(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 234 072**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **86301265.4**

(51) Int. Cl.[4]: **B08B 9/04**

(22) Date of filing: **21.02.86**

(43) Date of publication of application:
02.09.87 Bulletin 87/36

(84) Designated Contracting States:
BE DE FR GB IT NL

(71) Applicant: **Knapp, Kenneth M.**
1209 Hardy Street
Houston Texas 77020(US)

(72) Inventor: **Knapp, Kenneth M.**
1209 Hardy Street
Houston Texas 77020(US)

(74) Representative: **Adams, William Gordon et al**
RAWORTH, MOSS & COOK 36 Sydenham Road
Croydon Surrey CR0 2EF(GB)

(54) Bristle pig cup.

(57) For use with a mandrel (12) supporting a plurality of cups (14), an improved pipeline pigging cup - (10) is set forth in the preferred and illustrated embodiment. The cup (14) is equipped with a large protruding lip (36) around the periphery, and has a reinforcing member in the lip to secure the lip in a resilient fashion against the surrounding pipeline. The reinforcing member is formed of a strip of cloth backing (42) with upstanding staples (44) in the form of a multitude of small staple tips; the tips are arranged at or near the surface of the lip, thereby defining an abrasion resistant surface.

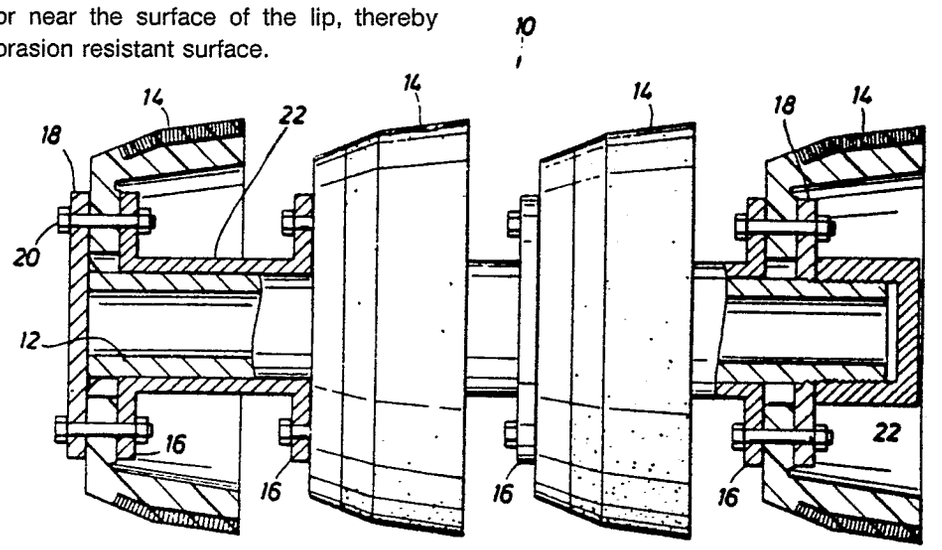

FIG. 1

EP 0 234 072 A1

BRISTLE PIG CUP

Background of the Disclosure

In pipeline pigging operations, it is necessary to periodically replace cups on a pigging mandrel. A pigging mandrel is an elongate body used to support two or more cups. The cups are equipped with a laterally extending central portion, having a peripheral lip around the edge, the lip sealing against the pipe. As the pig is forced through the pipeline, the lip on the cup holds a seal so that pressure fluid behind the mandrel pig forces the entire assembly along the pipe, and accomplishes the necessary pigging action to clean the pipe. Wear is localized at the lip on the replaceable cups. As wear occurs, fluid bypass begins to occur, thereby reducing the cleaning effect of the pig. It also slows down the rate of travel as additional fluid is bypassed. There is a chance that the lip will wear partially, thereby settling toward the bottom of the pipe and distributing the wear on the lip of the cup unevenly around the periphery. As these problems occur, they are cumulative. One cure is to reinforce the lip of the cup. For instance, U.S. Patent No. 4,365,379 shows a mandrel type pipe with a plurality of cups thereon wherein the cups are flared outwardly by the backing plates adjacent to the cups. An alternate form of reinforcing the lip of the cup is to include reinforcing gussets on the back face of the cup just beneath the lip. This is shown in the patent of Kidd, U.S. Patent No. 3,480,984. Various and sundry reinforcing or stiffening plates are known.

An alternate approach is to place more resilient material on the lip. However, doubling the thickness of the lip does not necessarily produce twice the life in the pig. In instances, it may simply make the lip stiffer and therefore subject to faster wear. Another reference of interest is U.S. Patent No. 4,077,079, which shows an abrasion material placed on a bullet-shaped pig body. Various and sundry abrading materials are known including tungsten carbide particles applied in mixed particle sizes either in strips or entirely across the face of elongate bullet-shaped pigs. When placed in strips spiraling around the pig body, they impart twist or rotation to cause the pig to spin as it travels the pipeline, thereby distributing wear around the full surface of the pig. As will be understood, bullet shaped pig bodies do not use replacement cups, and when worn, the entire pig must be discarded.

By contrast with the foregoing, a submerged stiffening member integrally cast in the peripheral lip of the replacement cup is set forth in the disclosure as a means of providing longer life in replacement cups. The replacement cup is reinforced by a stiffening member. The preferred form of the stiffening member must be slightly flexible or bendable before casting. It is preferably placed in the mold at the time of casting the replacement cup. Some degree of stiffening is obtained by merely placing the stiffening member in the mold, even should it be located so that it is not near or at the surface of the finished pig cup. The preferred form of stiffening is formed of multiple layers, typically between two and five layers, of heavy cloth of ducking. They are formed together in a strip so that the strip can be cut to length, enabling the proper length to be coiled in the mold before casting. The ducking supports uniformly and regularly positioned staples having staple points. This material is often available in the textile industry and is used in that industry as carding cloth. It has been discovered that the replacement cup of this disclosure can be markedly enhanced in its performance (referring to the number of miles of pipe that can be cleaned by a particular cup before the cup must be discarded) and gains of perhaps 100% or 200% are not uncommon in contrast with replacement cups not constructed in the mode of this disclosure.

As will be understood on review of the disclosed embodiment, the strip of carding cloth is positioned in the mold at the time of integrally casting the replacement cup. After the unset plastic material has been placed in the mold, the final product which is formed is a replacement cup having a peripheral lip wherein the lip is reinforced by the circular reinforcing member. Thus, if the pipeline has a 24 inch diameter, the replacement cup will have a nominal 24 inch size equipped with a surrounding lip of about 3 or 4 inches in width and a thickness of about 1/2 to 1 inch in thickness. On the inside of that lip, and integrally constructed with it, the reinforcing member is located, then holding the lip stiff somewhat in the fashion of a hoop or reinforcing bead in the lip.

One feature of the present disclosure is the incorporation of a stiffening hoop in the replacement cup lip. The reinforcing hoop enables the cup to yield during operation, but yielding is not so severe as to distort the lip and thereby prevent leakage past the pig during cleaning operation. The abrading surface is reinforced at or in the near vicinity of the tips of the staples which are carried in the carding cloth. Those staples are submerged beneath the surface of the cup lip, thereby forming a part of the body of the cup.

In the preferred embodiment, the peripheral lip has an internally cast hoop like member which stiffens it, and further includes a multitude of staple legs extending radially outwardly of the completed lip. The staple legs define an abrasion surface cooperative with the elastomeric material used in fabrication of the cup thereby obtaining longer life as an abrasion surface. As will be understood from this cursory summary and in greater detail on explanation below, the replacement cup thus has a stiffer lip able to last longer in operation.

A particular relationship between the staple leg spacing and the viscosity and wetability of the elastomeric material used in manufacture should be noted. The staples define a set of staple legs, thereby determining a common planar surface. The surface can be shaped as for instance by forming the stiffening hoop to go in the replacement cup lip. This set of staple legs includes hundreds, indeed thousands of parallel or approximately parallel, closely spaced metal legs sufficiently close that penetration by a liquid is somewhat difficult. It has been discovered that there is a relationship between the spacing of the staple legs and the flowability of the elastomeric material before curing.

The spacing on staple legs should be considered first. Briefly, they should be sufficiently close that they define a type of supportive surface considering the thousands of tips or points. On the one hand, they must be spaced closely together to provide a supportive surface. That is, they must be closely spaced to support the weight of the pig. Moreover, the close spacing provides improved performance in the pig in that the increased number of tips provides more staple tips functioning as small chisels cutting away corrosion on the interior of the pipeline. It has been discovered that there is an optimum range of spacing of the staple legs. This relates in large part to the penetration of elastomeric material into the spaces between the legs. The elastomeric material can be modified in pouring characteristics by incorporating different weights or mixes of elastomeric material. This can also be changed by adding more foaming agents. The use of centrifugal molding techniques also might be considered. All these factors, however, must relate to the poured elastomeric material which ideally substantially wets and penetrates the space between staple legs so that a solid elastomeric body is cast around the staple legs. In the preferred process described below, the casting process accomplishes this.

Brief Description of the Drawings

So that the manner in which the above recited features, advantages and objects of the present invention are attained and can be understood in detail, more particular description of the invention, briefly summarized above , may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

It is to be noted, however, that the appended drawings illustrated only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Fig. 1 shows a mandrel pig in section wherein replacement cups are mounted on the mandrel pig; and

Fig. 2 is a sectional view through a mandrel cup constructed in accordance with the teachings of this disclosure including a hoop located in the lip on a conic taper.

Detailed Description of the Preferred Embodiment

Attention is first directed to Fig. 1 of the drawings where the numeral 10 identifies a mandrel pig. The mandrel 12 is an elongate metal member, typically sized to support four cups. The mandrel 12 supports a set of backing plates 16 and 18. They are metal discs, having a central hole to enable them to fit onto the mandrel 12, and they sandwich a a replacement cup 14. The cup 14 is fastened to the metal discs 16 and 18 by a set of tie bolts 20. The tie bolts 20 fasten around the metal disc, perhaps four to eight bolts utilizing suitably sized drilled holes aligning the discs and cup for mounting. A spacer sleeve 22 separates each cup and backing discs to thereby enable the stack of components to be placed on the mandrel 12.

The foregoing describes the mounting of one cup on the mandrel. Typically four but sometimes a different number can be placed on the mandrel. The mandrel, after the cups have been assembled thereon, is placed in a pipeline and moves along the pipe so that the cups wipe the pipe and pressure fluid drive behind the mandrel moves the pig along the pipeline.

In Fig. 2 of the drawings, the cup is shown in sectional view. The cup 14 incorporates a transverse central web portion 24. That web portion extends inwardly to a central hole at 26. This hole is sized to fit around the mandrel 12. It is adjacent to a set of bolt circuit holes 28. Several such bolt holes are included and are arranged on a circle to coincide with the location of the bolts 20. The several holes enable the tie bolts 20 to be fastened

to the reinforcing metal disc. This enables the metal discs to be pulled snugly against the cup. The cup is equipped with parallel transverse faces 30 and 32 which sealingly abut against the reinforcing discs. The two reinforcing discs seal against the cup, thereby preventing leakage past the replacement cup in the area of the mandrel or through the bolt holes 28.

The central web portion 24 extends radially outwardly to a diameter almost matching that of the pipe. If the pipe has a nominal diameter of twenty-four inches, the central webbing extends outwardly to a leading edge 34 which is almost full gauge. There is however a flared lip 36 extending to the rear of the cup. It is constructed as a portion of a conic, typically having a taper between three and ten degrees. The lip typically has a thickness of perhaps one-half to one inch on a twenty-four inch cup. The lip need not be much wider than four inches even on larger sizes.

As shown in Fig. 2, the lip incorporates a first externally located chamfered face 38. A second face 40 is also included at a lesser angle. The face 40 is more or less parallel to the internal face of the lip, thereby defining a uniform lip thickness in the back portions of the lip. The chamfer at 38 has been exaggerated in width to shown the chamfer. At the forward edge 34, the lip is much thicker and tends to be somewhat stiffer because it is adjacent to the central web 24. The chamfer covers a width of about one quarter to one inch or more and is included to enable the lip to pass smoothly over internal upsets in the pipeline. For instance, when the pipe wall thickness changes, there is a slight upset on the interior. There is also an upset at the internal welding bead where the pipe joints are welded to one another. There may also be an internal upset where the pipeline joins to a valve or other fitting welded in the pipeline.

Preferably, the cup is made of polyurethane. That is a very acceptable material for fabrication of cups. The cup is formed to a suitable hardness by controlling the formulation of the elastomeric material. Needless to say, other types of plastic can be used in the fabrication of the cup. The cup is formed by molding in a mold, this requiring a cure interval. Before pouring the liquid elastomeric material into the mold, a reinforcing hoop is placed in the mold. The reinforcing hoop in this instance is formed of a circle of carding cloth material. It has a canvas backing 42 and supports a set of multitudinous parallel staple legs at 44. This hoop is sized where the hoop is at the outer face of the lip 36, and is not at the inside face. The hoop is positioned in the mold before pouring. The hoop sets immediately adjacent to the mold face which faces the chamfered external face 38 and the outer face 40. The hoop is tapered slightly to accommodate the taper of the lip 36. After positioning in the mold so that it is at the back end of the lip (not near the lip edge 34), the hoop is thus positioned so that it encounters the bulk of the abrasion in conjunction with the cast lip after construction. At this juncture, the liquid resin is poured into the mold. On pouring, the liquid resin completely surrounds the reinforcing hoop. The reinforcing hoop is thus integrally submerged and cast into the finished plastic body.

The backing material is multiple ply typically in the range of three to five layers of canvass or cloth. It is optionally overlaid with a plastic coating on the top surface, that is the surface where the staple legs protrude. Moreover, it is flexible or pliable to enable bending to the shape desired. The staple legs are in the range of about 1 cm in length. They can be longer upwards of about perhaps 1.5 cm. Such a long staple leg is typically not needed. Staple leg length of perhaps 0.5 cm is perhaps too short to sustain long life and operation. Accordingly, the optimum measure is about 1 cm in leg length.

A very important factor in construction of this device is the spacing of the legs. The wire is typically in the range of about 20 to 24 gauge wire. The wire can be heavier or lighter, a factor which is less important than the density of the staple legs. The density is preferably less than about 12 staple legs per inch. In a square inch, this would suggest about 150 or fewer staple legs. In the metric system, this is approximately 24 staple legs per square centimeter. In other words, this is he approximate maximum staple leg density that can be utilized. This maximum is suggested by virtue of the fact that the poured viscous polyurethane or other elastomeric must penetrate through the forest of legs. Typically, polyurethane, the preferred material, is mixed with a foaming agent which controls the density and hardness of the finished product. The foaming agent is typically a gas liberating material which forms small bubbles in the poured elastomeric material. The bubbles create surface tension which may snag the bubbles on the legs, loosely speaking, thereby making it difficult for the elastomeric material to penetrate the volume of space around the legs and thereby define a completed structure. In other words, voids may be formed, this being result of excessively close packing of staple legs.

Just as there is an optimum maximum leg density as described above, there is a minimum staple leg density which is also worth noting. Approximately, eight staple legs per linear inch or 64 per square inch is a reasonable minimum leg density. This permits the use of large diameter staple legs, meaning staples formed of heavier wire. In the metric system, this works out to about 10

staple legs per square centimeter. There is less difficulty with the poured elastomeric material wetting the volume around a few staple legs. As the number of staple legs is reduced, the number of metal points which bear against the pipeline for abrasive cleaning is then reduced. Reduction of the number of staple tips then may tend to shorten the life of the product. If the number of staple tips were reduced to much below this level, there would be a gradual reduction in durability. This would approach the durability of a pig having no staples whatsoever assuming that it were made of exactly the same polyurethane mix. Therefore, for practical purposes to obtain reasonable durability and longevity of pig operation, it is suggested that about 10 staple legs and associated points per square centimeter is the desired minimum number.

Considering the two limits above, it is therefore concluded that a reasonable range is approximately 10 to 25 staple legs per square centimeter. Practical factors relating to these two limits are described above. The number of the wires in conjunction with the hardness of the cured polyurethane material (typically measure in durometer) describes a device which is at once resilient to enable the pig to travel along pipeline with bends, elbows and constrictions and which is also relatively hard and durable to tolerate the abuse of ware.

In operation, it will be understood that the polyurethane which is cast around staple legs covers them and exceeds this depth by some fractional measure. This depends on the snugness of the materials in the mold before casting. Thus, the staple points may be within a few microns of the surface. This dimension refers to the thickness of the cast elastomeric material measured from the staple tips to the outer face. This thickness is a convenience in manufacture and can vary widely.

The finished product at first glance does not particularly appear to be different from any other replacement cup. At most, only the tips of the staple legs 44 are at the surface. They are relatively small, and typically do not show when the cup is new. This is because the cast polyurethane body completely encloses the reinforcing hoop and staple legs. Even where the staple legs actually extend to the exposed face, they do not protrude through the face and are not visible to casual inspection. The cloth backing of the hoop forms a reinforcing ring. So to speak, it is a stiffener which provides a stiffness to the lip 36 surprisingly beyond what would be expected from a cloth backing. In addition, the staples 44 improve the abrasion resistant characteristic of the lip. Not only is that accomplished, but the staples serve as a spacer to locate the backing at a specified distance from the outer face 40. If for instance, the staples have one cm length, the backing 42 is submerged in the lip by that distance.

As will be noted, the outer faces 38 and 40 are chamfered. This causes the backing material 42 to bend or slightly curve. This is certainly permissible in the construction of the cup 14. As will be understood, the reinforcing material has a uniformed width such as two inches. It is made by cutting a strip strip shaping it into a circle and positioning in the mold before casting. The two ends of the cloth hoop are simply abutted against one another in the mold, overlap being unneeded. No particular weakness is formed at this butt joint. In the finished product, the outer face has a hardness in the range of about 70A to 90A durometer, and is preferably not more than 95A durometer (as a maximum value).

In operation, the cup 14 is bolted to the mandrel 12 shown in Fig. 1. This initially sets up the mandrel pig for use. When it is placed in the pipeline, it travels the full length of the pipeline with the face 40 in the contact with the pipe. Occasionally, the chamfered face 38 might even contact the surface. Wear is encountered by abrasion. The resilient material is worn away at the face 40. Eventually, the material which is worn away exposes ever so slightly the staple tips. They also are worn away. However, they are worn away more slowly, being more resistant to abrasion than the elastomeric pig body. This provides greater life. Leakage past the cup is avoided because the cup lip is relatively stiff. There is of course a balance in stiffness. A metal ring in the lip would provide a lip which is unduly stiff and which would not perform as well. There is a balance between undue stiffness and undue abrasion resistant. It has been found that the polyurethane lip of perhaps one-half to one inch thickness (for the twenty-four inch cup) in conjunction with the somewhat plaint reinforcing hoop yields a device which performs exceedingly well in contrast with a monolithic polyurethane cup body. Performance by contrast shows a remarkable improvement in cup life. This is reflected by the ability of the cup to last for perhaps 100% to 200% greater distances in comparable pipelines.

As can be understood, the pig cup of this invention has been described insofar as the preferred embodiment is concerned above and the scope thereof is determined by the claims which follow.

Claims

1. A replacement mountable pig cup for transfer along a pipeline comprising a cup having a central mandrel engaging means, said cup having a peripheral lip around a central transverse web within said lip and surrounding said hole, said cup being formed of a resilient material sized to fit within a pipeline and sufficiently flexible to form an encircling sealing contact with the surrounding lip, and wherein said lip integrally comprises a stiffening means in said lip, and said stiffening means extends arcuately of said mandrel to stiffen said lip, and wherein said stiffening means is an elongate backing having staples arranged to extend radially outwardly, and said lip is integrally cast around said staples, locating tips of said staples at or below the surface of said lip when new and wherein said staples have a density per unit area sufficiently spaced apart to enable resilient material forming the lip to penetrate and surround said staples.

2. The apparatus of Claim 1 wherein said staples have a density less than about 150 stable legs per square inch.

3. The apparatus of Claim 1 wherein the surrounding lip has an outer face hardness of less than about 95A durometer.

4. The apparatus of Claim 1 wherein the surrounding lip has an outer face hardness in the range of about 70A to 90A durometer.

5. The apparatus of Claim 1 wherein said staples have a density of about 10 to about 25 tips per square centimeter.

6. The apparatus of Claim 5 wherein said staples are about 1 centimeter in length and are made of wire of about 20 to 24 gauge.

7. The apparatus of Claim 6 wherein said staple legs connect to a cloth backing comprising said stiffening means said staple legs extending through said cloth backing.

8. The apparatus of Claim 7 wherein said lip includes cured elastomeric material having a hardness less than about 95A durometer.

9. The apparatus of Claim 8 wherein hardness is in the range of about 70A to 90A durometer.

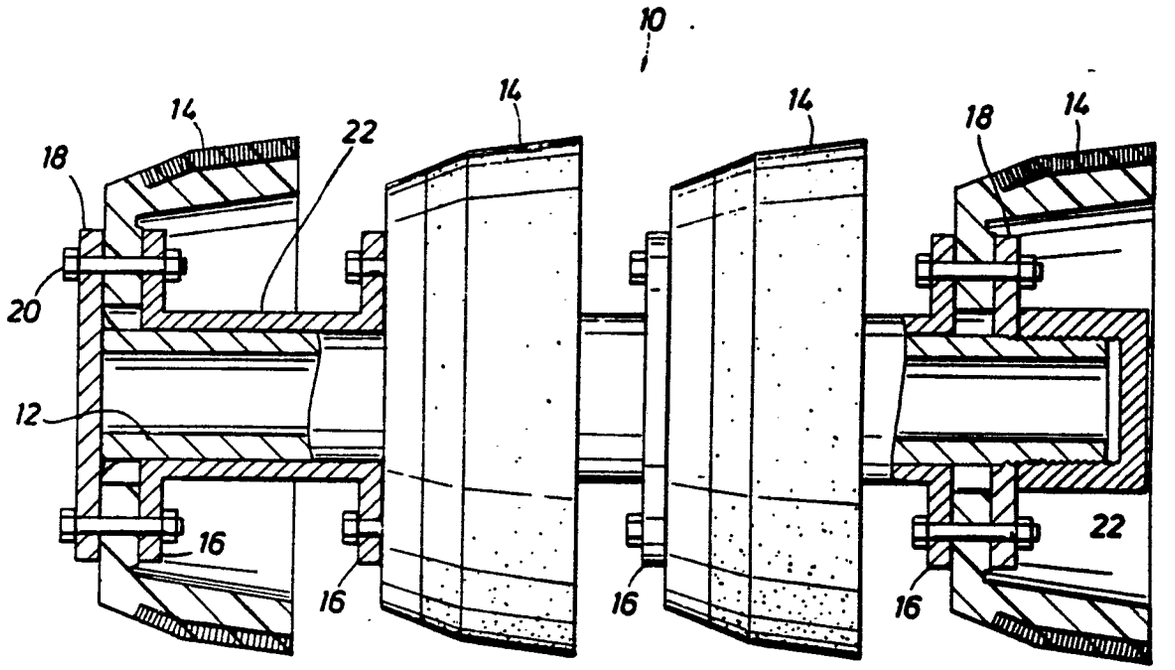
10
14
14
14
14
18
18
22
20
12
16
16
16
16
22

FIG. 1

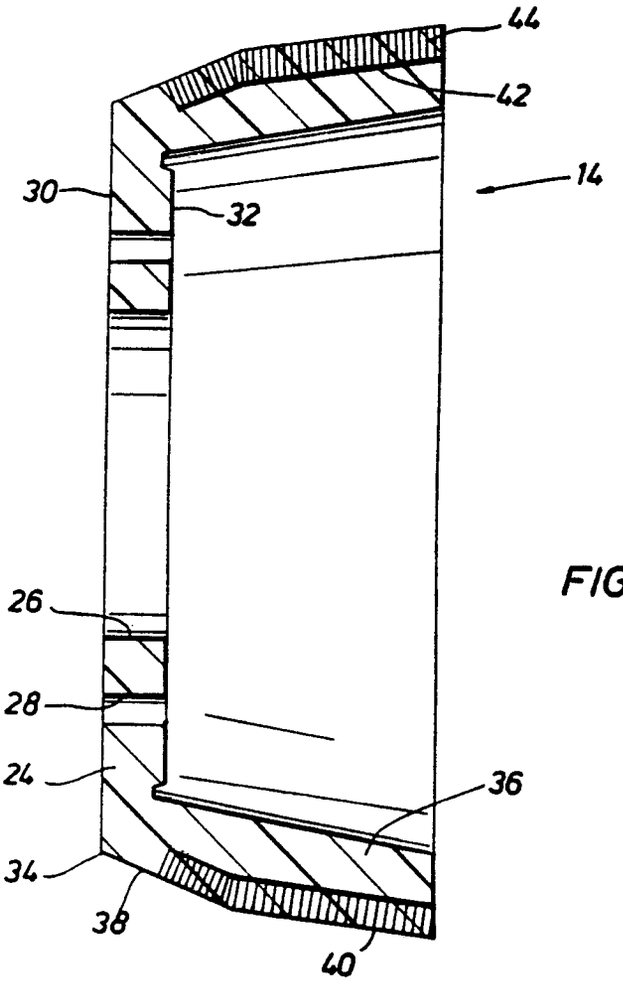
44
42
14
30
32
26
28
24
36
34
38
40

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 30 1265

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 506 401 (KNAPP) * Whole document *	1	B 08 B 9/04
Y		3,4,7-9	
D,Y	US-A-4 077 079 (KNAPP) * Whole document *	3,4,7-9	
D,A	US-A-3 480 984 (KIDD)		
D,A	US-A-4 365 379 (NEFF)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 08 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06-10-1986	VOLLERING J.P.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03 82