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(54) IMPROVEMENTS IN OR RELATING TO SUBMERSIBLE STRUCTURES

(71) We, ODENSE STAALSKIBSVAERFT A/S,a Danish Company, of Havnegade 100, 5100 Odense, Denmark, do hereby declare

the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to submersible storage systems and is particularly though not exclusively to drilling platforms.

It is known, for instance from the specification of U.S. Patent No. 3,145,359 to construct a submarine store, for instance for crude oil, as a cellular caisson adapted to be supported on the sea bed and to carry by means of vertical legs a platform above the water surface. The submarine store serves both as oil reservoir for an adjacent drilling platform and as a mooring buoy for a tanker which anchors up to empty the store.

This known store has the drawback that the pipe lines to some cells are carried through one or more partition walls of the other cells before being introduced into one of the vertical legs. A construction like this increases the risk of leakage, which is a particular drawback if the system is used for storing both crude oil and natural gas, which is often the case in initial drillings in oil fields that are not fully explored. The known stores suffer from the additional drawback that the individual cells are not directly accessible.

It is the object of the present invention to provide a storage system in which the said drawbacks have been overcome.

Accordingly the present invention consists in a submersible storage system comprising a base adapted in use to be supported on the sea bed and carrying by means of vertical legs a platform above the surface, the base and/or the platform being divided into cells serving as storage or ballast tanks, and wherein the cells in the base are divided into groups, each group being associated with a single leg, and the interior of each cell of a group being directly accessible from the interior of said leg without the necessity of passing through another cell.

In order that the present invention may be more readily understood an embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which

Fig. 1 shows a drilling platform having a submersible storage system according to the present invention.

Fig. 2 shows a horizontal section along line II-II in Fig. 1,

Fig. 3 is a horizontal section along line III-III in Fig. 1, while

Fig. 4 is a vertical section through the system shown in Fig. 1 along line IV-IV in Fig. 2.

Fig. 1 shows a drilling platform for use in ocean depths between about 35 and 80 meters and provided with storage tanks in a base 1, which in use is supported on the sea bed, and in a platform 2, which is supported above the water surface by means of vertical legs 3, 4, 5 and 6. The platform is provided with drilling equipment, power supply, personnel accommodation, etc., to enable new drillings to be made simultaneously with a certain oil production. The entire structure is made from steel and therefore is relatively easy to transfer from one site to another as well as having the advantage that tankers can anchor alongside the platform which, contrary to for instance concrete, is well suited to absorb tensional stresses so caused. The platform illustrated here is particularly suited to use in oil fields where the oil deposits have not been definitely explored. The platform will be positioned above an ascertained oil deposit to start test drillings and produc-

tion for assessment of the quality and extent of the oil field. In these circumstances it would be uneconomic to establish pipe lines to land and it is therefore important that the platform should have storage facilities for storing the products drawn from the wells until they can be carried away by a tanker. The drilling may disclose natural gas, volatile and heavier oils and must therefore comprise separate storage units or cells for storing the different products. Hence, the embodiment described provides a storage system in which the cells are constructed to ensure a maximum risk of leakage between the cells and in which the cells can be used separately and are readily accessible for cleaning and inspection. Drilling and production are performed through the conductor pipes 19 in the legs as indicated in the leg 3 in Fig. 2.

Fig. 2 shows a section of the floor pontoon 1 along line II-II, and it will be seen how for instance the cells 7*a, b, e* and *f* are grouped so that a relatively small portion of each cell is covered by the associated vertical leg 3. The other cells to and including cell 7*p* are grouped similarly around associated leg 4, 5 or 6. The advantage of this construction is that the pipe lines between the cells and the platform may be carried directly to their respective cells without being passed through the walls of other cells. Each tank can be made accessible from its associated leg through manholes for cleaning or inspection. It will be seen from Fig. 2 that there are sixteen cells in the base raft, which may be enlarged horizontally by additional groups with associated legs. An arrangement like this is expedient where the base 1 has the shape shown in Fig. 1, viz. a relatively large foundation area and a relatively low wall height, and has the advantage that the drilling platform will be stable even on a loose sea bed and only be slightly affected by horizontal wave impact. But the base might also be formed in other ways and may include for instance four units placed in the corners of a square and of circular horizontal section with sector-shaped cells the points of which are all covered by a vertical leg for each. It will be understood that the base when being transported to a site floats like a raft.

The 25 cells 8a-8z of the platform 2, as shown in Fig. 3, are grouped with four cells (f. inst. 8*a, b, f* and *g*) around each leg (3) and the cells are connected directly to pipe lines in the leg. The remaining nine cells (of which 8*c, k* and *m* are indicated in the drawing) form a cross between the four cell groups and may be used for purposes which do not require pipe lines to the legs, for instance drinking water tanks, fuel tanks for the power supply of the drilling platform, etc.

Fig. 4 presents a vertical section through the drilling platform shown in Fig. 1. It will be seen how for instance the cells 7*e* and 7*f* extend upwardly into the pertaining leg 3 to the level indicated by H. By means of the shown pipe lines, which extend through the associated cells, crude oil, sea water, natural gas etc. may be filled into the storage tanks. The shown pipe lines indicate how the cells of the base can be filled individually with oil from a buffer storage cell 8*g*. The buffer store serves as separation tank in which impurities that may occur in the crude oil can be separated, and the separation tank is readily accessible for cleaning and inspection. The oil in the cells of the base can for instance before being loaded into a tanker be pumped up to another storage cell 8*f* in the platform this can be done introducing sea water through one or more of the three-way valves 9*a, b, c, d* to the bottom of the said storage cell concurrently with drawing oil through one or more of the valves 10*a, b, c, d*. During the production of oil, ballast water leaves the bottom of the cells and passes in known manner through skimming tanks 11 before being discharged into the sea.

The illustrated embodiment of the invention, as previously mentioned, is a steel structure, which involves several advantages of which has been mentioned that the drilling platform is relatively easy to transfer from one site to another. Besides being of significance for the transfer of the platform within an oil field, the specific construction is also of significance if the platform is to be taken on land for repairs or is to be broken up on account of the scrap value. The prior art knows latticed steel structures which, contrary to concrete structures have a certain scrap value too, but these structures are more difficult to transfer than the structure described herein, which has the further advantage that until it is provided with permanent ballast its draught is quite shallow. The transport from the dock, in which the drilling platform can attain a very high degree of finishing before being undocked, can therefore take place in relatively shallow water. The draught can be increased gradually in step with the ocean depth by filling the tanks with permanent ballast (12 in Fig. 4) in the form of sand pebbles, concrete or iron ore. Also outside ballast can be used, such as for instance sea boulders (13 in Fig. 4) which serve as protection against washing away without contributing essentially to the uplift in high sea resulting from the permeability of the ballast.

With the grouping of the cells as described herein the cells can be constructed as uniform building blocks which for inst. can be assembled in the dry dock of a shipyard. Furthermore the construction can be further adapted to the facilities of a shipyard by using only plane (14) or circular (15) steel plate sections stiffened by means of straight (16, 18) or circular (17) steel girders, which elements are used also in the construction of larger tankers.

WHAT WE CLAIM IS:—

1. A submersible storage system comprising a base adapted in use to be supported on the sea bed and carrying by means of vertical legs a platform above the surface, the base and/or the platform being divided into cells serving as storage or ballast tanks, and wherein the cells in the base are divided into groups, each group being associated with a single leg, and the interior of each cell of a group being directly accessible from the interior of said leg without the necessity of passing through another cell.

2. A system as claimed in claim 1, wherein the platform is divided into cells, the cells of the platform being arranged in groups with the cells of each group being associated with a single leg.

3. A system according to claim 1, wherein at least some of the cells of the base extend upwards into the leg associated therewith.

4. A system according to claim 1 or 2, wherein the cells are similar and consist in plate sections stiffened by means of straight or circular girders.

5. A submersible storage system constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.

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1561270 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

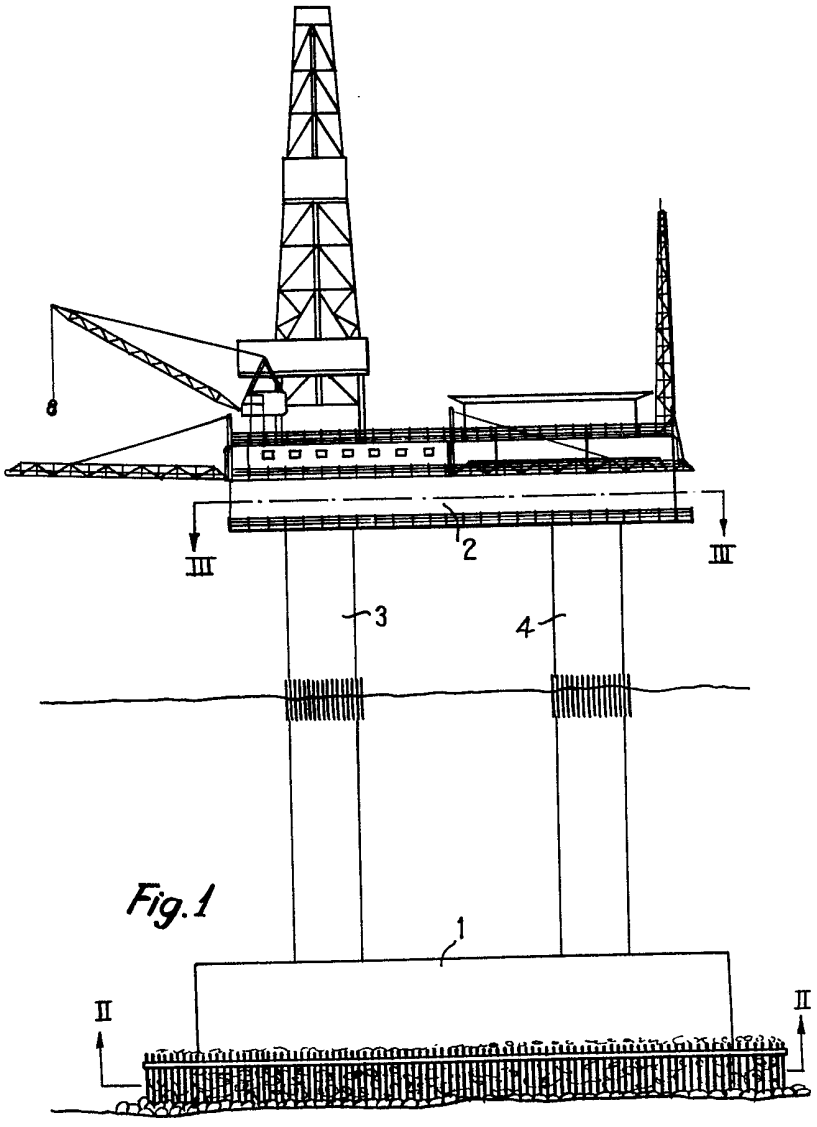

Fig. 1

1561270 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

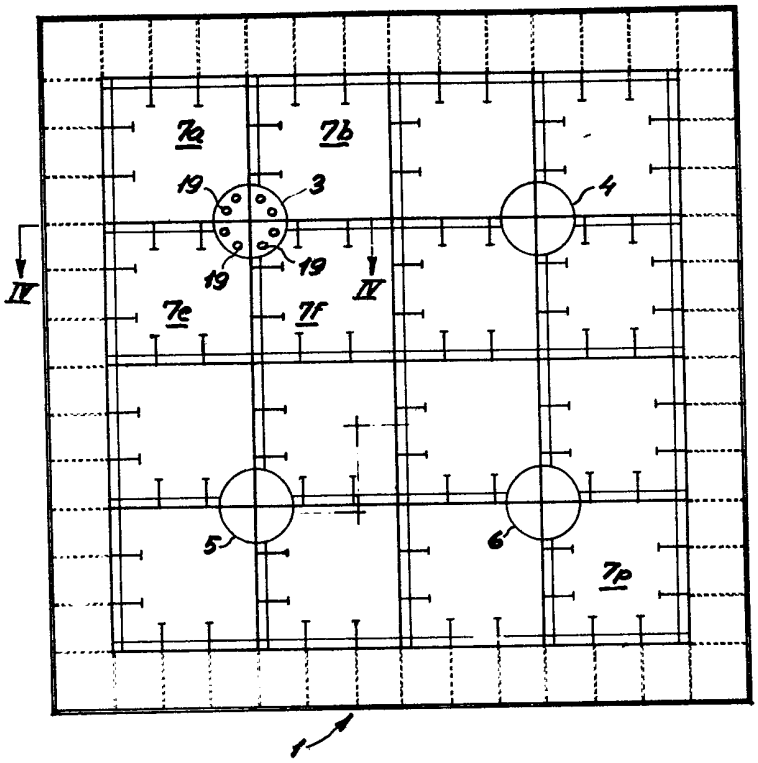

Fig.2

1561270 COMPLETE SPECIFICATION
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Sheet 3

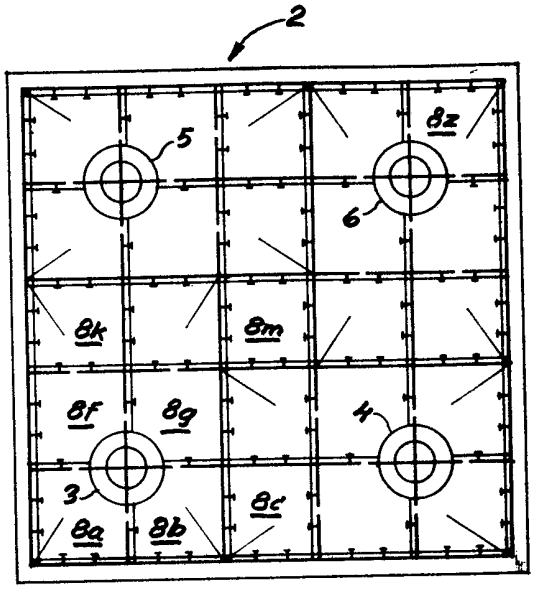

Fig. 3

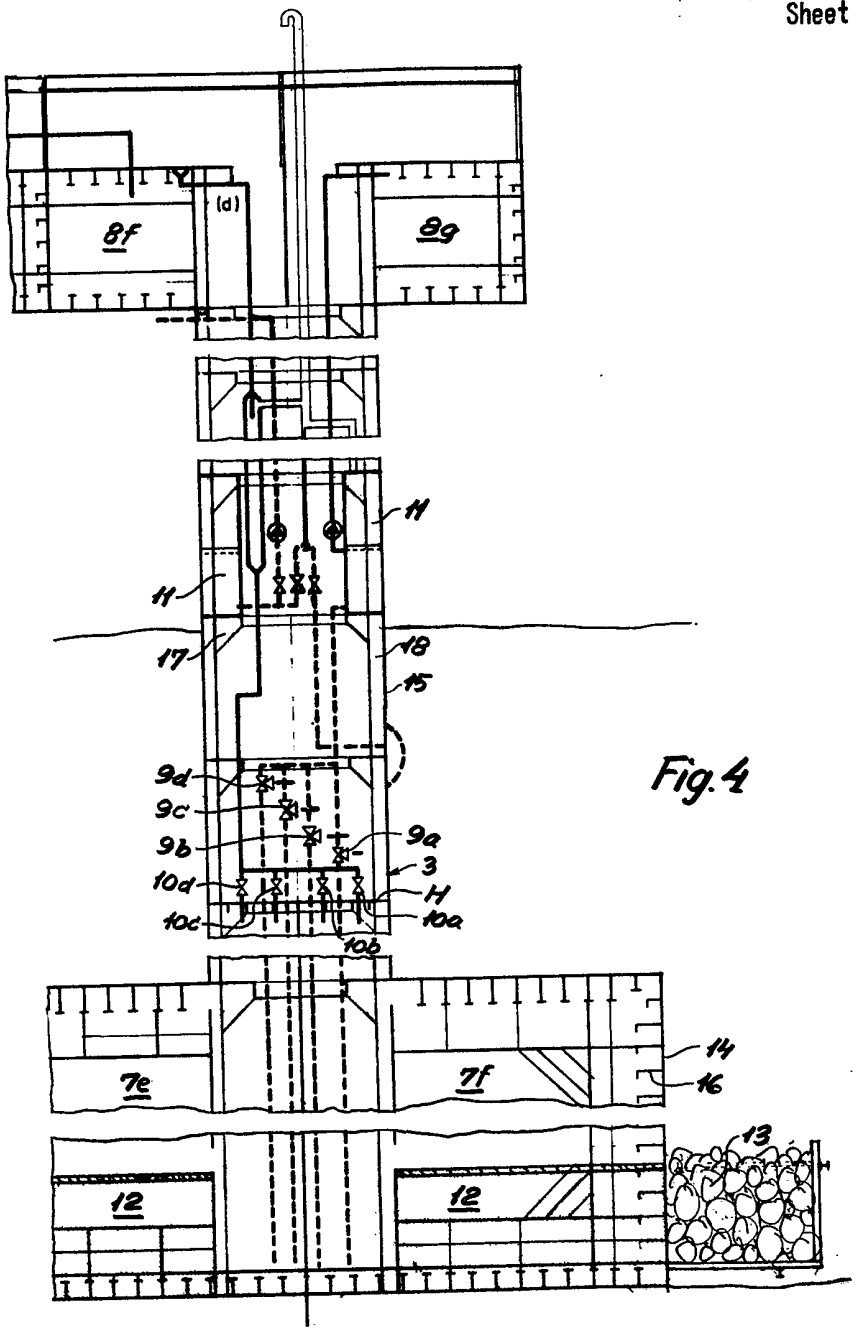
8f
(d)
8g
11
11
17
18
15
9d
9c
9b
9a
3
10d
H
10c
10a
10b
7e
7f
14
16
13
12
12

Fig. 4