



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **16.01.2002 Bulletin 2002/03** (51) Int Cl.7: **E21B 17/08, E21B 17/01**

(21) Application number: **00401888.3**

(22) Date of filing: **30.06.2000**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
 MC NL PT SE**  
 Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventor: **Alliot, Vincent**  
**75009 Paris (FR)**

(74) Representative: **Gray, John James**  
**Fitzpatricks, 4 West Regent Street**  
**Glasgow G2 1RS (GB)**

(71) Applicant: **Stolt Comex Seaway S.A.**  
**13016 Marseille (FR)**

(54) **Marine riser**

(57) The invention relates to a production riser system wherein the riser (1), at the touchdown point (5), has a bottom flexjoint (8) so that the dynamic motion of the riser (1) is absorbed by angular excursion (9) of the

flexjoint (8) and not by the interaction of the sag bend (10) with the seabed (6). The surface end of the riser may be fixed, or coupled by a second flexjoint to a production and storage vessel.

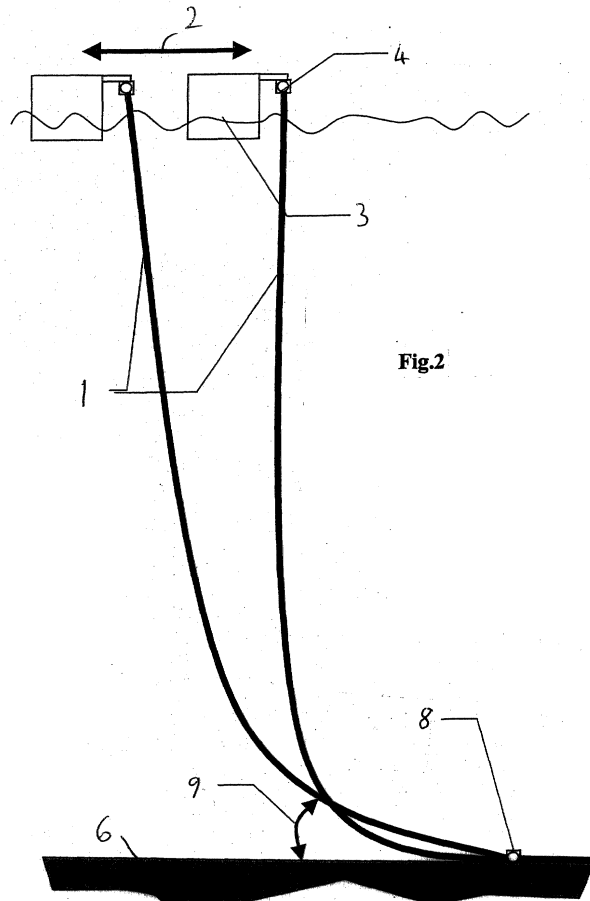


Fig.2

## Description

**[0001]** The present invention relates to a marine riser, and in particular a steel catenary riser, and to methods of operating such a riser.

**[0002]** In offshore oil and gas fields, a riser provides a conduit to connect a wellhead on the seabed to a surface support on the surface of the water. Catenary risers, and more particularly Steel Catenary Risers, known as SCRs have been considered for deep-water application for a considerable time now. The deep environment allows a metallic riser to be sufficiently flexible to accommodate the stress induced by first- and second-order motions of the surface support. Risers may be permanent, for production, or temporary, for maintenance or service operations.

**[0003]** A riser is subject to great pressures and tensions along its length, particularly when used in deep sea applications. These are due to factors such as the high hydrostatic pressures at such depths and the large weights due to its long suspended length. Furthermore, heave motions of the surface support will be transmitted to the point at which the riser first contacts the seabed, herein known as the touchdown point (TDP), and therefore large bottom tensions and compressions can occur.

**[0004]** The interface between the touchdown point and the catenary riser is very difficult to model and as a result the relative interaction between seabed and pipe is a very serious problem which could have adverse consequences if not handled properly, for example, causing seabed destruction or pipe embedment. It is therefore desired to control better the touchdown point.

**[0005]** Attempts have been made to address some of these problems previously, such as a "hybrid catenary riser" (HCR) described in "Optimisations and Innovations of UDW Flexible Riser Systems" by Coflexip Stena Offshore at Deeptec 2000. The HCR is comprised of a length of rigid pipe with a length of flexible pipe each end. This aims to combine the benefits of flexible pipe technology, with the lower cost of rigid steel risers. This though does not address directly the problem of touchdown point control nor prevent excursion of the touchdown point itself. WO-A-99/05388, published 4 February 1999, also proposes a similar configuration of flexible-rigid-flexible conduit sections, for maintenance operations from a DP (dynamically positioned) vessel.

**[0006]** Also known are flexible joints or "flexjoints". These devices can be welded between two sections of a pipeline, to allow relative angular rotation (typically up to +/-25 degrees) between two pipe sections. Use of some form of flexible joints as part of a riser system is suggested in US-A-5615917. In that case, flexible joints are incorporated at numerous points spaced along the length of the riser to give the riser flexibility. The use of many flexible joints along the length of the riser is expensive and unnecessary as the curvature of a riser can be high at the top of the riser and at the touchdown point but the section of the riser between these two points is

always relatively straight. WO-A-99/05388 mentioned above discusses briefly an alternative arrangement using a flexjoint. This is understood to refer to a drilling or workover application, however, as opposed to a permanent production riser. In this arrangement, again the surface support conventionally must provide motion compensation and/or constant tension, as the flexjoint must not be operated in compression.

**[0007]** An object of the present invention is to provide better control of the catenary riser at the touchdown point and to limit the stress level of the catenary riser structure in the sag bend, that is the bend at the bottom end of the riser.

**[0008]** This is achieved by the invention as set forth in the appended claim 1, by providing a catenary riser incorporating a device, such as a flexjoint, so as to fix the touchdown point, that is, the point at which the riser first contacts the seabed. The incorporation of such a device at the touchdown point is so that dynamic motion of the riser catenary is absorbed by angular excursion of the flexjoint and not by the interaction of the sag bend with the seabed. The riser, however can still be laid by conventional pipe laying methods such as S-lay or J-lay. The joint is kept in tension simply by the positioning of the surface support, the weight of the riser being permanently to one side of the touchdown point.

**[0009]** A preferred embodiment of the invention uses a second flexjoint to couple the surface support and the top of the riser. The role of this flexjoint is to absorb the bending moment generated at the top by the surface support. The expense of numerous intermediate joints is avoided, in any case, as is the expense associated with flexible conduit.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** Embodiments of the invention will now be described, by way of example only, by reference to the accompanying drawings, in which:

Fig 1 shows a surface support coupled to a conventional riser, before and after excursion; and

Fig 2 shows a surface support coupled to a novel riser, before and after excursion.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0011]** Fig. 1 shows the path of a catenary riser 1 before (A) and after (B) an excursion 2 of the surface support 3. The catenary riser, made of welded steel tubular sections, is coupled to the surface support 3 by means of a top flexjoint 4. Surface Support 3 is, for example, a floating production and storage vessel (FPSO). The touchdown point 5, that is the point in which the catenary riser 1 first contacts the seabed 6, is uncontrolled. Therefore the dynamic motions and excursion 2 of the surface support 3 generates modification of the cate-

nary configuration, resulting in an excursion 7 of the touchdown point 5 itself. This, in turn, results in the undesirable interaction of the sag bend 10 with the seabed 6.

**[0012]** Fig 2 shows a modified catenary riser 1 wherein at the touchdown point 5 there is incorporated in the catenary riser 1 a bottom flexjoint 8. The top of the catenary riser 1 is coupled to the surface support 3 by means of a top flexjoint 4 as in fig 1. In this example any dynamic motions or excursion 2 of the surface support 3 are absorbed by the angular excursion 9 of the bottom flexjoint 8 and therefore not absorbed by the interaction of the sag bend 10 with the seabed 6. The nominal position of the vessel is set so that the weight of the riser 1 in the catenary shape will keep the flexjoint under tension, over the entire expected range of surface vessel excursions. The excursions that can be accommodated in this way would result in very large and damaging excursions of the touchdown point in a conventional touchdown arrangement.

**[0013]** The flexjoint 8 can be of known type, permitting bending both up and down and side to side. A known form of flexjoint is described in US-A-5615917 mentioned above. Other types of flexjoint may of course be used, from suppliers such as Oil States Industries in Arlington, Texas, USA, alternatively Techlam in France. The flexjoints 4 and 8 at the top and bottom of the riser are adapted to the different combinations of pressure and axial load encountered at these locations. The bulk and mass of the flexjoints are not an issue in the present case, as they are supported by the seabed and the surface vessel respectively.

**[0014]** The skilled reader will appreciate that many variations are possible within the spirit and scope of the invention defined in the appended claims, and the embodiments disclosed herein should be regarded as examples only. It will be understood that terms such as "marine" and "seabed", as used in the description and claims, are not intended to exclude application in bodies of water other than open seas. Moreover, the touchdown point may be on part of a subsea installation raised from the seabed, or in a trench. "Seabed" is therefore not to be interpreted as being limited to the natural seabed in its undisturbed state.

### Claims

1. A riser system comprising a continuous metallic riser conduit (1) extending substantially from seabed to surface, to connect a surface installation (3) to a seabed installation wherein, where the riser reaches the seabed (6), there is incorporated at least a joint which allows relative angular rotation between the riser conduit and conduit supported by the seabed, so as to fix the point at which the riser reaches the seabed during expected excursions of the surface support position.

2. A riser system as claimed in claim 1 wherein the riser is coupled to the surface support by means of a second joint which allows relative angular rotation between the riser and the surface support.

3. A riser system as claimed in claim 1 or 2 wherein said riser conduit is made of steel pipe, and follows substantially a catenary path.

4. A riser system as claimed in claim 1, 2 or 3, in use as a permanent production system for hydrocarbons.

5. A riser system as claimed in any preceding claim, wherein said surface support is controlled so as to maintain a minimum horizontal displacement from the relative to the touchdown point.

6. A riser system as claimed in any preceding claim, wherein the surface support comprises a dynamically positioned vessel.

7. A riser system as claimed in any preceding claim, wherein the surface support comprises a moored vessel.

8. A riser system as claimed in any preceding claim, wherein said first joint provides at least two angular degrees of freedom.

9. A method of controlling the touchdown point of a substantially continuous catenary riser conduit, wherein a joint is incorporated which allows relative angular rotation between the riser and a conduit supported on the seabed.

10. A method as claimed in claim 8 wherein the riser conduit is coupled to a surface support by means of a second joint which allows relative angular rotation between the riser conduit and the surface support.

11. A method as claimed in claim 8 or 9 wherein said riser conduit is made of steel pipe, and follows substantially a catenary path.

12. A method as claimed in claim 8, 9 or 10 wherein said riser conduit forms part of a permanent production system for hydrocarbons.

13. A method as claimed in any of claims 8 to 11, wherein the surface support is controlled so as to maintain a minimum horizontal displacement from the relative to the touchdown point.

14. A method as claimed in any of claims 8 to 11, wherein the surface support comprises a dynamically positioned vessel.

15. A method as claimed in any of claims 8 to 13, wherein the surface support comprises a moored vessel.
16. A method as claimed in any of claims 8 to 14, wherein said first joint provides at least two angular degrees of freedom.

5

10

15

20

25

30

35

40

45

50

55

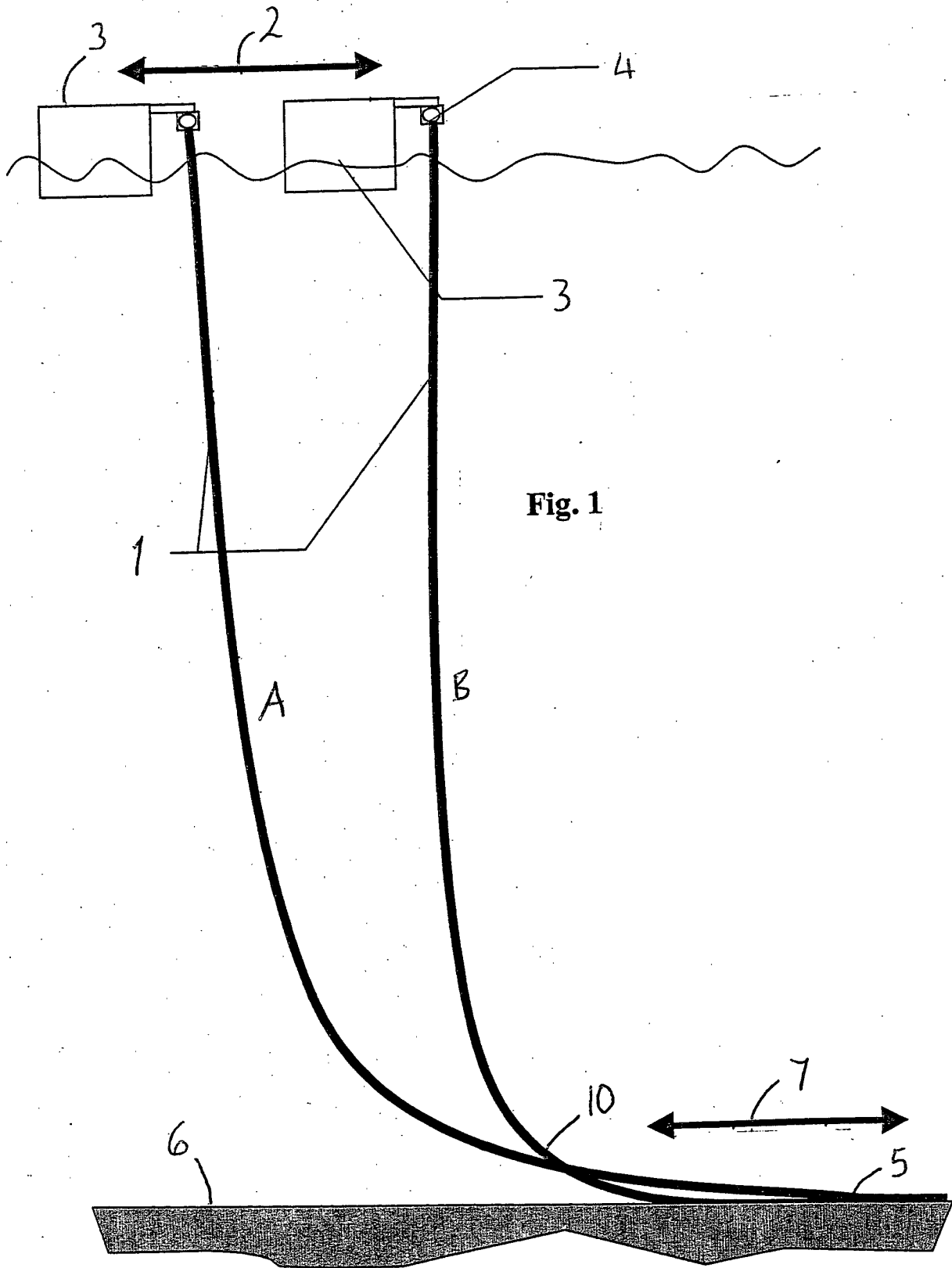


Fig. 1

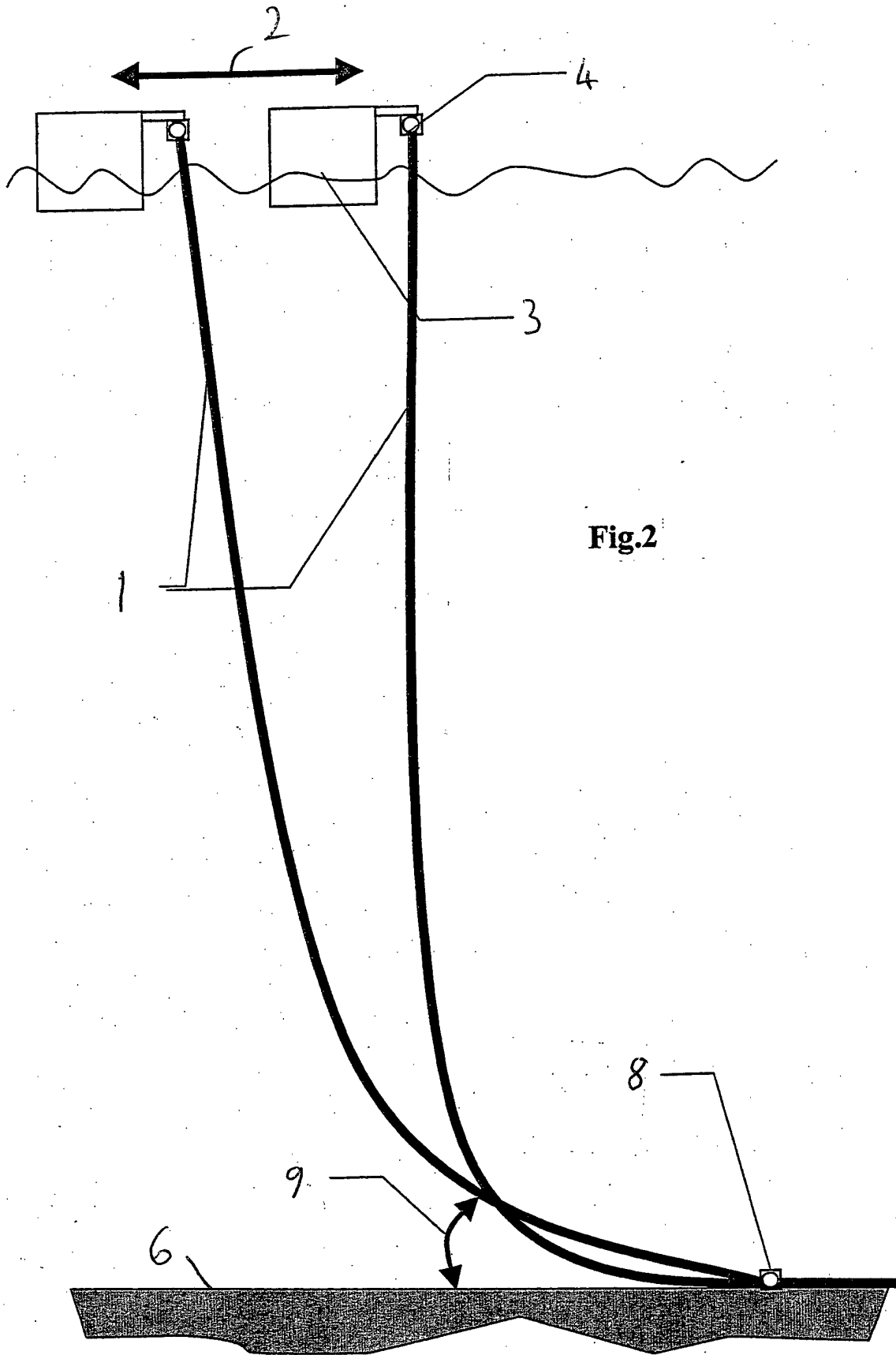


Fig.2



European Patent  
Office

EUROPEAN SEARCH REPORT

Application Number  
EP 00 40 1888

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.7)
A	GB 2 081 417 A (MOBIL OIL CORP) 17 February 1982 (1982-02-17)  * column 2; figure 1 * ---	1,2, 4-10, 12-16	E21B17/08 E21B17/01
A	GB 1 564 755 A (RYAN W J) 16 April 1980 (1980-04-16) * column 3; figures 1,2 * ---	1,9	
A	GB 2 311 503 A (ALCATEL KABEL NORGE AS) 1 October 1997 (1997-10-01) * page 3; figures 2-4 * ---	1,9	
A	GB 2 148 842 A (BECHTEL INT CORP) 5 June 1985 (1985-06-05) * figures 4-6 * ---	1,9	
A	US 3 841 357 A (VAN HEIJST W) 15 October 1974 (1974-10-15) * figure 1 * ---	1,9	
D,A	US 5 615 977 A (SIMIC RAJKO M ET AL) 1 April 1997 (1997-04-01) ---		TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	GB 2 330 157 A (BLUEWATER TERMINAL SYSTEMS NV) 14 April 1999 (1999-04-14) ---		E21B
A	US 5 865 566 A (FINN LYLE DAVID) 2 February 1999 (1999-02-02) ---		
A	US 3 778 854 A (CHOW P) 18 December 1973 (1973-12-18) -----		
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		22 August 2000	Fonseca Fernandez, H
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 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 40 1888

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-08-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2081417 A	17-02-1982	AT 9928 T	15-11-1984
		AU 539838 B	18-10-1984
		AU 7250781 A	04-02-1982
		CA 1163212 A	06-03-1984
		DE 3166712 D	22-11-1984
		EG 15297 A	31-03-1986
		EP 0045632 A	10-02-1982
		ES 503495 D	01-12-1982
		ES 8301529 A	01-03-1983
		HK 33285 A	10-05-1985
		JP 57040190 A	05-03-1982
		MX 152352 A	02-07-1985
		NO 812104 A	01-02-1982
		SG 14185 G	16-08-1985
US 4383554 A	17-05-1983		
GB 1564755 A	16-04-1980	NONE	
GB 2311503 A	01-10-1997	NO 961249 A	29-09-1997
		FR 2746977 A	03-10-1997
GB 2148842 A	05-06-1985	US 4704050 A	03-11-1987
		AU 3382584 A	18-04-1985
		CA 1224716 A	28-07-1987
		FR 2591655 A	19-06-1987
US 3841357 A	15-10-1974	NL 7203231 A	12-09-1973
		FR 2175871 A	26-10-1973
		GB 1374392 A	20-11-1974
		JP 1071310 C	30-10-1981
		JP 49085782 A	16-08-1974
		JP 56012560 B	23-03-1981
US 5615977 A	01-04-1997	AT 181138 T	15-06-1999
		AU 7871294 A	27-03-1995
		BR 9405579 A	08-09-1999
		CN 1118618 A,B	13-03-1996
		DE 69419000 D	15-07-1999
		EP 0666960 A	16-08-1995
		WO 9507405 A	16-03-1995
GB 2330157 A	14-04-1999	NO 982559 A	08-04-1999
US 5865566 A	02-02-1999	AU 8517898 A	01-04-1999
		BR 9803461 A	26-10-1999
		EP 0907002 A	07-04-1999

EPO FORM P4659

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 40 1888

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-08-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5865566 A		FI 981968 A NO 984238 A	17-03-1999 17-03-1999
US 3778854 A	18-12-1973	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82