United States Patent

Masuda et al.

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[54] **METHOD AND APPARATUS FOR MINING MANGANESE NODULES FROM THE DEEP SEA-BOTTOM**

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[21] Appl. No.: **28,287**

Related U.S. Application Data

[63] Continuation of Ser. No. 701,739, Jan. 30, 1968, abandoned.

[30] **Foreign Application Priority Data**

Feb. 14, 1967 Japan.....42/8979

[52] **U.S. Cl.**.....**37/69,** 37/195, 43/6.5, 198/116, 198/130, 198/141, 198/151

[51] **Int. Cl.**.....**E02f 3/14**

[58] **Field of Search**.....37/69, 60, 55, 119; 198/116, 198/130, 151, 141; 43/6.5

[56] **References Cited**

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[57] **ABSTRACT**

A mechanism for mining manganese nodules from the deep sea bottom including a number of dredge nets tied to a long endless rope suspended from both sides of a ship, the rope falling from one side of the ship to the deep sea-bottom with apparatus being provided to pull the rope therefrom to another side of the ship, whereby manganese nodules are continuously collected by the dredge nets.

6 Claims, 7 Drawing Figures

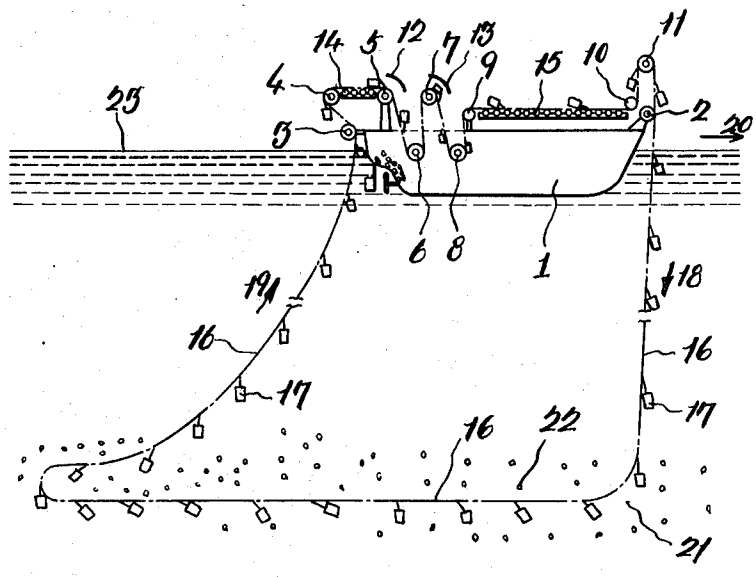

FIG. 1

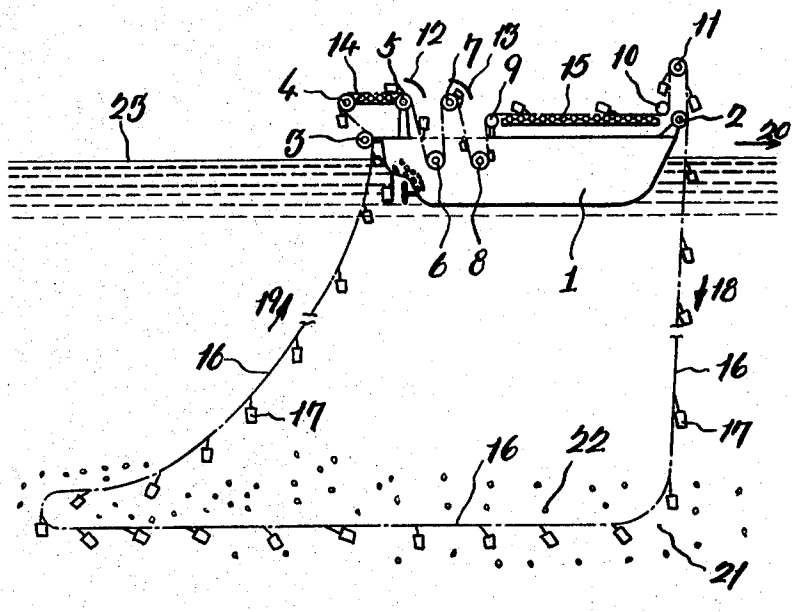
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FIG. 2

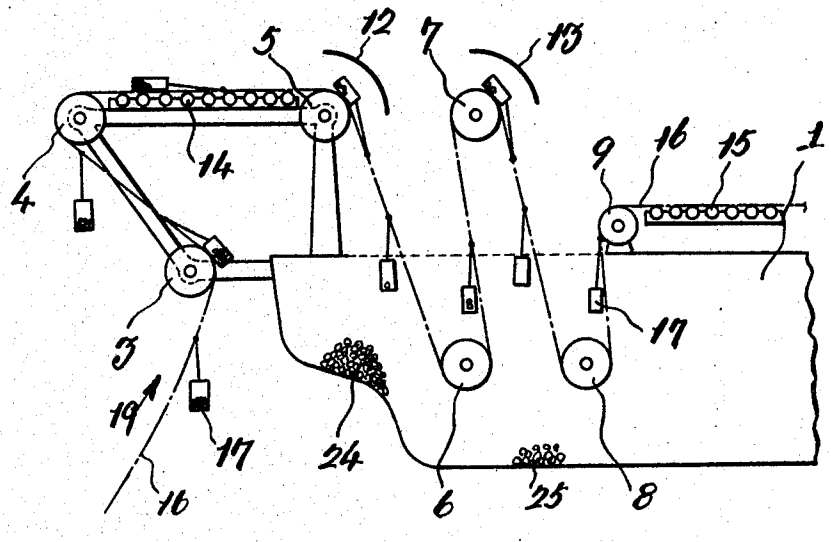
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FIG. 3

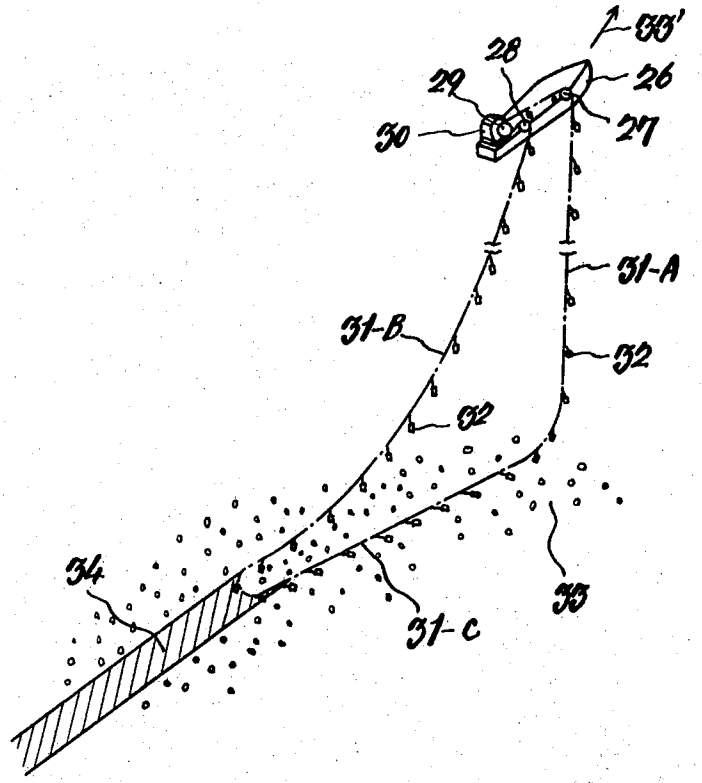


FIG. 4

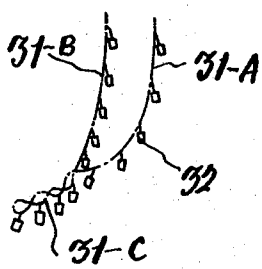


FIG. 5

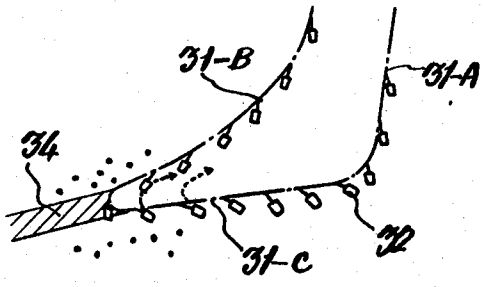


FIG. 6

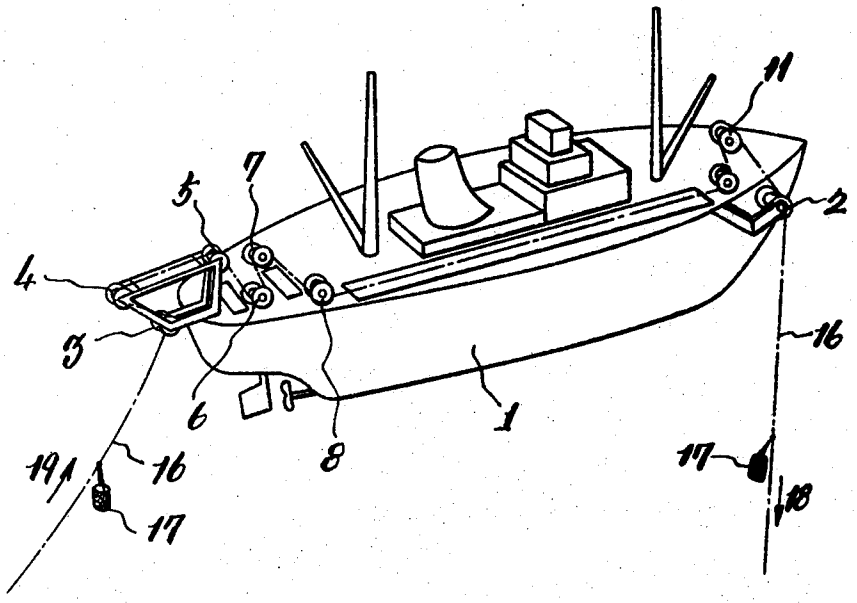
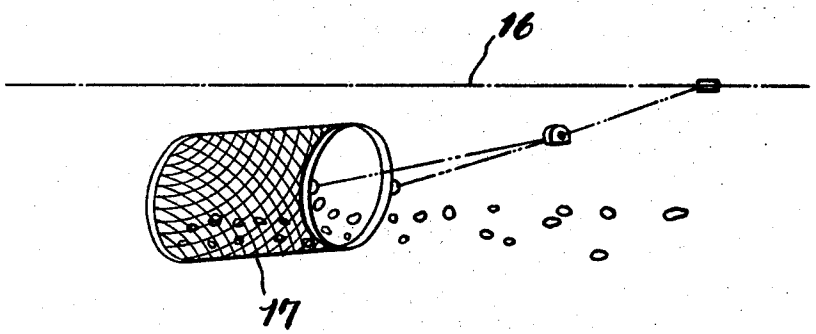


FIG. 7



METHOD AND APPARATUS FOR MINING MANGANESE NODULES FROM THE DEEP SEA-BOTTOM

This application is a continuation of application Ser. No. 701,739, filed Jan. 30, 1968, now abandoned.

This invention relates to a mechanism for mining manganese nodules from the deep sea-bottom by use of improved dredge nets.

A great amount of manganese nodules containing such elements as manganese, cobalt, nickel and copper have been found at the deep sea-bottom. These metals are originally contained in seawater and crystallized on and around fish bones, etc., and form manganese nodules. These manganese nodules lie scattered on the soft clay piled at the deep sea-bottom. According to the survey conducted by IGY, it has been found that approximately 10 percent of sea-bottom area of the Pacific is covered with manganese nodules. It has also been found that manganese nodules at the sea-bottom of the middle Pacific Ocean contain 31.7 percent manganese, 17.5 percent iron, 0.69 percent cobalt, 1.45 percent nickel and 1.09 percent copper. Assuming that such manganese nodules can be mined from the deep sea-bottom using some mining machines on an industrial scale, the cost of manganese nodules would be in the range of from 40 to 100 dollars per ton. The practicality and economy for mining have been studied and proposed by Mr. Mero in the U.S.A.

According to "Mineral Resources of the Sea" authored by Mero in 1965, nodules can be mined by ships on the surface of the sea by means of a long pipe using suction dredges, but it would be expensive and the venture marginal, considering the difficulties of operations on the sea with long pipe and underwater pumping machine. This invention, however, does not use such an underwater pump, etc. In this connection, the present inventors noticed that Japanese fisherman had used a dredge net having combs to collect a large quantity of shells from the sea-bottom, and that such a dredge net would be useful for collecting manganese nodules from the sea-bottom. Since a hundred years ago, many explorers have collected manganese nodules using dredge nets drawn by a long rope from ship's stern. It, however, takes a long time to lower the rope down and to pull it up from the deep sea-bottom. Therefore, the dredge net has been considered unpractical for the reason of slow production speed. However, the inventors, restings on a conviction that a dredge net is the only means which can collect manganese nodules, have studied the improvement in the dredge net system, i.e., on the possibility of increasing the production speed of manganese nodules by means of dredge net, and thus attained the present invention.

It is, therefore, an object of the present invention to provide an improved dredge net capable of increasing the production speed of manganese nodules.

The nature, principle, details and utility of the invention will be more clearly apparent from the following detailed description with respect to a preferred embodiment of the invention when read in conjunction with accompanying drawings, in which:

FIG. 1 is a side view of a mechanism for mining manganese nodules at the deep sea-bottom embodying the present invention;

FIG. 2 is a cross sectional view of a stern of a mining ship;

FIG. 3 is a perspective view showing one mode of the mechanism tested in a water tank;

FIG. 4 is a perspective view showing a tangled rope;

FIG. 5 is a perspective view showing the movement of rope and dredge weight at the tank's bottom;

FIG. 6 is a perspective view showing the mining ship equipped with the mining mechanism according to the present invention; and

FIG. 7 is a perspective view showing the dredge net.

FIG. 1 illustrates the general arrangement of the mechanism and according to the present invention, in which a mining ship 1 has a front wheel 2 at a position close to the bow and a rear wheel 3 at a position close to the stern, guide wheels 4,5, 6, 7, 8, 10 and 11 on the deck. Guide plates 12, 13 are respectively attached closely to said guide wheels 5 and 7. Guide rollers 14 is disposed between guide wheels 4 and 5 and guide rollers 15 between guide wheels 9 and 10. Along endless rope 16 extending from the bow to the deep sea-bottom by way of the stern passes through the rear wheel 3, guide wheels 4, 5, 6, 7, 8, 9, 10, 11 and the front wheel 2, the length of the rope being 2.4 times as long as the depth of the sea.

A number of dredge nets 17 are tied or secured in any suitable manner to the long rope 16 at regular intervals. Guide wheels 4, 5, 6, 7, 8, 9, 10 and 11 have electrically driven motors incorporated therein. Accordingly, the long rope 16 travels from the bow to the stern by way of the sea-bottom. The arrow 18 indicates the movement direction of the forward end of the rope and arrow 19 indicates that of the rear end of the rope. The mining ship makes headway at a slow speed. The arrow 20 indicates the direction of the ship's movement. When the speed of rope is almost equivalent to that of the ship, the forward end of the rope is suspended almost perpendicularly but the rear end thereof is pulled by the movements of the ship so that the dredge nets 17 are drawn on the clay at the deep sea-bottom 21 and collect manganese nodules 22 on the clay, and are pulled up onto the sea surface 23.

Now, referring to FIG. 2, when each dredge net 17 passes through the wheels respectively, the long rope 16 is at the inner side of each wheel and the dredge net at the outer side of each wheel so as to pass around each wheel smoothly, as shown in FIG. 2. The rope-line between wheels inclines and the dredge net 17 passes around the outer side of the wheel by the force of gravity at the rear wheel 3, guide wheels 4, 6, 8 and 9. The guide rollers 14 and 15 have a number of rollers to move dredge nets 17 in a smooth manner, and guide the dredge nets 17 to the outer side of the guide wheel 5 and the rear portion of the guide wheel 9.

Guide plates 12 and 13 support the dredge nets as they overturn and manganese nodules in said dredge nets are dropped onto the ship by the force of gravity. Collected manganese nodules 24 and 25 are transported to other places in the ship.

The inventors have tested the above mentioned mechanism using a small model in a water tank having a depth of 6.2 m.

Referring to FIG. 3, a small model ship 26 has a front wheel 27, a rear wheel 28 and roller 29 provided with a small motor 30. A long endless rope 31 extends from the front wheel 27 to water tank bottom 33 by way of the rear wheel 28 and the roller 29. The rope 31 has a diameter of 1.2 mm, a length of 15 m and small lead weights 32 tied thereto at a regular interval of 11 cm.

The distance between the front wheel 27 and the rear wheel 28 is only 14 cm, and the ratio of the distance to the depth of the water tank was 1 : 44. In the test within the water tank, two different ropes, i.e., a plaited rope and a three-strand rope were used and the plaited rope proved a success, but the test using the latter failed because of a rope tangle which occurred, as shown in FIG. 4. Since the plaited rope is torsionally balanced, it is capable of preventing rope tangle between two ropes. When the model ship 26 is manually moved in the direction shown by the arrow 33' in FIG. 3, the long rope 31 moves ahead from the front wheel 27 but is pulled toward the rear wheel 28 at the same speed as the ship's movement by the force of the small motor 30. The rope is vertically suspended at the fall portion 31–A, but it is suspended at the rise portion 31–B by forming a suspension curve. The floor portion 31–C extends on the floor.

Small lead weights 32 are drawn at the tank bottom with each locus shown by dotted line in FIG. 5, leaving the drawn space 34 on the tank bottom 33.

To prevent ropes from tangling each other, the rise portion 31–B must be pulled to a predetermined position against the fall portion 31–A.

In case this positioning of the rise portion is incorrect, it may cause a rope tangle. Therefore, care must be taken in this point by the designer and operator of the ship.

In a test on the sea of 80 m depth carried out subsequently to the aforementioned water tank test by the present inven-

tors, a plaited nylon rope having a length of 200 m with 80 small cans attached thereto was used. A small fishing boat was provided with a front wheel and a rear wheel, the distance between the front wheel and the rear wheel being 3 m, and the boat could continuously collect mud from the sea-bottom.

In the mining ship shown in FIG. 6, a line leading from the front wheel 2 to the rear wheel 3 is deflected slightly from a line leading from the bow to the stern. The deflection, however, serves for pulling the rise portion of the rope 16 at a predetermined position against the fall portion of the rope 16.

Guide wheels, guide rollers and guide plates are all installed on the mining boat 1 and operated by the force of ship engines.

Manganese nodules lie scattered on the soft clay at the deep sea-bottom, so that the dredge nets must collect them with good efficiency. The shape of dredge nets may be varied depending on the conditions of manganese nodules, and the dredge nets may be provided with combs in the vicinity of their mouths.

In FIG. 7, the dredge net 17 has a cylindrical shape and is covered with a wire netting and connected to the long rope 16 at a regular interval and collects manganese nodules by being drawn on the clay layer. An advantage of the cylindrical shape lies in facilitating the handling of the dredge net.

When dredge nets 17 each having a diameter of 0.8 m, a length of 1.4 m and weight of 100 kg and being capable of collecting 800 kg of manganese nodules in air by one dredging are employed by being tied to the long rope at the interval of 100 m, the production speed of manganese nodules will be 500 tons per day.

Presumed that a 10,000-ton mining ship is used, it would be estimated that the revenue per year would be 4.5 million dollars.

We claim:

1. Apparatus for deep-sea mining of manganese nodules from the bottom of the sea comprising:

a ship traversable on the sea surface,

an endless loop torsionally balanced rope extending from the ship bow, beneath the sea along the sea-bottom, upwardly over the ship stern and extending to the ship bow,

a plurality of nodule collecting members serially located on the rope,

said ship being traversable on the sea surface, the traversing motion of the ship dragging the nodule collecting members along the sea-bottom collecting manganese nodules therein,

means on said ship and engaging the endless line for conveying the nodule collecting members containing collected nodules therein from the sea-bottom to the ship stern, and for continuously passing said members to the bow of said ship, from the bow of said ship to the sea-bottom, resting said members on the sea-bottom and subsequently dragging said members prior to conveying to said ship, and

emptying means for emptying the nodule collecting members containing collected nodules.

2. The apparatus of claim 1 wherein said nodule collecting members are dredge nets.

3. The structure as recited in claim 1, wherein, said emptying means includes a plurality of rollers, said endless loop rope being trained to travel over the circulated peripheries of said rollers, and at least one of said rollers being elevated with respect to other of said rollers, said nodule collecting members being conveyed by said endless loop line over the surface of the elevated roller to an inverted condition, whereby the nodules collected therein are emptied.

4. An apparatus as recited in claim 1 wherein said endless rope is adapted to have a length approximately two–four times the depth of sea in which the system is being employed.

5. A method for deep-sea mining of manganese nodules from the bottom of the sea comprising the steps of:

traversing a ship over the sea surface,

urging travel of an endless loop line having a plurality of nodule collecting members serially located thereon in a direction from the ship bow downward to the sea-bottom, resting said members on the sea-bottom, subsequently dragging the nodule collecting members along the sea-bottom, raising said members to the stern of said ship, emptying the nodule collecting members of the nodules collected therein as the continuous loop line travels from the ship bow to the ship stern, and passing said members to the bow of the ship for return to the sea-bottom.

6. The method of claim 5 wherein the speed of the ship traversing the sea surface is substantially equal to the travel of the endless loop.

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