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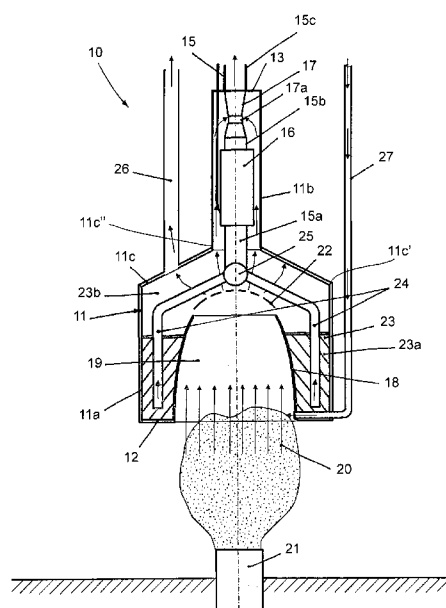


Fig. 1

(57) Abstract: The present invention relates to equipment for the conveying and recovery of hydrocarbons from an underwater well for the extraction of hydrocarbons under uncontrolled release conditions, comprising a chamber (23) for the separation of the hydrocarbon stream leaving the well, into a heavy phase (23a) and a light phase (23b), means (15,16,17,24,25,26) being envisaged, in connection with the separation chamber (23), for conveying the heavy phase (23a) and light phase (23b) towards the surface, characterized in that it comprises a directioning body (18) of the hydrocarbon stream, having a substantially cylindrical shape, or as a truncated paraboloid with both ends open, wherein a first end is an inlet of the hydrocarbon stream leaving the well, and a second end, distal with respect to the inlet of the hydrocarbon stream (20), is in fluid connection with the separation chamber (23) with the interpositioning of a perforated spherical cap (22).

EQUIPMENT FOR THE CONVEYING AND RECOVERY OF
HYDROCARBONS FROM AN UNDERWATER WELL FOR THE EXTRACTION
OF HYDROCARBONS, UNDER UNCONTROLLED RELEASE CONDITIONS

The present invention relates to equipment for the
5 conveying and recovery of hydrocarbons from an
underwater well for the extraction of hydrocarbons
under uncontrolled release conditions.

The constant increase in the worldwide demand for
fluid hydrocarbons has led to a growing activity in the
10 underwater or *offshore* exploration and production.

Underwater environments, in addition to making
production more difficult, create an increased risk of
environmental damage in the case of *blowout* events,
i.e. uncontrolled release of hydrocarbons from the
15 extraction wells, and/or other uncontrolled leakages of
hydrocarbons into the sea, for example as a consequence
of fractures of underwater piping.

These events, even if rare, not only cause a loss
in terms of energy, but can also create severe
20 consequences in terms of personnel safety,
environmental pollution and well restoration costs.

Various attempts have been made in the past to
guarantee an effective recovery of uncontrolled
leakages of hydrocarbons in deep water.

25 In this respect, hollow containers have been
produced, for example, such as that described in patent
US 4,318,442 which is essentially equipped with a
chimney controlled by a valve, a gas outlet configured
so as to maintain a gas stratification in the upper

part of the container and a liquid discharge in correspondence with the oil stratification in the lower part of the container.

This container is positioned above the well outlet
5 in *blowout* so as to capture the outgoing stream of hydrocarbons, also called *plume*, in order to convey its fluid part to the surface in a controlled manner, removing the gaseous part.

Alternatively, the use of dome-shaped protection
10 shields is known, such as that proposed in the USA patent US 4,405,258.

This patent describes a method for the containment of hydrocarbons inside a dome-shaped shield equipped with safety valves on its upper part which, positioned
15 above an underwater well in *blowout*, entraps the hydrocarbons in its interior.

Structures positioned above the well outlet, however, whether they be hollow or dome-shaped container, have proved to be unsuitable for an
20 effective containment of the *blowout* phenomenon, in particular of wells from which there is a great outflow of hydrocarbons. The power of these phenomena, in fact, tends to induce the hydrocarbons to exit not from the specific upward ducts but from the base of the
25 structure.

The dome shape, moreover, is not effective in deviating high-rate streams.

Other equipment known for the containment or recovery of hydrocarbons in gaseous and/or liquid form

is described in American patent US 4,324,505.

This equipment comprises a cone containing suitable slits. When the apparatus is positioned at the well head, as far as is possible, it drives and directs the fluid through a duct connected to the upper portion of the cone, up to the surface where the hydrocarbons can be separated from the other fluids.

In this equipment, particularly for high-rate blowout streams, the impact of the plume inside the cone can generate turbulent motions which can cause the emission of the jet from the cone with a consequent reduced efficiency in the recovery of hydrocarbons coming out of the well.

The necessity is therefore felt, in the case of offshore blowout events, to efficiently intercept, contain and convey the outgoing hydrocarbons in order to reduce their uncontrolled dispersion in the environment to the minimum.

An objective of the present invention is to overcome the drawbacks mentioned above, and in particular to provide equipment for the conveying and recovery of hydrocarbons from an underwater well, under uncontrolled release conditions, which allow to carry out an effective and substantially complete recovery of hydrocarbons exiting in an uncontrolled manner.

Another objective of the present invention is to provide equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions, which is capable of reducing to the

minimum the dispersion into the environment of hydrocarbons exiting in an uncontrolled manner.

A further objective of the present invention is to provide equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions, which allows the hydrocarbons exiting in an uncontrolled manner to be effectively intercepted, contained and conveyed.

Yet another objective of the present invention is to provide equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions, which is capable of separating the hydrocarbons coming from the well into a heavy phase consisting of water and liquid hydrocarbons and into a light phase mainly consisting of gas and liquid hydrocarbons and conveying said heavy phase to the surface.

These and other objectives according to the present invention are achieved by providing equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions as explained in the independent claims.

Further characteristics of the equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions are object of the dependent claims.

The characteristics and advantages of equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions,

according to the present invention, will appear more evident from the following illustrative and non-limiting description referring to the enclosed schematic drawings in which Figure 1 is a sectional
5 schematic view of the equipment for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions, according to a preferred embodiment of the present invention.

With reference to the figure, this shows equipment
10 for the conveying and recovery of hydrocarbons from an underwater well under uncontrolled release conditions, indicated as a whole as 10.

The equipment 10 for the conveying and recovery of hydrocarbons, comprises a chamber 23 for the separation
15 of the flow of hydrocarbons coming from the well 21 into a heavy phase 23a and a light phase 23b.

In particular, means 15, 16, 17, 24, 25, 26 for the conveying of the heavy phase 23a and light phase 23b towards the surface, are envisaged in connection with
20 the separation chamber 23.

According to the present invention, the equipment for the conveying and recovery of hydrocarbons also comprises a directioning body 18 of the hydrocarbon stream, having a substantially cylindrical shape, or as
25 a truncated paraboloid with both ends open, wherein a first end is an inlet of the hydrocarbon stream coming from the well 21, and a second end, distal with respect to the inlet of the hydrocarbon stream 20, is in fluid connection with the separation chamber 23 with the

interpositioning of a perforated spherical cap 22.

In the preferred embodiment illustrated, the separation chamber 23 is defined inside a hollow tubular body 11 comprising two hollow cylindrical portions 11a, 11b connected by a portion having a tapered conformation 11c.

A first cylindrical portion 11a is connected to the tapered portion 11c in correspondence with the enlarged end 11c' of the same 11c.

10 The first cylindrical portion 11a of the hollow body 11 ends with an annular base 12 defining an opening of the hollow tubular body 11 with reduced diameter with respect to the diameter of the first cylindrical portion 11a.

15 A second cylindrical portion 11b is connected to the tapered portion 11c in correspondence with the narrower end 11c" of the same 11c.

The tapered portion 11c preferably has a truncated-conical shape with the smaller diameter coinciding with the diameter of the portion of the second cylindrical portion 11b and the larger diameter coinciding with the diameter of the first cylindrical portion 11a of the tubular body 11.

20 The second cylindrical portion 11b ends, in correspondence with its free end, with an upper base 13, so as to define a closed containment space.

The separation chamber 23 is delimited in the perimeter and externally by the tubular body 11 and internally and centrally by the perforated cap 22 and

by the hollow body 18 for directing the incoming flow so as to have a substantially annular conformation.

For this purpose, the directioning body 18 is arranged coaxially with the tubular body 11 and extends
5 internally to the same.

The directioning body 18 preferably has, at least in correspondence of its own inlet end of the hydrocarbon flow, a diameter coinciding with the inner diameter of the annular base 12 and an extension
10 substantially equal to the development of the first cylindrical portion 11a of the tubular body 11.

The directioning body 18 is open in correspondence with both its ends, thus allowing, once positioned in correspondence with the outflow of hydrocarbons, the
15 plume 20 coming from the well 21 to be conveyed into its interior 19.

The hollow perforated spherical cap 22 is situated, however, in correspondence with the end of the directioning body 18, distal with respect to the inlet
20 of the hydrocarbon flow 20, preferably in a position distant from the directioning body 18.

The geometry of the directioning body 18 and perforated cap 22 is such as to attenuate the momentum of the plume of the multiphase stream at the inlet.

25 The gravitational separation of the incoming mixture into dense or heavy phase 23a and light 23b phase takes place inside the separation chamber 23.

The separation chamber 23 is in fluid connection with the means 15, 16, 17, 24, 25, 26 for conveying the

heavy phase 23a and light phase 23b towards the surface.

In particular, the lower part of the separation chamber 23a, in which the dense phase 23a is stratified, is in fluid communication with pumping means 16 situated inside the second cylindrical portion 11b of the hollow tubular body 11.

The fluid connection takes place by means of a plurality of conveying pipes 24, angularly spaced, preferably equispaced, consisting of a first vertical section and subsequently converging into a common collector 25 overlying the perforated cap 22.

The collector 25 is arranged centrally with respect to the tubular body 11 and is, in turn, connected with the pumping means 16 through a first section 15a of a conveying duct 15 situated inside the hollow tubular body 11, between the tapered portion 11c and the second cylindrical portion 11b of the hollow tubular body 11, coaxially with respect to the same.

A second section 15b of the conveying duct 15, again situated inside and coaxially to the second cylindrical portion 11b, puts the pumping means 16 in fluid communication with an ejection system 17, inside the second cylindrical portion 11b, also equipped with suction doors 17a for the suction of the light phase 23b.

A third and last section 15c of the conveying duct 15 is inserted on the upper base 13 of the second cylindrical portion 11b and puts the multiphase stream

produced inside the ejection system 17 in fluid communication with suitable treatment and collection systems situated on the sea surface (not illustrated).

5 The upper part of the separation chamber 23, in which the light phase is stratified, is in fluid communication with the surface by means of a vent duct 26 intercepted by a regulation valve (not illustrated) in the collection point on the sea surface.

A fluid connection duct 27 with the surface is also
10 envisaged, which extends for a first section externally and parallel to the tubular body 11 and is inserted for a subsequent section on the directioning body 18 passing through the wall of the first cylindrical portion 11a of the tubular body 11.

15 Said duct 27 for fluid connection with the surface is suitable for feeding a methanol distribution system (not illustrated), positioned in correspondence with the lower end of the directioning body 18.

The functioning of the equipment 10 for conveying
20 and recovering hydrocarbons from an underwater well for extraction is as follows.

In operative condition, the plume 20, consisting of a mixture of gas and oil, leaves the well at high pressure 21, thus englobing seawater in its interior.

25 The inlet of seawater inside the equipment for the conveying and recovery of hydrocarbons 10 favours the formation of the heavy liquid phase 23a. The quantity of seawater entering the equipment for the conveying and recovery of hydrocarbons 10 can be controlled by

varying the height at which the equipment 10 is positioned with respect to the sea bottom, together with the dimensions and rotation rate of the pumping means 16.

5 The multiphase stream at the inlet 20, generally consisting at least of oil, gas and seawater, enters the equipment for the conveying and recovery of hydrocarbons 10 through the hollow directioning body 18.

10 The geometry of said directioning body 18, together with that of the perforated cap 22, is such as to attenuate the momentum of the ingoing stream 20, preventing a downward reflux of the plume 20 and consequently its outflow.

15 Passing through the holes of the perforated cap 22, the multiphase stream 20 enters the separation chamber 23.

In its interior, the oil-gas-water mixture tends to separate and become stratified into two phases: a light
20 phase 23b, consisting of a mixture of gas and liquid hydrocarbons, is formed on the upper part of the separation chamber 23, and a dense phase 23a, consisting of a mixture of water and liquid hydrocarbons containing limited quantities of dispersed
25 gas, is formed on the lower part of the separation chamber 23.

The dense phase 23a is directed from the separation chamber 23, through the plurality of conveying pipes 24, towards the collector 25, due to the pumping means

16, and is conveyed at high pressure into the ejection system 17.

A part of the light phase 23b separated in the separation chamber 23, is sucked at low pressure by the suction doors 17a of the ejection system 17.

The multiphase stream produced in the ejection system 17 is then conveyed through the third section 15c of the conveying duct 15 in the direction of the sea surface towards specific conveying and recovery means.

The remaining portion of light phase 23b is extracted through the vent duct 16.

The distribution between the light phase 23b sucked by the ejection system 17 and that extracted through the vent duct 26, is regulated by the regulation valve situated on the vent duct 26.

The regulation valve also has the function of keeping the vent duct 26 full of air, guaranteeing the correct functioning of the system during the initial conveyance and recovery phases of the hydrocarbon mixture.

During the recovery of the hydrocarbons, the methanol is also distributed from the surface by means of the fluid connection duct 27 with the surface to the methanol distribution system in correspondence with the inlet of the plume 20 in order to prevent the formation of hydrates.

The characteristics of the equipment for the conveying and recovery of hydrocarbons from an

underwater well for extraction, object of the present invention, as also the relative advantages, are evident from the above description.

The particular conformation of the directioning
5 body of the flow, in addition to the perforated spherical cap at its end, allows the momentum of the multiphase stream at the inlet to be attenuated, thus preventing a downward reflux of the same and consequently its outflow.

10 Furthermore, the passage through the perforated cap facilitates an effective separation of the multiphase stream into a light phase and heavy phase, favouring its conveyance towards the surface.

Finally, the equipment thus conceived can obviously
15 undergo numerous modification and variants, all included in the invention; all the details, moreover, can be substituted by technically equivalent elements. In practice the materials used, as also the dimensions, can vary according to technical requirements.

20

CLAIMS

1. Equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions, comprising a chamber (23) for the separation of said hydrocarbon stream leaving said well, into a heavy phase (23a) and a light phase (23b), means (15,16,17,24,25,26) being envisaged, in connection with said separation chamber (23), for conveying said heavy phase (23a) and said light phase (23b), towards the surface, characterized in that it comprises a directioning body (18) of said hydrocarbon stream, having a substantially cylindrical shape, or as a truncated paraboloid with both ends open, wherein a first end is an inlet of said hydrocarbon stream leaving said well, and a second end, distal with respect to the inlet of said hydrocarbon stream (20), is in fluid connection with said separation chamber (23) with the interpositioning of a perforated spherical cap (22).
2. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to claim 1, characterized in that said perforated spherical cap (22) is positioned at a distance with respect to said distal end of said directioning body (18).
3. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to

claim 1 or 2, characterized in that said separation chamber (23) is defined inside a hollow tubular body (11), said separation chamber (23) being perimetrically and externally delimited by said tubular body (11),
5 and internally and centrally by said perforated cap (22) and said directioning body (18) so as to have a substantially annular configuration.

4. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well
10 under uncontrolled release conditions according to any of the previous claims, characterized in that said hollow tubular body (11) comprises a first (11a) and a second (11b) cylindrical portion interlinked by means of a portion having a tapered conformation (11c), said
15 first cylindrical portion (11a) being connected to said tapered portion (11c) in correspondence with an enlarged end (11c') of the same (11c) and said second cylindrical portion (11b) being connected to said tapered portion (11c) in correspondence with a narrowed
20 end (11c'') of the same (11c), the lower part of said first cylindrical section (11a) ending with an annular base (12) defining an opening of said hollow tubular body (11) having a reduced diameter with respect to the diameter of said first cylindrical portion (11a) and
25 the upper part of said second cylindrical portion (11b) ending with an upper base (13).

5. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to

claim 4, characterized in that said directioning body (18) is coaxially arranged with respect to said tubular body (11) and extends inside the same, said directioning body (18) having a diameter coinciding
5 with the inner diameter of said annular base (12) at least in correspondence with said first end, is an inlet, and an extension substantially the same as the expansion of said first cylindrical section (11a) of said tubular body (11).

10 6. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to any of the previous claims, characterized in that a lower part of said separation chamber (23), in which said
15 heavy phase (23a) is stratified, is in fluid communication with pumping means (16) by means of a plurality of conveying pipes (24) angularly spaced and interlinked in a collector (25) overlying said perforated cap (22), said collector (25) being
20 connected to said pumping means (16) through a first section (15a) of a conveying duct (15) towards the surface.

7. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well
25 under uncontrolled release conditions according to claim 6, characterized in that said pumping means (16) are situated in fluid communication with an ejection system (17) by means of a second section (15b) of said conveying duct (15) towards the surface.

8. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to any of the previous claims, characterized in that an upper
5 portion of said separation chamber (23), in which said light phase (23b) is stratified, is in fluid communication with the surface by means of a vent duct (26).

9. The equipment (10) for the conveying and recovery
10 of a stream of hydrocarbons from an underwater well under uncontrolled release conditions according to any of the previous claims from 6 to 8, characterized in that said pumping means (16) and said ejector (17) are positioned inside said second cylindrical portion (11b)
15 of said hollow tubular body (11), said conveying duct (15) towards the surface passing coaxially through said second cylindrical portion (11b).

10. The equipment (10) for the conveying and recovery of a stream of hydrocarbons from an underwater well
20 under uncontrolled release conditions according to any of the previous claims, characterized in that it comprises a duct (27) for fluid connection with the surface, and extends for a first section externally and parallel to said tubular body (11) and for a subsequent
25 section is inserted on said directioning body (18), passing through the wall of said first cylindrical section (11a) of said tubular body (11).

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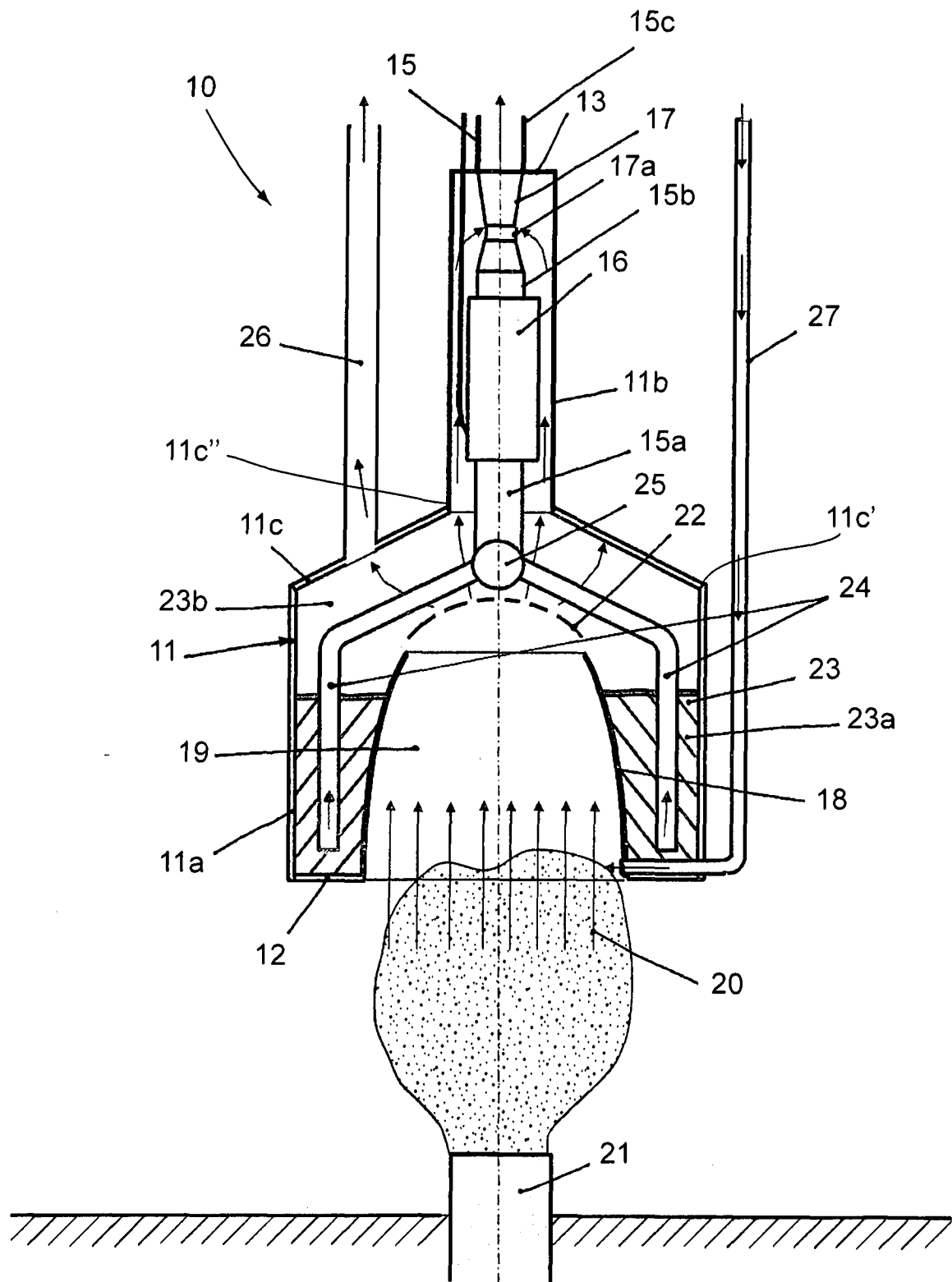


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/001326

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/01 E21B43/36
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 071 020 A (CHICAGO BRIDGE & IRON CO) 16 September 1981 (1981-09-16) figure 2	1-10
A	CA 1 107 661 A1 (AKERS MEK VERKSTED AS) 25 August 1981 (1981-08-25) figure 2	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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