Nov. 4, 1947. H. A. HANSEN 2,430,014

SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 1

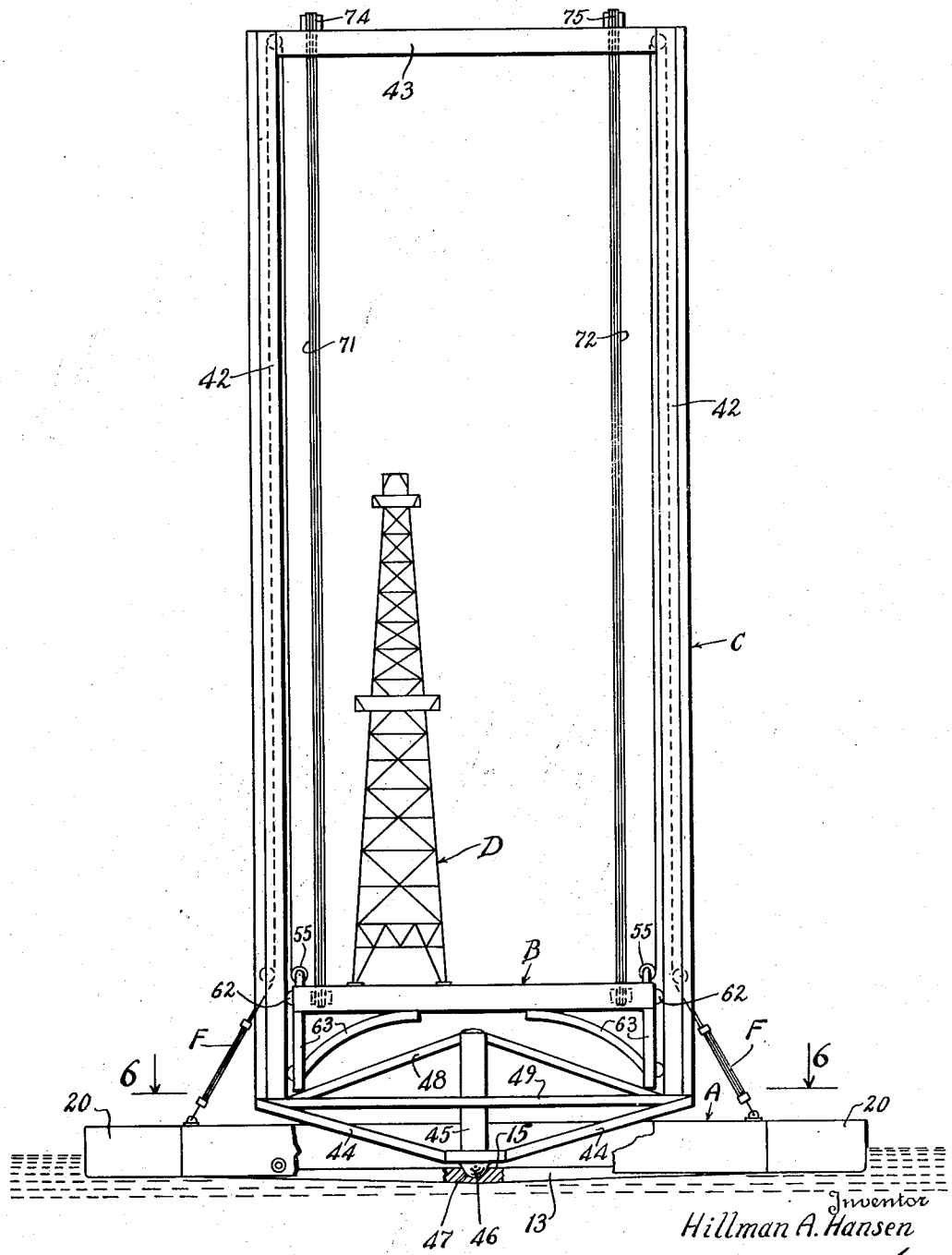


Fig. 1

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Nov. 4, 1947. H. A. HANSEN 2,430,014

SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 2

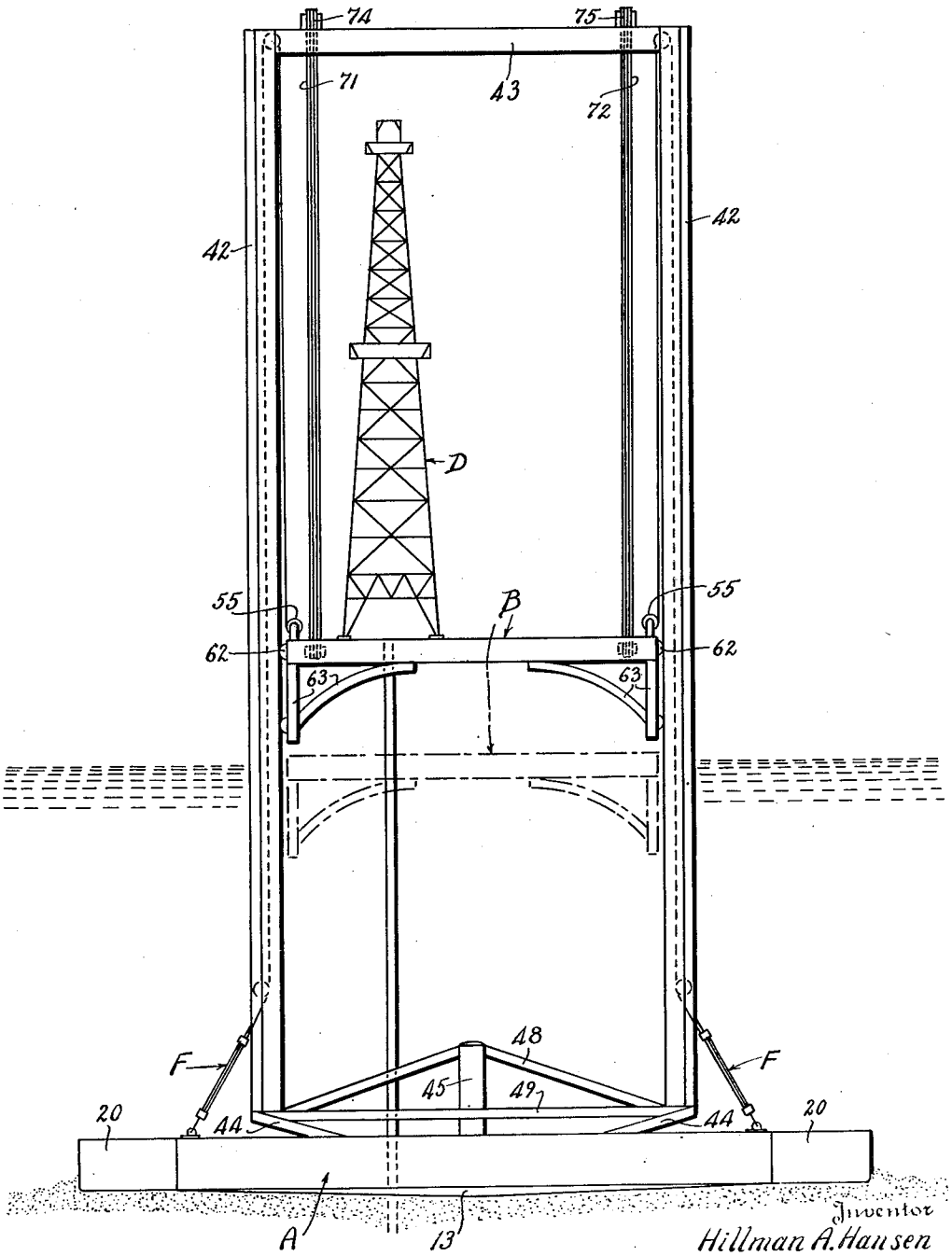


Fig. 2

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SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 3

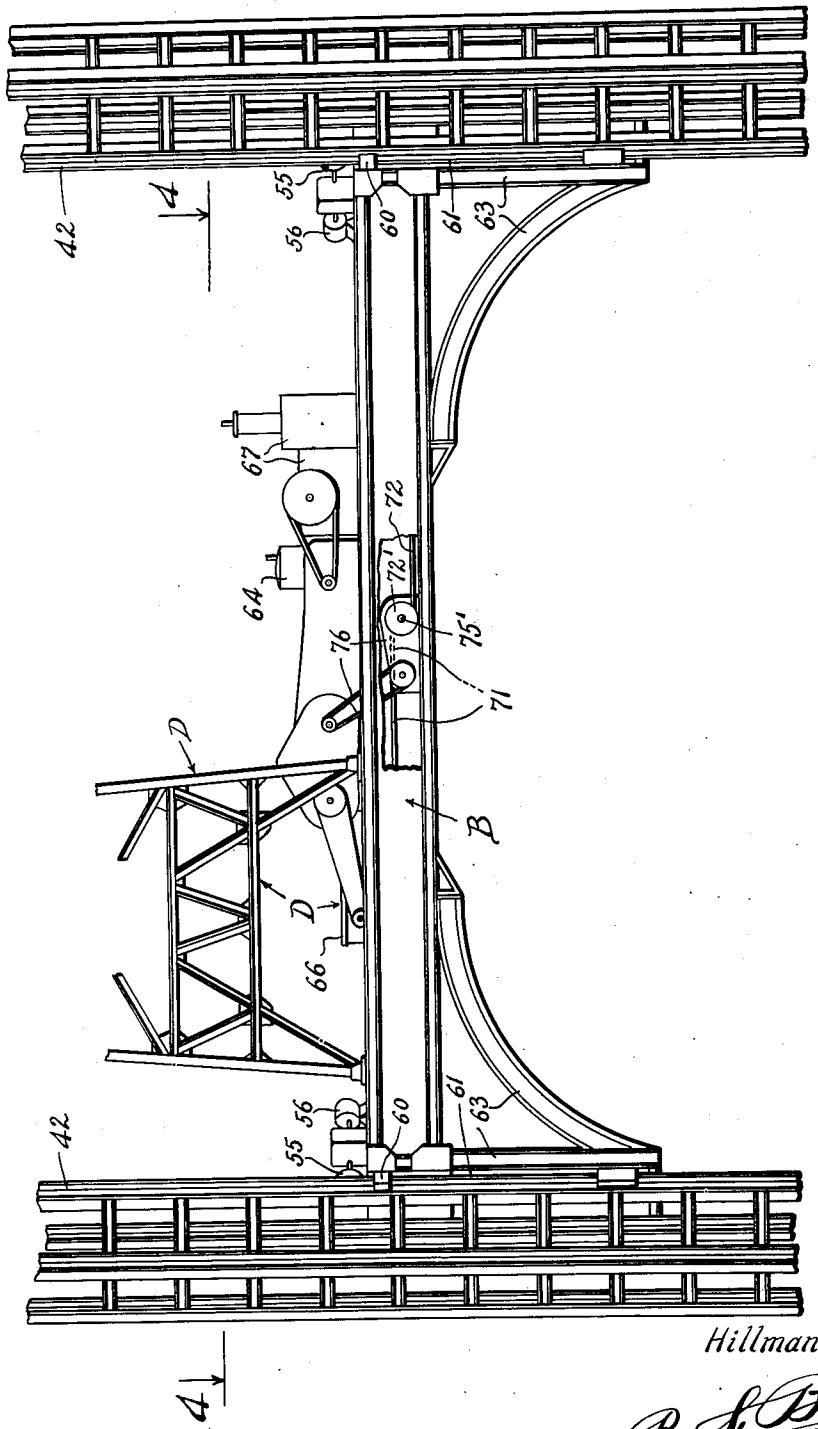


Fig. 3

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SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 4

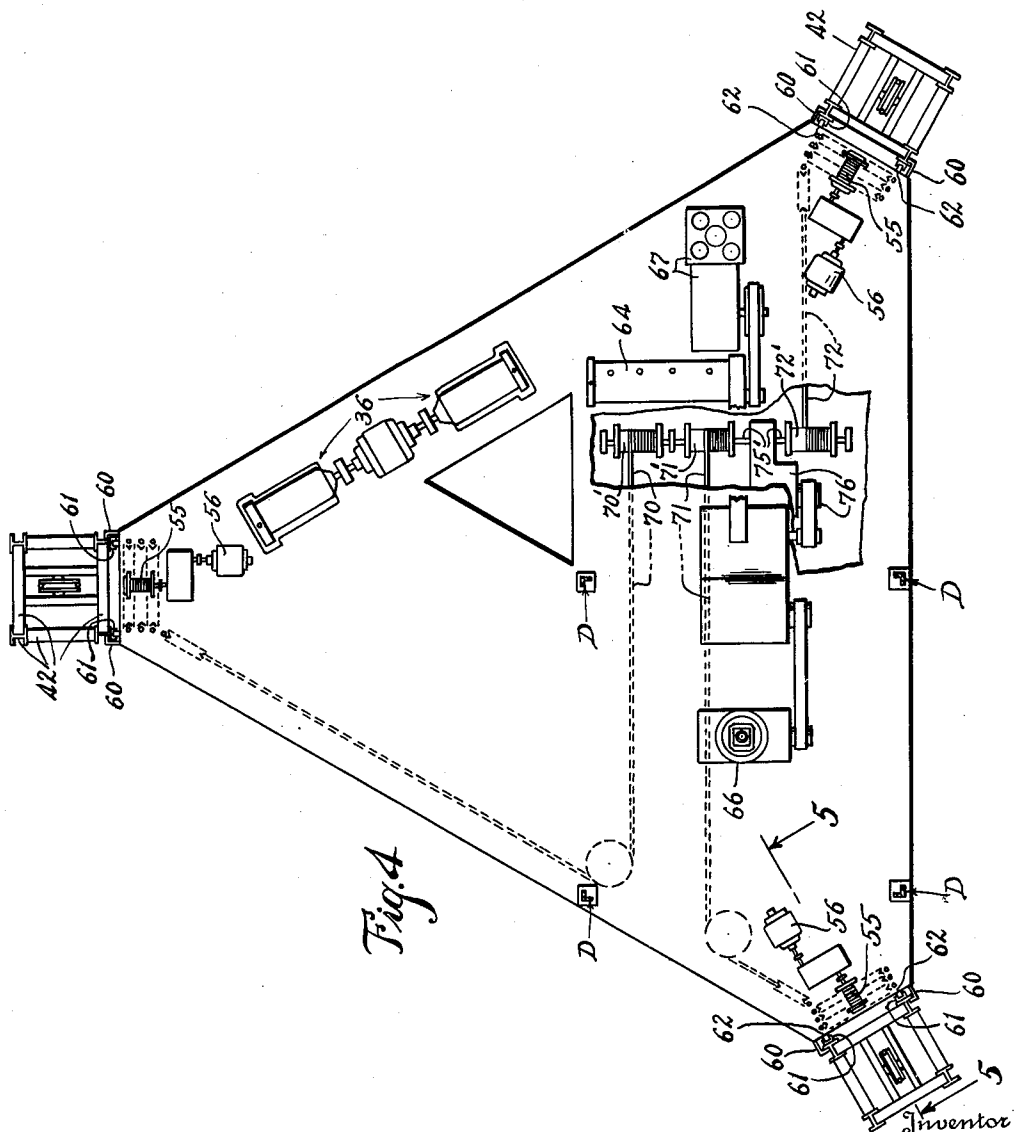


Fig. 4

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SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 5

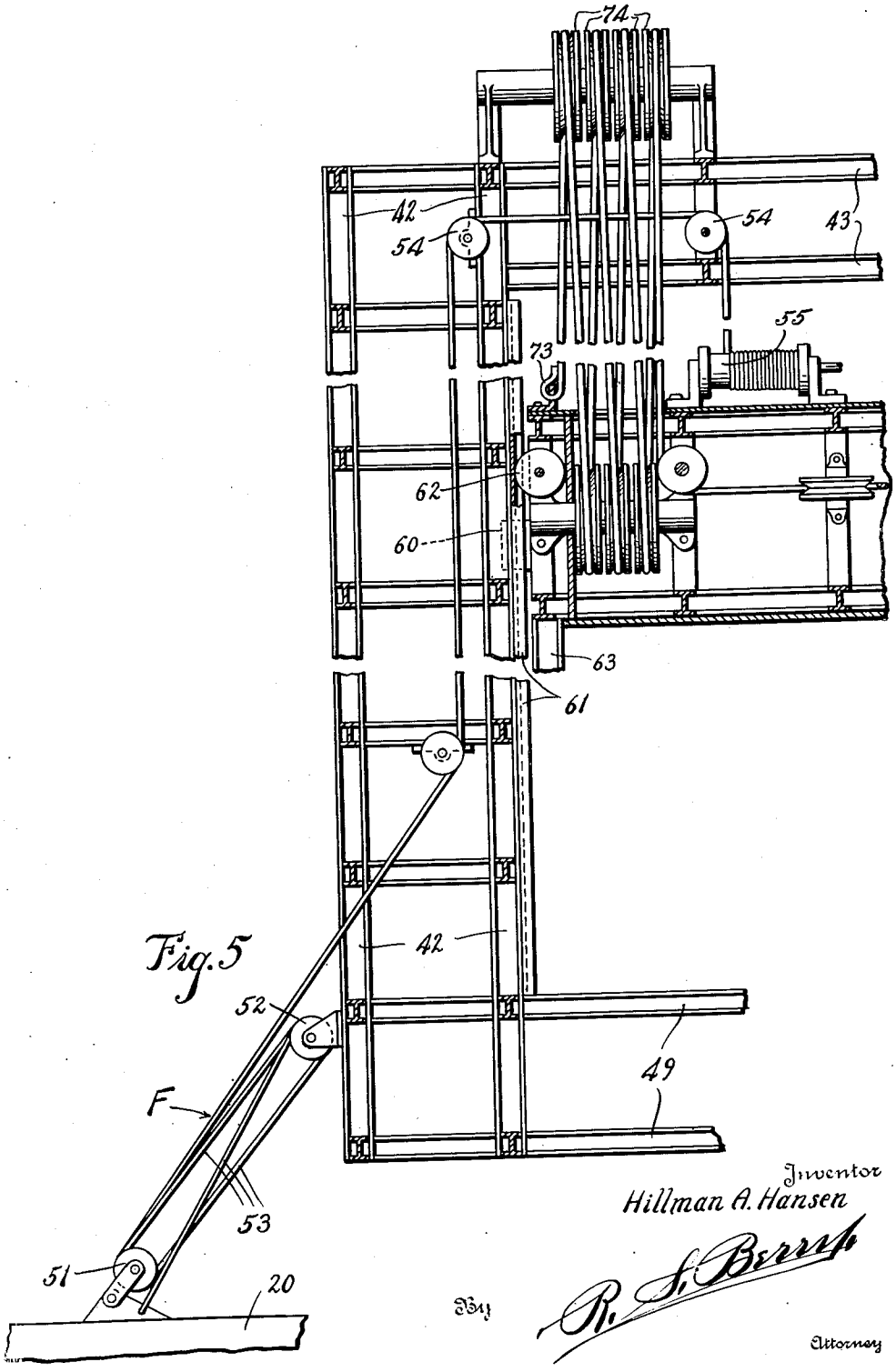


Fig. 5

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Nov. 4, 1947. H. A. HANSEN 2,430,014

SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 6

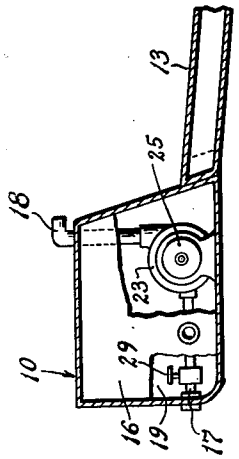


Fig. 7

Fig. 6

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Nov. 4, 1947. H. A. HANSEN 2,430,014

SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 7

Fig. 8

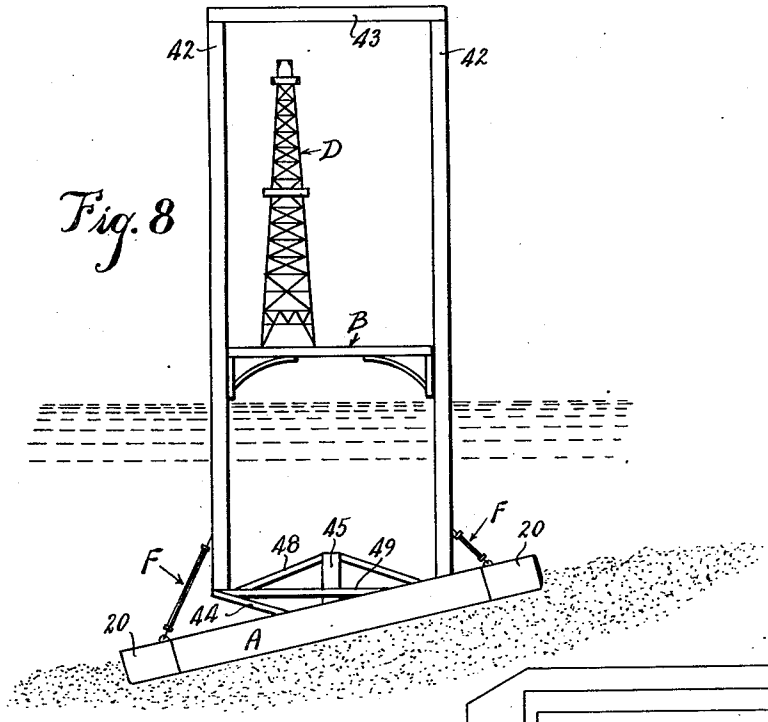
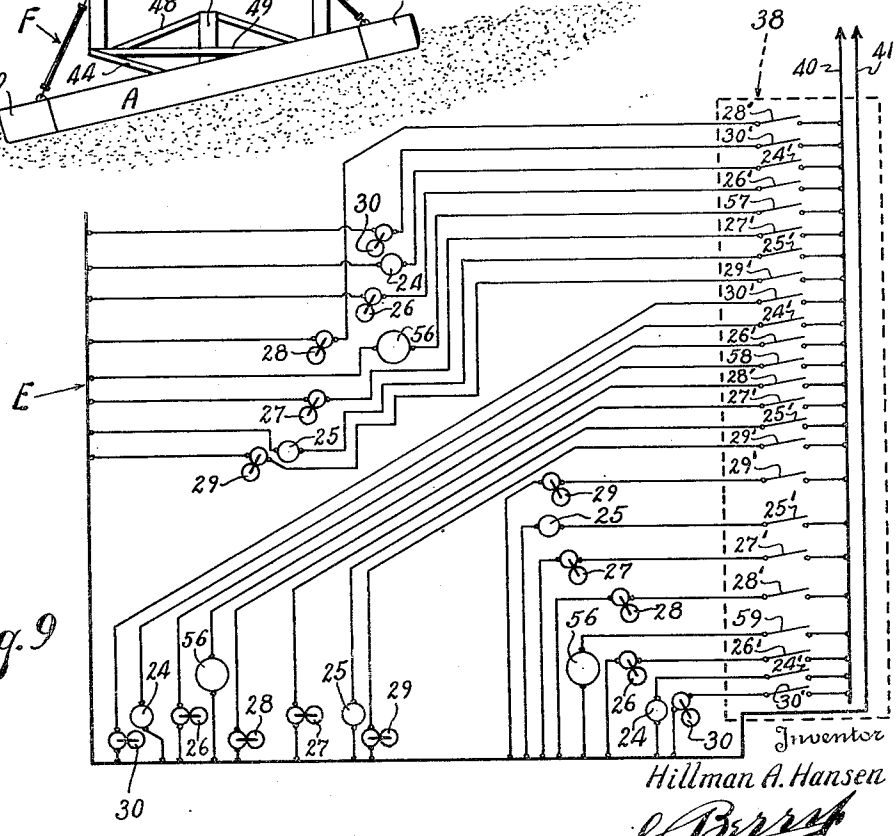


Fig. 9

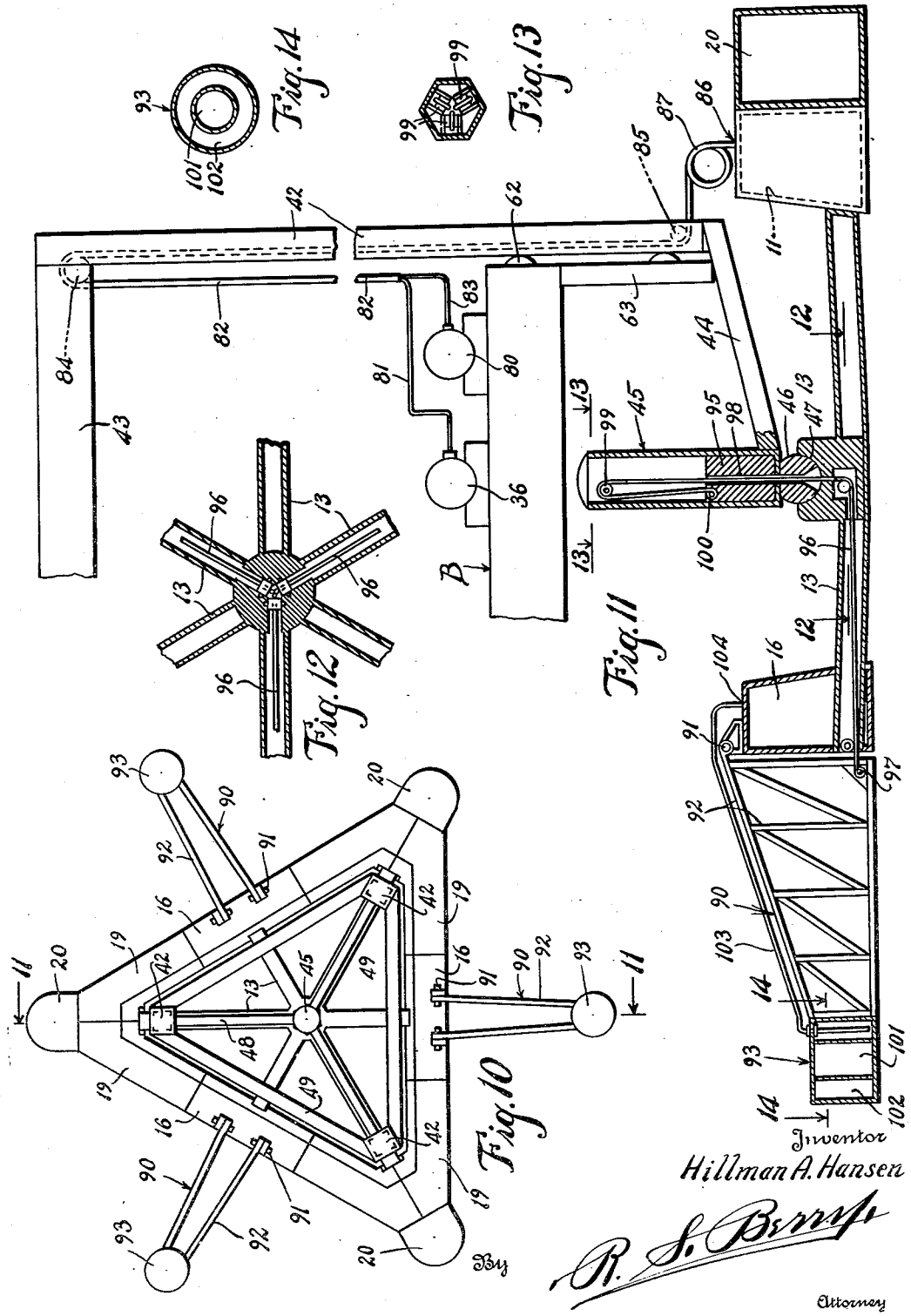


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Nov. 4, 1947. H. A. HANSEN 2,430,014

SUBMERSIBLE EXPLORATION BARGE

Filed Sept. 12, 1945 8 Sheets-Sheet 8



Patented Nov. 4, 1947 2,430,014

UNITED STATES PATENT OFFICE

2,430,014

SUBMERSIBLE EXPLORATION BARGE

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Application September 12, 1945, Serial No. 615,776

23 Claims. (Cl. 61—46)

1

This invention relates to the exploration of ocean beds, sea bottoms and other under-water lands for the purpose of locating sands, strata and structures productive of crude petroleum and other hydrocarbon substances and mineral values.

So far as I am aware no means has yet been developed by which test drilling and other petroleum and similar mineral exploration operations of ocean bottoms and other under-water formations may be conclusively and safely carried out from the surface of a body of water of any appreciable depth or where a considerable wave action is present, for example, in depths of from fifty feet to three hundred feet.

In my United States Letters Patent No. 2,331,072 for Method and means of developing oil fields, issued October 5, 1943, there are shown practicable ways of producing oil or other values from under-water formations and it follows that in order to carry out such methods or any other method of producing oil and other hydrocarbons or minerals from under-water regions it is desirable to provide a means by which from the surface of a body of water, under-water oil-bearing or mineral bearing formations may be located by use of exploration apparatus particularly where the body of water is quite deep or where the wave action is severe and due to one or both of such conditions the use of an exploration rig supported by a free vessel or float, or a stationary structure would be impracticable, unsafe and unreliable.

It is therefore the primary object of this invention to provide an exploration apparatus which will make it possible to conduct conclusive explorations of under-water formations with safety and without likelihood of damaging the equipment in water hundreds of feet deep or where a severe wave action in any depth would make the use of exploration equipment, as heretofore operated, impracticable and uncertain if not impossible.

Another object of this invention is to provide exploration apparatus which will accomplish the results here sought in a particularly efficacious manner by reason of such apparatus constituting what may be aptly called a barge constructed and arranged to include the following elements: a submersible pontoon-like hull affording surface travel of the apparatus on a body of water and adapted to be submerged to rest on the bottom as a stable foundation for the apparatus above it, a tower, for example, hundreds of feet in height mounted on the hull (the height of the tower determining the depth of the water in which the apparatus is workable) so that when the hull when submerged to the bottom will act as a safe foundation for the tower, and a buoyant platform or deck from which all operations of the barge apparatus and of the exploration equipment are controlled, the platform and tower being

2

connected so that they are relatively vertically movable and upon the raising and the lowering of the hull the platform will float on the surface of the water as a working stage and stabilizer subject however to support by the hull when the latter is surfaced.

A further object of my invention is to provide an exploration barge such as described hereinbefore in which the platform after the desired floating and stabilizing action thereof has been afforded during the submerging of the hull to the bottom, may be readily raised on the tower and held above the high wave level of the particular site whereby the exploration operations and operations of the barge components may be effected in safety.

Another important object of my invention is to provide an exploration barge such as described in which the tower is universally tiltably supported on the hull subject to be readily adjusted by a stabilizing means operable from the platform, so as to assume a vertical or the desired near vertical position in case the hull bottoms on uneven ground and slants from a horizontal position or for any other purpose best to position and operate the apparatus.

Another object of my invention is to provide in an exploration barge of the character described a novel and efficient suction-breaking means controllable from the working platform to break the suction grip which may tend to hold the hull on a muddy or deep sand bottom when it is desired to restore buoyancy to and raise the hull to the surface.

Another object of this invention is to provide an exploration barge of the character described in which the working platform carries a power operated means for controlling the lowering and raising of the hull and tower as buoyancy of the hull is nullified and restored respectively, this means also serving to raise the platform above the high wave level.

With the foregoing objects in view, together with such other objects and advantages as may subsequently appear, the invention resides in the parts and in the combination, construction and arrangement of parts hereinafter described and claimed, and illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevation of an exploration barge embodying the present invention, with parts broken away and parts shown in section to show how the tower is universally tiltable, the barge being shown fully afloat and subject to surface travel on a body of water;

Fig. 2 is a side elevation of the barge as it would appear when in use, the hull being shown on the bottom, for example, in a body of water 100 feet deep, with the tower extending above the surface of the water and the working platform

elevated from the afloat position (dotted lines) it assumed when submerging the hull, to a safe height above the high wave level;

Fig. 3 is an enlarged fragmentary elevational view showing the tower construction, the construction of the vertically movable working platform, and some of the equipment supported on the platform;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3 showing operating and control equipment on the platform and the manner in which the platform is associated with the three masts of the tower, also showing schematically the hoist means for controlling the movement of the hull and tower and for elevating the platform above the water;

Fig. 5 is an enlarged fragmentary sectional view taken on the line 5—5 of Fig. 4 showing details of the tower, platform and particularly the hoist means and the tower stabilizing means by which the tower may be tilted to vertical position in case the hull bottoms on uneven or slanting under-water ground;

Fig. 6 is an enlarged fragmentary horizontal sectional view taken on the line 6—6 of Fig. 1 showing the formation of the submersible pontoon-like hull and the manner of mounting the base of the tower thereon, also the flooding, buoyancy and trimming or suction-breaking compartments of the hull and the means for flooding and pumping out the flooding and suction-breaking compartments;

Fig. 7 is a cross sectional view of the hull taken on the line 7—7 of Fig. 6;

Fig. 8 is a schematic view showing how the tower is righted when the hull is bottomed on a slanting or uneven bottom;

Fig. 9 is a diagram of the electrical circuits for electrically operated components of the apparatus;

Fig. 10 is a schematic view of my apparatus equipped with outriggers;

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 10;

Fig. 12 is a sectional view taken on the line 12—12 of Fig. 11;

Fig. 13 is a sectional view taken on the line 13—13 of Fig. 11;

Fig. 14 is a sectional view taken on the line 14—14 of Fig. 11.

As shown in the accompanying drawing, one embodiment of my invention is preferably in the form of a barge which generally comprises a submersible hull A, a buoyant deck or platform B separated from the hull, and a tower structure C tiltably supported on the hull and operatively connecting the platform with the hull.

The barge with its working components supported thereon, as is apparent in Fig. 1, is adapted for surface travel in any suitable manner on any body of water to and from locations where exploration operations of land submerged by the body of water are to be carried out to locate hydrocarbon or other mineral bearing structures in such submerged land.

When it is desired to prepare the apparatus for exploratory operations it is operated and controlled from the hull-supported platform B so as to flood the hull and submerge it to the bottom. In submerging the hull A, the tower C and platform B are lowered until the platform becomes afloat as shown in dotted lines in Fig. 2. This launching of the buoyant platform takes place when the hull has been submerged but a comparatively short distance. Beyond this point the tower is lowered relative to the platform as the hull continues its descent to the bottom. The platform when afloat acts as a stabilizer for the tower and hull during and after the descent of the latter and, by means of suitable mechanisms and controls which will hereinafter be fully described, the rate of descent and ascent of the hull and tower is subject to exact control from the platform.

The depth of the body of water in which the apparatus of my invention is operable is determined by the height of the tower C which, for example, is preferably at least 300 feet high. Consequently the hull is submerged to the bottom only in depths such that the tower will project above the surface of the body of water so that the floating platform will be held in place in a stable manner by the tower subject to being raised thereon when desired above the surface of the water to clear the high wave level and subsequently lowered to floating position when it is desired to raise the hull and tower.

When the hull A is bottomed on slanting or uneven surface and the tower tends to tilt from the vertical, or at any time that a stabilizing tilting movement of the tower is required, it is possible to tilt the tower in any direction by means of a stabilizing mechanism controlled from the platform and which will be hereinafter fully described.

After the barge is operated to submerge the hull to the bottom as shown in Fig. 2, the exploration operation may be commenced as, for example, by setting into operation a test drill rig D on the platform B, or by use of any suitable exploratory methods and means subject to being worked from the platform. These operations are facilitated by reason of the skeleton construction of the hull which as here shown is in the form of a triangular pontoon of greater extent than the platform and therefore sufficiently open directly beneath the platform for drilling and other operations necessary to explore the bottom and submerged land.

When it is desired to surface the hull A suitable controls on the platform are operated to start pumps and operate valves arranged in the hull, as will be hereinafter described, so that the water will be pumped therefrom. This may be carried out so as to achieve a controlled buoyancy and with the aid of hoist means on the platform raise the hull and tower to the surface at the desired rate.

Means are provided as a part of the hull for creating relative buoyancy at critical points of the hull area when the hull is bottomed whereby an angular lifting action on the hull will be effected to break any suction grip of the hull in muddy or sandy bottoms. This means is controlled from the platform and will be hereinafter more fully described.

The submersible hull

As here shown (see Fig. 6) the hull A is triangular, being formed of three like steel ponton sections 10 welded or otherwise secured together at their abutting and angularly extended ends 11. A spider formation 12 of girders 13 is secured as at 14 by welding or otherwise at points midway of the ends of sections 10 and at the joined ends thereof with the center of hub 15 disposed at the center of the triangular hull and arranged as will be described hereinafter to act as a bearing for the tiltable tower C. This spider also effectively reinforces the hull and is arranged to rest on the bottom when the hull proper is bot-

tomed whereby a stable foundation is provided for the tower.

Each section may as here shown be of substantially rectangular cross section or of any other suitable shape in cross section and is suitably compartmented so that it may be rendered submersible by being flooded and when not flooded will be sufficiently buoyant to support the entire apparatus like a barge. Any number of these compartments may be provided but for illustration purposes I have here shown each section 10 as formed with a central flooding compartment 16. Water is taken into the hull through screened intake pipes 17 and discharged from the hull through screened outlet pipes 18 as best shown in Fig. 7. The remainder of each section 10 as here shown is formed to provide two like permanently buoyant or "dry" compartments 19 in which are located the above noted intake and discharge pipes.

Suction-breaking means embodied in the hull

As a means for breaking a suction grip of the hull on muddy and other bottoms, elevator tanks or chambers 20 are welded or otherwise secured to the corners of the triangular hull and are subject to being simultaneously or otherwise flooded when submerging the hull and selectively or simultaneously pumped out and rendered buoyant when the hull is bottomed and held in a suction grip on the bottom. This selective operation makes it possible to render one or more of the corners of the hull buoyant so that an angular lifting or rocking of the hull will break the suction grip. In this connection it should be noted that the hub 15 of the spider 12 is below the plane of the bottoms of the sections 10 whereby the hull as a whole has a somewhat convex center bearing resting on the bottom thus making it possible when rendering the end tanks 20 buoyant, to rock the hull about this bearing and break the suction grip. Moreover the tanks 20 may be operated at any time as "trimming" tanks to control the stability of the apparatus or "barge" as desired.

Pumps and valves in the hull

As best shown in Figs. 6 and 7, each hull section 10 is provided in a corresponding "dry" compartment 19 with pumps 22 and 23 driven by electric motors 24 and 25, also valves 26, 27, 28, 29 and 30 for controlling the flooding and pumping out of the associated flooding compartment 16 as well as the elevator tank or chamber 20 next adjacent the dry compartment containing the pumps and valves.

The dual pumps and motors are used separately, the extra pump and motor being provided as a safety factor in case of failure of one of the pump units. I may use any suitable arrangement of the pump units and valves which will afford the pumping out and flooding necessary to submerge and render buoyant the flooding compartments 16 and 20. As here shown, however, in each section 10 a pipe line 31 extends between and is connected to the intake sides of the pumps 22 and 23 and has a connection with the intake pipe 17 which extends out through the outer side wall of the associated "dry" compartment 19. The valves 26 and 27 are mounted in the pipe 31 adjacent the pumps 22 and 23 so that either pump may be opened or closed to the pipes 31 and 17 as desired.

The valve 28 controls the intake pipe and is opened to flood the flooding compartments 16 and 20 but closed when the pumps are operated to pump out said flooding compartments.

The valves 29 and 30 are mounted in a pipe line 32 which is connected with the intake pipe 17 at 33 and extended into the compartments 16 and 20 respectively, this being the case in each section 10 of the hull.

It will now be apparent that valves 28, 29 and 30 are opened and valves 26 and 27 are closed in order to flood the compartments 16 and 20, whereas to empty both said compartments at the same time in each section 10 of the hull only one of the pump valves 26 and 27 is opened for the pump which is to be operated and the intake valve 28 is closed. As the pump is operated its associated outlet pipe 18 (there being an outlet pipe 18 for each pump) will discharge the water from the flooded compartments 16 and 20.

When it is desired to empty the elevator compartment 20 of a section 10 of the hull, the valve 29 for the flooding compartment 16 of the section is closed, also intake valve 28, while valve 30 is opened and one of the pair of pumps is then operated.

Each of the valves in each section 10 of the hull is preferably electrically operated as by means of a motor or electromagnetic means of any suitable kind which is considered indicated diagrammatically in the representation of the valves in Fig. 6 and shown diagrammatically in the wiring diagram of Fig. 9. It is not deemed necessary to show the actual electrical operating means for the valves as the market affords various suitable types and anyone skilled in the art may readily provide suitable valves from the showing made herewith, wherewith to carry out this detail of the invention.

Electrical circuits for the valves and pumps in the hull

As here provided (Figs. 4 and 9) a source of electrical power for the pumps and valves in the hull and for any other uses, is provided on the platform B, as for example, an internal combustion engine-operated generator unit designated 36. A flexible cable 82 is arranged to be extended and guided through the tower C to supply electrical energy to the pumps and valves and a suitable switch control panel 38 indicated in Fig. 9 may be provided on the platform to selectively operate the hull-carried pumps and valves. Fig. 9 shows a typical, simple circuit E which in part is used to control the pumps and valves. These units are so connected in parallel to the main leads 40 and 41 of the circuit. Arranged in this circuit in the usual manner and located on the switch panel 38 are a series of switches 24' and a series of switches 25' for selectively closing the circuits for the several pump motors 24 and 25 respectively. Series of switches 26', 27', 28', 29' and 30' control the electrically operated valves 26, 27, 28, 29 and 30 respectively whereby such valves may be selectively operated. At this point it should be noted that Fig. 9 also shows branch circuits for other electrical components of the apparatus which will be described hereinafter in connection with the means for tilting and stabilizing the tower C. It is also to be noted that the generator unit E may be employed for the operation of any other electrical machinery, flood lights, etc. which are to be employed in the operation of the apparatus.

The tower

The tower C as here shown is preferably con-

structed of three like skeleton masts 42 projecting upwardly from points adjacent the three corners of the triangular hull A and connected at their tops by a triangular arrangement of steel beams 43 and at their bases by a special base structure which includes three like cantilever rocker arms 44 downwardly and inwardly inclined toward the hub or center 15 of the spider 12. The outer ends of the arms 44 are normally disposed above the plane of the upper side of the hull as are also the bases of the masts proper as shown in Fig. 11 but the inner ends of said arms are joined to a centered suspension column 45 which carries on its lower end a spherical bearing 46 seated in depression 47 in the hub or center of the spider 12 whereby the tower is universally tiltably mounted on the hull. The top of the suspension column 45 is connected to the bases proper of the masts 42 by means of stabilizing tie members 48 which extend downwardly from the column to such bases. The base structure is further braced and stabilized by means of a triangular frame 49 of steel girders extending between and connected to the bases of the masts and lying normally in a horizontal position between the cantilever arms 44 and the tie members 48.

Stabilizing stay means for the tower

As shown in Figs. 1, 2 and 5, the tower C is held in upright position and stabilized by means of three like cable and block assemblies generally designated F and connected between the hull A and the masts 42 of the tower, said assemblies being adjustable for stabilizing and righting the tower should they lean at any time and particularly when the hull bottoms on uneven or slanting ground.

In order to provide for selective adjustment of the three stay assemblies F each thereof comprises, as shown in Fig. 5, a block 51 on a tank or compartment 20 of the hull and a block 52 tied to the adjacent mast 42 of the tower, with a cable 53 reeved around said blocks and extending within the mast to the top thereof over another block 54, thence downwardly to a winch 55 (Fig. 4) on the associated corner of the platform B. This winch is operated by an electric motor 56, as here shown.

Upon now referring again to Fig. 9, it is seen that the three motors 56 for the three winches 55 are connected in parallel in the circuit E and that switches 57, 58 and 59 are arranged so that the motors and winches may be selectively operated from the switch panel on the platform B, whereby the cables 53 may be taken up and let out to adjust and stabilize the tower for the purposes hereinbefore noted.

Buoyant platform

The platform B as shown in Figs. 3 and 4, in keeping with the shape of the hull A and the arrangement of the tower masts 42, is constructed as a triangular hollow or compartmented float-like stage which is permanently buoyant and has its corners connected with the three masts in such manner that the masts and the platform are relatively vertically movable while the platform is held between the masts against lateral movement.

The corners of the platform are provided with suitable slide shoes 60 which embrace guide rails 61 on the masts so as to slidably secure the platform and masts to one another. Suitable anti-friction rollers 62 are carried by the corners of the platform and on depending bracing structures 63 at said corners so as to ride on the rails

61. The lower ends of the bracing structures 63 are disposed to rest on the base structure of the tower C as shown in Fig. 1 when the hull is afloat for surface travel on a body of water. In this position the platform is well above the surface of the body of water, as best shown in Fig. 1. However, as shown in dotted lines in Fig. 2, the platform is lowered into the water and becomes afloat upon submerging the hull and tower and thereafter acts as a stabilizing means during the balance of the submerging operation to bottom the hull.

As shown in Figs. 3 and 4, a suitable internal combustion or other type engine indicated at 64 is carried on the platform for operating the rotary table 66 of the drill rig, mud pumps 67, the hoist means for raising the hull and tower, and any other mechanism (not shown) which may be employed.

Hull and platform hoist means

By means of a system of sheaves, cables and power operated winches, as best shown in Figs. 1, 4 and 5, the lowering operation of the hull and tower may be controlled and the raising thereof controlled, also the platform elevated and lowered on the tower as desired.

As shown in Figs. 4 and 5, the corner portions of the platform have cables 70, 71 and 72 fastened thereto. Fig. 4 shows how the cable 70 is anchored as at 73 to the deck of the platform, then extended around sheaves 74 and 75 located at the top of the adjacent mast and within the interior of the platform respectively, and finally around a winch drum 70' as shown in Fig. 4. The cables 71 and 72 are arranged in the same manner relative to other masts and extend to and around winch drums 71' and 72', as also best shown in Fig. 4. For the purpose of conserving working space the drums are mounted interiorly of the platform on a common shaft 75' operated from one of the engines by a drive means 76 as shown in Figs. 3 and 4, whereby the several cables may be let out and taken up simultaneously to assure the proper lifting and lowering action. The means for controlling the winch drums is not here shown as it is obvious that they may be controlled in any manner known in the art whereby the hoist means will effect the desired lowering of the hull and tower, also control the lifting of the hull and tower, as well as the desired raising and lowering of the platform relative to the surface of the water or relative to the hull when the latter is afloat. When the tower and hull are being lowered the buoyancy of the hull is controlled from the platform B which is afloat at this time and has a buoyancy factor sufficient to support the weight of the hull and tower and thus control the lowering thereof. During this descent of the hull and tower the slack of the hoist cables 70, 71 and 72 is taken up whereas the cables 53 are let out. If the cables 70, 71 and 73 are taken up at a rate such as would tend to lift the platform, then some of the weight of the platform will be added to the hull which would increase the rate of descent, wherefore it is apparent the rate of descent may be controlled by the operation of the cables 53, 70, 71 and 72 inasmuch as the weight of the platform may be added and removed from the hull momentarily as desired upon appropriate manipulation of the winches for said cables.

In the raising of the hull and tower from the bottom, the controls on the platform which is then afloat are operated to restore sufficient buoyancy to the hull to tend to lift the hull from the

bottom while the cables 53 are taken up and cables 70, 71 and 72 are let out, the buoyancy factor of the hull being then so determined that upon a studied operation of said cables in consideration of the lifting force of the hull, the rate of ascent of the hull and tower may be controlled. In other words, if the rate of paying out of the cables 70, 71 and 73 is below that of the rate of ascent of the hull and tower some of the weight of the floating platform will be applied to the tower and hull to impede the lifting rate of the hull and upon momentary applying and removing the added weight without lifting the platform entirely out of the water, the rate of ascent of the hull and tower is regulated as desired.

The hoist means here shown and described is but illustrative of any suitable comparable means and it is to be understood that any hoist means by which the lowering of the hull and tower may be controlled and the raising of the hull and tower, also the raising and lowering of the platform relative to the tower and base may be effected, is within the scope of the present invention.

Electrical conductor and air hose leads to the pontoon hull

For the sake of clarity of illustration, means for directing the electrical conductors and an air hose from the platform B to the pontoon hull A has been omitted from all of the views in the drawings except Fig. 11 which latter is especially laid out to show such means schematically. In this view there are shown on the platform B, the generator 36 and a suitable air compressor 80. An electrical conductor cable 81 leads from the generator 36 through a larger flexible cable 82 which also contains an air hose 83 leading from the compressor 80. The large flexible cable 82 extends upwardly to the top of the tower C over a pulley 84 thence downwardly through one of the masts 42, around a pulley 85 and to the point 86 on the pontoon hull A. A coil or other suitable slack arrangement of the cable 82 indicated at 87, is provided between pulley 85, and the point 86 where the cable is connected with the hull A, whereby the tower and hull may be relatively tilted without breaking the cable. The connection point 86 of the cable 82 with the pontoon hull A is made so that the conductors and air hose will enter a dry compartment 19 of the pontoon section 10. From this point suitable electrical conductors and air hose lines (not shown) may be extended to the several electrically operated pumps and valves and dry compartments 19 throughout the hull, it being thought unnecessary to show these electrical lines and air lines as they may obviously be arranged as desired by any one skilled in the art to which the present invention relates. The air base lines make it possible to supply air to the dry compartments of the hull to assure proper operation of the electrical components therein also make possible increasing the internal pressure in the hull as may be necessary when submerging the hull to considerable depths.

It should be understood that any suitable means may be employed as within the scope of my invention to provide adequate electrical connection between the generator on the platform and the hull carried electrically operated components, as well as any suitable means for introducing air from the platform into the hull, and that the means herewith shown and described is but semi-schematically illustrative of suitable instrumentalities for making the electrical and air line connections for the purposes herein stated.

Outrigger stabilizing means

For the sake of clarity of illustration, I have omitted from all the views of the drawings, except Figs. 10 to 14 inclusive, an outrigger stabilizing means which forms a part of this invention. This stabilizing means is desirable when operating the barge in rough water and winds of high velocity, also during the time that the hull A is being submerged to the level at which the platform B becomes afloat, inasmuch as by the action of the outrigger means the tower C will be prevented from capsizing and maintained in the desired upright position. Referring to Fig. 10 it is seen that one form of stabilizing outrigger means embodying my invention includes three like articulated outriggers 90 hinged as at 91 to the mid-portions of the sections 10 of the hull A and extending outwardly at right angles thereto. Each outrigger as shown in Figs. 10 and 11 comprises a suitably fabricated spar 92 carrying a circular or cylindrical tank or float 93 on its outer end and arranged so that it normally extends substantially horizontally but is subject to swinging upwardly on its hinge. This upward swinging will take place when the hull is being submerged to the extent that the platform B becomes afloat and acts as a stabilizer for the entire structure. Consequently the overall length of each outrigger is such that the tanks or floats 93 will remain on the surface while the spars 92 swing upwardly on their hinges until the platform B is floated at which time the stabilizing action of the floating platform will maintain the tower in upright position. After the platform B is floated the outriggers will descend with the hull A until the latter is bottomed.

Means is provided for counter-balancing the articulated outriggers 90 so that the upward swinging thereof on their hinges is resisted sufficiently to assure that the outriggers will have the desired stabilizing action. As here shown an extremely heavy weight 95 is employed to counterbalance the outriggers and may be mounted in the suspension column 45 as shown in Fig. 11. A cable 96 is attached at one end as 97 to each outrigger and extended to the center of the hull A thence upwardly through a central passage 98 in the weight around a pulley 99 adjacent the top of the column then downwardly where it is secured as at 100 to said weight. Figs. 12 and 13 show how the three cables 96 are connected to the weight, each being extended and arranged in the same manner as the single cable shown in Fig. 11.

Suitable openings, sealing means and stuffing boxes (not shown) may be provided as desired for leading the cables 96 from the points where connected with the outriggers 90 to the weight. Preferably the cables extend through the box girdles 13 forming the spider 12, as shown in Figs. 11 and 12.

It will now be seen that the outriggers 90 are independently movable on their hinges and will act effectively as counter-balancers so that they will afford considerable stability and operate to positively resist dangerous tilting of the tower C as may be caused by high seas and high winds.

Should the tower tend to tilt toward one of the outriggers, that outrigger will tend to swing upwardly on its hinge against the action of the weight. This will make taut the cable 96 of the particular outrigger toward which the tower tends to lean, while the cables of the other two outriggers will slacken so that in case the hull A

is partly submerged when this tilting action takes place the two "slackened" outriggers will be free to remain on the surface of the water rather than be lifted out of the water. Moreover the hinging of the outriggers will make it possible for the outrigger to come to rest on uneven underwater surfaces without tending to tilt the hull proper or in any way interfere with the desired bottoming of the hull.

Each circular or cylindrical outrigger float 93 as here shown includes a central dry or permanently buoyant compartment 101 and an annular flooding compartment 102 constructed and arranged so that the buoyancy of the dry compartment 101 is sufficient to overcome the weight of the associated outrigger as a whole when the flooding compartment 102 is flooded and has negative buoyancy.

Means is provided for selectively regulating the buoyancy of the tanks or floats 93 so that a controlled stabilizing action may be had to meet all conditions tending to tilt the tower structure also to assist in the ascension of the hull A to the surface of the water. I have shown this means schematically in Fig. 11 as applied to the outriggers on the left side of said figure and as including a flexible pipe line 103 leading from the bottom of the flooding compartment 102 out through the top of the float 93 and thence to point 104 of the hull A. This line is connected to the pump mast in the adjacent dry compartment 19 of the hull in any suitable manner and which it is not deemed necessary to illustrate.

As such connection will be obvious to any one skilled in the art, its illustration would confuse the showing of the essential structural part of the outrigger means.

It is apparent that by means of the pipe lines 103, there being one to each outrigger float 93, the flooding compartments 102 may be flooded or pumped out as desired to control the buoyancy thereof.

After the platform B is lowered into the water the flooding compartments 102 will be flooded whereby the outriggers may be readily submerged with the hull A to rest on the bottom. In preparing the apparatus for ascent to the surface of the water, the compartments 102 will be pumped out. However these compartments may be controlled as to buoyancy as desired, best to stabilize the apparatus when afloat and under other conditions where stabilizing is required.

It will now be apparent that I have provided a mobile exploration apparatus in the form of a barge which may be towed or otherwise caused to travel on the surface of seas, oceans and other bodies of water to and from points where exploration of lands submerged by the water are to be made, and that when in a desired location the apparatus is readily operable to submerge the hull of the barge to rest on the bottom as a support for a means such as the tower or its equivalent for maintaining the platform on or above the surface of the water as a working stage from which desired exploratory or other operations may be carried out.

The control afforded from the platform to regulate the rate of descent of the hull and tower as well as the rate of and to assist in the ascent, the means operable from the platform for stabilizing the tower the suction breaking means, the provision for lifting the platform above the water level, and the construction and relative arrangements of the hull, tower, platform and the other components hereof are factors which make possible the successful operation of the apparatus of my invention in carrying out desired exploration operations with a maximum of safety and accuracy and conclusiveness as to location and extent of hydrocarbon and other mineral values present in under-water ground.

While I have shown and described a specific embodiment of my invention I do not limit myself to the exact details of construction set forth, and the invention embraces such changes, modifications and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

I claim:

1. In a submersible exploration barge adapted for surface travel over a body of water to a point where exploration of the bottom or submerged land is desired, a submersible hull, a tower supported on said hull and having a height greater than the depth of the water where exploration is to be made, means for flooding said hull to nullify its buoyancy and submerge it until the hull rests on the bottom as a foundation for the tower, a buoyant working platform mounted on the tower so that it may float apart from said hull whereby exploration operations may be carried out therefrom when the hull is bottomed, and means for pumping the water out of the hull to restore its buoyancy for ascension to the surface of the body of water.

2. In a submersible exploration barge, a submersible hull adapted for surface travel on a body of water to locations where it is desired to explore the bottom and submerged lands, a tower supported by the hull, a buoyant platform from which exploration operations may be carried out, means for vertically adjustably mounting the platform on said tower, means in the hull and operable from the platform for pumping the water out of the hull and restoring its buoyancy so that it is subject to ascent to the surface of the body of water for surface travel thereon, and means operable from the platform for controlling relative movement of the hull and platform.

3. In a submersible exploration barge adapted for surface travel on a body of water to locations where it is desired to explore the bottom or submerged lands, a submersible hull, a tower supported on said hull, a buoyant working platform mounted on the tower above and apart from the hull, means connecting the tower and platform for relative vertical movement, means operable from the platform for flooding the hull to nullify its buoyancy and sink it to the bottom, means operable from the platform for pumping the water out of the hull and restoring buoyancy thereof, and power operated hoist means operable from the platform for raising and lowering the platform on the tower relative to said hull.

4. In a submersible exploration barge which is adapted for surface travel over a body of water to locations where it is desired to explore underwater lands or bottoms, a pontoon hull constructed so that it may be flooded to nullify its buoyancy and submerge it to rest on the bottom and pumped out to restore its buoyancy for ascent to the surface, a tower supported on said hull and adapted to extend above the surface of the water when the hull is bottomed, a buoyant working platform separated from and maintained by the tower above the hull, means connecting the tower and platform for relative vertical movement whereby on submerging the hull and lowering the tower the platform will float on the surface as a stabilizer and working stage, means operable

from the platform for flooding the hull to nullify its buoyancy, means operable from the platform for pumping water out of the hull and restoring buoyancy thereto, and means operable from the platform for controlling the ascent of the hull and tower relative to the platform when the latter is afloat, being also operable to raise and lower the platform relative the surface of the body of water when the hull is on the bottom.

5. In a submersible exploration barge which is adapted for surface travel over a body of water to locations where it is desired to explore underwater lands or bottoms, a pontoon hull constructed so that it may be flooded to nullify its buoyancy and submerge it to rest on the bottom and pumped out to restore its buoyancy so that it will rise to the surface, a tower tiltably supported on said hull and adapted to extend above the surface of the water when the hull is bottomed, a buoyant working platform from which exploration operations may be carried out, means connecting the tower and platform for relative vertical movement whereby on submerging the hull the platform will float on the surface as a stabilizer, means operable from the platform for flooding the hull to nullify its buoyancy, means operable from the platform for pumping water out of the hull and restoring its buoyancy, means operable from the platform for controlling relative movement of the hull and platform while the platform is afloat, and means operable from the platform for tilting the tower into and holding it in vertical position relative to the hull when the latter becomes bottomed in an inclined position.

6. In a submersible exploration barge, adapted for surface travel over a body of water to a point where exploration of the bottom or submerged land is desired, a submersible hull, a tower supported on said hull and having a height greater than the depth of the water where exploration is to be made, means for flooding said hull to nullify its buoyancy and submerge it until the hull rests on the bottom as a foundation for the tower, a buoyant working platform mounted on the tower so that it may float apart from said hull whereby exploration operations may be carried out therefrom while afloat when the hull is bottomed, and means for pumping the water out of the hull to restore its buoyancy for ascension to the surface of the body of water, and means embodied in the hull and operable from the platform for exerting an angular lifting force on the hull to break a suction grip of the hull on the bottom preliminary to surfacing the hull.

7. A submersible exploration rig for operation in a body of water to explore the ground submerged by the water, comprising: a hull constructed for surface travel on a body of water and being subject to being flooded and submerged to the bottom; a buoyant working platform arranged to float apart from the hull while the latter is bottomed and from which the explorations may be carried out; a tower carried by the hull and comprising a plurality of masts for connecting the hull and platform for relative vertical movement and maintaining the platform therebetween over the hull; means for flooding and submerging the hull to the bottom controlled from said platform; means controlled from the platform for pumping out the hull to restore its buoyancy; and means operable from the platform while the hull is bottomed for raising and lowering the platform relative to the surface of the water.

8. In exploration apparatus for operation in a body of water for the purpose of exploring land

submerged by the body of water, a hull constructed and arranged so that it may be caused to travel over the surface of a body of water to a point where exploration is to be made of the land submerged by the water, and there submerged to rest on the bottom, a tower structure supported by said hull and arranged so that it will project above the surface of the body of water when the hull is bottomed, a buoyant working platform vertically adjustably supported by said tower structure above said hull so that it becomes afloat when the hull is submerged and the tower structure is lowered with the descending hull and means operable from the platform for controlling the buoyancy of the hull to effect the submergence and ascendence of the hull, and other means operable from the platform for vertically adjusting the platform on the tower whereby the platform may be raised above the surface of the water when the hull comes to rest on the bottom.

9. In exploration apparatus for operation in a body of water for the purpose of exploring land submerged by the body of water, a hull constructed and arranged so that it may be caused to travel over the surface of a body of water to a point where exploration is to be made of the land submerged by the water, and there submerged to rest on the bottom, a tower structure supported by said hull and arranged so that it will project above the surface of the body of water when the hull is bottomed, a buoyant working platform vertically adjustably supported by said tower structure above said hull so that it becomes afloat when the hull is submerged and the tower structure is lowered with the descending hull and means operable from the platform for controlling the buoyancy of the hull to effect the submergence and ascendence of the hull, and other means operable from the platform for vertically adjusting the platform on the tower whereby the platform may be raised above the surface of the water when the hull comes to rest on the bottom, and outriggers hinged to said hull for upward movement relative thereto, including buoyant members on the outer ends thereof, and counterweight means carried by the hull and connected to said outriggers to resist upward hinging movement thereof relative to the hull.

10. In exploration apparatus for operation in a body of water for the purpose of exploring land submerged by the body of water, a hull constructed and arranged so that it may be caused to travel over the surface of a body of water to a point where exploration is to be made of the land submerged by the water, and there submerged to rest on the bottom, a tower structure supported by said hull and arranged so that it will project above the surface of the body of water when the hull is bottomed, a buoyant working platform vertically adjustably supported by said tower structure above said hull so that it becomes afloat when the hull is submerged and the tower structure is lowered with the descending hull and means operable from the platform for controlling the buoyancy of the hull to effect the submergence and ascendence of the hull, and other means operable from the platform for vertically adjusting the platform on the tower whereby the platform may be raised above the surface of the water when the hull comes to rest on the bottom, means providing a connection between the hull and the tower structure whereby said hull and tower structure are relatively tiltable, and stabilizing means operable from the platform for controlling the relative tilting movement of the hull and tower structure.

11. In a submersible exploration barge, a submersible hull adapted for surface travel over a body of water to a point where exploration of submerged land is to take place, a tower tiltably supported on the hull, a buoyant working platform vertically adjustably supported on the tower over the hull and arranged to float when the hull is submerged, means operable from the platform for stabilizing the tower and maintaining it in upright position should the hull bottom on slanting ground, means operable from the platform for flooding the hull and submerging it to the bottom, means operable on the platform for restoring buoyancy to the hull whereby it will ascend to the surface and a hoist means operable from the platform for effecting and controlling relative vertical movement of the tower and platform.

12. In a submersible exploration barge, a submersible hull constructed and arranged for surface travel on a body of water to a point where exploration of submerged ground is to take place, a tower supported on said hull so that the hull and tower may be relatively tilted, a buoyant working platform vertically adjustably supported on the tower over the hull and arranged to float on the surface of the water when the hull and a part of the tower are submerged, means operable from the platform for flooding the hull and submerging it to the bottom, means operable from the platform for restoring buoyancy to the hull whereby it will ascend to the surface and raise the tower relative to the platform while the latter is afloat and when reaching the surface will lift the platform above the surface of the water, means for stabilizing the tower, and holding it in upright position when the hull tilts upon resting upon a slanting or uneven bottom, and a hoist means on the platform including cables and pulleys connected with the tower and platform and operable for effecting and controlling relatively vertical movement of the platform and tower.

13. In a submersible exploration barge, a submersible hull constructed and arranged for surface travel on a body of water to a point where exploration of submerged ground is to take place, a tower supported on said hull so that the hull and tower may be relatively tilted, a buoyant working platform vertically adjustably supported on the tower over the hull and arranged to float on the surface of the water when the hull and a part of the tower are submerged, means operable from the platform for flooding the hull and submerging it to the bottom, means operable from the platform for restoring buoyancy to the hull whereby it will ascend to the surface and raise the tower relative to the platform while the latter is afloat and when reaching the surface will lift the platform above the surface of the water, means for stabilizing the tower, and holding it in upright position when the hull tilts upon resting upon a slanting or uneven bottom, and a hoist means on the platform including cables and pulleys connected with the tower and platform and operable for effecting and controlling relatively vertical movement of the platform and tower, and outriggers hinged to the hull for upward swinging movement relative thereto including floats on the outer ends of said outriggers, and counter-balancing means for resisting upward hinging movement of said outriggers.

14. In a submersible exploration barge, a submersible hull constructed and arranged for surface travel on a body of water to a point where exploration of submerged ground is to take place, a tower supported on said hull so that the hull and tower may be relatively tilted, a buoyant working platform vertically adjustably supported on the tower over the hull and arranged to float on the surface of the water when the hull and a part of the tower are submerged, means operable from the platform for flooding the hull and submerging it to the bottom, means operable from the platform for restoring buoyancy to the hull whereby it will ascend to the surface and raise the tower relative to the platform while the latter is afloat and when reaching the surface will lift the platform above the surface of the water, means for stabilizing the tower, and holding it in upright position when the hull tilts upon resting upon a slanting or uneven bottom, and a hoist means on the platform including cables and pulleys connected with the tower and platform and operable for effecting and controlling relatively vertical movement of the tower and platform, and outriggers hinged to the hull for upward swinging movement relative thereto including floats on the outer ends of said outriggers, and counter-balancing means for resisting upward hinging movement of said outriggers, said floats each including a permanently buoyant compartment and a flooding compartment, and means selectively operable for flooding and pumping water out of said flooding compartments to regulate the buoyancy of said floats.

15. In a submersible exploration barge, a triangular submersible hull having permanently buoyant compartments and flooding compartments, said hull being normally buoyant so that it will float on the surface of a body of water, a tower structure supported on the hull, a working platform, means connecting the tower and platform so that they are relatively vertically movable and the platform is carried over the hull when the latter is afloat on the surface of the water, means in said buoyant compartments and operable from the platform for intaking water into and flooding said flooding compartment to submerge the hull and tower, means in said buoyant compartments and operable from the platform for pumping out said flooding compartments to restore buoyancy to said hull and cause it to ascend to the surface; said hull, tower and platform being arranged so that when the hull and a part of the tower are submerged the platform will float on the surface of the water and so remain until the hull rests on the bottom, and means operable from the platform for raising the platform relative to the tower whereby it may be disposed above the surface of the water.

16. In a submersible exploration barge, a triangular submersible hull having permanently buoyant compartments and flooding compartments, said hull being normally buoyant so that it will float on the surface of a body of water, a tower structure supported on the hull, a working platform, means connecting the tower and platform so that they are relatively vertically movable and the platform is carried over the hull when the latter is afloat on the surface of the water, means in said buoyant compartments and operable from the platform for intaking water into and flooding said flooding compartment to submerge the hull and tower, means in said buoyant compartments and operable from the platform for pumping out said flooding compartments to restore buoyancy to said hull and cause it to ascend to the surface; said hull, tower and platform being arranged so that when the hull

and a part of the tower are submerged the platform will float on the surface of the water and so remain until the hull rests on the bottom, and means operable from the platform for raising the platform relative to the tower whereby it may be disposed above the surface of the water normally buoyant elevator tanks at the corners of the hull, means for regulating the buoyancy of said tanks by flooding them and pumping water therefrom whereby lifting forces may be applied at corners of the hull to break the suction grip of the hull on the bottom.

17. In apparatus for conducting tests of submerged ground from a point above the surface of the body of water which submerges such ground, to ascertain mineral values of the ground; a normally buoyant hull constructed and arranged so that it may be flooded and submerged to the bottom and pumped out to cause it to ascend to the surface, a buoyant working platform from which such tests may be conducted, rigid means connecting the platform with the hull so that when the hull is afloat it will support the platform but will lower the platform to floating position and maintain it directly over the hull during submergence of the hull to the bottom and while the hull is bottomed, means operable from the platform for flooding and submerging the hull, and means operable from the platform for pumping out the hull whereby it will ascend to the surface.

18. In apparatus for conducting tests of submerged ground from a point above the surface of the body of water which submerges such ground, to ascertain mineral values of the ground; a normally buoyant hull constructed and arranged so that it may be flooded and submerged to the bottom and pumped out to cause it to ascend to the surface, a buoyant working platform from which such tests may be conducted, a plurality of masts fixed to the hull and enclosing the platform so that when the hull is afloat it will support the platform but will lower the platform to free floating position within the confines of said masts during submergence of the hull to the bottom, means operable from the platform for flooding and submerging the hull, and means operable from the platform for pumping out the hull whereby it will ascend to the surface and means operable from the platform for raising the platform above the surface of the water when the hull rests on the bottom.

19. In a submersible exploration barge, a normally buoyant submersible hull adapted to float on the surface of a body of water, a tower structure including a plurality of masts, a base common to said masts, bearing points on the base and said hull by means of which the tower and hull are relatively tiltably connected, a buoyant working platform vertically adjustably supported relative to and between the masts of the tower, a stabilizing means by which the tower may be maintained in upright position should the hull bottom on slanting ground, said stabilizing means including a plurality of cables and pulleys connected to and between the hull, masts, and platform and means on the platform for taking up or letting out on said cables; means operable from the platform for flooding the hull to submerge it and a part of the tower relative to said platform, and means on the platform, for pumping the water out of the hull to raise it and the tower.

20. In combination, a submersible hull constructed and arranged to travel on the surface of a body of water to a point where ground submerged by the water is to be explored, means whereby said hull may be flooded and submerged so as to rest on such ground and may be pumped out and raised to the surface of the water, a buoyant working platform from which exploration operations may be carried out, and masts carried by said hull with said platform maintained therebetween so that the platform will be supported upon the hull when the latter is afloat and will float on the surface of the water between said masts during the submergence of the hull, when the hull is at rest on the bottom and while the hull is being raised.

21. In apparatus for conducting tests of submerged ground from the surface of a body of water which submerges such ground, to ascertain values of such ground, a submersible hull of generally triangular outline having open spaces within its confines and adapted for surface travel on a body of water, means whereby said hull may be flooded and submerged to the bottom on such ground and may be pumped out and raised to the surface of the water, masts carried by said triangular hull at the corners thereof, and a buoyant working platform arranged for free vertical movement between said masts and from which exploration rigs may be manipulated in said ground through the open spaces of said hull when the latter is bottomed.

22. In apparatus for conducting tests of submerged ground from the surface of a body of water which submerges such ground, to ascertain values of such ground, a submersible hull of generally triangular outline, masts connected to said hull and extending upwardly from points adjacent corners of said hull, a base common to said masts, coacting bearing members centered on said base and hull affording a tilting of said hull relative to said masts in case the hull is bottomed on uneven ground and a working platform vertically movably supported between said masts.

23. In apparatus for conducting tests of submerged ground from the surface of a body of water which submerges such ground, to ascertain values of such ground, a submersible hull, means whereby said hull may be flooded to submerge it to the bottom and pumped out and floated to the surface of said body of water, a plurality of rigid masts connected to said hull, a working platform from which test operations may be conducted, confined between said masts for vertical movement relative thereto and relative to the surface of the body of water, means operable on said platform for controlling the relative vertical of said masts and platform, a base common to said masts, coacting bearings on said base and hull respectively constructed and arranged to afford relative tilting of said masts and hull, and means operable from said platform for controlling the relative tilting movement of said hull and masts.

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