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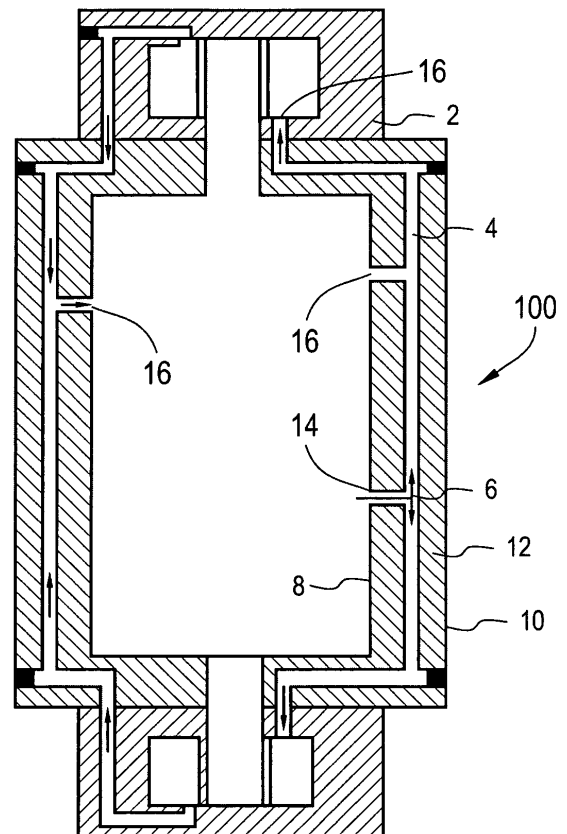
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(54) **A gas compressor casing and a system comprising the casing**

(57) The present invention provides a reliable integrated arrangement for cooling a compressor system. This is provided by a casing design, where said casing (2) for gas compressor (100), comprises a channel (4) to carry a cooling medium (6), said channel (4) enclosed within an inner surface (8) and an outer surface (10) of a wall (12) of the casing (2) of the gas compressor (100), wherein said channel (4) is along the direction of the wall (12). The casing (2) has at least one inlet (14), extending to said channel (4) to receive the cooling medium (6) from the gas compressor (100) and at least one outlet (16) in the casing (2), extending to said channel (4), to let the cooling medium (6) enter hot regions of the gas compressor (100) from the channel (4).

FIG 1



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Description

[0001] The present invention relates to gas compressors, particularly a gas compressor casing for cooling a gas compressor.

[0002] Gas compression systems are used in a wide variety of applications, including air compression for powering tools, gas compression for storage and transport of gas, etc. In each system, motors or gas turbines are provided for driving the compression mechanism to compress the gas. Providing adequate motor and compressor cooling, without sacrificing energy efficiency of the compression system, continues to challenge designers of gas compression systems.

[0003] Gas compressors, for example centrifugal gas compressors are usually driven by electric motors that are normally a standalone machine in a casing or within a casing that encases the motor and compressor. The compressors, particularly rotary ones, must be provided with means to cool the rotating parts during operation of the unit in order to prevent damages due to over-heating. Generally compressors are designed to have an external cooling mechanism arranged outside the gas compressor. This involves external piping which carries the cooling medium, which is generally the comparatively cooled hydrocarbon gas, intended to be compressed by the gas compressor. One of the risks is leakage of hydrocarbons to the environment. Such leakages could result in equipment failure or severe HSE (Health Safety Environment) danger. In order to limit these leakage risks and optimize machine reliability levels; splits in piping and casings shall be minimized to the absolute minimum. This will be more useful specially for subsea applications. For such external piping flanged connections can be limited by applying welded connections but not all flanged connection can be avoided when using external piping.

[0004] It is an object of the present invention to provide more reliable integrated arrangement for cooling a compressor system.

[0005] The said object is achieved by providing gas compressor casing according to claim 1 and by a system according to claim 4 and a method according to claim 11.

[0006] The underlying idea is to have a gas compressor casing having at least one channel to carry a cooling medium. This channel is enclosed within an inner surface and an outer surface of a wall of the gas compressor casing. The channel is along the direction of the wall. The gas compressor casing has at least one inlet in the casing, extending to said channel to receive the cooling medium from the gas compressor and at least one outlet in the casing, extending to said channel, to let the cooling medium enter different parts in the gas compressor especially the hot regions of the gas compressor. Providing the channels inside the casing avoids the need of external piping to carry the cooling medium, thereby invariably reducing the number of splits and flanged connections. This helps in reducing the vulnerability of these types of intermediary connections and thereby obviating possible

leakages. More over the current design provides an integrated structure for casing along with the gas compressor.

[0007] In a preferred embodiment the channel is directed parallel to the inner surface and/or the outer surface of the wall of the gas compressor casing. This ensures that the cooling medium has a smooth flow inside the wall of the casing and also the design will ensure to have an equal pressure distribution across the wall of the casing.

[0008] In a further preferred embodiment, the casing further comprises at least one additional channel to carry the cooling medium and the at least one additional channel is positioned functionally parallel to the original channel. This enables to carry enough amount of the cooling medium for cooling the hot regions. This further facilitates to have multiple channels with lesser diameters instead of one single channel with a large diameter. Having multiple channels with lesser diameters adds more stability, when comparing to having a single channel with a large diameter. This type of a design ensures an equal pressure distribution across the wall of the casing. Functionally parallel, referred here does not strictly restrict the channel and the additional channel to be parallel as such. It shall be interpreted to have some sort of parallel orientation to achieve equal or stable pressure distribution.

[0009] In another alternative embodiment, the cooling medium adapted to flow through the channel in the casing is a gas provided from a pressurized gas supply, which needs to be compressed by the gas compressor. In another alternative embodiment, the cooling medium is taken through the inlet from an initial stage of an impeller discharge for circulation in the channel. The solution is to use the hydrocarbon gas itself as the cooling medium. Since the gas is taken for the cooling process at a very early stage of the compression it would be much cooler and would have enough pressure to circulate through the channel.

[0010] In another alternative embodiment, the channel is adapted to provide the cooling medium for cooling the motor, the bearings and the close clearance gaps in the gas compressor. This enables to cool the various hot regions inside the gas compressor.

[0011] In another alternative embodiment, the casing is adapted to be used in a compressor having a compressor module and the motor, which shares a common rotor shaft. This enables the casing to be used in this type of a specific gas compressor design.

[0012] In another alternative embodiment, the at least one channel in the gas compressor casing is provided by drilling. In another alternative embodiment, the at least one channel in the gas compressor casing is provided by casting. These techniques enable to have different options for the manufacturing of the channels. These techniques could be chosen based on the cooling requirements or based on the mechanical integrity of the casing material used or even the complexity of the design of the compressor.

[0013] The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 illustrates a diagram of a compressor casing according to an embodiment of the invention,

FIG 2 illustrates a diagram of a system for compressing gas along with a casing according to an embodiment of the invention,

FIG 3 illustrates a casing split in the compressor casing according to an embodiment of the invention, and

FIG 4 illustrates a diagram showing a channel made in a portion of a casing by drilling.

[0014] The invention will be explained with respect to a hermetically sealed gas compressor, even though the idea could be extended to other type of gas compressors.

[0015] FIG 1 illustrates a diagram of a casing 2, of a gas compressor 100 according to an embodiment of the invention. The casing 2, along with the compressor module and the motor section which is not shown together constitute the gas compressor 100. The casing 2 for gas compressor 100 comprises a channel 4 to carry a cooling medium 6. The cooling medium 6, which is adapted to flow through the channel 4 in the casing 2 is a gas provided from a pressurized gas supply 208 as shown in FIG 2, which needs to be compressed by the gas compressor 100. The channel 4 is enclosed within an inner surface 8 and an outer surface 10 of a wall 12 of the casing 2 of the gas compressor 100; wherein said channel 4 is along the direction of the wall 12. The casing 2 further comprises at least one inlet 14 extending to the channel 4 to receive the cooling medium 6 from the gas compressor 100. The casing 2, also has at least one outlet 16, extending to said channel 4, to let the cooling medium 6 enter hot regions of the gas compressor 100 from the channel 4.

[0016] The channel 4 is directed parallel to the inner surface 8 or the outer surface 10 of the wall 12 of the casing 2 of the gas compressor 100. The channel 4 in the casing 2 of the gas compressor 100 is provided by drilling. As an alternative to drilled channels, casted-in channels could be used in case of casted casing.

[0017] FIG 2 illustrates a block diagram of a system 200 for compressing gas along with a casing according to an embodiment of the invention. The system 200 comprises a casing 2, a compressor module 202 having a rotor 204 and a motor 206 to drive the rotor 204 of the compressor module 202. The cooling medium 6 is taken through the inlet 14 from an initial discharge stage of an impeller 210 for circulation in the channel 4. The channel 4 is adapted to provide the cooling medium 6 for cooling the hot regions in the gas compressor 100. The gas compressor 100 has a common rotor shaft 220 for the compressor module 202 and the motor 206. The gas com-

pressor having the compressor module 202 and the motor 206, sharing the common shaft 220 can be mounted vertically or horizontally. The hot region of the gas compressor 100 includes close clearance gaps (216, 218) in the gas compressor 100. All close clearance gaps in the gas compressor 100 need cooling. Due to the high density of the high pressure gas and the high velocity of the high speed running shaft during the compressor operation, the heat generated is significant. This needs to be cooled. There could be close clearance gaps in the magnetic bearings 212 and 214. Practically this means close clearance gaps in the magnetic bearings i.e. between the outer diameter of the rotating shaft sleeve and the inner diameter of the bearing stator, which is gap 216 as shown for bearing 212, and in the main motor i.e. between the outer diameter of the rotor shaft 220 and inner diameter of the stator 222, which is the gap 218. The channel 4 could be further extended, if needed using piping to supply the cooling medium to the hot regions or hot parts inside the gas compressor 100. The cooling medium 6, which is now hot, is driven back to the suction nozzle 224 of the gas compressor 100. A discharge nozzle 226 is used by the system 200 to supply the compressed hydrocarbon gas for further practical use for other associated systems.

[0018] FIG 3 illustrates a casing split 300 of the compressor casing according to an embodiment of the invention. The casing 2 may further comprise at least one additional channel 302 to carry the cooling medium 6. The additional channel 302 could be arranged parallel to the original channel 4. The channel 4 along with the additional channel 302 returns the cooling medium 6 back to the gas compressor 100. This enables to have a fresh intake of the cooling medium into the channel 4 or/and the additional channel 302 for cooling the hot regions, since the cooling arrangement acts more or less like a closed circuit.

[0019] Subsea environment equipment design shall target the highest level of reliability since maintenance costs are extremely high, especially for heavy equipment at deeper water. One of the risks here is leakage of hydrocarbons to the seawater environment or vice versa i.e. sea water ingress into the compressor system. Such leakages could result in equipment failure or severe HSE danger. At the location of casing splits 308, dedicated axial sealing elements could be used. Individual sealing element 304 could be used in the case of single channel and combined sealing element 306 in case of parallel channels.

[0020] The casing 2 with the channel 4 and the additional channels could be practically realized in different ways. A method of manufacturing a casing 2 comprises of providing a channel 4 in a wall 12 of the casing 2 and then providing at least one inlet 14 in the wall 12 of the casing 2, which extends to said channel 4, to receive a cooling medium 6 from a gas compressor 100. The method of manufacturing also provides at least one outlet 16 in the wall 12 of the casing 2, which extends to said chan-

nel 4, to let the cooling medium 6 enter the gas compressor 100 from the channel 4. The channel 4 in the wall 12, the at least one inlet 14 and the at least one outlet 16 of the casing 2 of the gas compressor 100 is provided by drilling or casting. During drilling, there is possibility that openings are created in the outer surface of the wall 12. Welding is performed to seal an opening created during drilling in the outer surface 10 of the wall 12. Channels with required dimensions could be made in the casing 2 based on the cooling needs and also based on the thickness of the wall 12 of the casing 2.

[0021] As an example, FIG 4 shows a channel 402, made in a portion 400 of the casing 2. A bore could be made from each of the surfaces 404, 406 and 408 to intersect at particular locations so as to create a continuous channel for the flow of the cooling medium 6 as shown in FIG 4. Considering the surface 404, as the outer surface of the casing the head of the bore at the surface 404 shall be closed by a welding plug 410 as shown, to ensure that no gas is leaked.

[0022] Summarizing, the present invention introduces a casing 2 of the gas compressor 100 having at least one channel 4 to carry a cooling medium 6. This channel 4 is enclosed within an inner surface 8 and an outer surface 10 of a wall 12 of the casing 2 and is in the direction of the wall 12. The casing 2 has at least one inlet 14 in the casing 2, extending to said channel 4 to receive the cooling medium 6 from the gas compressor 100 and at least one outlet 16 in the casing 2, extending to said channel 4, to let the cooling medium 6 enter hot regions of the gas compressor from the channel.

[0023] Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternate embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that such modifications can be made without departing from the embodiments of the present invention as defined.

Claims

1. A casing (2) for gas compressor (100), comprising:
 - a channel (4) to carry a cooling medium (6), said channel (4) enclosed within an inner surface (8) and an outer surface (10) of a wall (12) of the casing (2) of the gas compressor (100), wherein said channel (4) is along the direction of the wall (12);
 - at least one inlet (14) in the wall (12) of the casing (2), extending to said channel (4) to receive the cooling medium (6); and
 - at least one outlet (16) in the wall (12) of the casing (2), extending to said channel (4), to let the cooling medium (6) enter the gas compressor (100) from the channel (4).
2. A casing (2) according to claim 1, wherein the channel (4) is directed parallel to the inner surface (8) and/or the outer surface (10) of the wall (12) of the casing (2) of the gas compressor (100).
3. A casing (2) according to the claim 1 or 2, further comprises at least one additional channel (302) to carry the cooling medium (6), wherein the at least one additional channel (302) is functionally positioned parallel to the channel(4).
4. A system (200), comprising:
 - a casing (2) as claimed in any of the claims 1 to 3;
 - a compressor module (202), said compressor module (202) having a rotor (204); and
 - a motor (206), to drive the rotor (204) of the compressor module (202).
5. A system (200) according to claim 4, wherein the cooling medium (6), adapted to flow through the channel (4) in the casing (2) is a gas provided from a pressurized gas supply (208), which is compressed by the gas compressor (100).
6. A system (200) according to claim 4 or 5, wherein the cooling medium (6) is taken through the inlet (14) from an initial discharge stage of an impeller (210) for circulation in the channel (4).
7. A system (200) according to any of the claims 4 to 6, wherein the channel (4) is adapted to provide the cooling medium (6) for cooling the motor (206).
8. A system (200) according to any of the claims 4 to 7, wherein the channel (4) is adapted to provide the cooling medium for cooling the bearings (212, 214).
9. A system (200) according to any of the claims 4 to 8, wherein the channel (4) is adapted to provide the cooling medium (6) to the close clearance gaps (216, 218) in the gas compressor (100).
10. A system (200) according to any of the claims 4 to 9, wherein the casing (2) is adapted to be used in a gas compressor (100) having a common rotor shaft (220) for the compressor module (202) and the motor (206).
11. A method of manufacturing a casing (2) comprising:
 - providing a channel (4) in a wall (12) of the casing (2);
 - providing at least one inlet (14) in the wall (12) of the casing (2) extending to said channel (4),

to receive a cooling medium (6) from a gas compressor (100); and
- providing at least one outlet (16) in the wall (12) of the casing (2) extending to said channel (4), to let the cooling medium (6) enter the gas compressor (100) from the channel (4).

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12. The method according to claims 11, wherein the channel (4) in the wall (12) of the casing (2) of the gas compressor (100) is provided by drilling. 10
13. The method according to claims 11, wherein the at least one inlet (14) and the at least one outlet (16) in the wall (12) of the casing (2) of the gas compressor (100) is provided by drilling. 15
14. The method according to claims 11, further comprising the step of providing a welding plug (410) to an opening created during drilling in the outer surface (10) of the wall (12). 20
15. A method according to claim 11, wherein the channel (4), the at least one inlet (14) and the at least one outlet (16) in the casing (2) of the gas compressor (100) is provided by casting. 25

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FIG 1

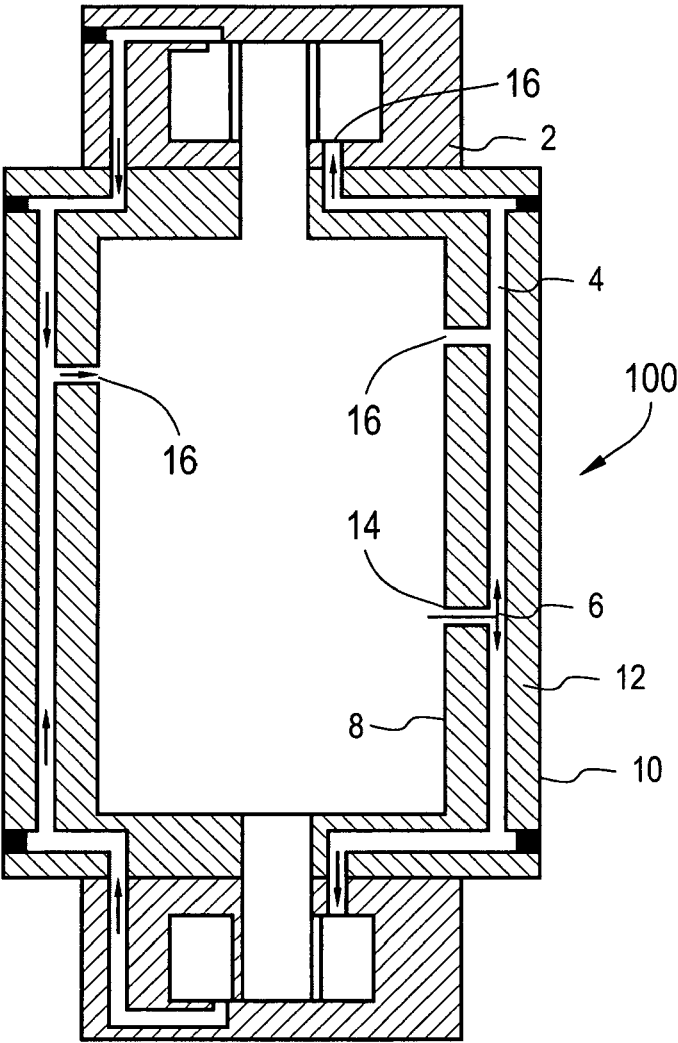


FIG 2

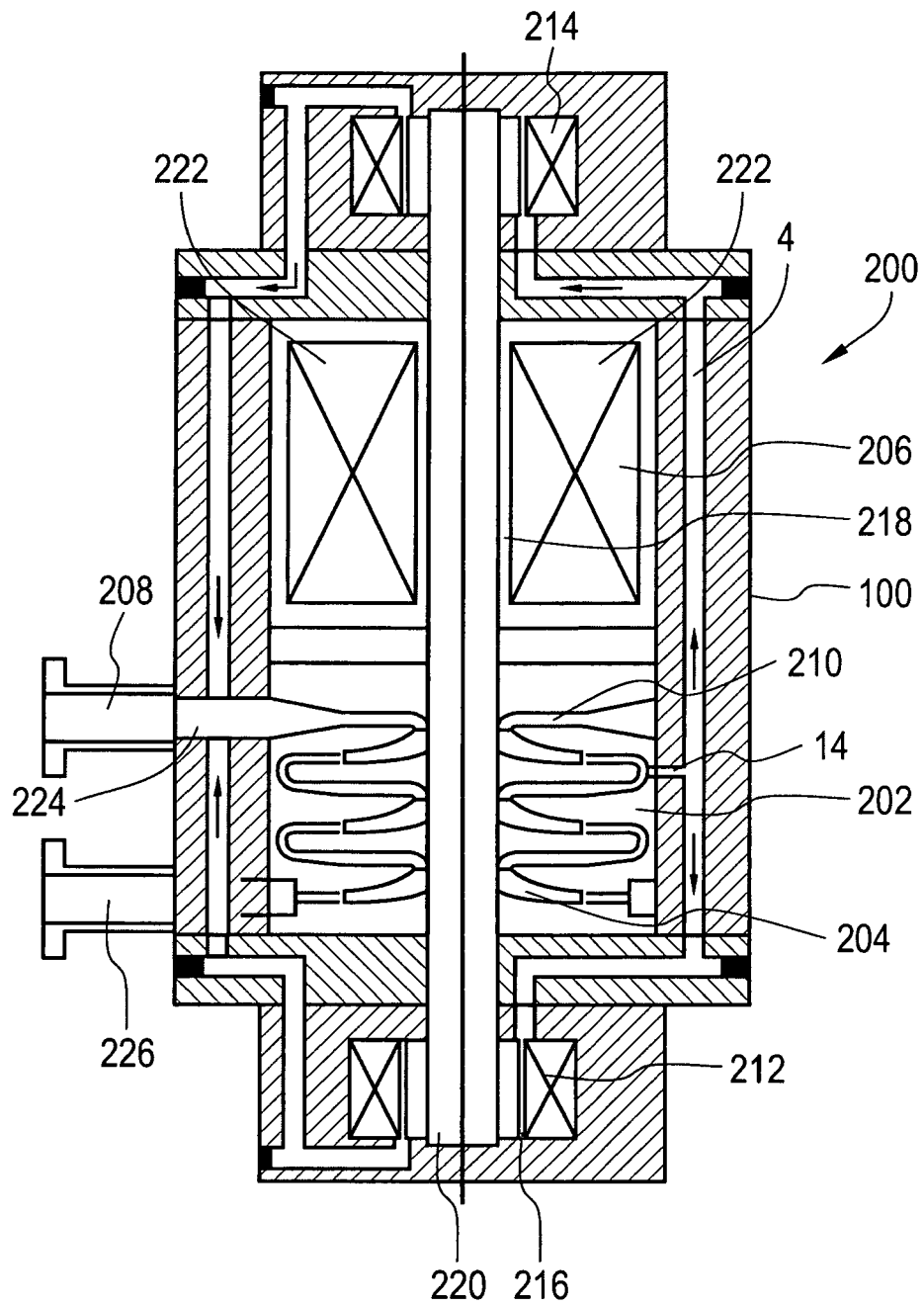


FIG 3

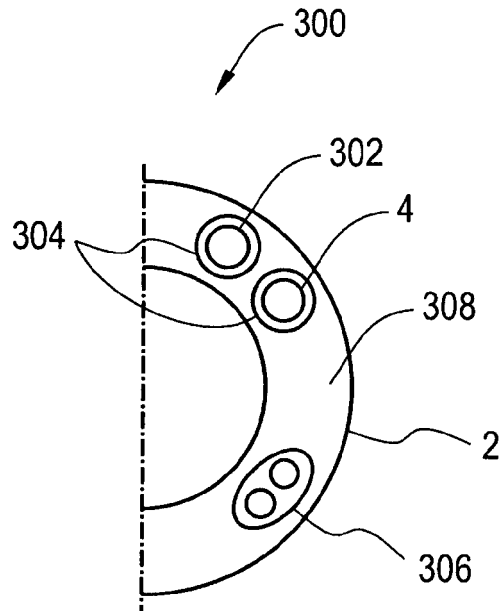
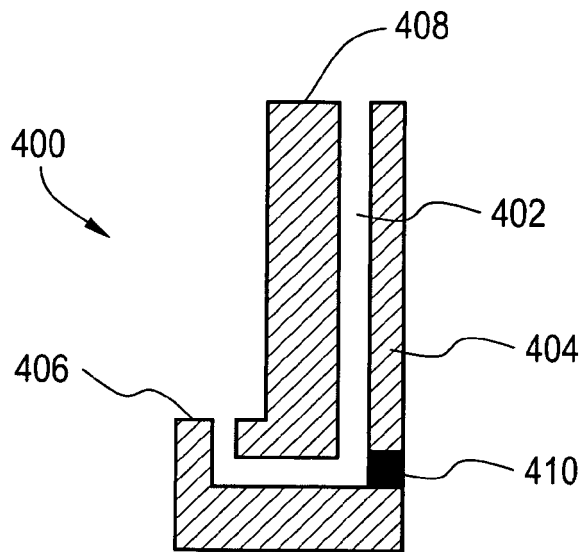


FIG 4





EUROPEAN SEARCH REPORT

Application Number
EP 09 00 8922

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 941 756 A (STALKER E.A.) 20 January 1949 (1949-01-20) * the whole document * * page 3, lines 68-100; figure 1 * -----	1-15	INV. F04D25/06 F04D29/42 F04D29/58
A	DE 915 137 C (HERMANN WENGER; PAUL SPAHR; JAKOB ZINDEL G M B H) 15 July 1954 (1954-07-15) * the whole document * * figure 1 * -----	1,11	
A	EP 1 321 680 A2 (MISCEL OY [FI]) 25 June 2003 (2003-06-25) * figures 3a,3b *	1,11	
A	US 2004/179947 A1 (AGRAWAL GIRIDHARI L [US] ET AL) 16 September 2004 (2004-09-16) * the whole document * -----	1,11	
			TECHNICAL FIELDS SEARCHED (IPC)
			F04D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 December 2009	Examiner Ingelbrecht, Peter
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 00 8922

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11-12-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 941756	A	20-01-1949	NONE	
DE 915137	C	15-07-1954	CH 303395 A NL 77856 C	30-11-1954 16-03-1955
EP 1321680	A2	25-06-2003	NONE	
US 2004179947	A1	16-09-2004	NONE	

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