June 3, 1947. H. E. GROSS 2,421,377

APPARATUS FOR SALVAGE

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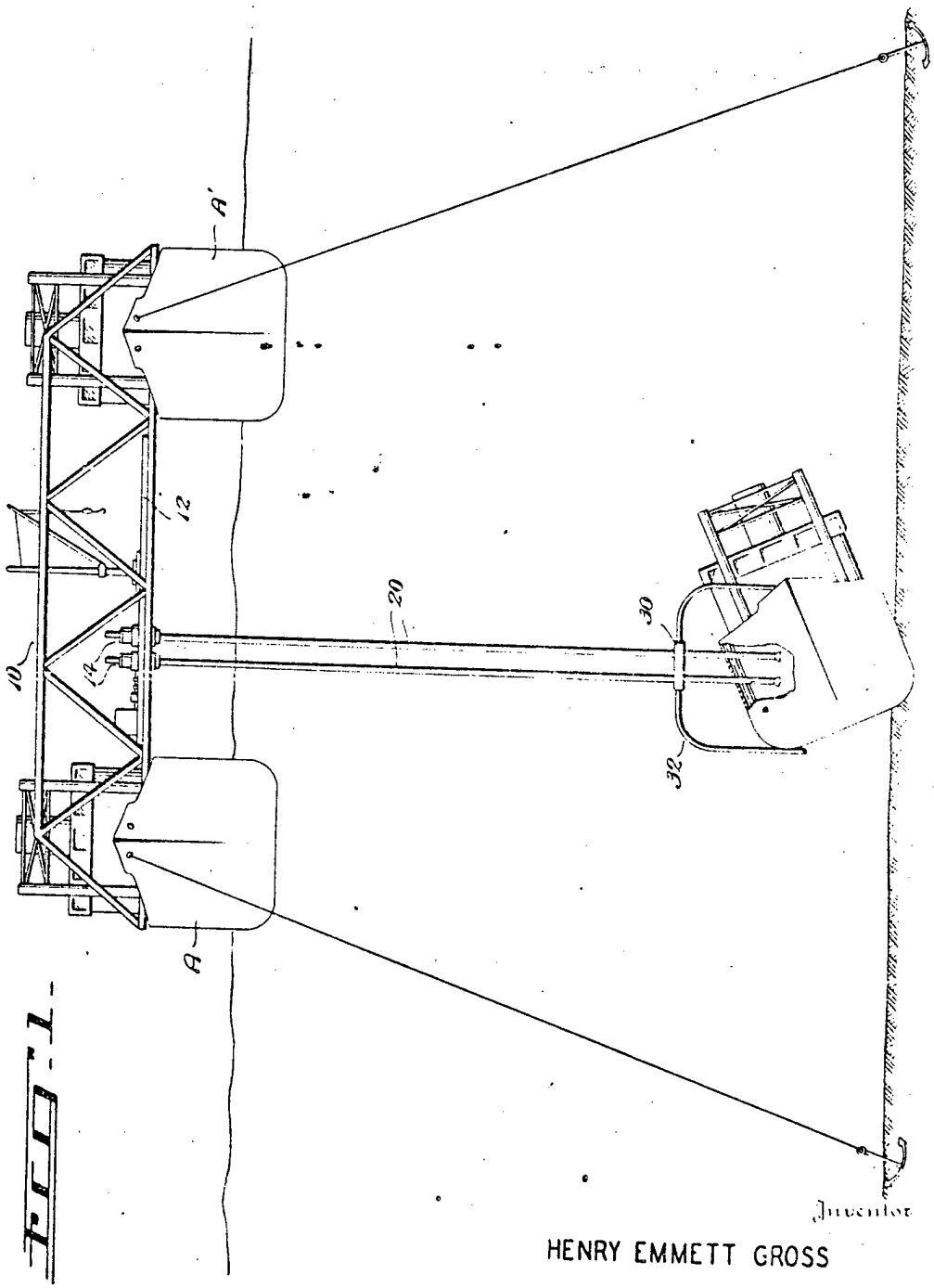

FIG. 1.

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FIG. 2.

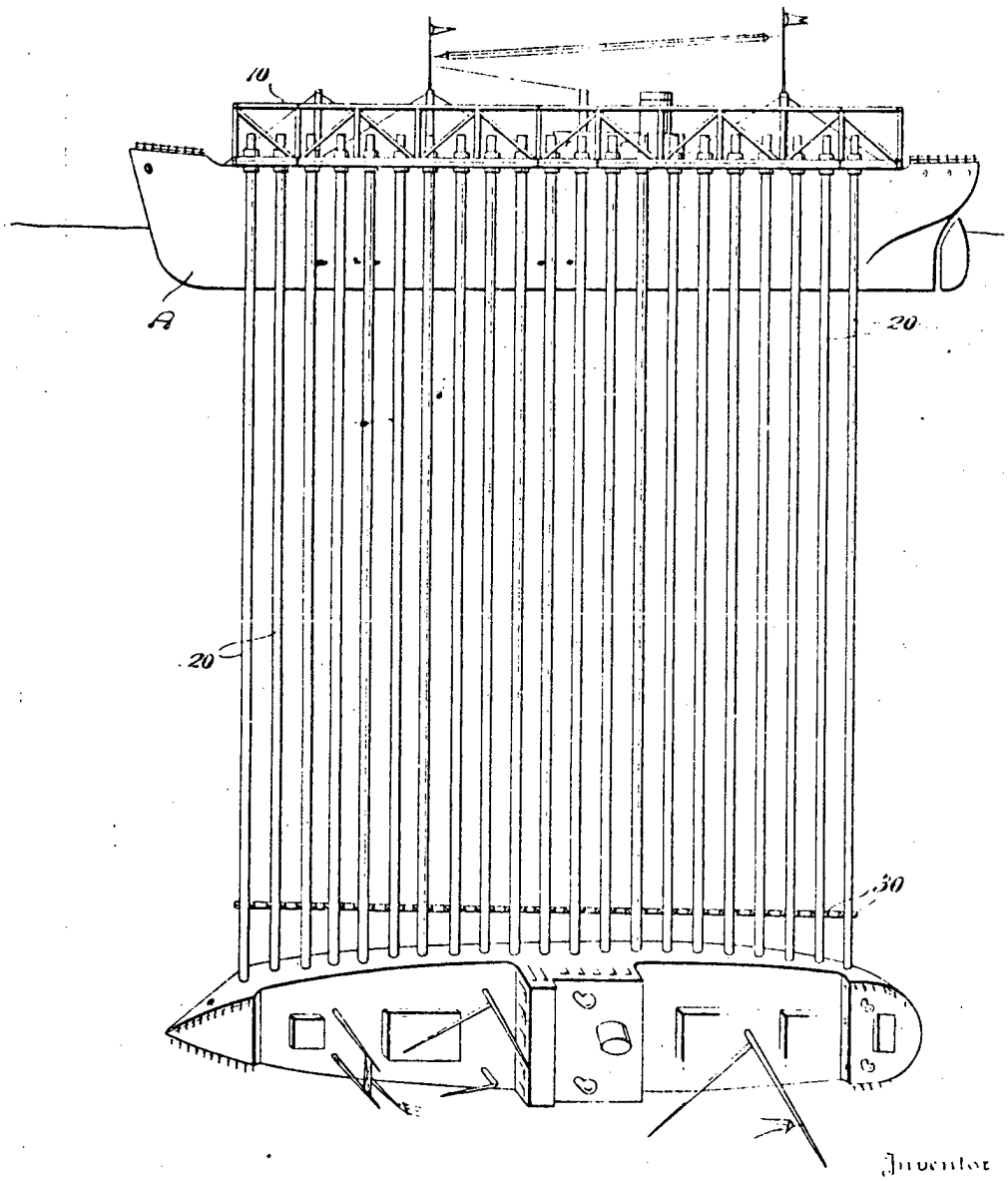

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Fig. 3.

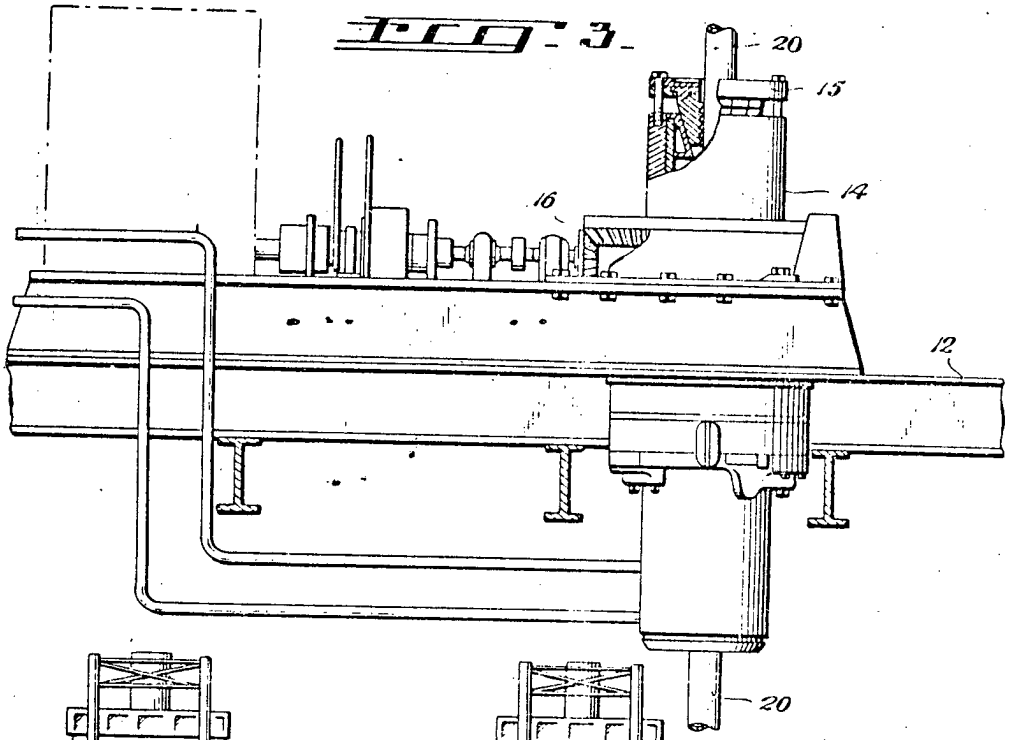

Fig. 8.

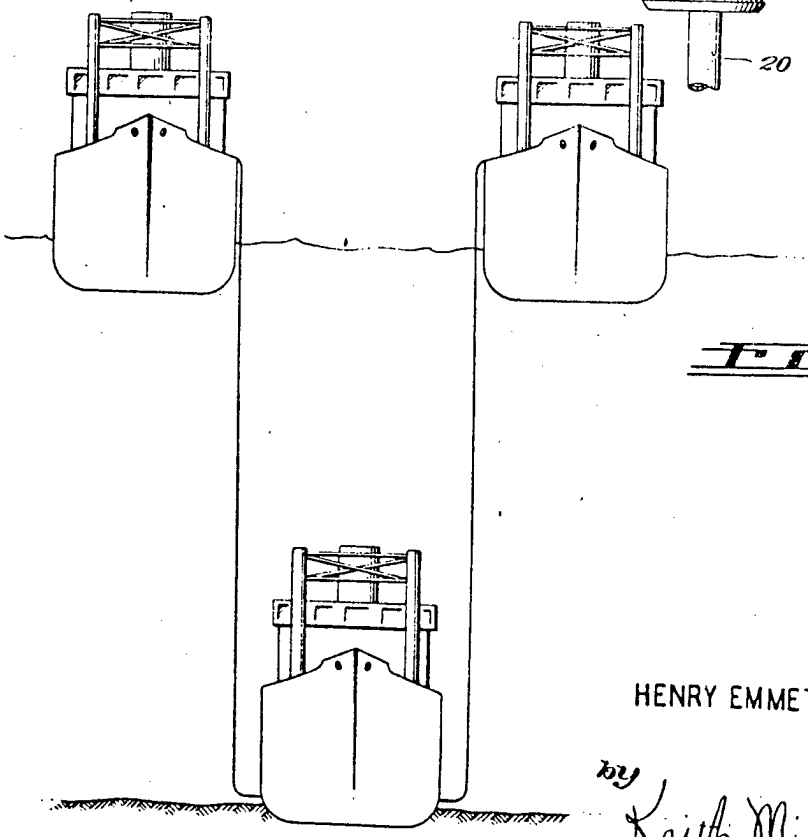

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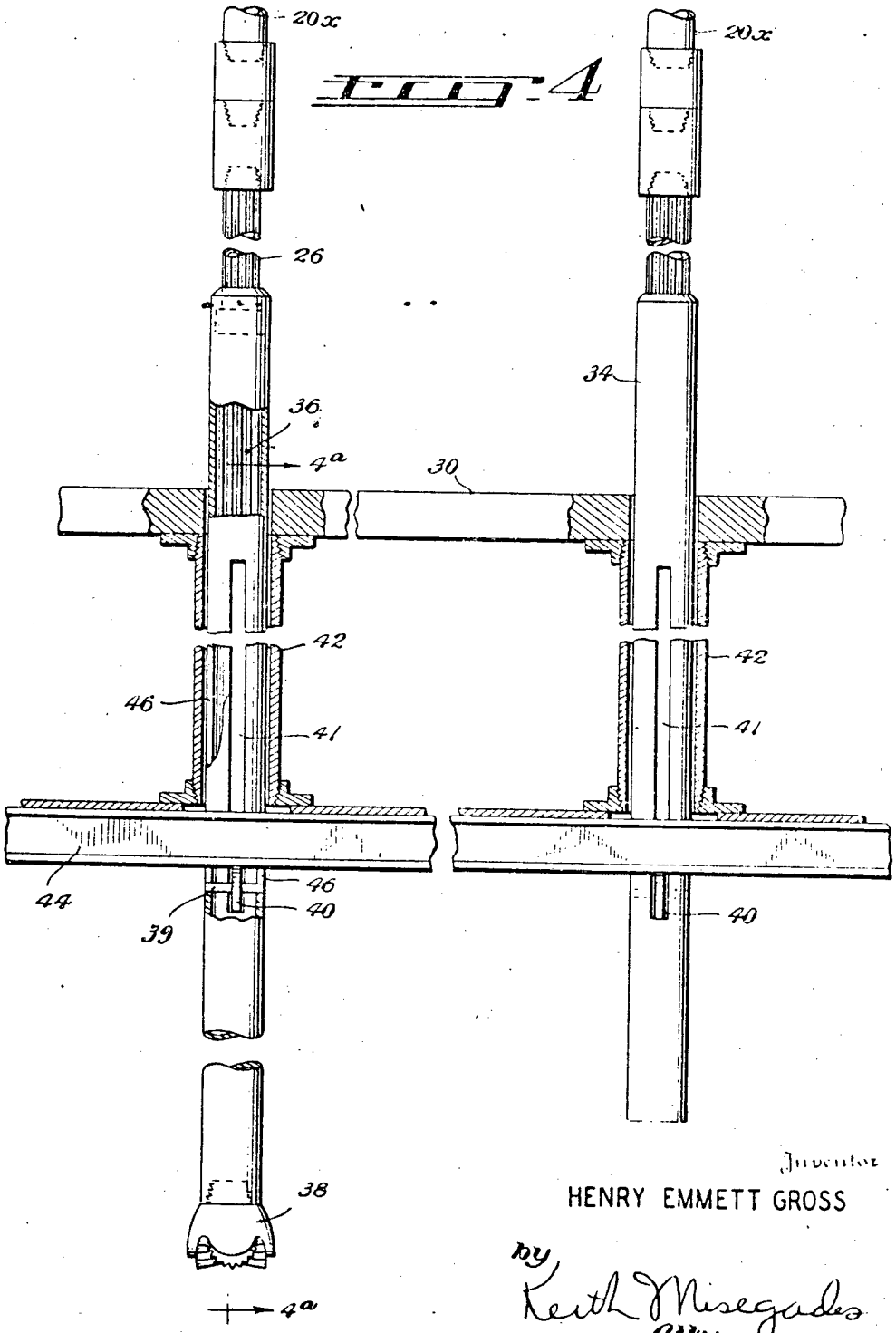
FIG. 4



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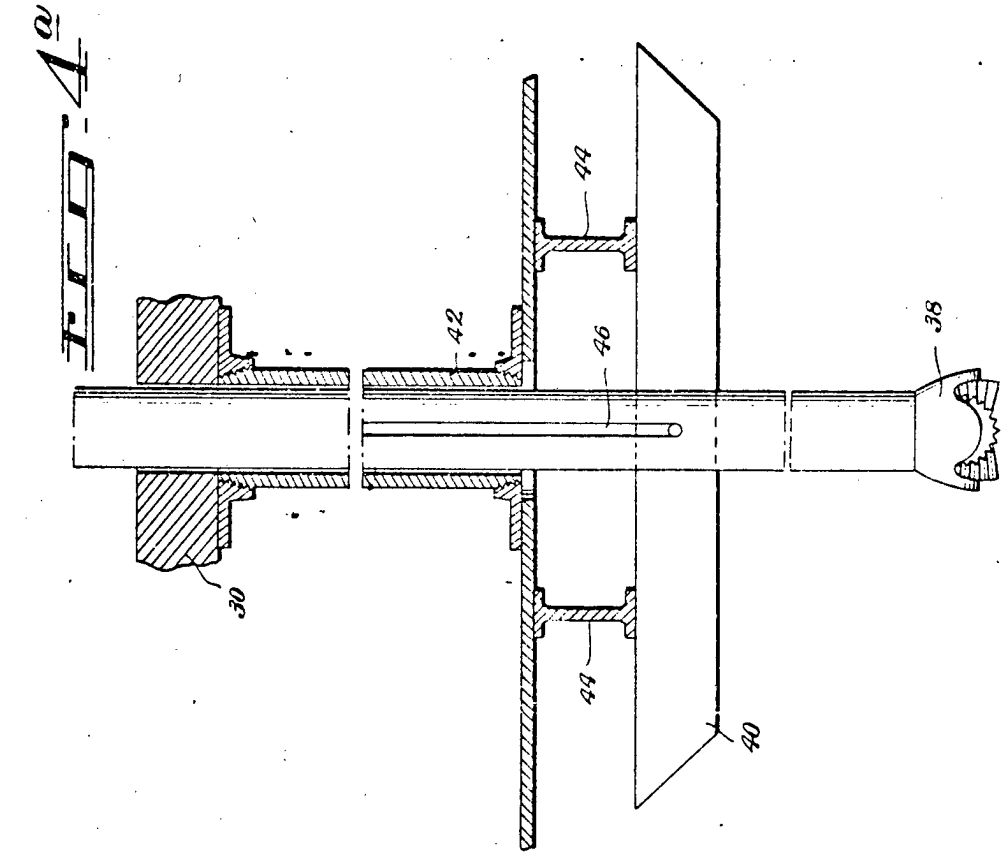

FIG. 4a

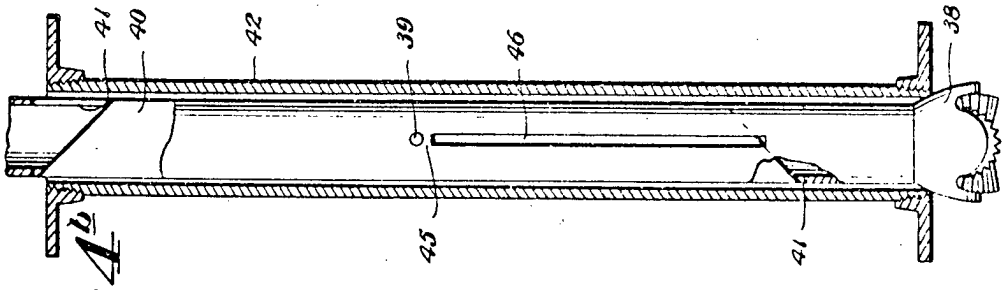

FIG. 4b

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FIG. 5.

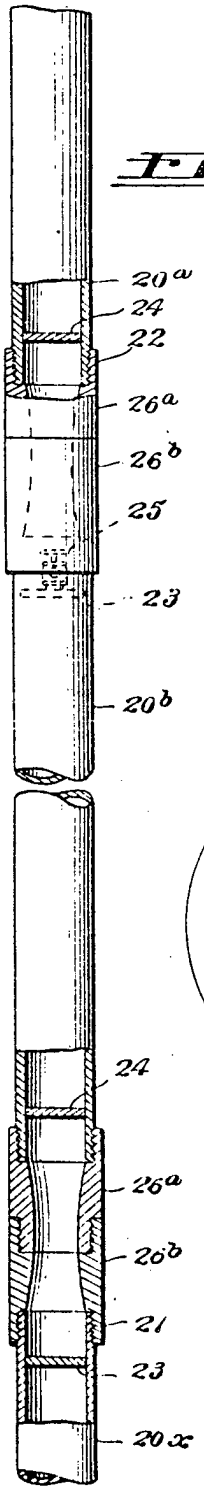

FIG. 10.

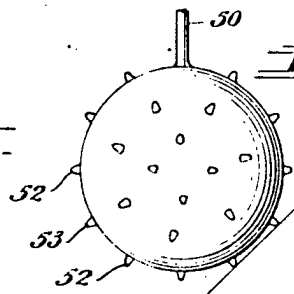

FIG. 11.

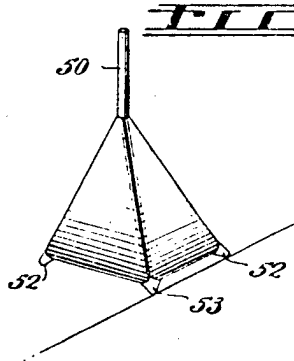

FIG. 12.

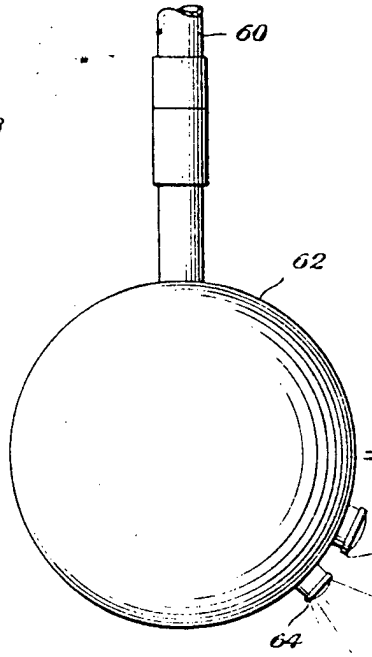

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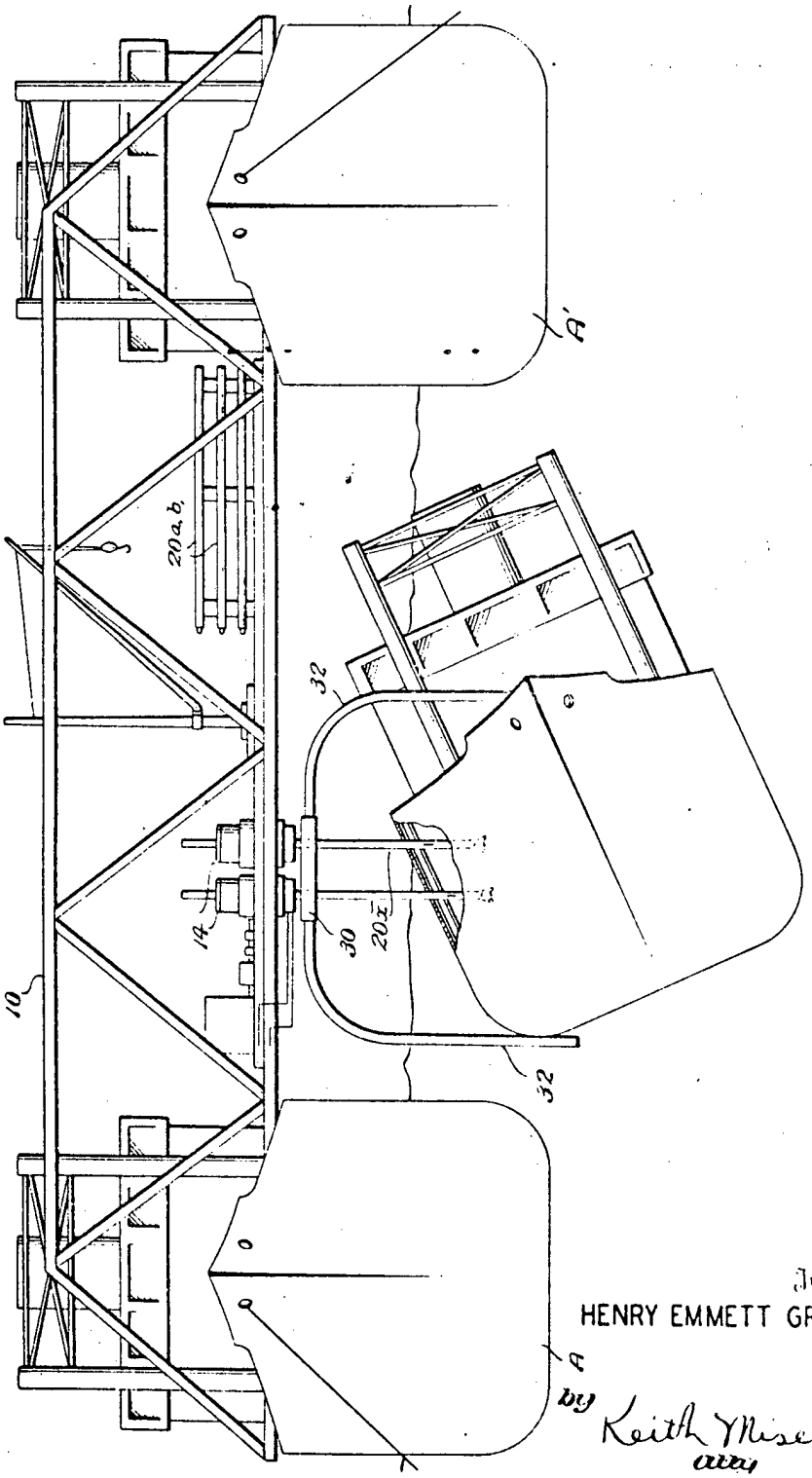
FIG. 6.



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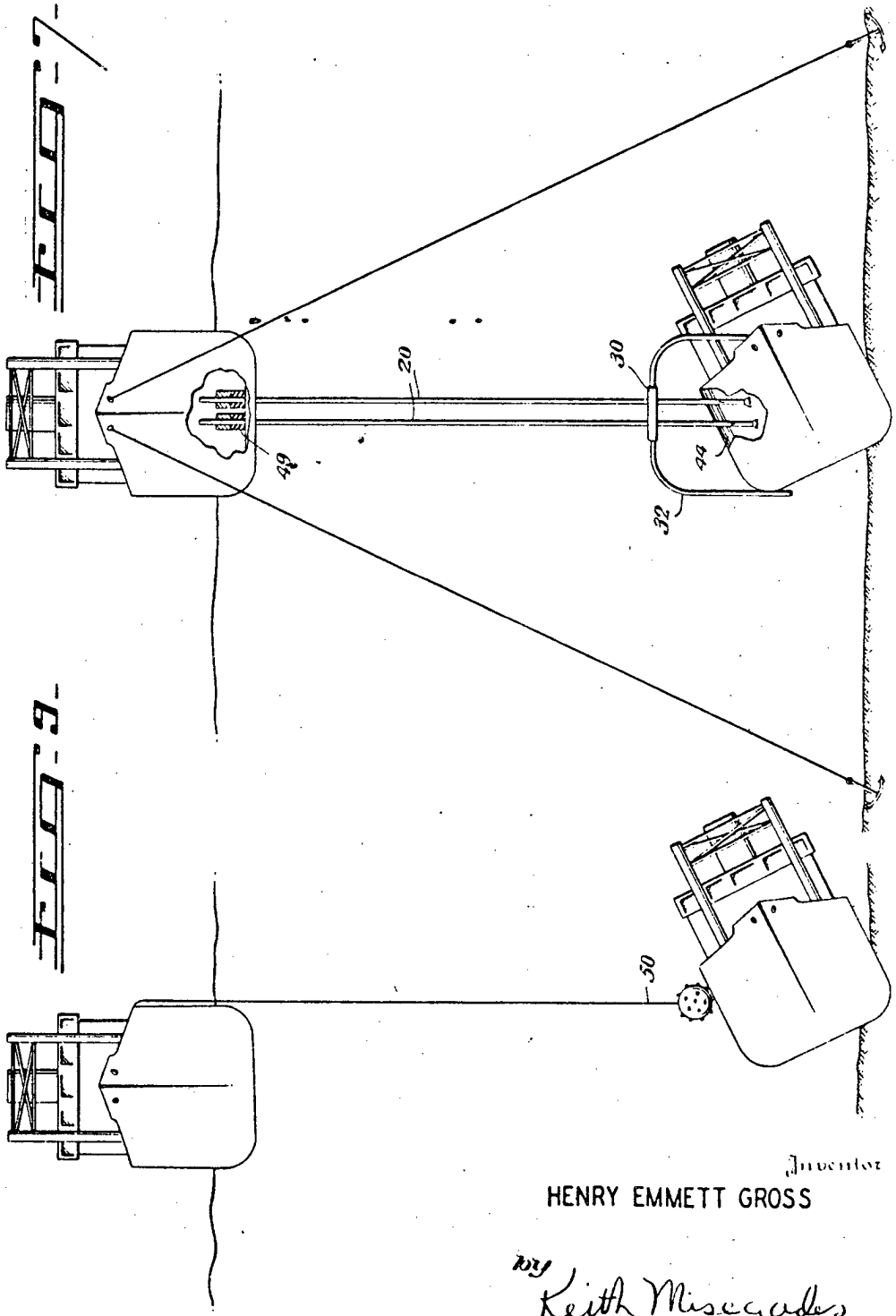

Fig. 7.

Fig. 9.

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Patented June 3, 1947

2,421,377

UNITED STATES PATENT OFFICE

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APPARATUS FOR SALVAGE

Henry Emmett Gross, Chicago, Ill.

Application November 30, 1942, Serial No. 467,446

12 Claims. (Cl. 114—51)

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This invention relates to a method and its associated apparatus for salvage of a sunken vessel. Prior practice for the recovery of articles from the ocean floor has required the employment of divers for operation on the submerged object. An operation of this character is therefore subject to all of the limitations imposed on it by human limitations. No recovery can be carried out unless the diver can descend to the wreck thereby eliminating many of the more desirable prizes from recapture. The practice of dragging and grappling is not susceptible to sufficiently precise management to enter into consideration.

The present invention does not contemplate the employment of deep-sea divers for establishment of contact with the sunken vessel and is hence free of the concomitant limitations. Furthermore, the apparatus employed has no inherent limitations of its own. From the performance of analogous apparatus, it requires only sound engineering practice to carry out salvage operations at depths deemed fantastic when contemplated in terms of the prior art. Recovery even of the largest size sunken vessels from depths of 10,000 or even 15,000 feet, is dependent only on economic considerations.

The invention contemplates first, accurately locating the sunken vessel either by some of the known means or preferably by methods described more particularly below. It is contemplated that there will be a determination of the latitude, longitude and precise depth and as well the manner in which it rests on the ocean floor both as to direction and relative angle to the vertical.

Next, the salvage apparatus is brought into place above the wreck. This may be incorporated in a single vessel or preferably mounted on a framework supported between two or more vessels. In any event, the vessel or vessels are securely anchored in such manner that the relationship of the apparatus to the wreck in rectangular coordinates will be fixed and constant.

From construction records and the position of the ship as previously determined, a template is prepared and this is lowered to the sunken ship by means of a plurality of strings of rotary drill pipe of the type common to the oil drilling industry. Each pipe is provided with a milling cutter and means for securing the string to the sunken vessel. Guided by the template the various strings of pipe are then operated to be secured to the ship.

By operating the drills through hydraulic rotary tables all of the pipes may be raised

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simultaneously just as they were lowered. When brought near the surface of the water, the ship may be towed to shallow water or otherwise disposed of in any suitable manner.

For a fuller understanding of the invention reference should be had to the drawings wherein:

Fig. 1 shows a schematic front elevation of one embodiment of the invention, with the drill pipe in place ready for raising the sunken vessel.

Fig. 2 shows a side elevation of the apparatus showing the drills in position just after drilling.

Fig. 3 shows an enlarged view of the hydraulic tables used for operating the drills.

Fig. 4 shows an enlarged view of the lower portion of the drill stem and the template showing the manner in which they co-operate.

Fig. 4*a* is a similar view at right angles thereto as indicated at 4*a* on Fig. 4.

Fig. 4*b* is a similar view showing the dog housed within the drill collar.

Fig. 5 shows the drill pipe used.

Fig. 6 is a view similar to Fig. 1 showing the sunken vessel raised, ready for towing inshore.

Fig. 7 is a view similar to that of Fig. 1 showing a modification suitable for less difficult operations.

Figs. 8 to 12 inclusive disclose schematic arrangements of ships and other apparatus for locating wrecks to be salvaged by the apparatus disclosed in Figures 1 to 7.

Fig. 8 shows two vessels dragging by means of cable.

Fig. 9 shows an electrical detection device.

Figs. 10 and 11 show enlarged views of alternative heads for the device of Fig. 9.

Fig. 12 shows an electronic scanning device and means for carrying the same.

According to Figs. 1, 2 and 6 of the drawings, the invention employs two or more ships A, A^1 of approximately similar construction, provided with steel trusswork, united to the framework of the two ships so that the resulting structure is secure but not necessarily rigid. The span between the two vessels should accommodate the full height from keel to superstructure of the largest ship upon which operations are contemplated.

Running the length of the trusswork is the operating floor 12 preferably at least three quarters as long as the wreck. Since the weight of the salvaged ship will be carried by this floor during its elevation from the ocean floor, provision must be made for supporting and transmitting it to the salvage ships. Along the length of the floor are distributed a series of hydraulic rotary drilling tables 14, of the sort commonly

employed in the drilling of oil wells by the rotary method. The number of tables employed may amount to one hundred or more and the scheme employed for determining the number required will be set below. Each table consists of a large chuck 15 through which there may be passed or held securely pipe of diameters up to 10 or 20 inches. By means of power applied to the rotational member 16 of the table the pipe may be rotated. An indexing means may be provided so that the exact angular position of the lower end of the drill pipe may be determined.

The drill pipe is also of the type commonly employed in oil well drilling save that it is not necessary to provide a fluid passage through the pipe as is required for oil drilling. Instead, I propose to seal the pipe at each end. This serves two purposes. First, it enables the use of relatively thin wall pipe without any danger of collapse at working depth. Pressure in the sea increases .447 pound per square inch for each foot of depth. Consequently, if a particular length of drill pipe is to be employed at a depth of 10,000 feet, an internal pressure of 4470 pounds will be built up in the section before lowering it into the sea. Corresponding pressures can be built up for each length of pipe according to its position in the string.

For the shallower depths of the order of 5000 feet or less the use of compressed air is satisfactory. As the amount of pressure necessary increases, compressed air becomes appreciably dense and the loss of buoyancy makes it advisable to employ a lighter gas preferably hydrogen or helium, especially the non-explosive mixtures thereof. The second advantage of sealing each length of pipe lies in this buoyancy. By selection of pipe size it is possible to give the pipe just the right displacement enabling it to pull just as big a load at 10,000 feet as at 100. Assuming the use of steel pipe having a density of 7.8 the ratio of the external diameter D and the internal diameter d, are determined according to the following equation:

$$\frac{D^2\Pi}{4}=\frac{(D-d)}{2}\frac{(D+d)}{2}\Pi\times 7.8;\ d=.93D$$

This calculation neglects the weight of the fluid contained in the pipe. If this is substantial, correction must be made. One of the standard drill pipes is that of 8⅝ O. D. This can be had in .32'' wall thickness, weighing approximately 32 pounds per foot of length; such pipe has just about the right proportionate dimension. The total tensile strength of the standard pipe of this dimension is roughly 500 tons. Apparatus equipped with a hundred drill tables is thus capable of handling sunken ships up to 25,000 tons if a safety factor of 2 is required. As shown in Figure 5, the pipe 20, consists of individual lengths 20a, 20b, 20x of pipe usually 20 to 40 feet each in length provided with upper 21 and lower 22 threaded ends, all of standard dimensions, and preferably provided with drill joints 25a and b of the rugged style used in oil fields.

Plates, 24 and 23 are welded in each joint of pipe just clear of the threaded portion to seal the pipe. In the top plate, 23, a valve 25 is provided enabling any desired pressure to be maintained within the pipe.

When the sunken ship is located and the manner in which it rests upon the bottom is determined, a template 30 is prepared from this information with the aid of known construction details of the ship. It is contemplated that drilling will so far as possible be spaced between the ribs of the ship so that as to be indicated the ribs will be intact and available to support the ship during the raising thereof. The template is provided wtih holes for each of the drill pipes to be employed and these holes are arranged in the pattern which it is desired to be followed in sinking the drills into the ship. It is not necessary however, to employ precisely this same pattern on the drilling floor as it is well known in the art of oil drilling, to alter the direction of drilling as it proceeds: The template is provided with one or more guides, 32 of appropriate shape, to align the template in proper position over the sunken ship.

Each drill pipe 20 is provided with a corresponding drill collar 34 connected thereto by means of interfitting splines 26 and 36 on the pipe and collar respectively. Thus there may be relative vertical movement of an amount sufficient to compensate for the rise and fall of waves, say 30 feet, while rotation is strictly controlled.

The cutting through the side of the wreck is performed by milling heads 38 carried by the drill collars. Pivoted on pin 39 within the collar above the milling head is a dog 40; during the drilling operation this is held within the collar by means of slidable sleeve 42 which is of too small a diameter to slide off the mill at the bottom of the collar. When the mill has penetrated the wall of the vessel and passed into the interior of the ship, the sleeve is retained outside allowing the dog to open outwardly within the vessel. Using the indexing device on the drill table enables the operator to bring the dog lengthwise of the ship so that by drilling midway between two ribs, the pull of the drill pipe through the dog is thus transmitted from the strongest portion of the wreck directly to the drill pipe.

When the initial pull on the drill pipe 20 is applied to raise the wreck its weight is transmitted thru the ribs 44 to the dog 40 and thence thru pivot pin 39 to drill collar 34 and drill pipe 20. If desired, the pivot pin 39 may be designed to properly carry the anticipated load. However, I prefer to design the pin relatively much smaller and support it by means of a relatively light web 45 at the top of slot 46 which terminates opposite the foot of slot 41 in which dog 40 is pivoted. Thus as the pull is increased, pin 39 breaks thru web 45 and the dog then will come to rest at the foot of slot 41 thus transmitting the weight on the dog directly to the drill collar 34 and thus thru the drill pipe to the salvage apparatus.

Since the drill pipes 20 are raised and lowered hydraulically through the drill tables 14, interconnection of the tables to a common source of hydraulic pressure enables a steady, even lifting action. When a full length of pipe is exposed above the drill table, it may be uncoupled from the string and put aside for further use. As soon as the sunken vessel is brought close to the surface it may be desirable to move salvage apparatus and the vessel inshore together, the vessel being carried suspended between the salvage ships. However, it may prove more expedient when the vessel is brought within the reach of deep sea diving equipment to use such means to transfer the support of the vessel to any of the more conventional means, thus freeing the salvage ships for further operation.

According to Figure 7 of the drawing, a modification is shown whereby for the less difficult operations, a single ship may be employed. In such event, it is necessary to bring the sunken

ship within perhaps say 50 to 100 feet of the surface and then remove it for further operations. In order to provide for the roll of the salvage ship in heavy seas, the hydraulic tables are preferably mounted on large rubber blocks 49 which are sufficiently flexible to take up the twisting strains set up by the rolling. Less desirable, but effectively, ball and socket joints may be employed.

For locating the exact position of the sunken ship, there may be employed first such records as are available which records will usually at least provide information as to approximate position. Therefore, if the ocean floor in the particular locality is known to be relatively smooth, a cable may be dragged between two ships as shown in Figure 8.

In Figures 9 to 11 an electrical device is employed consisting of a cable 50 provided with electrically conducting leads within its jacket. Suspended from the cable is a sphere, pyramid or other shaped body provided with protuberances 52, 53 acting as terminals for the conducting leads, and insulated from the main body. The leads are connected within the ship in an electrical circuit having a suitable source of current, indicating device and balancing resistance so that no significant amount of current will flow between the exposed terminals in ordinary sea water. However, when two of the exposed terminals contact an electrically conducting surface such as a ship's side, there will be an additional amount of current flowing and this will be shown on the indicating device.

For a more thorough examination of the under water scene of action the device shown in Figure 12 may best be employed. There may be lowered from the salvage or other ship a single string of pipe 60, having an unobstructed passage throughout its length and at its lower end a watertight observation sphere 62; the pipe is identical with that designated by reference numeral 20 save that the interior plates 23 and 24 are not employed. An illuminating light 64 is arranged to cast its light downwardly toward the ocean floor, current for the same being provided through leads sent down through the open pipes. Through an adjacent window 66, an electronic scanning device views and transmits to the surface through additional wires the appearance of the surrounding ocean floor. By means of the indexing device on the pipe supporting table at sea level, the field of view scanned may be related angularly with respect to the salvage vessel so that the wreck may be fully oriented thereto.

Having set forth my invention and the best method by which it may be carried out, what I claim is:

1. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby, a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when unconstrained, the dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe and a template provided with holes for guiding and spacing the various drill pipes, resting upon said sleeves and thru which the various drill pipes pass.

2. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe each string comprising a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a splined drill collar whereby the lower end has freedom to rise and fall without being free to rotate independently of the drill pipe, said drill collar being provided with a pivoted dog, eccentrically heavy, whereby, when unconstrained, the dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe.

3. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each joint comprising an elongated tubular member sealed at the ends thereof to render the same buoyant, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when unconstrained, the dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along said drill pipe.

4. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, all of said tables being connected to a common source of hydraulic fluid whereby said tables may all be actuated simultaneously and uniformly each said table being provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when unconstrained, the dog will normally assume a position at right angles with said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe.

5. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe each string comprising a plurality of joints of drill pipe, each joint comprising an elongated tubular member sealed at the ends thereof to render the same buoyant, each string being provided at its lower end with a milling bit, next above the bit a splined drill collar whereby the lower end has freedom to rise and fall without being free to rotate independently of the drill pipe, said drill collar being provided with a pivoted dog, eccentrically heavy, whereby, when unconstricted, the dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe.

6. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a splined drill collar whereby the lower end has freedom to rise and fall without being free to rotate independently of the drill pipe, said drill collar being provided with a pivoted dog, eccentrically heavy, whereby, when unconstricted, the

dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe and a template provided with holes for guiding and spacing the various drill pipes, resting upon said sleeves and thru which the various drill pipes pass.

7. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, all of said tables being connected to a common source of hydraulic fluid whereby said tables may all be actuated simultaneously and uniformly, each said table being provided with a string of drill pipe each string comprising a plurality of joints of drill pipe each joint comprising an elongated tubular member sealed at the ends thereof to render the same buoyant, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when unconstricted, the dog will normally assume a position at right angles to said drill pipe, and a sleeve constraining said dog and freely slidable along said drill pipe.

8. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, all of said tables being connected to a common source of hydraulic fluid whereby said tables may all be actuated simultaneously and uniformly, each said table being provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each joint comprising an elongated tubular member sealed at the ends thereof to render the same buoyant, each string being provided at its lower end with a milling bit, next above the bit a splined drill collar whereby the lower end has freedom to rise and fall without being free to rotate independently of the drill pipe, said drill collar being provided with a pivoted dog, eccentrically heavy, whereby, when unconstricted, the dog will normally assume a position at right angles to said drill pipe, and a sleeve constraining said dog and freely slidable along said drill pipe.

9. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby, a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe, each string comprising a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when constrained, the dog will normally assume a position at right angles to said drill pipe and a sleeve constricting said dog and freely slidable along the drill pipe and a template provided with holes for guiding and spacing the various drill pipes, resting upon said sleeves and through which the various drill pipes pass said template being provided with a plurality of outwardly and downwardly extending guide arms to guide the drilling heads in contact with the vessel.

10. Apparatus for raising sunken vessels, comprising buoyant means, a drilling floor supported within said means a plurality of hydraulic drilling tables, flexible mounting means supporting said tables on said floor whereby a string of drill pipe supported by the said hydraulic table may swing freely beneath said buoyant means, pendulum-fashion, each said table being provided with a string of drill pipe, each string provided with a plurality of joints of drill pipe, each string being provided at its lower end with a milling bit, next above the bit a section provided with a pivoted dog, eccentrically heavy, whereby, when constrained the dog will normally assume a position at right angles to said drill pipe and a sleeve constraining said dog and freely slidable along the drill pipe.

11. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe each string being provided at its lower end with a milling bit, next above the bit a section slotted longitudinally to receive a dog, pivot means passing transversely thru the slotted section to support the dog to swing freely in said slot and a second pair of longitudinal slots spaced radially from the first slots and extending from a point a little below the pivot to a point opposite the lower end of the first mentioned slots whereby only two thin metal webs support the pivot pin whereby when a substantial load is placed on the dog as it extends at right angles to said drill pipe, the webs will be sheared and the dog will fall to the bottom of the first mentioned slot and a sleeve freely slidable along the drill pipe for confining said dog in its slot.

12. Apparatus for raising sunken vessels comprising buoyant means, a drilling floor supported thereby and a plurality of hydraulic drilling tables positioned thereon, each provided with a string of drill pipe each string comprising a plurality of joints of drill pipe, each joint comprising an elongated tubular member provided with screw threads at the ends thereof and having plates within the ends, sealing the same and a valve in one of said plates, each string being provided at its lower end with a drilling bit.

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