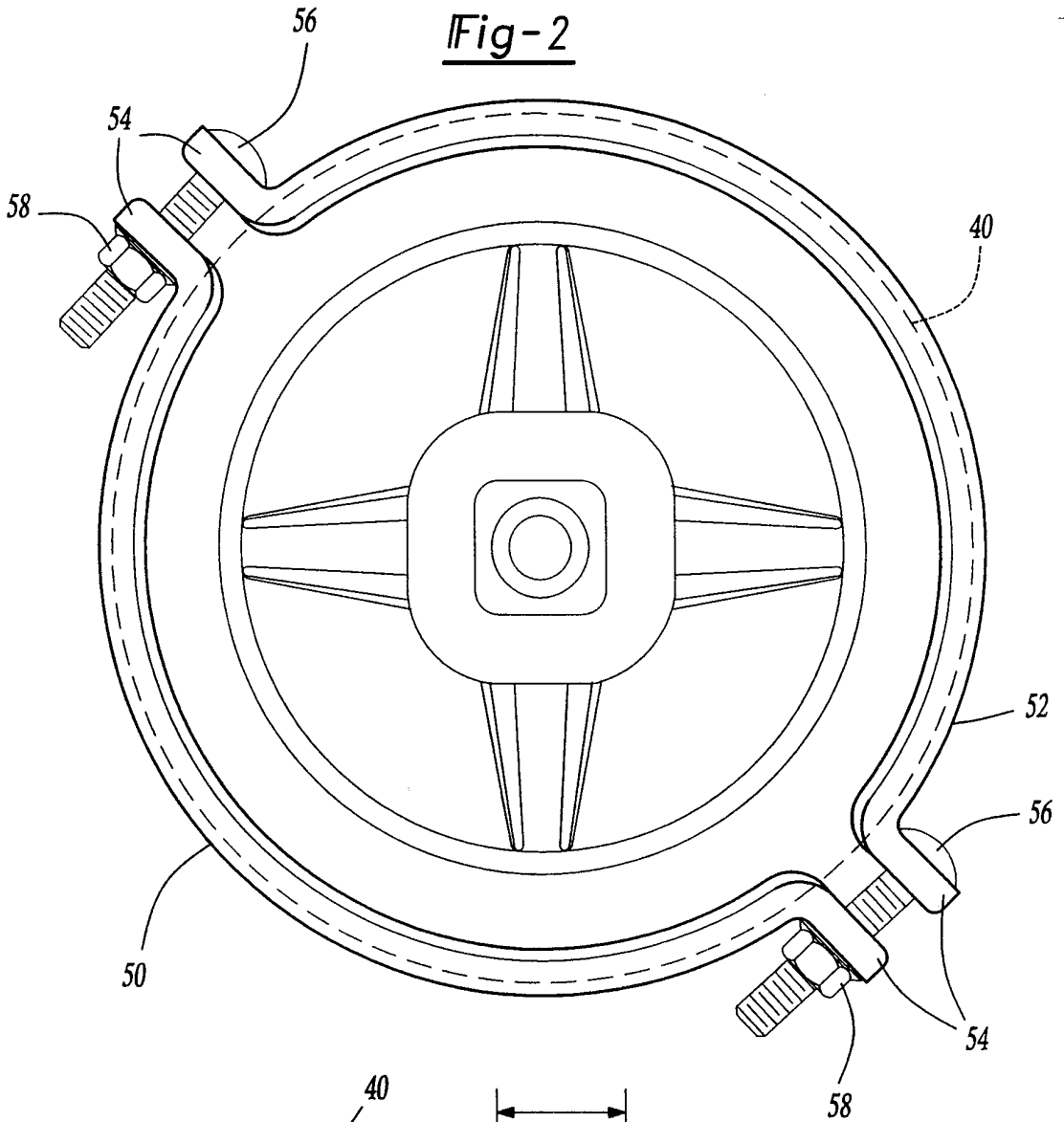


Fig-4

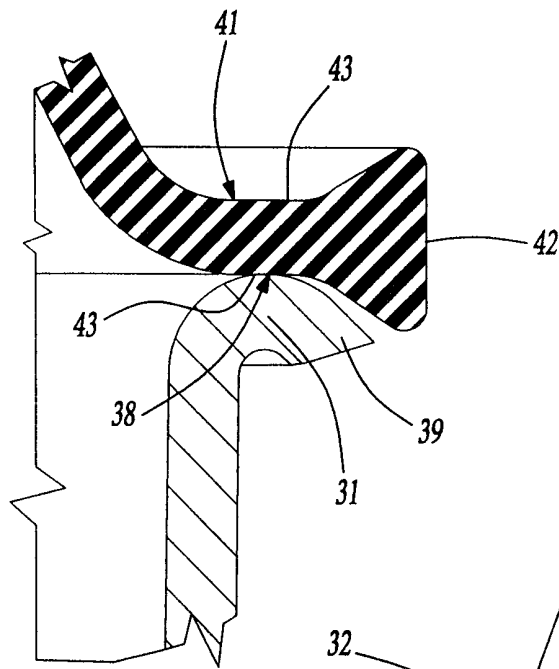


Fig-5

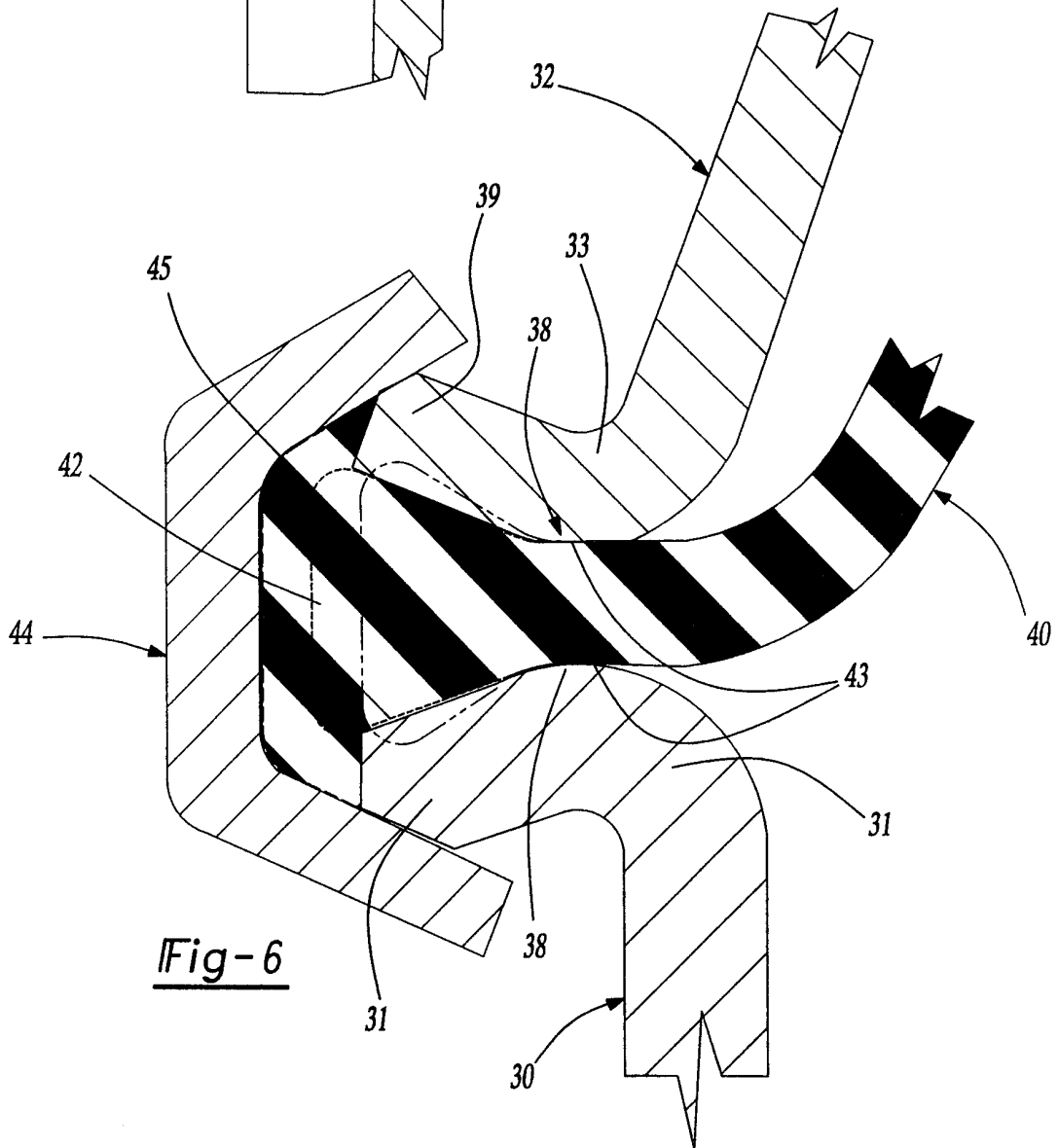


Fig-6

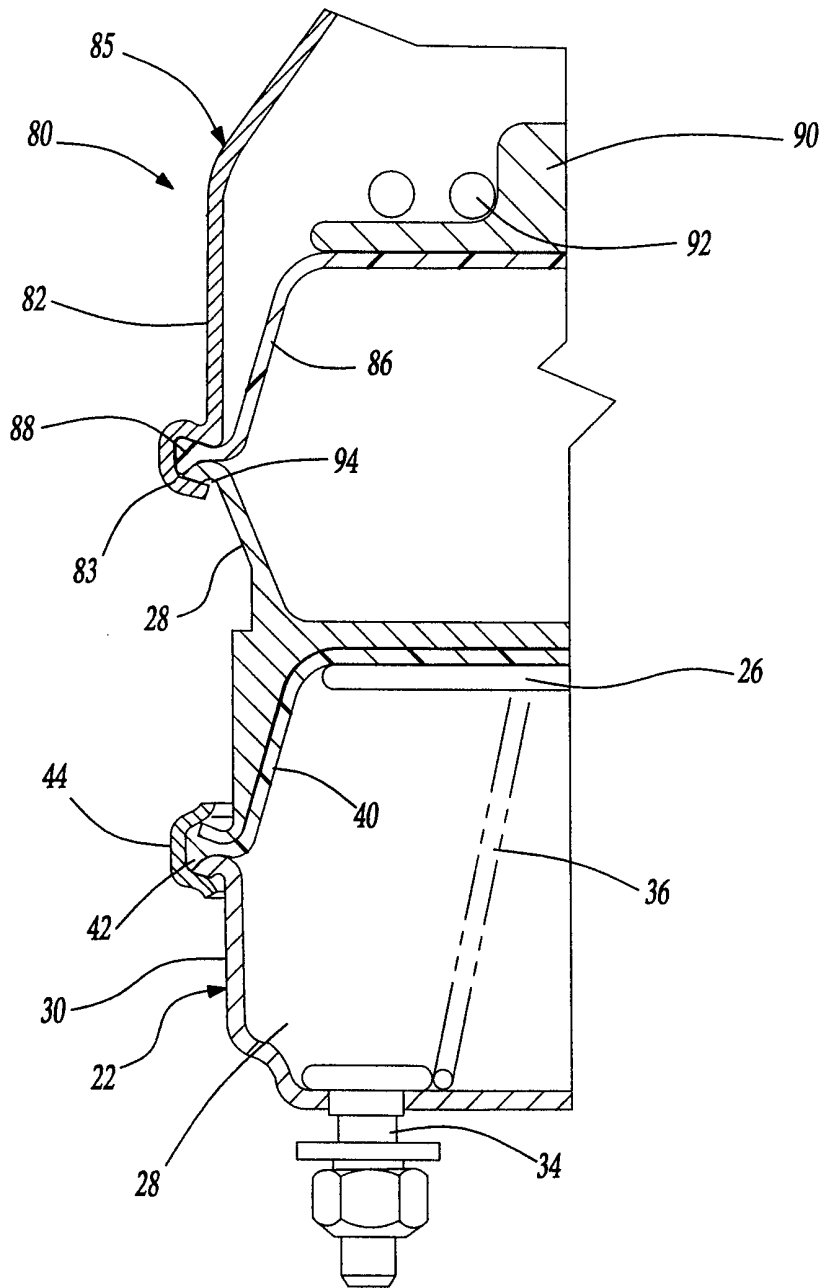


Fig-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/10340

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F01B 19/00, 29/00; F16J 3/00;
US CL : 92/98R, 128

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 92/98R, 128

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,285,716 A (THOMPSON) 15 Febuary 1994, Figs. 2, 3.	1-3,7-10,13-15
X, P	US 5,758,564 A (SMITH et al.) 02 June 1998, Figs. 1, 2, 3-19.	13
X, P	US 5,765,466 A (PLANTAN et al) 16 June 1998, Fig. 2.	1-4,7
X, Y	US 5,315,918 A (PIERCE) 31 May 1994, Fig. 9.	1-4,7-10,13/14,15
Y	US 4,201,057 A (MARTIN) 06 May 1980, Fig. 1.	5,6,11,12
Y	US 5,205,205 A (CHOINSKI et al) 27 April 1993, Fig. 2.	5,6,11,12

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search 16 JUNE 1999	Date of mailing of the international search report 11 AUG 1999
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/10340

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,960,038 A (CHIBA et al) 02 October 1990, Figs. 3-7.	1,8
A	US 5,193,432 A (SMITH) 16 March 1993, Figs. 1, 3, 4, 6, 9.	1, 8
A	US 3,424,064 A (VALENTINE) 28 January 1969, Fig. 1.	1,8
X, Y	SU 0638787 A (ALTAISVINETSSTROI) 10 December 1978, Figs. 1, 2.	1-6,8-11,13/ 14,15