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[54] **UNDERWATER HULL INSPECTION**

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[52] **U.S. Cl.** **283/1,** 114/222

[51] **Int. Cl.** **B63b 59/00**

[58] **Field of Search** ..... 178/DIG. 1, DIG. 38; 114/104, 222, 0.5; 273/130 D; 283/1, 34

[56] **References Cited**

UNITED STATES PATENTS

3,113,777	12/1963	Senick	273/130 D
3,514,110	5/1970	Thomander	273/130 D

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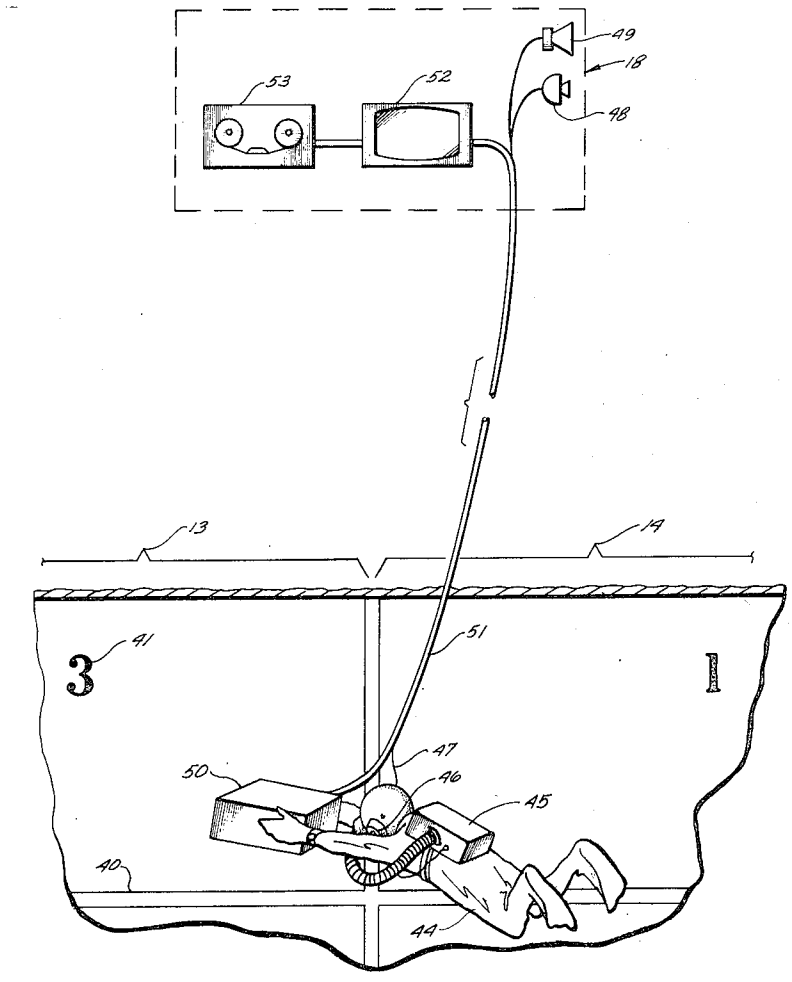
[57] **ABSTRACT**

There is described an improved method for directing a diver-inspector to a hull location of interest during the process of performing an inspection of the submerged surfaces of the hull of a floating ship. The submerged surface area of the hull is visibly subdivided into a plurality of discrete areas. A designating indicium for each discrete area is applied to each area to be visible from adjacent the area. A map is provided, at an inspection control site, of the several discrete areas into which the hull submerged surface area is subdivided and of the designating indicia applied to the areas. Also, a communication path is provided to the diver-inspector by which the diver, when submerged, may receive instructions from the inspection control site which preferably is located aboard the vessel. By reference to the map, an inspection controller may direct the diver-inspector to a designated hull location of interest for scanning of the hull by an underwater television camera, or by a plate sounding mechanism or the like.

5 Claims, 2 Drawing Figures



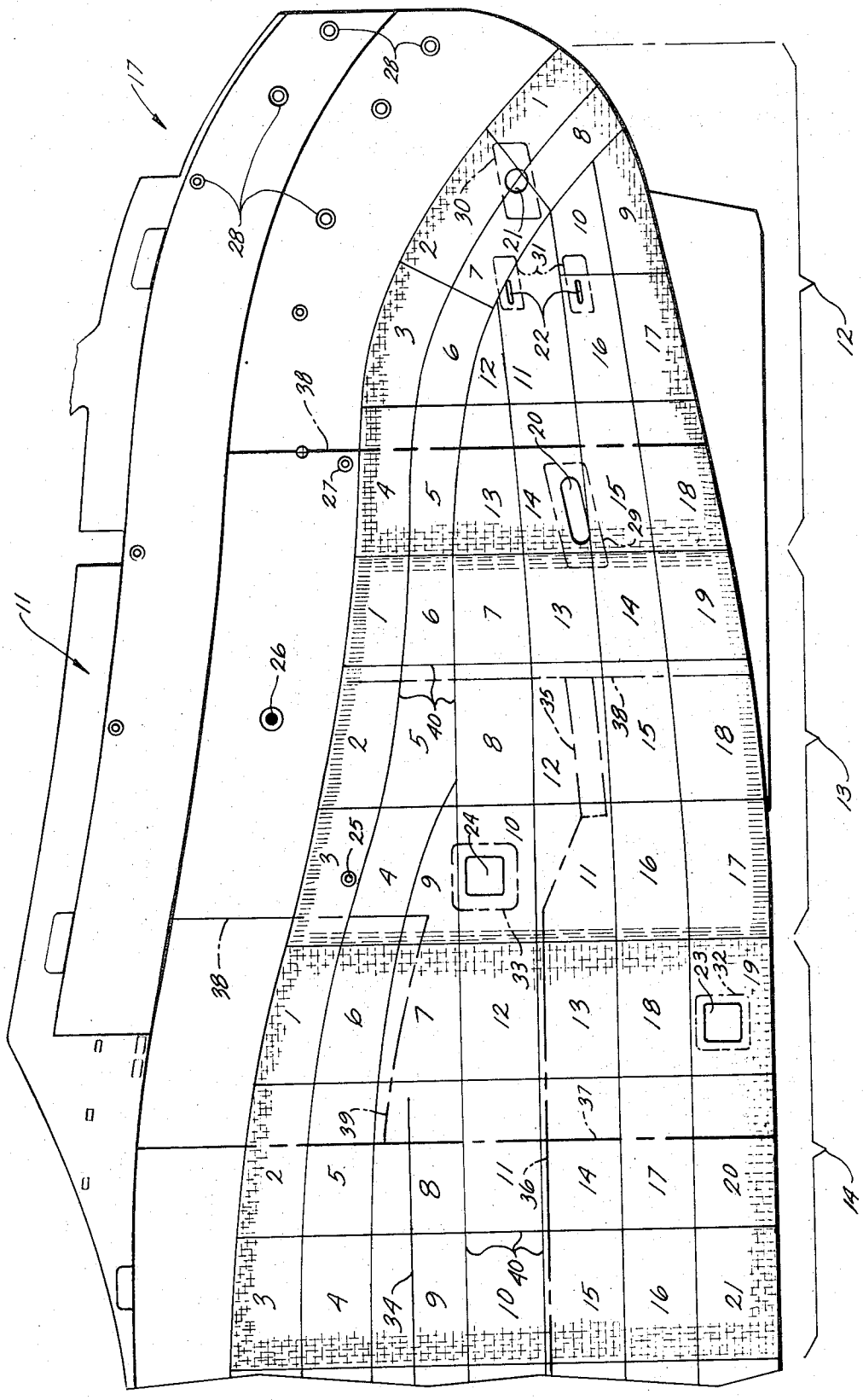
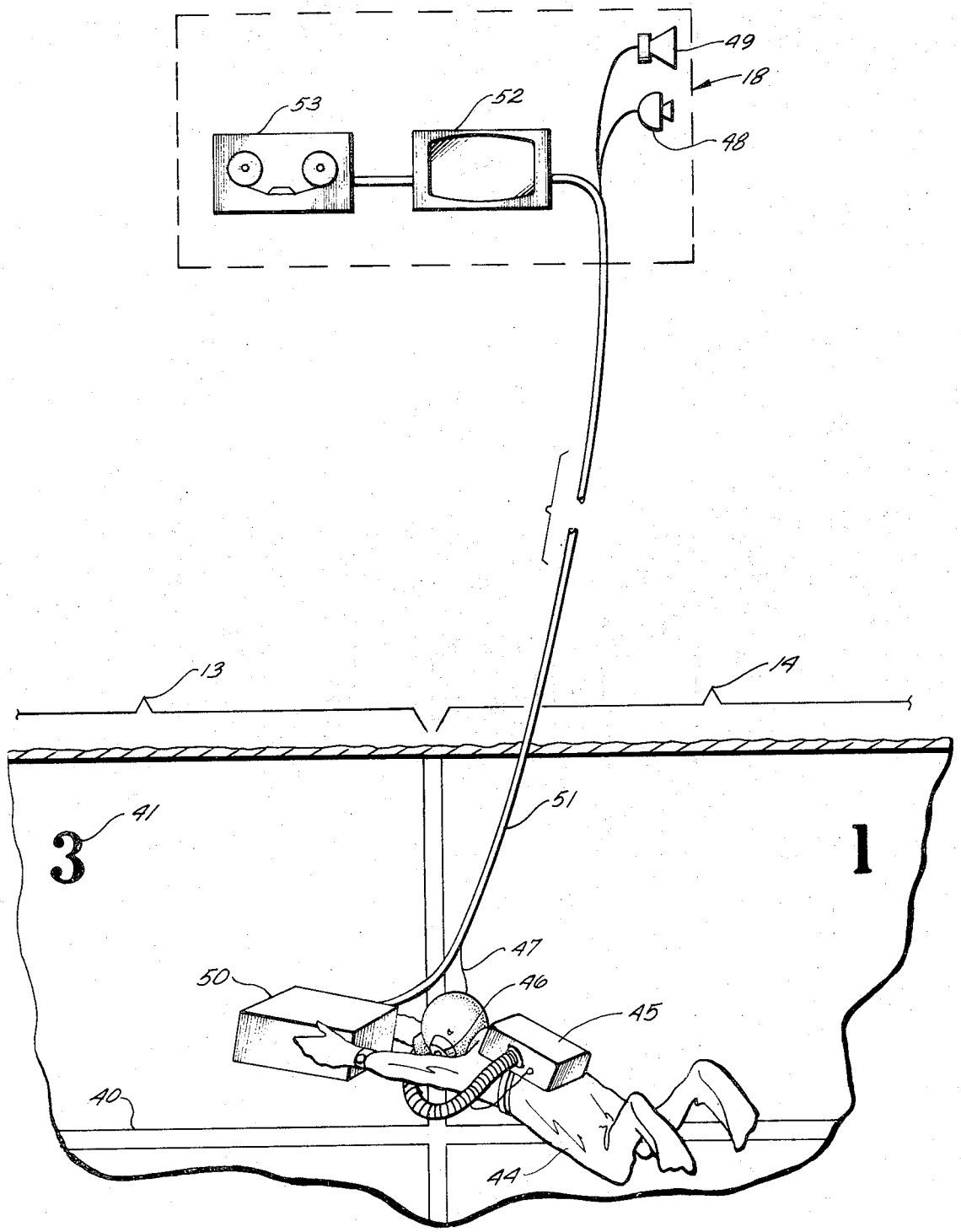


FIG. 1

FIG. 2



UNDERWATER HULL INSPECTION

FIELD OF THE INVENTION

This invention pertains to the field of marine hull maintenance and, more particularly, to procedures and apparatus for performing hull certification inspections while the hull is afloat.

BACKGROUND OF THE INVENTION

Description of the Prior Art: Shipowners, in order to maintain their vessels safe, seaworthy and insurable, are obliged to conform to certain certification rules and regulations promulgated, in the United States, by the U.S. Coast Guard and the American Bureau of Shipping, the latter being a certification agency for member marine insurance underwriters. A major part of the expense incurred by shipowners in meeting these requirements by drydocking of the vessels at certain minimum time intervals. Drydocking gives the appropriate Coast Guard inspector or ABS surveyor the opportunity to inspect hull shell plating for cracks, pitting, erosion, and weld deterioration and also to examine the condition of hull penetrations such as propeller shafting, rudders, and the like. Drydocking, however, requires that the vessel be scheduled for a particular drydock months in advance. During the drydocking, the vessel is out of service from its normal function which is to earn money for the shipowner.

Also, some vessels, such as supertankers, because of their size and weight, may not be drydocked except at a few locations throughout the world, which locations may not be adjacent to the normal service routes of the vessel. Drydocking of such vessels requires a long voyage out of the normal operating route of the vessel solely for the purpose of a certification inspection. Other vessels, such as floating drill ships and the like, often operate in areas remote from adequate drydocking facilities. Thus, in all cases time is lost from the normal operating schedule of the vessel during the drydocking interval and, depending upon the size and nature of the vessel, the time lost from the normal operation of the vessel may be quite extended.

Recently, a process known as wetdocking has been developed to enable shipowners to obtain and maintain U.S. Coast Guard and American Bureau of Shipping certification without requiring actual physical removal of the vessel from the water as by conventional drydocking. In the wetdocking process, the vessel is subjected to a certification inspection while the vessel is afloat, preferably at the same time that the vessel may be working cargo or the like as required by the regular commercial function of the vessel.

The wetdocking procedure may be as simple or as complex as is desired by the appropriate inspector, surveyor or shipowner. Thus, the wetdocking process may include underwater hull cleaning, sea chest maintenance, overhaul of sea suction and overboard discharge valves, installation of corrosion inhibiting sacrificial anodes, hull plate thickness measurements, visual survey of the hull, sea chests, shafts, propellers, rudders, and of welded plate seams and butts. Conveniently, the desired visual survey may be obtained by the use of an underwater television camera operated by a diver to present a television picture aboard the vessel or at some other inspection control site for examination by the certifying inspector or surveyor. Also, if desired, the output from the underwater television camera may be supplied to a video tape recorder for recording and playback at a later and more convenient time. Hull plate thickness measurements may be obtained by the use of an ultrasonic plate thickines meter operated by a diver.

In prior wetdocking procedures, it has been difficult to coordinate the desires of the certifying inspector, at the inspection control site, to the movements of the diver handling the underwater television equipment or plate thickness meter. A principal cause of this difficulty has been the disorientation experienced by the diver working close to the submerged surfaces of the hull. That is, much of the submerged surface of a ship hull, when viewed closely by a diver, looks much the same as most other areas of the hull. For this reason it is difficult for the diver to know where he is at any given time relative to a particular location on the hull. Even though the diver may be linked to the controlling inspector by two-way audio communication path and can readily understand requests made of him by the controlling inspector, the disorientation effect makes it difficult for the diver to move from one location on the hull to another location of interest promptly at the request of the controlling inspector.

Prior attempts at overcoming these communications difficulties between the controlling inspector and the diver involved the use of hogging lines run around the girth of the hull at spaced locations along the length of the hull. Such hogging lines provide reference points for the diver, particularly when he is working directly below the hull, but such lines are difficult and time consuming to move from station to station along the hull. Also, the use of hogging lines does not provide an entirely satisfactory answer to the situation which arises when the controlling inspector wishes to go back and recheck a particular location of the hull, as after inspecting the video tape of the television scan of the entire hull made by the diver. The rechecking situation has arisen frequently in prior wetdocking procedures because of the difficulty experienced by the controlling inspector in identifying a particular hull area directly from the information presented on the television monitor either as the signal is generated originally or as played back from a video tape recording.

It is apparent, therefore, that the efficiency and efficacy of wetdocking procedures may be improved by the provision of improved communications methods between the controlling inspector and the diver, and by which the diver can respond promptly and accruately to change-of-position requests made of him by the controlling inspector. Wetdocking procedures can also be improved by the elimination or the reduction of the situations requiring the recheck or reexamination of particular hull areas. The more rapidly and efficiently a wetdocking inspection may be made, the more likely is the possibility that the entire wetdocking certification inspection may be made while the vessel is occupied at dockside during the performance of the normal commercial task assigned to the vessel at essentially any location of the vessel within the world.

SUMMARY OF THE INVENTION

This invention provides improved, simple, efficient, and economic procedures and equipment for directing a diver-inspector to a hull location of interest during the process of performing an inspection of the submerged surfaces of the hull of a floating ship.

Generally speaking, the improved method of this invention includes the step of providing to a diver-inspector a communication path by which the diver, when submerged, may receive instructions from an inspection control site. The method also includes the steps of visibly subdividing the submerged surface area of the hull into a plurality of discrete areas and of applying to the hull within each discrete area a designating indicium visible from adjacent the area. The method also includes providing a map at the inspection control site of the several discrete areas and the designating indicia thereof. By adherence to these procedural steps, it is a simple matter for the diver-inspector to respond to commands from the inspection control site to move to or perform a specified function at a particular point on the submerged surface of the hull.

DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features of this invention are more fully set forth in the following detailed description of a presently preferred embodiment of the invention, which description is presented with reference to the accompany drawing, wherein:

FIG. **1** is a portion of a locating map useful by a controlling inspector at an inspection control site aboard the vessel or otherwise; and

FIG. **2** is a fragmentary elevation view showing a diver-inspector at work using the precedures of this invention.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

As shown in the drawings, the submerged surface area of the hull **10** of a ship **11** is subdivided into a plurality of zones **12, 13** and **14**; zones **12, 13** and **14** are representative of a greater number of zones into which the hull submerged surface area may be divided. Preferably, each zone extends from the waterline **15** of the hull to the keel **16** or to the centerline of the hull at its bottom. The zonal subdivision of one side of the submerged surface area of ship **11** adjacent its stern is shown in FIG. **1.** FIG. **1** is illustrative of a portion of a locating map **17** which is provided to a controlling inspector at an inspection control site **18.**

Preferably, map **17** is provided as a modified shell expansion drawing. A shell expansion drawing is one of the drawings which is normally provided by the naval architect or the shipbuilder. A shell expansion drawing constitutes a transverse, but not longitudinal, development of the entire plated area of the hull. Since the shell expansion drawing conventionally is expanded transversely of the vessel, all dimensions taken vertically on a shell expansion drawing are true dimensions, whereas dimensions taken horizontally are not, in all cases, true dimensions but are apparent side elevation dimensions.

A single drawing, by suitable notes thereon, shows both port and starboard hull features. The shell expansion drawing, therefore, can illustrate the location **20** where a propeller shaft extends through the hull, the location **21** where a rudder stock may penetrate the hull, and the location **22** at which propeller shaft support struts may be connected to the hull. A shell expansion drawing also conventionally illustrates the location on the ship hull of the openings of sea chests **23** and **24,** as well as the location of condenser overboard discharge opening **25,** the engine cooling water overboard discharge opening **26,** plumbing drain opening **27** and the locations **28** at which anchor stowage rack struts are connected to the hull. Further, the shell expansion drawing illustrates the extent of doubler plates **29, 30, 31, 32** and **33** provided within the hull around each of features **20, 21, 22, 23** and **24,** respectively. Further, the shell expansion drawing shows the location of a bilge keel **34** on the exterior of the hull and the location within the hull of propulsion machinery foundations **35,** watertight longitudinal bulkheads **36,** oil tight transverse bulkheads **37,** watertight transverse bulkheads **38,** and tank tops **39.** Each of features **20–39** are features which are of particular interest to a Coast Guard inspector or an American Bureau of Shipping surveyor. A conventional shell expansion drawing shows other features of the hull structure which are not relevant to the purposes of map **17** and which preferably are deleted from the modified shell expansion drawing which constitutes map **17.**

According to this invention, a map **17** preferably is provided for each of the port and starboard sides of the hull in view of the color of zones **12, 13, 14** etc. It is within the scope of this invention, however, that a single map **17** may be provided for the entire vessel and such is the case shown in FIG. **1** wherein both starboard and port features of the hull are depicted.

As shown in FIG. **1,** each zone **12, 13, 14,** etc., into which the total submerged surface area of the hull is subdivided, is painted a color which contrasts from the color of any zone abutting it. The painting of zone **12** to have a yellow color is indicated by appropriate hatching around the margins of this zone in distinction to the hatching of the margins of zone **13** to represent the color red. Thus, on the starboard side of the vessel zone **12** may be painted yellow, but be painted red on the port side of the vessel; zone **13** may be painted red to starboard and yellow to port; and so on forwardly along the length of the entire ship.

Each zone is further subdivided into a plurality of discrete areas which are separated from each other by suitable grid lines **40** which are painted on the hull, over the appropriate zone color, in a color which corresponds with the underlying zone color. Further, each discrete area defined within zone is given a designated indicium **41** which also contrasts with the underlying zone color. Each indicium **41** conveniently may be a large number painted within the boundries of the corresponding discrete area as defined by grid lines **40.** Grid lines **40** and the designating indicia should have sufficient contrast to the background zone color and should be sufficiently large to be readily visible by a diver working adjacent that location of the hull. As shown in FIG. **1,** the zonal designation colors, the pattern of grid lines **40** subdividing each of the zones into plural discrete areas, and the designating indicia for each descrete area within a zone are all set forth on map **17.** Map **17,** therefore, constitutes an accurate plan or map of the colors, subdividing grid lines, and various designating indicia carried by the hull itself.

Workers skilled in the art will readily appreciate that hull zonal designation colors, grid lines, and designating indicia are preferably applied to the hull of a new vessel as a part of the construction process. In the case of an existing vessel not painted in accord with this invention, the hull is painted with desired zonal designation colors, grid lines, and designating indicia as a part of a conventional certifying drydocking and inspection;

thereafter, the vessel maybe inspected, surveyed and certified by practice of the present invention procedures without need for drydocking solely for the purposes of such inspections.

According to this invention, the inspection of the submerged surfaces and features of a floating vessel may be conveniently and expenditiously performed by a diver-inspector **44** who preferably is equipped with a self-contained underwater breathing apparatus **45** so that he may move readily and freely about, around, and under the vessel. Diver-inspector **44** is placed in communication, preferably two-way communication, with inspection control site **18** by an audio communication system which includes a headphone **46** for the diver and a lightweight umbilical communications cable **47** which extends to a microphone **48** and a loudspeaker **49** at the inspection control site. The necessary visual inspection of the submerged surfaces of the hull is implemented by use of an underwater television camera **50** which preferably is neutrally buoyant for convenient operation by the diver-inspector. The television camera is connected to a suitable transmission cable **51** with which audio communication cable **47** preferably is linked. Cable **51** extends to a television monitor **52** and a video tape recorder **53** at inspection control site **18.** In place of an underwater television camera, diver-inspector **44** may be provided with an ultransonic hull plating thickiness meter which may be connected by a suitable cable to appropriate recording equipment or the like at the inspection control site. The inspection control site preferably is located aboard ship **11** but, if desired, may be located elsewhere, as aboard an inspection tender vessel or the like.

The underwater inspection process is greatly facilitated by the color coding and subdivision of the total submerged surface area of the hull into a plurality of discrete areas, each of which is given its appropriate designating indicium. The designating indicium assigned to any discrete area of the hull need not be an indicium which is unique to the entire hull. Rather, it is sufficient for the purposes of this invention that the designating indicium applied to a particular discrete area, in association with the background color for the zone within which the descrete area lies, is unique to all of the zones within reasonable proximity to the particular discrete area of interest. For example, zone **14** on the starboard side of the vessel may be distinguished from starboard yellow zone **12** by generally designating starboard zone **14** as "yellow starboard **2**" and by designating starboard yellow zone **12** as "starboard yellow **1.**" Thus, diver-inspector **44** may be commanded to move from "upper right **11** starboard yellow **1**" to "lower left **15** starboard yellow **2;**" by reference to FIG. **1,** such a command would be a command for the diver-inspector to move from a location adjacent to the upper right-hand corner of area **11** shown in zone **12** of map **17** on the starboard side of the vessel to a new location adjacent the lower left corner of area **15** appearing in zone **14** on the starboard side of the vessel. By reference to the basic zonal color code, to the presence of the grid lines within each zone, and to the designating indicia for the several discrete areas within each zone, it is a simple matter for the diver-inspector to respond to such a command. Prompt and accurate response of the diver-inspector to such commands means that the underwater inspection process may be carried out rapidly and efficiently to obtain all the information necessary to the certifying inspector or surveyor at inspection control site **18.** Also, in the event that the certifying inspector requires additional information from any particular point on the submerged surface of the hull, it is a simple matter for the diver to go directly to the particular area of interest and to obtain the desired information by television or otherwise. All these advantages are obtained without the use of cumbersome hogging lines which are difficult to place in the first instance, and which are difficult and time consuming to move along the hull and to position accurately.

Workers skilled in the art to which this invention pertains will readily appreciate that the procedures and apparatus described above may be altered or modified without departing from the scope of this invention, while still realizing the benefits and advances provided by this invention. Accordingly, the foregoing description should not be considered as limiting the scope of this invention.

What is claimed:

1. In the process of performing an inspection of the submerged surfaces of the hull of a floating ship, an improved method for directing a diver-inspector to a hull location of interest, the method comprising the steps of

a. visibly subdividing the submerged surface area of the hull into a plurality of discrete areas,

b. applying to the hull within each discrete area a designating indicium visible from adjacent the area,

c. providing to the diver a communication path by which the diver when submerged may receive instructions from an inspection control site,

d. providing a map at the inspection control site of the several discrete areas and the designating indicia thereof.

2. The method according to claim **1** wherein the map is provided as a shell expansion drawing for the hull, and including modifying the drawing to correspond to and indicating the hull area subdivision and the designating indicia.

3. The method according to claim **1** wherein the subdividing step includes painting different parts of the hull submerged area in different colors.

4. The method according to claim **3** wherein each of said parts of the hull submerged area includes a plurality of said discrete areas, and including subdividing each said part into the corresponding discrete areas by painting over the part boundary lines for discrete areas in a color which contrasts with the color for the part.

5. In apparatus for facilitating inspection of the submerged surfaces of the hull of a floating ship and the like by a diver and the like equipped with means for receiving directing signals from the ship, the improvement comprising:

a. indicia applied to the submerged surface of the hull and subdividing the submerged surface area into a plurality of discrete areas, said indicia including designating indicia applied to the hull within each discrete area to render that discrete area unique to all others of said discrete areas proximate thereto, and

b. a map of the submerged hull surface area arranged to show all of the discrete areas, their location, and their designating indicia.

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