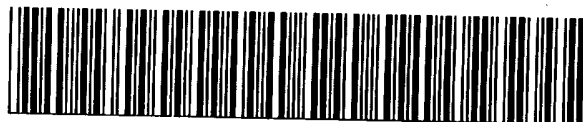


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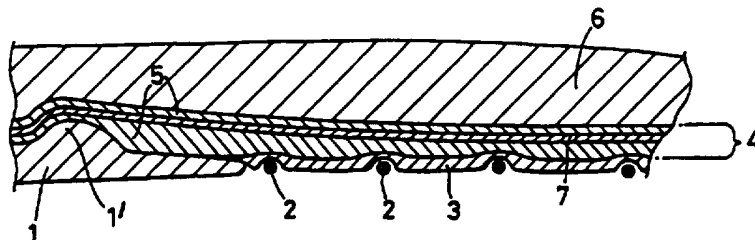
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(54) Title: FLEXIBLE HOSE



(57) Abstract

A flexible hose comprises a reinforcement structure (6) of reinforcing elements embedded in polymeric material and a permeation barrier (4) which comprises a layer (7) of high permeability material sandwiched between two layers (5) of a relatively low permeability.

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FLEXIBLE HOSE

This invention relates to a flexible hose and in particular, although not exclusively, to a flexible hose for the conveyance of LPG (liquified petroleum gas).

It can be difficult to construct a flexible hose which can be used reliably to transfer cooled liquified gas. This is a particular difficulty if a hose is to lie immersed in water for example to transfer cooled gas from a sea floor pipeline to a vessel.

Liquid permeating into the hose wall from the bore of the hose vaporises when the flow of cooled liquid ceases and the hose temperature rises. The volume of the permeated liquid increases dramatically when it vaporises. The hose inhibits the escape of vapour, which then forms blisters, so weakening the hose and reducing its operating life.

The difficulty of constructing a reliable flexible hose for the conveyance of LPG is described in greater detail in United States Patent Specification US 4,315,408. That describes an attempt to overcome the difficulty of conveying LPG by providing one hose within a larger hose so that a ventable or purgable annular space exists between the two concentric hoses. That hose is not easy to construct. The need to provide an annular space leads to a hose outer diameter which is relatively large, and hose flexibility is impaired. The relatively large diameter increases the weight and cost of the hose.

This invention seeks to provide an improved flexible hose which at least mitigates some of the problems of prior art hoses.

In one of its aspects the present invention provides a flexible hose comprising a reinforcement structure of reinforcing elements embedded in polymeric material and a permeation barrier comprising at least one layer of barrier material having a low permeability as herein defined, said permeation barrier comprising a layer of high permeability material sandwiched between two layers of a relatively low permeability.

The permeation barrier may be radially inwards or radially outwards of the reinforcement structure.

The high permeability material may have uniform permeability in all directions. Alternatively and preferably the material has a preferential direction of permeability and in the flexible hose is arranged with that preferential direction of high permeability extending axially along the length of the hose.

The radially inner and radially outer layers of relatively low permeability material preferably are of a material having a permeability (as measured in a radially outwards direction when in situ in a hose) which is less than one fifth, preferably less than 2% and more preferably less than 1% of the permeability or highest permeability of the high permeability material. Examples are nitrile butadiene rubber, polychloroprene and fluorinated rubbers.

The radially inner layer of relatively low permeability material and/or the material of that layer may have a permeability which is less, e g at least two times less, than the radially outer layer of relatively low permeability material and/or the material of that outer layer. The invention envisages also that the radially inner and outer layers and/or the material of those layers may be of the same permeability.

The material of a layer of relatively low permeability preferably has a permeability of less than $2 \text{ cm}^3/\text{m}^2/\text{day}$, more preferably less than $0.3 \text{ cm}^3/\text{m}^2/\text{day}$.

In this specification the references to permeability and relative permeability relate to the permeability of material when measured at 23°C under a pressure difference of 1 bar and in relation to permeation of oxygen.

Suitable material for the layers of low permeability include polymeric material such as rubber and other elastomeric materials, non-elastomeric materials such as metallised film, e g aluminium or brass on a base layer of e g polyester and/or polyethylene, ethylene vinyl alcohol, fluorinated ethylene propylene and polyamide film such as nylon 6.

A layer of low permeability material may be formed for example by extrusion or by spiral or lengthwise application of strip material.

A layer of low permeability preferably comprises at least one layer of

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barrier material having a low permeability and comprising an elongate strip of said barrier material arranged to provide a barrier which is substantially continuous along the length of and around the bore of the hose.

A layer of said barrier material in strip form may be provided additionally or alternatively at a part of the hose which is separate from the permeation barrier of the invention. In particular, preferably it is provided inwards of said permeation barrier though a radially outer location is not excluded by the teaching of the invention.

Said strip material of a permeation barrier preferably has a thickness less than 150 microns. A thickness in the range 10 to 40 microns is believed to be particularly preferred.

The strip material may lie spirally within the hose. The strip may be applied with successive turns overlapped and/or one strip may be overlapped by a second strip. The strip material may be bonded to the surrounding reinforcement structure and to any radially inwards layers of the hose such as an inner polymeric lining layer.

For strip material comprising a metallised film the bond at overlap regions may be provided by a base layer material of the strip, e g polyester or polyethylene and which has a melting point lower than that of the metallised material.

Said layer of high permeability material may be bonded to at least one and preferably both of the layers of relatively low permeability.

Suitable materials for the layer of high permeability material include fabrics of e g polyester, glass, ceramics, cotton, rayon and other materials such as rubber. The material preferably is in filamentary form, as in a yarn, strand or cord and arranged with the filaments extending generally lengthwise of the hose so that the material provides a higher permeability in that direction than radially of the hose. Filamentary material may lie spiralled or extend generally parallel with the lengthwise direction of the hose.

The permeation barrier may be bonded to the radially outer reinforcement layer.

The flexible hose may be of a twin carcass construction comprising two reinforcement carcasses each able individually to withstand the pressure of fluid in the bore of the hose. An example of a suitable twin carcass construction is that described in our United Kingdom Patent Specification No. 1,503,502. In a twin carcass hose a second said permeation barrier may be provided to surround the inner carcass reinforcement and lie inwards of the outer carcass reinforcement.

Two of said permeation barriers may be provided in a twin carcass hose and be arranged to be separately rupturable. Thus in the event of failure of the inner, main carcass only one of the permeation barriers should be damaged or liable to damage and the other should remain serviceable. Two permeation barriers may be arranged to lie respectively outwards of the main and a secondary reinforcement carcass, or respectively inwards of those carcasses.

The flexible hose may be a buoyant hose. It may have a layer of buoyancy material which surrounds the or each reinforcement structure.

The flexible hose may be part of a hose assembly in which an end fitting is built in integrally at at least one end of the hose. The end fitting may have a tubular insert portion which extends axially within the bore of the hose. An outer surface of that insert portion may be formed with an annular rib. The permeation barrier may be constructed to have at least some of its layers extending over that rib. The outer low permeability layer and the high permeability layer may interconnect with means for recovery or venting of fluid permeating axially along the high permeability layer.

The outer low permeability layer may extend over the rib and the high permeability layer may terminate adjacent the rib; vent means such as a passage(s) extending axially through the rib may be provided to assist recovery or venting of fluid permeating axially along the high permeability layer. The radially inner low permeability layer may be bonded to the end fitting e.g. at least at a position axially inwards of a rib.

The radially inner low permeability layer may be an innermost layer of the hose and it may be supported against collapse by an inner helical

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support wire, e g a metal cord. The radially inner low permeability layer may lie outwards of a hose lining layer which may be a layer adapted to protect the low permeability layer from abrasive or other damage,

Embodiments of the present invention will now be described by way of example, with reference to the accompanying Drawings, in which:

- Figure 1 is a longitudinal section of part of a hose assembly and flexible hose of the invention;
- Figure 2 is a longitudinal section showing an end fitting in more detail; and
- Figures 3A and 3B are end and side views of the end fitting shown in Figure 2.

Figure 1 shows part of a rough bore standard dock hose and an end fitting 1. The hose has an inner wire helix 2 which supports the hose body against collapse by external pressure and resists kinking. The helix 2 is surrounded by an inner support lining 3 of a textile fabric over which is located a permeation barrier 4. Barrier 4 is surrounded by and bonded to the main hose reinforcement carcass 6 comprising reinforcing elements embedded in polymeric material, e g rubber.

The permeation barrier 4 comprises a high permeability layer 7 sandwiched between and bonded to radially outer low permeability layers 5. The three layers of the barrier 4 extend axially over an annular rib 1' on the outer surface of the insert portion of the end fitting. The inner low permeability layer is bonded to the rib and the outer surface of the insert portion at the region thereof which is axially inwards of the rib 1'.

The inner low permeability layer 5 terminates adjacent the axially inwards side of a second rib 1'' and the high permeability layer also terminates at that rib 1'' at a position adjacent a series of axially extending passages 9.

The outer low permeability layer 5 extends over and is bonded to said second rib 1''.

The inner and outer low permeability layers 5 are each layers of a relatively low permeability type of rubber such as nitrile butadiene rubber or

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chloroprene rubber. The layers are formed by spiral winding of strips of the rubber, and the strip material forms axially and circumferentially continuous barrier layers during vulcanisation of the completed hose assembly.

The intervening high permeability layer 7 comprises a layer of polyester cords wound spirally and optionally at touch pitch at an angle e g of $54^{\circ}44'$ relative to the lengthwise direction of the hose. This angle minimises the restrictive effect of the cords on the hose flexibility.

A pipe 10 collects from the passages 9 the fluid e g vapour, which has permeated along the high permeability layer 7 and conveys it to a control valve 11 for recovery or controlled venting. Recovery or venting is via a pipe 12 which extends spirally along the hose around the reinforcement carcass 6.

A layer 20 of buoyancy material surrounds the carcass 6 and the pipe 12.

Figures 3A and 3B show the end fitting in more detail and the pipes 10 which connect with three rib passages 9.

CLAIMS:

1. A flexible hose comprising a reinforcement structure of reinforcing elements embedded in polymeric material and a permeation barrier, said permeation barrier comprising a layer of high permeability material sandwiched between two layers of a relatively low permeability.
2. A flexible hose according to claim 1 wherein the radially inner and outer layers of relatively low permeability material are of a material having a permeability, as measured in a radially outwards direction when in situ in the hose, which is less than one fifth of the permeability or highest permeability of the high permeability material.
3. A flexible hose according to claim 2 wherein said low permeability material has a permeability less than 2% of the permeability of highest permeability of the high permeability material.
4. A flexible hose according to any one of the preceding claims wherein the high permeability material has a uniform permeability in all directions.
5. A flexible hose according to any one of claims 1 to 3 wherein the high permeability material has a preferential direction of permeability and is arranged with that direction of high permeability extending axially along the length of the hose.
6. A flexible hose according to any one of the preceding claims wherein the radially inner layer of low permeability material has a permeability which is less than that of the radially outer layer of relatively low permeability material.
7. A flexible hose according to any one of the preceding claims wherein the material of the radially inner layer of relatively low permeability material has a permeability which is less than that of the material of the radially outer layer of relatively low permeability material.
8. A flexible hose according to claim 6 or claim 7 wherein the said permeability is less by at least two times.
9. A flexible hose according to any one of claims 1 to 5 wherein the radially inner and outer layers or the material of those layers are of the same permeability.

10. A flexible hose according to any one of the preceding claims wherein the material of a layer of relatively low permeability has a permeability of less than $2\text{cm}^3/\text{m}^2/\text{day}$ when measured at 23°C under a pressure difference of 1 bar and in relation to permeation of oxygen.
11. A flexible hose according to any one of the preceding claims wherein the layer of high permeability material is bonded to at least one of the layers of relatively low permeability.
12. A flexible hose according to any one of the preceding claims wherein the permeation barrier is bonded to the radially outer reinforcement layer.
13. A flexible hose according to any one of the preceding claims wherein the high permeability layer comprises filamentary material.
14. A flexible hose according to any one of the preceding claims wherein the layer of low permeability material is formed by strip material arranged with parts of the strip overlapping.
15. A flexible hose according to any one of the preceding claims wherein the radially innermost low permeability layer is an innermost layer of the hose.
16. A flexible hose according to claim 15 wherein said innermost layer is supported against collapse by an inner helical support wire.
17. A flexible hose according to any one of the preceding claims wherein the hose comprises a layer of low permeability material which is additional to said permeation barrier.
18. A flexible hose according to claim 17 wherein said additional layer provides a barrier which is substantially continuous along the length of and around the bore of the hose.
19. A flexible hose according to claim 17 or claim 18 wherein said additional layer comprises an elongate strip of material of a permeability less than $2.0\text{ cm}^3/\text{m}^2/24\text{ hour}$ when measured at 23°C under a pressure difference of 1 bar in relation to permeation of oxygen.
20. A flexible hose according to claim 19 wherein the material of said additional layer has a permeability less than $0.3\text{ cm}^3/\text{m}^2/24\text{ hour}$.
21. A flexible hose according to any one of claims 17 to 20 wherein the

additional layer comprises strip material which has a thickness less than 150 microns.

22. A flexible hose according to claim 21 wherein said thickness is in the range 10 to 40 microns.

23. A flexible hose according to claim 21 or claim 22 wherein the strip material lies spirally within the hose.

24. A flexible hose according to claim 23 wherein successive turns of the spiralled strip material lie overlapped.

25. A flexible hose according to claim 23 or claim 24 wherein one strip is overlapped by a second strip.

26. A flexible hose according to any one of claims 21 to 25 wherein said strip material is bonded to a surrounding reinforcement structure.

27. A flexible hose according to any one of claims 21 to 26 wherein the strip material comprises ethylene vinyl alcohol.

28. A flexible hose according to any one of claims 21 to 26 wherein the strip material comprises fluorinated ethylene propylene.

29. A flexible hose according to any one of claims 21 to 26 wherein the strip material comprises a polyamide film.

30. A flexible hose according to any one of claims 21 to 26 wherein the strip material comprises a metallised film.

31. A flexible hose according to claim 30 wherein the strip material comprises aluminium or brass applied to a base layer.

32. A flexible hose according to claim 30 or 31 wherein the strip material is overlapped and is bonded at overlapped regions by base layer material which has a melting point lower than that of the metallising material.

33. A flexible hose according to any one of claims 18 to 32 wherein said additional layer is surrounded by a venting or bleed structure comprised by the high permeability material of the permeation barrier.

34. A flexible hose according to any one of the preceding claims wherein the hose comprises two reinforcement carcasses each able to withstand the pressure of fluid in the bore of the hose and a second permeation barrier is provided to surround the inner carcass reinforcement and lie inwards of the

outer carcass reinforcement.

35. A flexible hose substantially as described with reference to the drawings.

36. A hose assembly comprising a hose according to any one of the preceding claims and a hose end fitting built in integrally at an end of the hose, said end fitting comprising a tubular insert portion which extends axially within the bore of the hose, an outer surface of the insert having an annular rib and at least some layers of the permeation barrier being arranged to extend over said annular rib.

37. A hose assembly according to claim 36 wherein the outer low permeability layer and the high permeability layer interconnect with means for recovery or venting of fluid permeating axially along the high permeability layer.

38. A hose assembly according to claim 36 or claim 37 wherein the outer high permeability layer extends over the rib.

39. A hose assembly according to any one of claims 36 to 38 wherein the high permeability layer terminates adjacent the rib.

40. A hose assembly according to any one of claims 36 to 39 wherein vent means extends axially through the rib for recovery or venting of fluid permeating axially along the high permeability layer.

41. A hose assembly according to any one of claims 36 to 40 wherein the radially inner low permeability layer is bonded to the end fitting.

42. A hose assembly substantially as described with reference to the drawings.

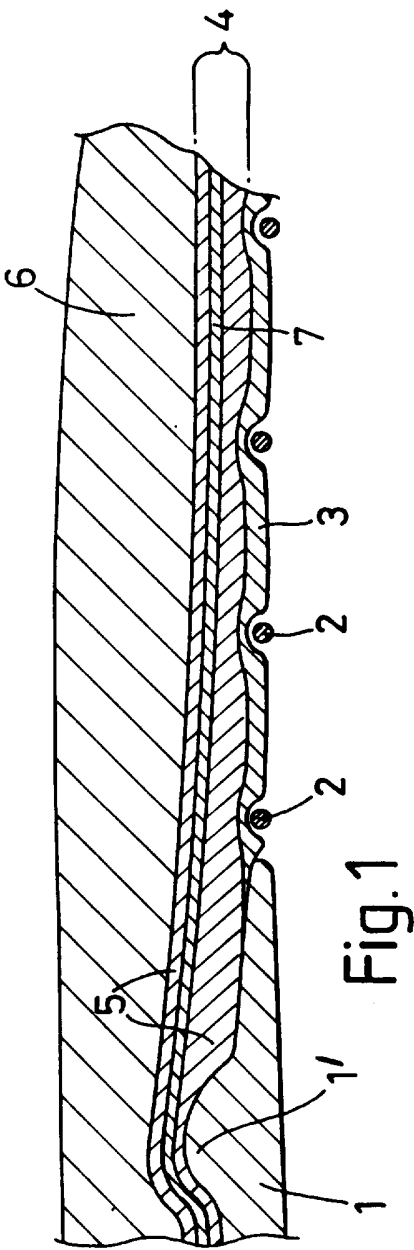


Fig. 1

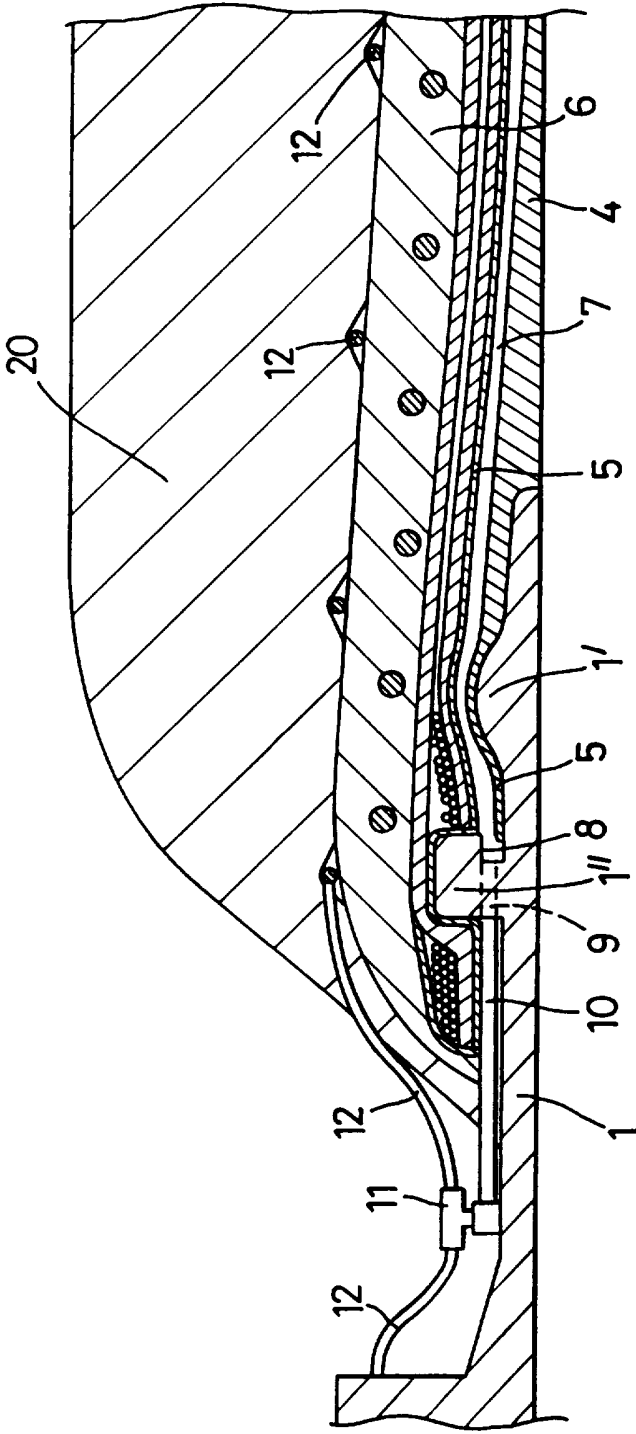


Fig. 2

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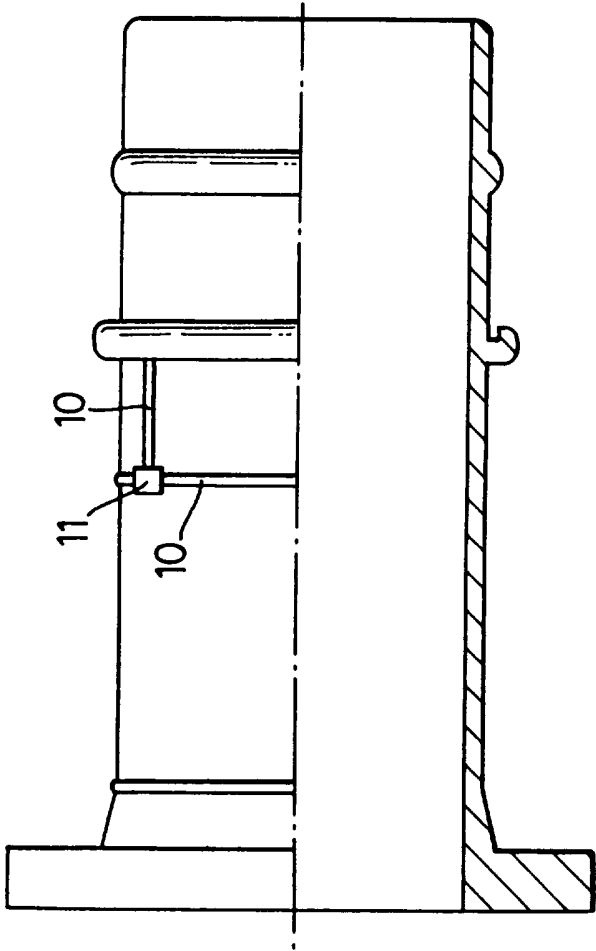


Fig. 3B

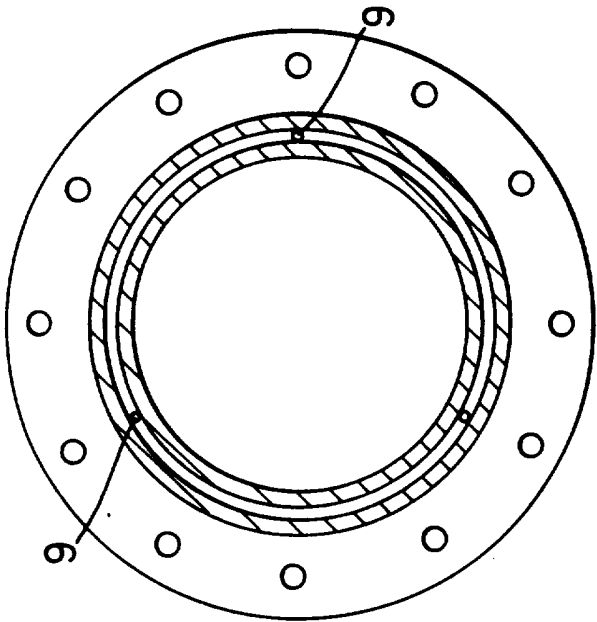


Fig. 3A

INTERNATIONAL SEARCH REPORT

Inter. nal Application No

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A. CLASSIFICATION OF SUBJECT MATTER

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Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F16L

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 practical, search terms used)

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X	GB,A,2 027 838 (BRIDGESTONE TIRE) 27 February 1980 see abstract; figures 2,3	1, 36, 37, 40-42
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Date of the actual completion of the international search

14 November 1995

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INTERNATIONAL SEARCH REPORT

International Application No
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