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Brooks et al.

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[54] **UNDERWATER PRODUCTION AND STORAGE SYSTEM**

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[51] **Int. Cl.** **E21b 43/01**

[58] **Field of Search** ..... 166/.5, .6; 175/8; 137/263; 141/387; 114/.5 T, .5 D

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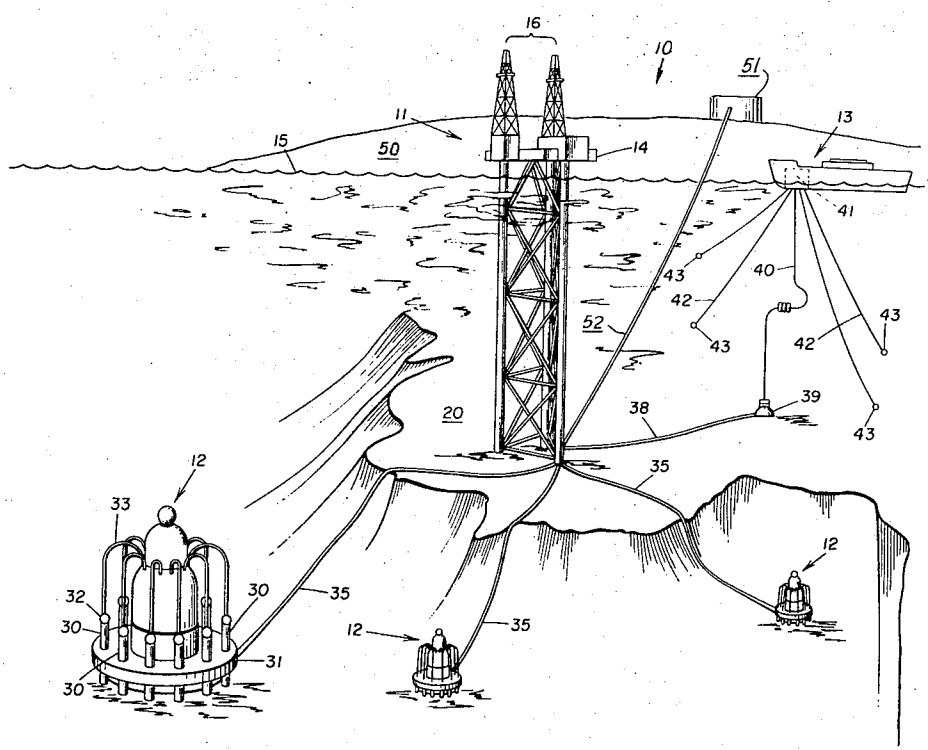
[57] **ABSTRACT**

The specification discloses a method and system for producing minerals from an underwater production area where the marine bottom slopes from relatively shallow depths to greater depths. A bottom-supported platform is fixed in the relatively shallow depths of the production area and is used to process minerals produced from wells spaced from the platform and completed in depths greater than that at which the platform is fixed. After the minerals are processed on the platform, they are transferred to a storage means.

15 Claims, 2 Drawing Figures



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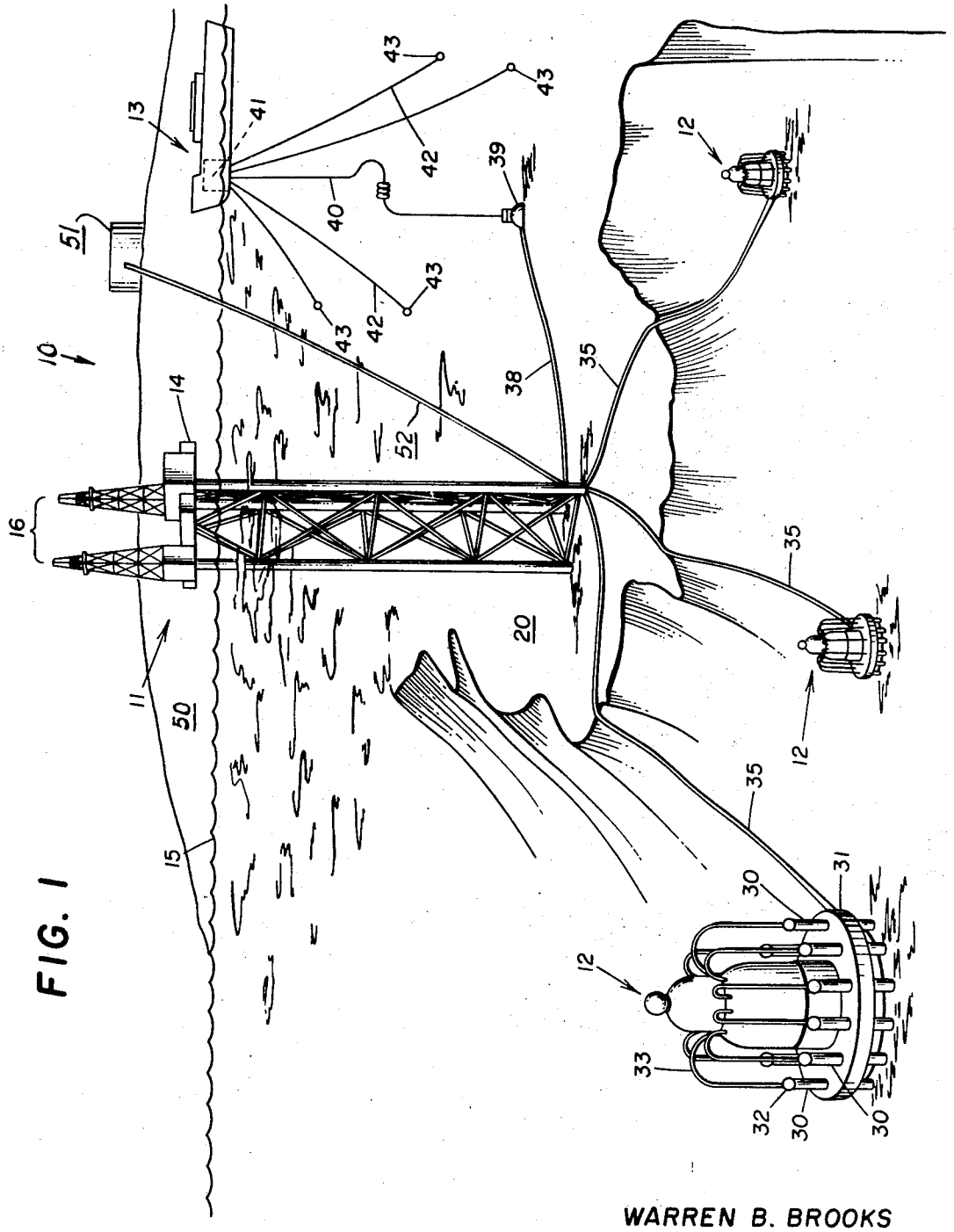

FIG. 1

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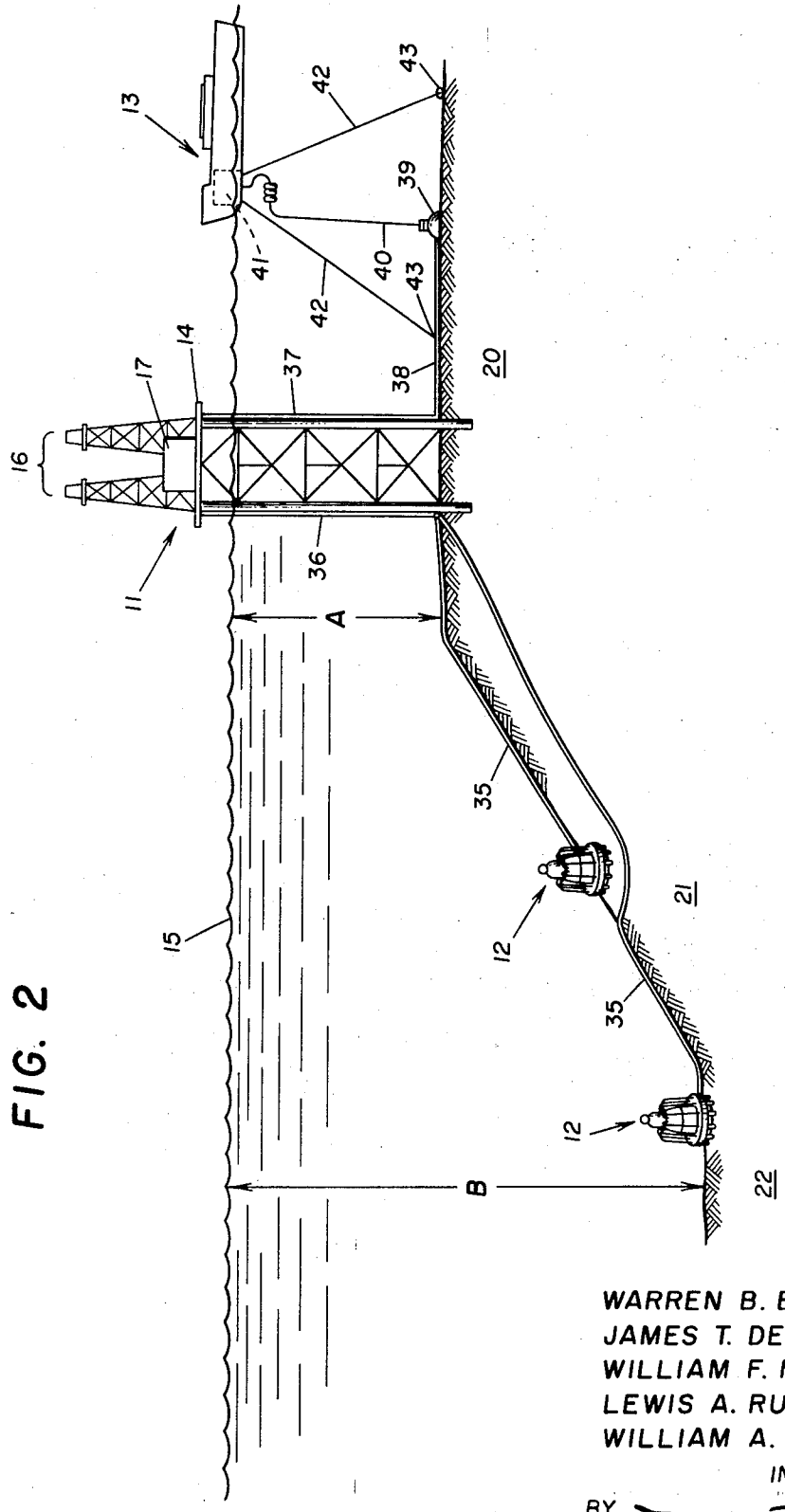

FIG. 2

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UNDERWATER PRODUCTION AND STORAGE SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to the production of minerals from underwater production areas and more particularly relates to a method and system for producing minerals such as oil and gas from an underwater production area where the marine bottom slopes from relatively shallow depths to greater depths.

Heretofore, production of minerals from underwater deposits has been carried out primarily in areas underlying relatively shallow depths of water. One of the most commonly used systems for producing such areas utilizes a bottom-supported, above-surface platform which is first used for drilling and completing wells in the immediate vicinity of the platform and then converted to a production platform for processing the produced minerals. The processed minerals are usually offloaded onto tankers or are piped to shore. However, as the depth of water increases, the building and installing of a bottom-supported platform become prohibitive from a cost standpoint. Therefore, as exploration and exploitation of underwater mineral deposits are forced outward from the relatively shallow depths of continental shelves adjacent shorelines to the greater depths of continental slopes and adjacent marine floors, new systems for producing these minerals must be developed.

One such system involves drilling and completing wells in a production area from drilling vessels and then producing the wells through facilities mounted on a floating platform. The platform is maintained on location by either a fixed multipoint mooring system of anchor and lines or by a dynamic positioning system. Such a production system requires substantially continuous maintainence and surveillance of the locating system since any failure of the locating system may cause shear or rupture of the multiple flexible hoses connecting the wells to the floating platform.

Other deep-water production systems utilize production facilities which are submerged in watertight enclosures which in turn are secured to the marine bottom. The produced minerals, after processing within the enclosures, are brought to the surface through a riser pipe or the like and are either loaded onto a waiting tanker or are stored in floating or submerged storage facilities. Still other systems utilize combinations of submerged production facilities, e.g., wellheads, and floating production facilities. All of the above-described deep-water systems have merit. The present invention provides still another system for producing minerals from deep-water locations.

SUMMARY OF THE INVENTION

The present invention provides a method and system for producing minerals, e.g., oil and gas, from deposits in a production area which underlies substantial depths of water and is particularly adaptable for use in production areas where the marine bottom slopes from relatively shallow depths to much greater depths. Such production areas exist near the outer perimeter of a continental shelf where the marine bottom drops off rapidly to the ocean floor.

Structurally, the present invention comprises three subsystems which are integrated into a unitary production and storage system. The first subsystem comprises a bottom-supported, above-surface platform located in the more shallow depths of the area to be produced. This normally will be near the outer perimeter of a continental shelf. The basic design and installation of the platform is in accordance with known procedures in the art. Preferably, the platform is first used to drill and complete wells in the vicinity of the platform, after or during which the platform is converted into a production platform.

The second subsystem comprises producing means such as individual wells or satellite gathering units which are spaced from the platform. These producing means which can range in number from one to many are normally drilled and completed from drilling vessels or by any other known techniques on the sloping part of the production area or on the marine bottom which lies at substantially greater depths than that at which the platform is positioned. However, some of the producing means may lie on the same level or even on shallower levels of the marine bottom than the platform, if desired. The produced minerals are flowed through flowlines extending across the marine bottom from the producing means to the platform and then up to a deck thereon for processing, e.g., separating gas from oil, etc. Where the producing means is comprised of satellite gathering units, some processing may occur in the units, but most of the major processing operations are carried out on the platform.

The third subsystem comprises a storage means which is used to store minerals from the platform once they have been processed. The storage means may comprise onshore storage connected to the platform by underwater pipeline, submerged storage anchored on the marine bottom, or floating storage means moored near the platform.

By integrating the subsystems as described above, a highly efficient and economical system is provided which allows the desirable features of a fixed platform to be utilized in a deep-water production area. The above-mentioned and other advantages of the invention will be more readily appreciated as the invention becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals refer to like parts throughout the figures and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an underwater production system in accordance with the present invention; and

FIG. 2 is a schematic, sectional view of the system of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to the drawings, FIG. 1 discloses a system **10** for producing and storing minerals, e.g., oil and gas, from underwater deposits. System **10** is comprised of three subsystems; a bottom-supported, fixed platform **11**, one or more (three shown in FIG. 1) means **12** for producing minerals from deposits which are spaced from platform **11**, and a storage means, e.g., moored, floating storage means **13**.

Platform 11 is shown in the figures as a typical three-legged, bottom-supported platform having a deck 14 above the surface 15 of a body of water. Platform 11 can be fabricated on shore, towed to location, righted, and anchored to the bottom of the water, e.g., by piles driven through the legs, all of which is in accordance with well-known techniques in the art. The three-legged platform is shown for illustration only and it should be recognized that several other types of well-known platforms of various configurations, e.g., four legs, could be used without departing from the present invention. The platform 11 is shown with twin drilling towers 16 on deck 14 which can be used for drilling and completing directional wells (not shown), e.g., through the legs of platform 11, in the immediate vicinity of the platform. These wells can be produced through riser pipes (not shown) or the like to deck 14 on which production equipment 17, e.g., oil-gas separators (see FIG. 2), is mounted.

In a production area such as shown where the marine bottom slopes from relatively shallow depths to greater depths, platform 11 is fixed to the marine bottom at the relatively shallow depth A (FIG. 2), e.g., 300 to 600 feet, near the outer perimeter of shelf 20. Due to cost and other considerations, it is considered impractical to construct fixed platforms in depths much greater than 600 feet. Therefore, producing means 12 are used to produce minerals in the deeper parts of the production area.

Producing means 12 are drilled and completed from drilling vessels or the like at locations spaced from platform 11, e.g., producing means are completed on both slope 21 and marine bottom 22 which lies at depth B, e.g., 1,000 to 6,000 feet. Wellheads of the producing means are completely submerged. The producing means 12 may comprise individual wells or may comprise groups of wells joined together in satellite gathering units. Normally, individual wells will be spaced at relatively short distances, e.g., less than 2 miles, due to the small diameter lines involved and the pressure drops across same. Where satellite gathering units are used, the producing means may be spaced at greater distance from the platform since the output of minerals from such units justify the use of larger diameter lines. Also, large diameter lines require less maintainence, e.g., paraffin cleanout, etc., than smaller lines.

A typical satellite gathering unit is illustrated which has a plurality of wells drilled through standing conductor pipe elements 30 (FIG. 1) of a template ring 31 resting on the marine bottom. The wells are all completed with subsea wellheads 32 mounted atop conductor elements 30 and are in turn capped with connector pipes 33 for directing produced minerals from the wells into the interior of the satellite gathering unit 12. Means are normally provided within the satellite for testing the production from each of the wells and for carrying out minor processing operations before the fluids are transferred from satellite units 12 to platform 14. The actual details of such a satellite gathering unit and the method of installing same are described in copending United States patent application, Ser. No. 740,520, filed June 27, 1968. Other examples of satellite gathering units having test and process equipment therein are described in U.S. Pat. Nos. 3,391,734, issued July 9, 1968, and 3,366,173, issued Jan. 30, 1968.

Produced minerals from the individual wells or satellite gathering units 12 are flowed to deck 14 of platform 11 through flowlines 35 which lie along the marine bottom. All flowlines 35 can be manifolded into a riser pipe 36 (FIG. 2) which can be either internally or externally mounted in or on a leg of platform 11. Of course, individual riser pipes for each flowline 35 could be used, if desired. The riser pipe 36 or individual lines (not shown) carry the minerals to the deck 14 where it is processed by equipment 17, e.g., water, gas, and oil separated into separate phases.

After processing on deck 14, the desired minerals are stored. The means used for storage may be of any type which would lend itself to the particular environment involved. For example, if the platform were relatively close to shore 50, the minerals may be transferred to onshore storage facilities 51 by underwater pipeline 52. Also, submerged or partially submerged storage means (neither shown) could be provided near the platform. Or, as illustrated in the figures, floating storage means 13 can be moored near the platform for receiving processed minerals from deck 14.

In the illustration, processed minerals are flowed down through another riser pipe 37, which is preferably also supported by a leg of platform 11, to a flowline 38 which extends across the marine bottom to an anchored manifold 39 or the like. From manifold 39, buoyed riser pipe 40 carries the processed fluids to floating storage means 13. Floating storage means 13 can be of the barge-type floating storage but preferably comprises a swivel tanker of the type disclosed and described in copending U.S. patent application, Ser. No. 775,351, filed Nov. 13, 1968. Another floating storage tanker which can be used is of the type disclosed in U.S. Pat. No. 3,407,768, issued Oct. 29, 1968. The buoyed, riser pipe 40 is connected to floating storage means 13 through a swivel 41 (shown in dotted lines) whereby storage means 13 may pivot in the manner of a weather vane. This allows the means 13 to always point into the direction of wind and waves and alleviates several mooring problems. The floating storage means 13 is moored over riser pipe 40 by means of mooring lines 42 extending between anchor points 43 and the swivel mechanism.

The present production system allows the benefits of a fixed platform to be utilized in the production of minerals from deep-water areas. By using a platform along with outlying production means, the problems normally associated with bringing produced minerals to the surface from deep-water producing means and the processing of such minerals are significantly reduced. For example, by extending the flowlines along the marine bottom from the producing means 12 to the platform and then using the legs of platform 11 to support riser pipe 36, the flowlines carrying the essentially unprocessed minerals to the processing means are never completely unsupported as is normally the case with a typical buoyed, riser pipe commonly used with other known deep-water systems. Also, utilization of a fixed platform for supporting the processing equipment allows said equipment to be of simpler design since the effects of waves and surface conditions normally encountered by floating-platform mounted equipment are not present.

What is claimed is:

1. A method for producing minerals from an underwater production area where the marine bottom of said area slopes from relatively shallow depths to greater depths comprising:
constructing a bottom-supported platform in said relatively shallow depths of said area, said platform having a deck above the surface of the water;
completing a plurality of wells for producing minerals, grouped in a close-spaced relationship at a point spaced from said platform;
testing each of said plurality of wells at said point spaced from said platform;
manifolding each of said plurality of wells with the others of said plurality of wells at said point spaced from said platform;
flowing the produced minerals from said manifolded grouped wells to the deck of said platform through a single production flowline; and
processing said produced minerals on said deck of said platform.

2. The method of claim 1 including:
storing said minerals after they have been processed.

3. The method of claim 1 wherein:
said each of said plurality of wells is manifolded into a hollow-shelled satellite gathering unit.

4. The method of claim 1 wherein:
said grouped wells are completed at depths greater than the depth at which the platform is constructed.

5. The method of claim 4 wherein:
the produced minerals are flowed from said grouped wells along the marine bottom to and then substantially vertical upward at said platform to said deck.

6. The method of claim 5 including:
storing said minerals after they have been processed.

7. The method of claim 6 wherein:
said processed minerals are stored in onshore storage means which is connected to said platform by underwater pipeline.

8. The method of claim 6 wherein:
said processed minerals are stored in said floating storage means by flowing the processed minerals substantially vertical downward from said deck of said platform to the marine bottom, across the marine bottom to a point substantially underlying said floating storage means, and then upward into said floating storage means.

9. The method of claim 8 wherein:
said moored, floating storage means comprises a swivel tanker.

10. A system for producing minerals from deposits underlying water comprising:
a bottom-supported platform having a deck above the surface of the water;
means for processing the minerals on said deck of said platform;
a plurality of closely spaced, mineral producing wells grouped at a point spaced from said platform;
means located at said point spaced from said platform for testing each of said plurality of wells;
means for manifolding said plurality of wells together at said point spaced from said platform; and
means for conducting said minerals from said grouped manifolded wells to said processing means on said deck of said platform through a single production flowline.

11. The system of claim 10 wherein:
each of said plurality of wells is completed on a single template, said system including:
a hollow-shelled satellite mounted on said template in which said test means and said manifolding means are located; and
means for connecting each of said plurality of wells to said test and said manifold means within said satellite unit.

12. The system of claim 10 including:
means for storing said minerals after they have been processed; and
means for conducting said processed minerals from said deck of said platform to said storage means.

13. The system of claim 12 wherein:
said storage means comprises onshore storage means; and
said means for conducting said processed minerals to said storage means comprises an underwater pipeline.

14. The system of claim 12 wherein:
said storage means comprises a floating storage means spaced from said platform; and
said means for conducting processed minerals from said deck of said platform to said storage means comprises:
flow means extending substantially vertically downward from the deck of said platform to the marine bottom, said flow means extending across the marine bottom from said platform to a point substantially underlying said floating storage means; and
flow means fluidly connected to said first-mentioned flow means and extending upward to fluidly communicate with said floating storage means.

15. The system of claim 14 wherein said floating storage means comprises:
a bottom-moored, swivel tanker.

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