March 17, 1970 R. J. STRANGE 3,500,785

SYSTEM FOR SALVAGING SUBMERGED OBJECTS

Filed Feb. 5, 1968 4 Sheets-Sheet 1

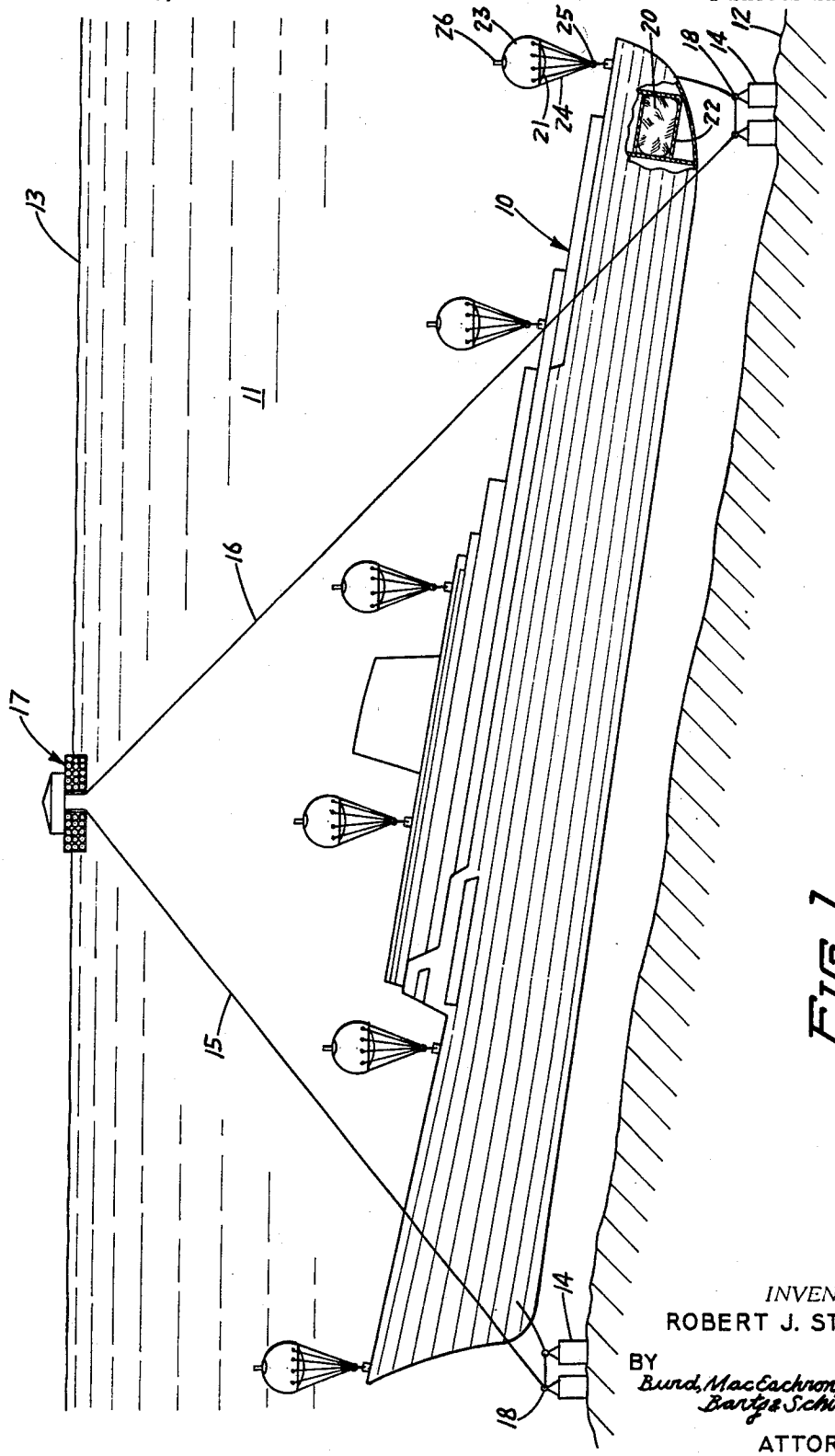

FIG. 1

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SYSTEM FOR SALVAGING SUBMERGED OBJECTS

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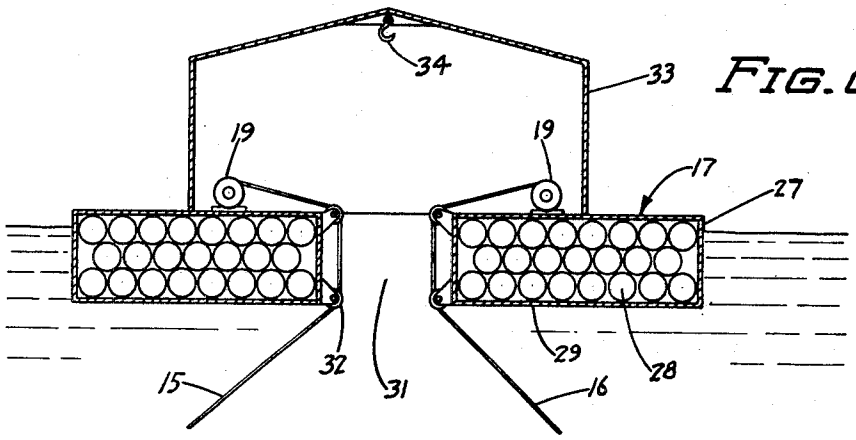

FIG. 2

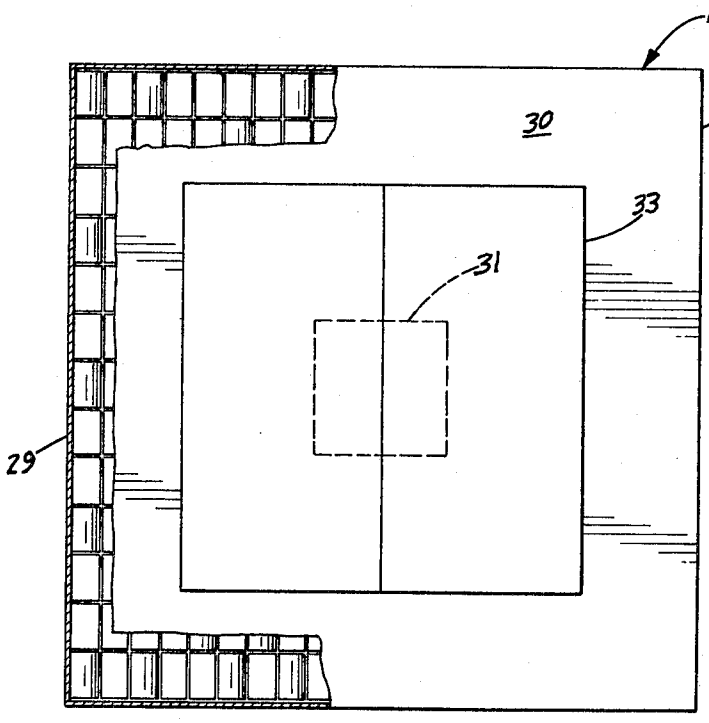

FIG. 3

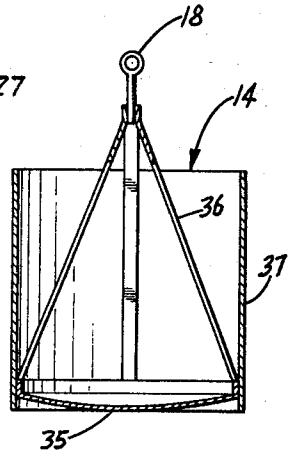

FIG. 4

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SYSTEM FOR SALVAGING SUBMERGED OBJECTS

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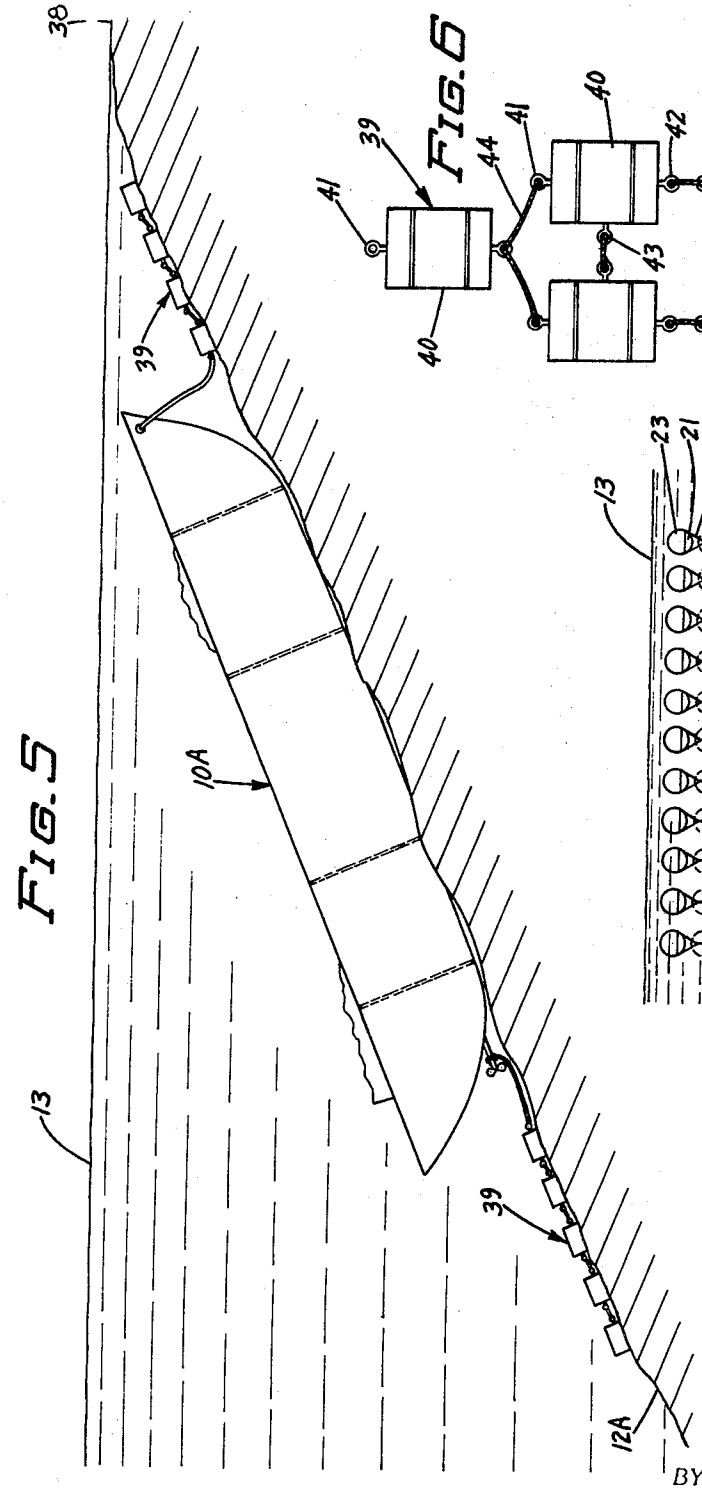

FIG. 5

FIG. 6

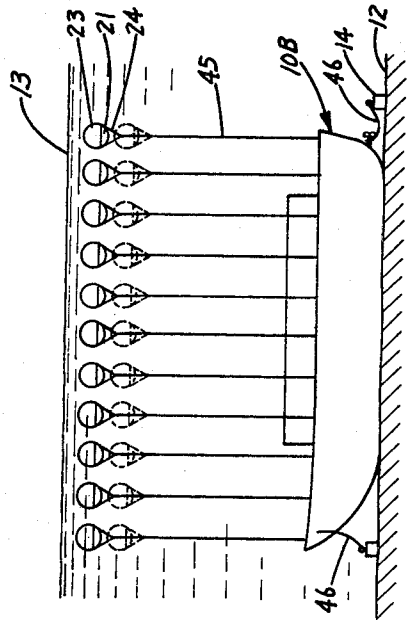

FIG. 7

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SYSTEM FOR SALVAGING SUBMERGED OBJECTS

Filed Feb. 5, 1968 4 Sheets-Sheet 4

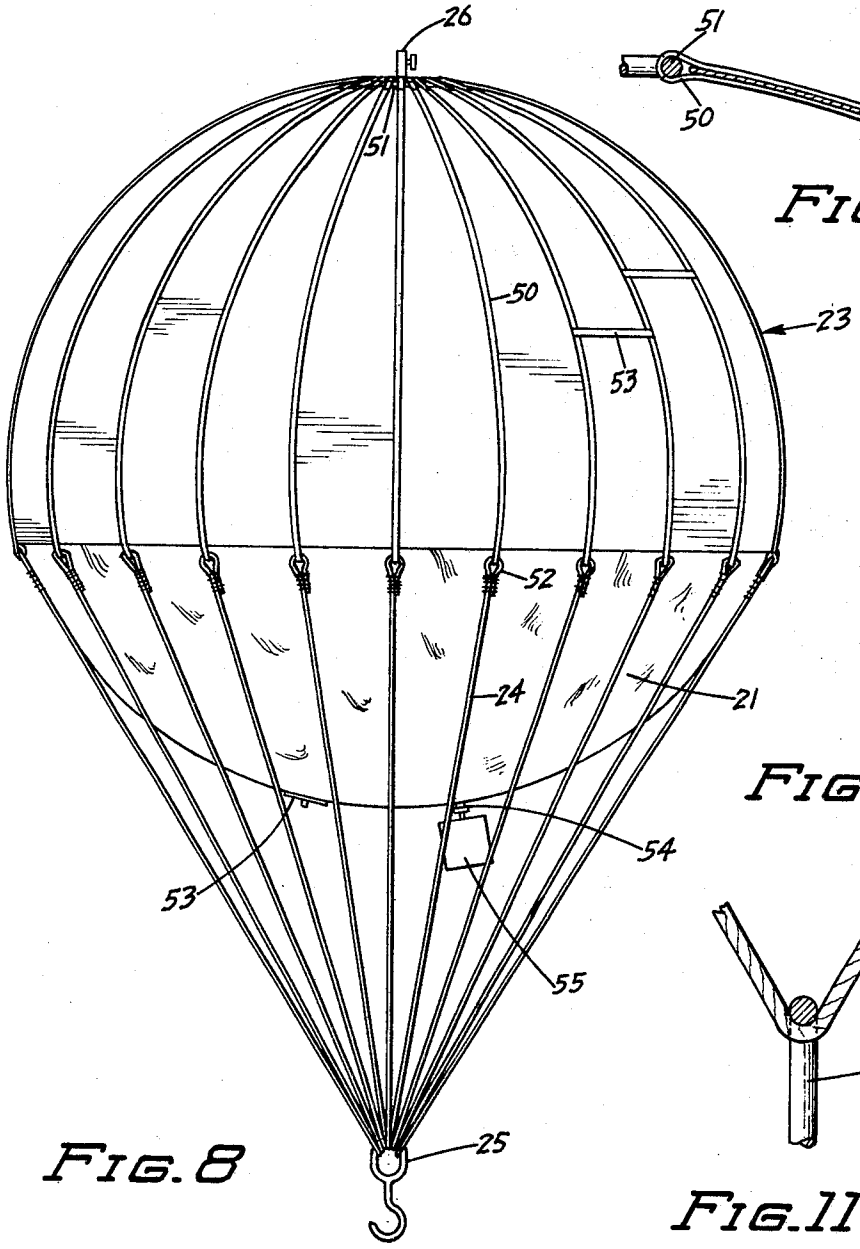

FIG. 8

FIG. 9

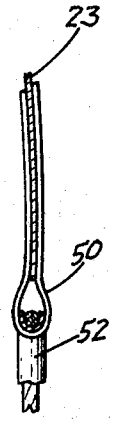

FIG. 10

FIG. 11

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3,500,785

SYSTEM FOR SALVAGING SUBMERGED OBJECTS

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Int. Cl. B63c 7/12
U.S. Cl. 114—50 13 Claims

ABSTRACT OF THE DISCLOSURE

A system and method for salvaging submerged marine vessels and other submerged objects, according to which a plurality of flexible inflatable containers are disposed in accessible compartments of the sunken object and/or secured to its exterior and inflated until the object is buoyant. The submerged object is permitted to rise progressively in controlled predetermined increments. Rapid upward acceleration of the object due to rapid expansion of the volume of gas in the inflated containers is prevented. When the object reaches the limit of each controlled incremental rise, the buoyancy of the containers is reduced by bleeding air therefrom or otherwise, while still maintatining the object buoyant. Then the submerged object is permitted to rise a further predetermined amount, and the buoyancy of the inflated containers is again reduced. This is repeated until the object is surfaced. This invention relates to a relatively simple and relatively inexpensive system and method for economically salvaging submerged marine vessels and other objects. Hundreds or ships have been sunk, as the result of storms or collisions or otherwise, through the ages. Although many of these ships may contain valuable cargo or fittings and may themselves have considerable salvage value, relatively few sunken ships have been recovered because the great cost of salvaging usually exceeds the value of the ship and its contents. Similarly, many aircraft have been lost due to ditching and off-shore radar and drilling platforms have been damaged and sunk.

Numerous techniques for raising sunken vessels and similar objects have been proposed in the past. With particular reference to submerged ships: (1) Openings in the vessel may be sealed and water forced out as air is pumped in, or water is displaced by air pumped into dome-like areas near ceilings, in holds, and the like. (2) Cables may be passed under the ship and attached to ballasted barges. The barges may be pumped out raising the ship a few feet. The ships are moved toward land until the submerged vessel again touches bottom. The cables are shortened and the process repeated until the submerged vessel is afloat. (3) Large rubber bags may be introduced into the holds and staterooms and the like and then inflated forcing the water out. (4) Plastic foam may be formed in place within the sunken ship displacing the water until gradually the ship rises. (5) Lightweight rigid plastic balls capable of withstanding tremendous pressure may be introduced into open spaces within the vessel. (6) Metal pontoons may be attached to the vessel and filled with air.

All of these proposed salvaging methods have serious drawbacks. Most are prohibitively expensive. Where the ship is to be raised as a result of air pumped into a closed chamber, whether it be part of the vessel, an inflatable bag, a pontoon or tank, or the like, one of the main obstacles is control of the rate of rise. Unless the total gas volume in the ship is reduced as the vessel rises, the vessel will gain momentum and explode as the result of rapid uncontrolled expansion of the gas. This may occur before surfacing or the vessel may burst out of the water and crash to the surface doing great damage.

It is the principal object of the present invention to provide a relatively simple and relatively inexpensive means by which the obstacles of the prior art may be overcome and a vessel or other object may be salvaged economically. In its broadest terms, the system and method of the present invention involves rendering a submerged vessel or other object buoyant and then controlling the rate of rise of the buoyant vessel or other object. For convenience, the invention will be described and illustrated with reference to ships, but it will be understood that the same principles are equally applicable to other submerged objects. A plurality of flexible lightweight inexpensive inflatable plastic containers are disposed in accessible compartments of the sunken vessel or secured to the exterior of the vessel, or both. Enough of these inflatable containers are provided to render the vessel buoyant when they are inflated with air or other gas. When the inflatable containers are filled with gas sufficient to render the sunken vessel buoyant, the vessel is permitted to rise a predetermined limited short distance, but not so far that the vessel gains uncontrollable momentum as a result of reduced pressure and gas expansion. The buoyancy of the containers is then reduced by bleeding air from them, or otherwise, until they are just barely able to maintain the vessel buoyant. Then the vessel buoyant when they are inflated with air or other gas. limited distance. The buoyancy of the containers is again reduced and the procedure is repeated as necessary to raise the vessel in stages until the vessel is surfaced.

The rate of rise of the vessel may be controlled in either of two principal ways: (a) The vessel may be connected to heavy-duty anchors by means of securing or tethering lines held down by, but movable and extendible with respect to, the anchors. By extending the lines relative to the anchors a predetermined limited amount after the vessel is made buoyant, the vessel will rise a corresponding short distance. After the buoyancy is reduced by bleeding gas from the containers the lines are extended a further predetermined limited amount to permit the vessel to rise a corresponding short distance. (b) The vessel may be connected by lines to a plurality of balloon-like inflated containers floating near the surface of the water. When these containers rise to the surface, the lifting of the vessel stops. While some of the containers maintain the vessel buoyant, other inflatable containers are fastened to the lines a predetermined distance below the first, say 10 feet or so. When these other containers are inflated, the vessel rises that predetermined distance and the first containers may then be refastened to the lines to repeat the lifting a further short distance. In some instances, a combination of the two principal systems of controlling rise of the vessel may be used.

The invention is illustrated in the accompanying drawings in which corresponding parts are identified by the same numerals and in which:

FIGURE 1 is a schematic representation of one form of system for raising a submerged vessel according to the present invention showing a vessel just after it has been lifted from the ocean floor;

FIGURE 2 is a vertical section illustrating one form of hoist vessel which is economical to build and which may optionallly be used in conjunction with the system of the present invention;

FIGURE 3 is a top plan view of the vessel of FIGURE 2 shown with part of the decking broken away to reveal internal construction;

FIGURE 4 is a vertical section showing one form of simple heavy-duty anchor which may be used in conjunction with the systems of the present invention;

FIGURE 5 is a schematic representation of a modified form of system for recovering a submerged vessel lying

at a point near the shore or elsewhere where the floor of the body of water falls away rapidly in a sharp incline;

FIGURE 6 is a plan view of an alternative form of heavy-duty anchor means useful for general duty but especially adapted for use on a sloping sea floor;

FIGURE 7 is a schematic representation of a still further alternative form of system for raising submerged vessels according to the present invention;

FIGURE 8 is an elevation of one form of heavy-duty lifting harness for enclosing an inflatable container to be attached to the outside of a submerged object; and

FIGURES 9, 10 and 11 are fragmentary sections on an enlarged scale showing details of the harness of FIGURE 8.

Referring now to the drawings, and particularly to FIGURE 1, there is shown a submerged vessel, indicated generally at **10**, resting in the sea or ocean water **11**, between the bed **12** and surface **13**. The vessel **10** is shown in a position of buoyancy after release from the ocean bed. The vessel **10** is anchored in this position by means of a plurality of heavy-duty anchor means, indicated generally at **14**. A plurality of lines, of which two indicated at **15** and **16** are shown, extend from a surface service vessel, indicated generally at **17**, through eyes **18** of the anchors **14**, and thence to points of attachment to vessel **10**. The lines are slidable with respect to the anchors so that, as line is played out from winches **19** on the service vessel in short increments of predetermined length, the segment of line between the anchors and the vessel **10** may increase while the segment of line between the anchors and the service vessel remain substantially constant.

The vessel **10** is made buoyant by means of a plurality of inflatable containers **20** and **21**. A portion of the hull of vessel **10** is shown broken away to reveal an interior placed inflatable container **20** occupying most of the space in a hold **22** or similar compartment in the vessel. Container **20** is made of relatively light gauge air-impermeable plastic sheet material. For ease of construction of each container of a size and shape such that it will substantially fill the compartment for which it is designed upon inflation, the material should be heat sealable. It may be relatively inelastic because it is intended to be inflated only within predetermined limits established by the size of the compartment in which it is to be located.

Because of its ready availability in wide widths, good heat-sealability, ease with which it may be worked and low cost, polyethylene is a preferred film material. However, other materials available for use in forming a relatively thin, impermeable, smooth, tough, pliable, membranous, relatively inextensible, sealable synthetic resinous film include butadiene-acrylonitrile copolymers, vinyl choride-vinyidene chloride copolymers, rubber hydrochloride, other vinyl chloride and vinylidene chloride polymers and copolymers, butadiene-styrene copolymers, polyester such as Mylar, and the like.

The inflatable containers are formed easily from large sheets of the plastic film cut to appropriate size and shape and then sealed, by heat or with adhesive or tape or otherwise. The container is formed with gas inlets, valves, etc., sealed into the container walls suitably located. For example, when the container is to be inflated with air, the inlet tube or other entry is located so as to be readily accessible when the container is installed in a compartment in a submerged vessel so that it may be inflated. When the container is to be inflated, for example, with carbon dioxide from a Dry Ice canister, the inlet should also be accessible. The container is fitted with a pressure relief valve. When intended to be manually operated by a diver, this is also located so as to be accessible after the container **20** is inflated, so as to relieve pressure within the container periodically as the vessel is being raised. When an automatic pressure release valve is used, accessibility is less important.

If the compartment in which an inflatable container is to be placed has sharp edges or projections such as corners of furniture; furniture legs; heating, lighting or plumbing fixtures; or the like which might pierce or tear the plastic film, the container is desirably enclosed in a tough fabric envelope, such as canvas. Such an envelope may be formed by cutting sheets of canvas to generally the same size and shape as the plastic film from which the container is formed, only slightly larger, and then stitching the edges together over the heat-sealed plastic edges. Not only is the plastic container protected against sharp objects but also against ballooning out through open doorways, portholes, etc.

The inflatable containers **20** are placed in all of those interior compartments of the vessel which are most readily accessible to the divers who must place the containers and gain access to them for inflation for initial buoyancy and partial deflation as the vessel rises. Because of this limitation, only the more readily accessible compartments, such as the lounges and other public rooms, foyers, staircases, cargo holds, enclosed promenade decks, and the like are available.

If it is difficult for any reason upon inflation of containers **20** to displace sufficient water to render the submerged vessel buoyant, then auxiliary buoyancy means, such as inflatable containers **21**, may be utilized. Containers **21** are similar to containers **20** in that they are formed from the same or similar lightweight sealable plastic film material. Each inflatable container **21** is partially enclosed in a harness such as canopy **23**. A plurality of shroud lines **24** are connected to the periphery of the canopy and extend to a common fitting **25** by which the canopy and partially enclosed inflatable bag are securely attached to some portion of the hull or superstructure of the submerged vessel.

The canopy may be formed, for example, from canvas, fishnetting, or similar material strong enough to restrain the inflatable container **21**. Similarly, the lines **24** and fitting **25** must be strong enough to restrain the inflatable container **21** to prevent it from breaking away from the submerged vessel as it is inflated and as it becomes more buoyant as the vessel raises. For easy access, the pressure release means for each container is desirably located at **26** at the top of the canopy when the enclosed container is inflated.

Sufficient auxiliary inflatable containers **21** are provided so that, in combination with the interior inflatable containers **20**, they displace in the aggregate enough water to render the submerged vessel **10** buoyant. Under some circumstances, it is desirable that the required buoyancy be achieved by use of exterior inflatable containers **21** only, without the use of any inside compartment containers **20**. In other instances where compartments of ample displacement capacity are readily accessible, no auxiliary buoyancy means may be necessary.

In most instances, the volume of water which must be displaced from the vessel in order to render the vessel buoyant can be estimated with reasonable accuracy. Then the required number of inflatable containers, both interior and exterior, necessary to provide this displacement volume upon inflation, can also be determined with reasonable precision. According to one embodiment of the invention, while the submerged vessel still rests at the bottom of the body of water, anchors of sufficient size, weight and number to control the vessel are lowered in the near proximity of the submerged vessel and lines are extended from the vessel to the anchors, and optionally to a service vessel **17** at the surface. The length of line between the vessel and anchor means is adjustable in increments. Initially, it is slack enough to permit the vessel to rise some predetermined limited distance from the bottom, such as 10 or 15 feet, for example.

Once the submerged vessel **10** is secured to the anchors, the inflatable containers are filled with gas to their approximate designed capacities. The containers may be

inflated, for example, by compressed air or air pumped from the service vessel **17**, or by carbon dioxide released by sublimation from Dry Ice from a canister connected to the container. Initially, the containers are desirably inflated to the point where the vessel is just buoyant such that it barely floats at the ends of its tethering lines but without exerting great force on those lines. Then a small amount of additional gas is introduced so that the vessel begins to rise to the limits of its tethering lines.

As the submerged vessel begins to rise and water pressure on the exterior of the inflated containers decreases due to diminished water depth, the confined gas expands increasing the interior pressure, the volume of water displaced and the buoyancy of the vessel. The resulting acceleration of the rate of rise of the submerged vessel is maintained under control because of the limited rise permitted because of the limited slack in the lines between vessel and anchor means.

When the vessel reaches the limit of its rise as permitted by its tethering lines, then the pressure within each of the inflated containers is released to the point where the vessel is once again just barely buoyant, but this time at its new level above the bed of the body of water from which it has been lifted. Then each of the tethering lines is extended a predetermined limited amount between the vessel and the anchor means. This creates new slack in the lines. Again the buoyancy of the submerged vessel is increased enough to initiate further rise of the vessel to the new limits imposed by the lengthened tethering lines.

In the case of a vessel lying in a position as illustrated in FIGURE 1 with the stern lower than the bow, the stern lines may be lengthened in increments while the bow lines remain constant until the submerged vessel is on approximately even keel. Thereafter, all of the lines are lengthened uniformly so as to raise the ship in its level position.

Where a surface service vessel **17** is utilized, then the tethering lines may be lengthened by virtue of winches **19** playing out a predetermined length of line. Such a service vessel is not essential, however. Instead, the lines may be lengthened manually by divers, or otherwise. Regardless of how the tethering lines are lengthened, the submerged vessel is permitted to ease up gradually in limited progressive increments by repeating the described process until the vessel is surfaced. Then the water within the vessel may be pumped out and the vessel refloated. Because of the use of relatively low cost inflatable containers, relatively inexpensive heavy-duty anchoring means and relatively inexpensive service vessels, salvage operations may be carried out inexpensively and economically.

Referring now to FIGURES 2 and 3, there is shown one form of easily constructed relatively inexpensive service vessel which may be used to assist in the salvaging of submerged vessels. The hull **27** is a simple platform composed of a plurality of sealed metal barrels or drums **28** secured together by welding or by means of chains or cables and enclosed in a framework or housing **29**, the upper surface of which supports a deck **30**. The hull desirably includes a central vertical hoist opening **31** through which divers, material, hoist lines, etc. may be lowered and raised during the salvaging operation. A plurality of heavy-duty sheaves **32** are provided in the opening **31** to guide tethering lines from hoist means **19**, etc.

A superstructure **33**, which may be in the form of a reinforced steel frame building, is desirably mounted on the deck over the central opening **31**. Means, such as hook **34** for suspending sheaves, etc., are desirably mounted over the central opening **31** to facilitate the salvaging operations. Auxiliary equipment such as generators, air pumps and compressors, power means for the hoists, and the like may be located within the superstructure.

A weight of about two hundred tons would be required to sink a pontoon vessel constructed according to the illustrated design and including nine hundred 55-gallon drums. Because such drums are readily available in second hand condition at nominal prices, a pontoon vessel may be built with relatively unskilled labor at relatively low cost. Generally speaking, a service vessel should be able to withstand the rigors and forces of at least about type 5 seas.

Referring to FIGURE 4, there is shown one form of relatively simple inexpensive hanger hook anchor means, indicated generally at **14**, which is useful in carrying out salvage operations according to the system of the present invention. The anchor includes a frame which comprises a large diameter circular disk **35**, preferably concave, to the periphery of which are welded or otherwise attached the ends of a plurality of elongated steel plate stringers **36** extending inwardly and upwardly to a large eye bolt **18**, to which the opposite ends are welded. The stringers **36** are evenly spaced about the periphery of disk **35** and eye **18** lies on the approximate longitudinal axis of the anchor means. The lower end of a heavy cylindrical steel shell **37** is secured to the periphery of disk **35**, preferably detachably as by pins or light shearable welds.

In use, the anchor means **14** is first lowered to the floor of the body of water adjacent the submerged vessel to be raised. Thereafter, high density ballast is placed in the anchor means within the shell until it is filled. This may be done through a large diameter conduit from the service vessel at the surface. Upon completion of the salvaging operation, the shell **37** is detached from the disk **35** of the anchor frame and raised relative to the frame. This permits the ballast contained within the tubular shell to flow out to the sea or ocean floor so as to substantially decrease the gross weight of the anchor means to permit withdrawal.

By way of example, the anchor of the naval aircraft carrier, U.S.S. *Midway*, a 60,000 ton vessel, weighs 29,000 pounds. An anchor constructed as illustrated, with a diameter of ten feet and a height of eleven feet ballasted with concrete rubble whose density is about 190 pounds per cubic foot, will have a gross weight of about 164,000 pounds. An anchor of the same size loaded with lead, whose density is 687 pounds per cubic foot, will weigh 595,000 pounds. Such an anchor may be constructed relatively inexpensively using as disk **35** a standard steel ¼ inch thick bulkhead as used in making steel tanks. Similarly, shell **37** may be formed from steel tank drum stock of ¼ inch thickness and stringers **36** may be formed from six inch by ¼ inch steel plates, all of which are readily available.

Referring now to FIGURE 5, there is shown a submerged vessel **10A** which lies on the bed **12A** of a body of water relatively close to the shore **38** so that the bottom falls off rapidly in a relatively deep incline. Such a vessel may be salvaged in the manner already described in connection with the system illustrated schematically in FIGURE 1, using inflatable containers located within accessible compartments of the vessel or suspended from the outside of the vessel or both in combination. However, control of the vessel is made difficult because of the slope of the floor **12A**. Heavy-duty anchor means of the type shown in FIGURES 1 and 4 tend to slide down the inclined floor of the body of water. For this reason, an alternative form of heavy-duty anchor means is provided for use on sloping surfaces.

As best seen in FIGURE 6, this form of anchor means, indicated generally at **39**, includes a pluralty of drums or barrels **40**, each of which is filled with concrete in which are embedded one or more eye bolts **41**, **42** and **43**. The anchor is assembled at the salvaging site to meet the requirements dictated by the conditions which are present. Adjacent drums **40** are flexibly linked together by means of short lengths of chain or cable **44** in side-by-side and end-to-end relation. As many drums are

linked together as are needed to supply the required gross anchor weight. The assembled anchor resembles a loose net or open work blanket which lies flat on the bed **12A** of the body of water hugging the surface and remaining in place in spite of the incline of the surface.

Although especially adapted for use on sloping surfaces, the anchor means **39** has general utility under all conditions. When a force is applied to the lead drum tending to lift it from the sea floor the following drums are subjected to a dragging force. The lips on the lead edges of the drums act like digging buckets and tend to dig into the soft soil or silt of the sea floor creating a drag force of large magnitude making dragging of the anchor difficult. A large network composed of many individual drums flexibly linked together can be assembled at the site to adapt to whatever conditions may be found.

Referring now to FIGURE 7, there is shown schematically a further alternative system by which submerged vessels may be salvaged using lightweight inflatable plastic containers suspended from the exterior of the submerged vessel. This system is best adapted for used for salvaging small vessels or where access by divers is difficult or where the submerged vessel lies in relatively shallow water. According to this alternative method, a plurality of inflatable plastic containers **21** partially enclosed in a canopy **23** are connected by means of shroud lines **24** to a hoist line **45** which extends to the submerged vessel **10B** where it is secured to the hull or superstructure of the vessel. Hoist lines **45** are of such a length that the containers **21** when inflated lie a predetermined relatively short distance below the surface **13** of the body of water in which the vessel **10B** is submerged. The vessel may be anchored by anchor means **14** and tethering lines **46** although this is not always necessary. While the position of the vessel is controlled by the anchor means, the containers are inflated sufficiently to render the vessel buoyant. The tethering lines are temporarily released from the anchor means and the vessel rises the predetermined short distance by which the inflated containers **21** lay beneath the water surface **13**. When the inflated containers emerge from the water at the surface, they displace less water and are less buoyant, while remaining buoyant enough to support the vessel **10B** lifted from the floor **12**. While the ship is thus supported off the bed of the body of water, it is again tethered to the anchor means by lines **46** and a second set of inflatable containers **21** is attached to the hoist lines **45** a predetermined distance below the point of attachment of the first set and inflated. The first set of containers may then be removed from the hoist lines and the vessel raised a further increment. The procedure is repeated until the vessel is surfaced.

Under many circumstances adequate control over the lifting rate of the submerged vessel may be exercised without the use of any anchoring means whatsoever. Hoist lines **45** are desirably provided with spaced apart fittings, at intervals of about every ten feet, for example, to which the balloon-like inflatable containers may be attached. The limit of rise is imposed by the surfacing of the inflated containers and reduction in their buoyancy due to displacement of a lesser volume of water. The increment of rise is determined by the spacing of the connecting fittings along the hoist lines. Chains may be used as hoist lines and the inflatable containers attached to appropriately spaced apart links.

Referring now to FIGURES 8 through 11, there is shown one preferred form of harness or sheath to enclose an inflatable container for attachment to the outside of a submerged object for salvage. According to this form of construction containers capable of lifting as much as 100 tons or more each are possible. The canopy, indicated generally at **23**, is desirably made from canvas or similar sturdy fabric. It is provided at its apex end with a central circular opening. A plurality of web straps **50** radiate out from the central opening to the canopy skirt. A strong ring, such as a high tensile steel ring **51** is disposed within the central opening. Each strap **50** preferably extends around ring **51** in a loop. The opposite end of each strap **50** extends a short distance beyond the canopy skirt and passes in a loop through a ring fitting **52** to which shroud lines **24** are connected.

Each strap is of double thickness, its ends being overlapped and stitched together to form a continuous loop which in turn is stitched to the canopy. Desirably, one side of each strap extends along the outside of the canopy and the other extends along the inside of the canopy as shown, although this is not essential. The strap **50** is desirably formed from heavy-duty material such as high tensile nylon webbing, or the like. If desired or necessary, the canopy can be additionally reinforced by the means of cross webbing **53** extending between adjacent straps **50** and secured thereto. For maximum strength, the shroud lines **24** desirably extend from one fitting **52** at the skirt of the canopy through fitting **25** and thence to the corresponding fitting **52** diametrically opposite from the first.

The inflatable lightweight plastic container is enclosed within the canopy and shroud lines. This form of construction allows even distribution of the loading force put on the inflated container and its enclosing canopy. The materials are selected to meet load requirements. High tensile nylon rope or cables or steel cables are readily available. Similarly, high tensile webbing of nylon and other fibers are readily available. It is desirably fitted with an exhaust valve **26** extending through the ring **51** at the apex of the canopy. The inflatable container is also desirably fitted with a pressure relief valve **53**, which is desirably of a self-operating bellows type. The container is also provided with a gas inlet valve **54**. The inflating gas may be air pumped into the container. Alternatively, a Dry Ice canister **55** may be attached to the gas inlet.

Such a canister consists, for example, of a closed housing of aluminum or the like of sufficient strength to withstand the water depths in which it is to be used and having an exit valve adapted to mate with the gas inlet valve of the inflatable container. The housing is partially filled with crushed Dry Ice and also contains a rupturable film bag of acetone. The canister is fitted with a plunger whose stem extends through the canister wall to an outside handle for manual operation. By pulling on the plunger handle after the canister has been connected to an inflatable container, a driver may rupture the acetone bag causing rapid evolution of carbon dioxide due to sublimation of the Dry Ice.

I claim as my invention:

1. A system for salvaging submerged marine objects which comprises in combination:

(A) a plurality of flexible inflatable containers disposed in water displacement relationship with said submerged object,

(B) means for inflating said containers,

(C) means for controlling the rise of said submerged object in response to the buoyancy of the inflated containers in predetermined increments, said means comprising:

(1) heavy duty anchor means on the bed of the body of water adjacent to the submerged object,

(2) lines extending from the submerged object to said anchor means,

(3) said lines being extendible relative to said anchors, the length of line between said anchor and said submerged object increasing as said object rises, and

(D) means for partially and progressively reducing the buoyancy of said container in increments as said object rises and gas within said containers expands.

2. A system according to claim **1** further characterized in that the submerged object has internal compartments and said flexible inflatable containers are disposed in at least some of the compartments of the submerged object,

each of said containers corresponding in size and shape to the compartment in which it is disposed, having means for inflation, being capable of substantially filling the compartment when fully inflated, and having means for partial and progressive deflation.

3. A system according to claim 1 further characterized in that a plurality of flexible inflatable containers are disposed in the body of water above said submerged object, each of said containers being connected to the exterior of said submerged object, said containers being at least partially enclosed within a force distributing sheath and having means for inflation and partial and progressive deflation.

4. A system according to claim 1 further characterized in that each of said anchors comprises:

(A) a large diameter circular steel base,

(B) a plurality of similar relatively narrow elongated steel stringers rigidly secured to said base at spaced intervals about its periphery,

(C) said stringers extending inwardly and diagonally upwardly and being rigidly secured together adjacent their upper ends,

(D) means secured to the upper ends of said stringers at their connection to one another for engaging said lines at spaced intervals along their lengths, and

(E) a cylindrical shell secured to said base and extending upwardly to about said line engaging means.

5. A system according to claim 4 further characterized in that said cylindrical shell is detachably secured to said base.

6. A system according to claim 1 further characterized in that said anchor means comprises:

(A) a plurality of dense weighted cylindrical tanks,

(B) means in the ends of said tanks for flexible end-to-end connection of at least some of said tanks, and

(C) means in the sides of at least some of said tanks for side-to-side connection of at least some of said tanks.

7. A system according to claim 1 further characterized in that said inflatable containers are constructed of thin relatively inelastic synthetic resinous sheet material.

8. A system according to claim 2 further characterized in that said inflatable containers are enclosed within a protective envelope of tough fabric, said envelope corresponding in size and shape to the inflatable container and the compartment in which it is disposed.

9. A system according to claim 3 further characterized in that said flexible inflatable container is generally spherical, said force distributing sheath enclosing the container is generally semi-spherical, a plurality of high tensile reinforcing straps extend radially from the apex of said sheath to the edges thereof, and a plurality of high tensile lines extend from the ends of said straps to means for attachment to the submerged object.

10. A method of salvaging submerged marine objects which comprises:

(A) disposing a plurality of flexible inflatable containers in water displacement relationship with the submerged object,

(B) inflating said containers to displace water until the submerged object is buoyant,

(C) controlling the movement of said submerged object to permit it to rise a predetermined limited distance by

(1) locating heavy duty anchor means on the bed of the body of water adjacent to the submerged object,

(2) extending lines from said anchor means to the submerged object, and

(3) lengthening said lines a predetermined fixed amount to permit extension of the lines relative to said anchor means to permit controlled limited lifting of said submerged object,

(D) reducing the buoyancy of said containers while still maintaining the object buoyant,

(E) again controlling the movement of the submerged object to permit it to rise a further predetermined limited distance by again lengthening said lines a predetermined fixed amount to permit further controlled limited lifting of the submerged object, and

(F) repeating said last two steps to raise the submerged object in controlled increments until surfaced.

11. A method according to claim 10 further characterized in that at least some of said inflatable containers are disposed in compartments of the submerged object, each of said containers corresponding in size and shape to the compartment in which it is disposed and capable of substantially filling the compartment when fully inflated.

12. A method according to claim 10 further characterized in that at least some of said inflatable containers are connected to the exterior of the submerged object to suspend the object when lifted from the bed of the body of water.

13. A method according to claim 10 further characterized in that the movement of said submerged object is controlled by:

(A) disposing in the body of water above the submerged object just below the surface of the water and connected by lines to said object, a plurality of first inflated containers sufficient to render the submerged object buoyant,

(B) permitting said first inflated containers to lift the submerged object, rising to the surface of the water and thereby partially losing their buoyancy,

(C) while said first containers support the submerged object partially lifted, attaching a plurality of further inflatable containers to the lines connecting said first containers to the submerged object a short predetermined distance below the point of attachment of the first containers and inflating the same,

(D) permitting said further containers to rise to the surface of the water further lifting the submerged object said predetermined distance,

(E) deflating said first containers, detaching and reattaching to said lines a short predetermined distance below said further containers and re-inflating, and

(F) repeating said steps until the submerged vessel is surfaced.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,500,785 Dated March 17, 1970

Inventor(s) Robert J. Strange

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, Abstract of the Disclosure should end on line 27 after "faced." Balance of paragraph should constitute first paragraph of specification.

Column 1, line 30, "or" should be --of--.

Column 2, line 26, "buoyant when they are inflated with air or other gas." should be --is again permitted to rise a further predetermined--.

Column 7, line 47, "lines" should be --line--.

Column 8, line 70, "container" should be -containers--.

SIGNED AND
SEALED
JUL 28 1970

(SEAL)
Attest:

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Commissioner of Patents