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

(11) Publication number: **0 493 866 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **91300025.3**

(51) Int. Cl.5: **B63C 7/12**

(22) Date of filing: **02.01.91**

(43) Date of publication of application:
08.07.92 Bulletin 92/28

(84) Designated Contracting States:
AT BE CH DE DK ES FR GR IT LI LU NL SE

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(54) Valve apparatus for use in raising a sunken vessel.

(57) Valve apparatus (24) for use in raising a sunken vessel (2), which valve apparatus (24) comprises a vent pipe (26), attachment means (28) for attaching one end portion (30) of the vent pipe (26) to the sunken vessel (2), and cover means (32) which is provided at the other end portion (34) of the vent pipe (26) and which allows compressed air introduced into the sunken vessel (2) to escape from the sunken vessel (2) through the valve apparatus (24) as the sunken vessel (2) starts to rise.

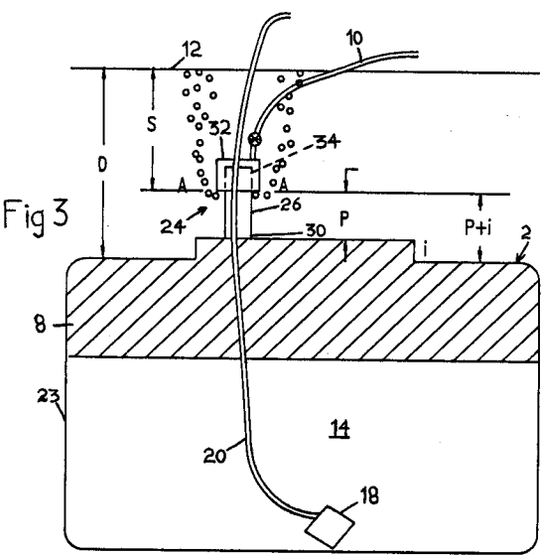

Fig 3

EP 0 493 866 A1

This invention relates to valve apparatus for use in raising a sunken vessel.

Hitherto, there have been three usual methods of raising a sunken vessel in salvage operations. The first method involves physically lifting the sunken vessel by a crane or floatation bags or tanks. The second method is by pumping air under pressure into the vessel. The third method is by cofferdamming (ie providing a trunking from the sunken vessel to the surface) and pumping out the water in the sunken vessel.

The first method of physically lifting the sunken vessel is not practical on large sunken vessels. Huge cranes are often not readily available and they are very costly. Furthermore, it is often impossible to secure sufficiently heavy wires around the sunken vessel. The use of the floatation bags or tanks gives only a limited lift and is not practical on large sunken vessels.

The second method of pumping air under pressure into the sunken vessel is not very practical on sunken vessels such as cargo ships where the hatches and decks of the cargo ships are not designed to take an upward load. When raised on air pumped in under pressure, a vessel is lifted up by its deck and the entire weight of the vessel is carried by the deck and the hatches. It is very difficult to make the sunken vessel airtight, except on oil tankers. Care has to be taken to vent excess air as the sunken vessel rises, otherwise the vessel could burst open with the release of the external balancing pressures as the sunken vessel rises.

The third method of cofferdamming and pumping out the water is probably the most widely used method of raising a sunken vessel. As the water is pumped out, the water level in the sunken vessel drops but this places a great strain on the decks of the sunken vessel. The load on these decks is the full head of water above the decks and the decks of most sunken vessels will not support a head of water of about six metres (20 feet). Thus salvage by this third method is not very practical in deep waters unless expensive internal shoring of the sunken vessel is undertaken in order to help the decks of the sunken vessel take the strain of the head of water above the sunken vessel. This internal shoring can be expensive and time consuming to install.

It is an aim of the present invention to reduce the above mentioned problems.

Accordingly, this invention provides valve apparatus for use in raising a sunken vessel, which valve apparatus comprises a vent pipe, attachment means for attaching one end portion of the vent pipe to the sunken vessel, and cover means which is provided at the other end portion of the vent pipe and which allows compressed air introduced into the sunken vessel to escape from the sunken vessel through the valve apparatus as the sunken vessel starts to rise.

The valve apparatus of the present invention operates as a pressure inverter valve. The valve apparatus is able to invert the pressure on the sunken vessel so as to normalize the pressure acting on the decks and hull of the sunken vessel to within acceptable limits, thereby making salvage simple, speedy and inexpensive. The valve apparatus is able to allow expanding air to escape rapidly during raising of the sunken vessel. The valve apparatus is able to prevent an air pressure build up in the sunken vessel whilst the sunken vessel is on the bottom, the valve apparatus is able to avoid a vacuum being created inside the sunken vessel during pumping out, and the valve apparatus is able to maintain constant pressure inside the sunken vessel. Advantageously, the valve apparatus is able to allow a constant volume of water to remain inside the sunken vessel and so prevent the sunken vessel from tending to rush dangerously to the surface, as often happens with the known salvage method of pumping air into the sunken vessel under pressure, the air expanding during the raising of the sunken vessel and tending to cause the sunken vessel to rush to the surface.

The valve apparatus of the present invention enables the sunken vessel to be raised by normal floatation, with lift being given through the bottom of the hull of the sunken vessel. This is in contrast to the known method of pumping air under pressure into the sunken vessel where decks and hatches of the sunken vessel have to carry the entire weight of the vessel and where hatches or decks can easily be blown open during lifting as the air inside the sunken vessel rapidly expands.

The valve apparatus of the present invention avoids the need for extensive internal shoring as is required by the above mentioned known method of cofferdamming and pumping out the water.

The valve apparatus of the present invention allows water pressure on the decks and hull of the sunken vessel to be reduced during salvage, and to be kept at safe and acceptable levels. By creating an internal pressure of slightly less than the outside pressure, sealing and patching of the sunken vessel by divers or by other means is made simple by the inward suction of water. The valve apparatus eliminates the depth limitations of salvage caused by pressure from the head of water above the sunken vessel since the pressure inside the sunken vessel can automatically be kept at a pressure slightly less than the external pressure irrespective of depth. The depth limitation of the valve apparatus of the present invention is only governed by the depth at which divers, remote controlled vehicles or other means can operate. Air at ambient pressure can enter the sunken vessel

whilst it is being pumped out.

The required pressure to suit any particular size, strength and type of sunken vessel can be achieved by varying the distance from the bottom of the cover means to the decks of the sunken vessel.

The valve apparatus may be one in which the vent pipe is from 1 - 3 metres (3 - 10 feet) long.

Usually, the vent pipe will be of circular cross section. If desired however, the vent pipe may be of a cross sectional shape other than circular. Where the vent pipe is of circular cross section, then it may be from 150-900mm (0.5-3 feet) in diameter.

The vent pipe may be a rigid vent pipe or it may be a flexible vent pipe.

The valve apparatus may be one in which the attachment means comprises a base for engaging with the sunken vessel around a hole in the sunken vessel, and fastener means for fastening the base in position.

Preferably, the fastener means comprises hook bolts. Other types of fastener means may however be employed.

The attachment means may comprise sealing means for forming a seal between the valve apparatus and the sunken vessel. The sealing means may be made of a rubber or a plastics material. The rubber or the plastics material may be of solid or foam form.

The cover means may be approximately one half of the length of the pipe and twice the width of the pipe.

The valve apparatus may include air connector means for connecting an air line to the valve apparatus. The apparatus may also include water discharge connector means for connecting a water discharge line to the valve apparatus. The air connector means and the water discharge connector means may be provided on the cover means.

An embodiment of the invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 illustrates a known method of lifting a sunken vessel involving pumping air under pressure into the sunken vessel;

Figure 2 illustrates a known method of lifting a sunken vessel by cofferdamming and pumping out the water;

Figure 3 shows the valve apparatus of the present invention in use;

Figure 4 shows the valve apparatus in more detail; and

Figure 5 is a top plan view showing the valve apparatus of Figure 4 as it is fixed to the sunken vessel.

Referring to Figure 1, there is shown a sunken vessel 2 resting on a bottom 4 in water 6. The sunken vessel 2 is provided with compressed air 8 from an air line 10 which extends above the surface 12 of the water 6. The air 8 forces water 14 from the sunken vessel 2 through a hole (not shown) and the sunken vessel 2 rises when sufficient water 14 is removed from inside the sunken vessel 2. During raising, the sunken vessel 2 is lifted up by its decks 16 and the whole weight of the sunken vessel 2 is carried by the decks 16 and hatches (not shown). It is often very difficult, except with oil tankers, to make the sunken vessel 2 sufficiently airtight to retain the air 8. Also, care has to be taken to vent excess air 8 as the sunken vessel 2 rises as otherwise the sunken vessel 2 could burst open as the pressure of the water 6 acting on the outside of the sunken vessel 2 reduces.

Referring now to Figure 2, similar parts as in Figure 1 have been given the same reference numerals for ease of comparison and understanding. In Figure 2, a pump 18 pumps water via a water discharge line 20 up to the surface 12 of the water 6. Trunking 22 has to be provided to the surface 12 in order to enable the air 8 to enter the vessel 2. As the water 14 is pumped out of the sunken vessel 2, the volume of air 8 increases. However, since this air is at surface pressure, a considerable strain is placed on the decks 16 of the sunken vessel 2. This pressure is a function of the head of water above the decks 16. The decks 16 of most sunken vessels 2 are not able to support a head of water of more than six metres (20 feet). Thus salvage of the sunken vessel 2 by the method illustrated in Figure 2 presents considerable problems in deep waters. Often extensive internal shoring of the sunken vessel 2 is required in order to stop the decks 16 and/or the hull 23 from collapsing.

Referring now to Figures 3, 4 and 5 similar parts as in Figures 1 and 2 have again been given the same reference numerals. In Figures 3, 4 and 5 there is shown valve apparatus 24 comprising a vent pipe 26, attachment means 28 for attaching one end portion 30 of the vent pipe 26 to the sunken vessel 2, and cover means 32. The cover means 32 is provided at the other end portion 34 of the vent pipe 26. The cover means 32 allows compressed air introduced into the sunken vessel 2 to escape from the sunken vessel 2 through the valve apparatus 24 as the sunken vessel 2 starts to rise.

The attachment means 28 comprises a base 36 for engaging with the sunken vessel 2 around a hole 38 in the sunken vessel 2, and fastener means in the form of hook bolts 40 for fastening the base 36 in position. The hole 38 can be formed in a part 42 of a deck or hatch of the sunken vessel 2. The hook bolts 40 are tightened in place by means of

wing nuts 44. The attachment means 28 also includes a foam rubber seal 46 for forming a seal between the valve apparatus 24 and the sunken vessel 2.

The cover means 32 sits as shown over the end portion 34 of the vent pipe 26. The cover means 32 allows easy passage of air or water around the end portion 34 of the vent pipe 26.

During a salvage operation, water will be pumped out of the sunken vessel 2 by the pump 18. The pump 18 may be a submersible electric pump. The water being pumped out of the sunken vessel 2 is led through the cover means 32 as shown. Optionally, the pumped water is then led to the surface 12 for monitoring. Whilst pumping is in progress, compressed air is pumped along the air line 10 and into the sunken vessel 2 via the cover means 32. The compressed air may be pumped into the sunken vessel 2 at any pressure above the water pressure at the depth of the sunken vessel 2. This water pressure may be represented as A.S. As the water 14 is pumped out of the sunken vessel 2, the air, at pressure A.S, is drawn into the sunken vessel 2 as shown. The air is at a pressure of A.S which may be regarded as the water pressure at depth A. There is thus a small downward pressure P or P + i on the decks 16 and the hatches. This small downward pressure seals hatches and facilitates the sealing of leaks from outside by divers. The sunken vessel 2 is then in its designed situation of a slight downward pressure on the decks, and the sunken vessel 2 will eventually float to the surface.

The sunken vessel 2 is advantageously best raised by mechanical means when it is almost buoyant, so as to give control of ascent of the sunken vessel 2. As the sunken vessel 2 rises, excess air is allowed to escape from the valve apparatus 24. Water may be allowed to re-enter the sunken vessel 2 if the sunken vessel should be lowered. Preferably the sunken vessel 2 is maintained in a vertical position. If the sunken vessel 2 is such that the valve apparatus 24 cannot be kept vertical, then a flexible pipe may be employed as part of the valve apparatus 24 to attain a vertical working position for practical purposes.

As can be seen from Figure 4 the air line 10 is provided with a valve 48. This valve 48 enables the air supply to the cover means 32 to be cut off when desired, for example when sufficient air has been provided inside the sunken vessel 2 or in the event that the air line 8 should become ruptured when, without the valve 48 being in a closed position, air from inside the sunken vessel 2 would be lost.

As also shown in Figure 4, the water discharge line 20 connects to a water discharge pipe 50 in the cover means 32 by means of a quick connecting coupling 52. The water discharge line 20 is also preferably provided with a valve (not shown) in case it should be desired to cut off the water discharge line 20.

It is to be appreciated that the embodiment of the invention described above with reference to the accompanying drawings has been given by way of example only and that modifications may be effected. Thus, for example, the illustrated shape of the attachment means 28 and the cover means 32 may be varied.

Claims

1. Valve apparatus for use in raising a sunken vessel, which valve apparatus comprises a vent pipe, attachment means for attaching one end portion of the vent pipe to the sunken vessel, and cover means which is provided at the other end portion of the vent pipe and which allows compressed air introduced into the sunken vessel to escape from the sunken vessel through the valve apparatus as the sunken vessel starts to rise.

2. Valve apparatus according to claim 1 in which the vent pipe is from 1 - 3 metres (3 - 10 feet) long.

3. Valve apparatus according to claim 1 or claim 2 in which the vent pipe is of circular cross section, and in which the vent pipe is 150 - 900mm (0.5 - 3 feet) in diameter.

4. Valve apparatus according to any one of the preceding claims in which the attachment means comprises a base for engaging with the sunken vessel around a hole in the sunken vessel, and fastener means for fastening the base in position.

5. Valve apparatus according to claim 4 in which the fastener means comprises hook bolts.

6. Valve apparatus according to any one of the preceding claims in which the attachment means comprises sealing means for forming a seal between the valve apparatus and the sunken vessel.

7. Valve apparatus according to any one of the preceding claims in which the cover means is approximately one half the length of the pipe and twice the width of the pipe.

8. Valve apparatus according to any one of the preceding claims and including air connector means for connecting an air line to the valve

apparatus.

9. Valve apparatus according to any one of the preceding claims and including water discharge connector means for connecting a water discharge line to the valve apparatus.

10. Valve apparatus according to claims 8 and 9 in which the air connector means and the water discharge connector means are provided on the cover means.

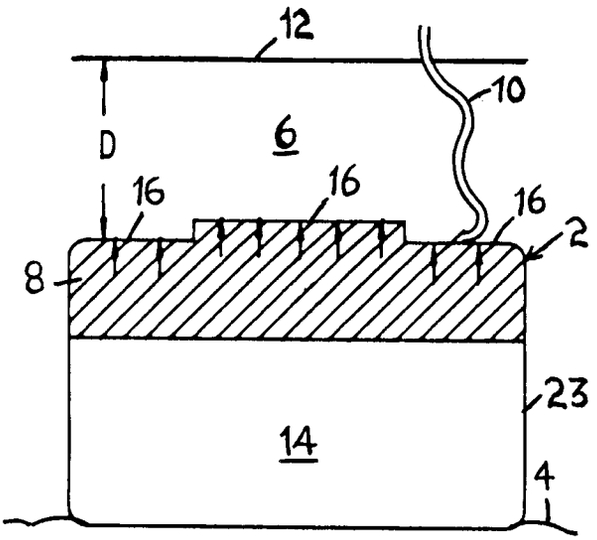

Fig 1

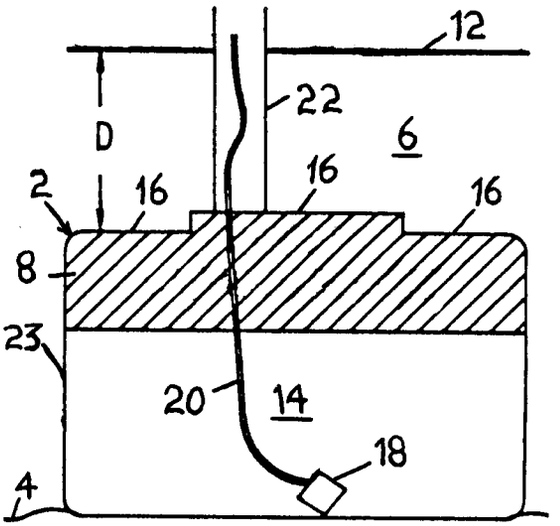

Fig 2

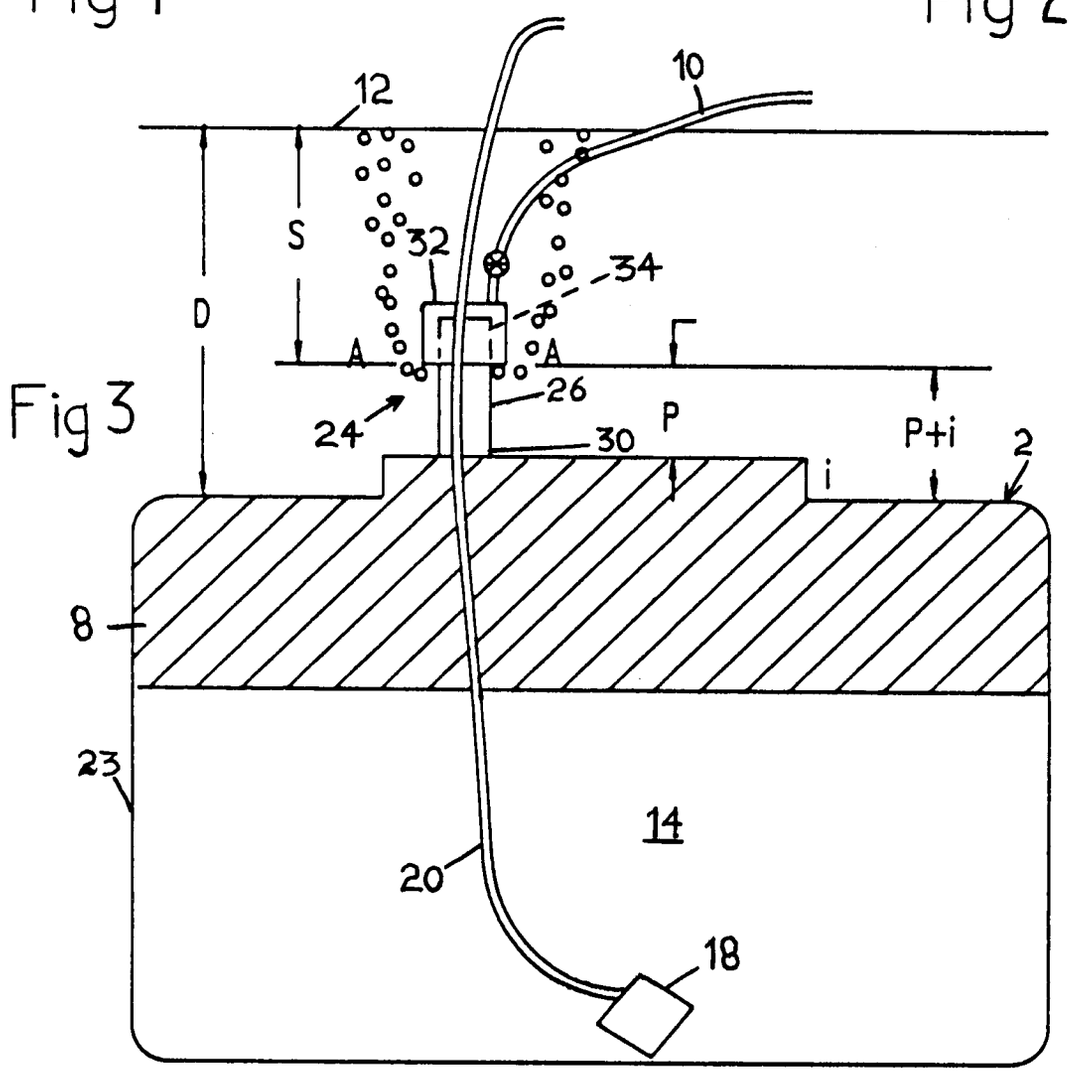

Fig 3

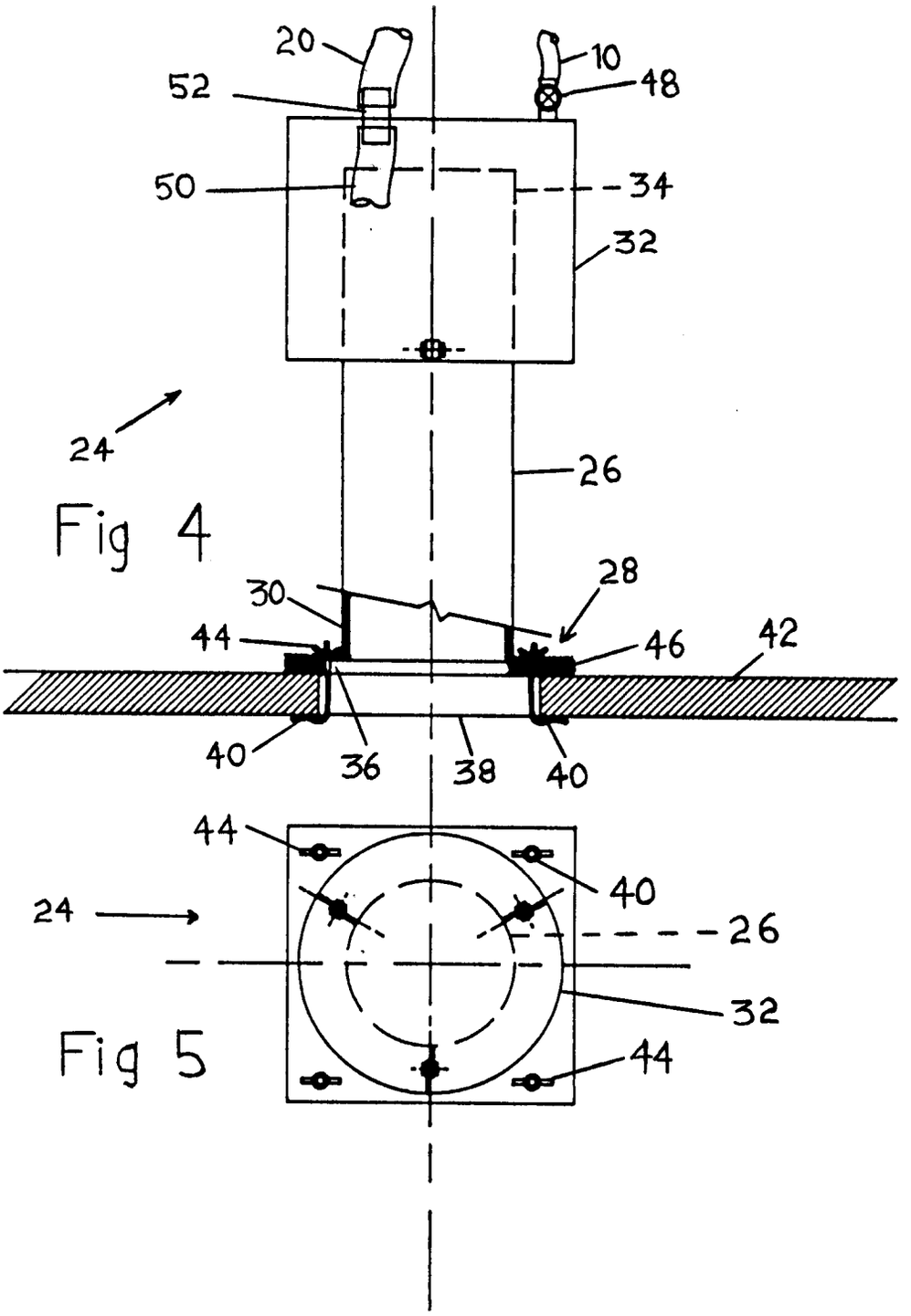

Fig 4

Fig 5

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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 0025

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.5)
X	FR-A-948103 (F.CAMELLI) * the whole document *	1, 4-6, 8	B63C7/12
A		3, 7, 9	

X	FR-A-910259 (E.BEROUDIAUX) * page 2, lines 53 - 71; figures 1, 3 *	1, 8	
A		3, 7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B63C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 AUGUST 1991	CZAJKOWSKI A.R.

CATEGORY OF CITED DOCUMENTS

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