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Michaelsen

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[54] **AUTOMATIC HULL CLEANING SYSTEM**

[75] Inventor: **Randolph C. H. Michaelsen,** Malibu, Calif.

[73] Assignee: **Global Marine Inc.,** Los Angeles, Calif.

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[52] **U.S. Cl.** **114/222**

[51] **Int. Cl.** **B60s 3/02**

[58] **Field of Search** 114/222; 15/DIG. 2, 15/53, 179

[56] **References Cited**

UNITED STATES PATENTS

3,303,812	2/1967	Sierra et al.	114/222
3,561,391	2/1971	Locati	114/222
3,227,124	1/1966	Campbell	114/222
2,257,255	9/1941	Yingling	15/DIG. 2
693,242	2/1902	Culpepper	114/222
2,381,054	7/1943	Holmes	15/DIG. 2

FOREIGN PATENTS OR APPLICATIONS

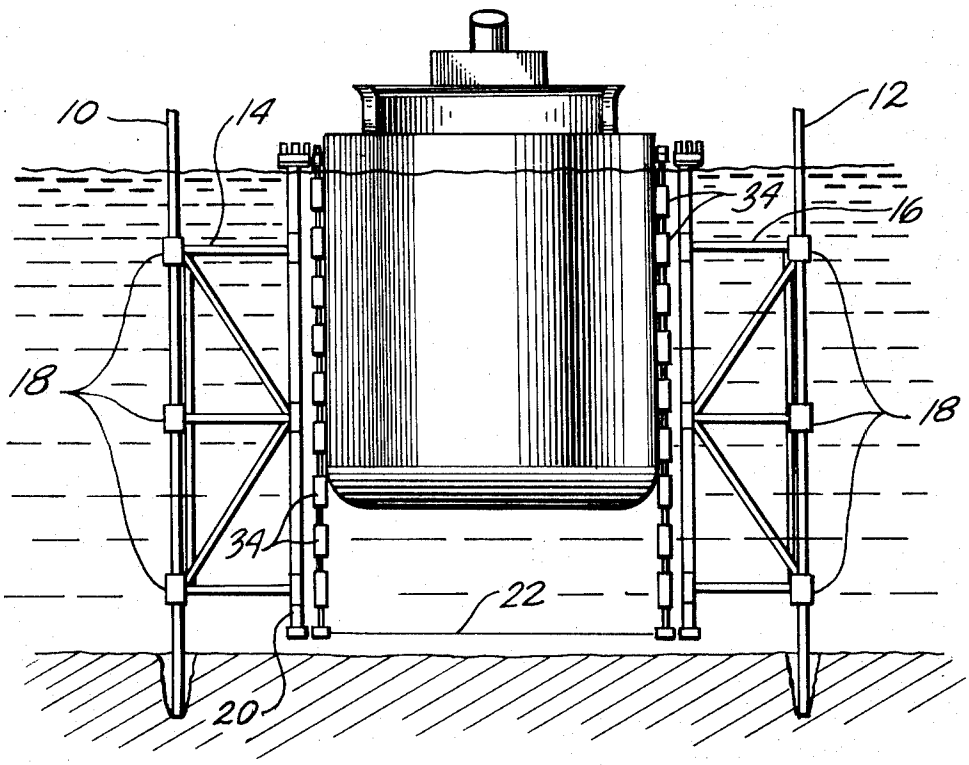
1,503,196	11/1967	France	114/222
557,514	11/1943	Great Britain	114/222

Primary Examiner—Milton Buchler
Assistant Examiner—Gregory W. O'Connor
Attorney—Christie, Parker & Hale

[57] **ABSTRACT**

There is described apparatus for scrubbing the sides of a ship in which two pairs of vertical strings of rotary brushes are urged against the opposite sides of the ship as it passes through the apparatus. The rotary brushes in each string are linked by flexible or articulated shafts, permitting the string to deform to conform to the shape of the hull. A combination of weights associated with a pivoted frame supporting the strings of brushes, plus jets associated with the individual brushes, urge the brushes into contact with the sides of the ship.

8 Claims, 6 Drawing Figures



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SHEET 1 OF 2

FIG. 1

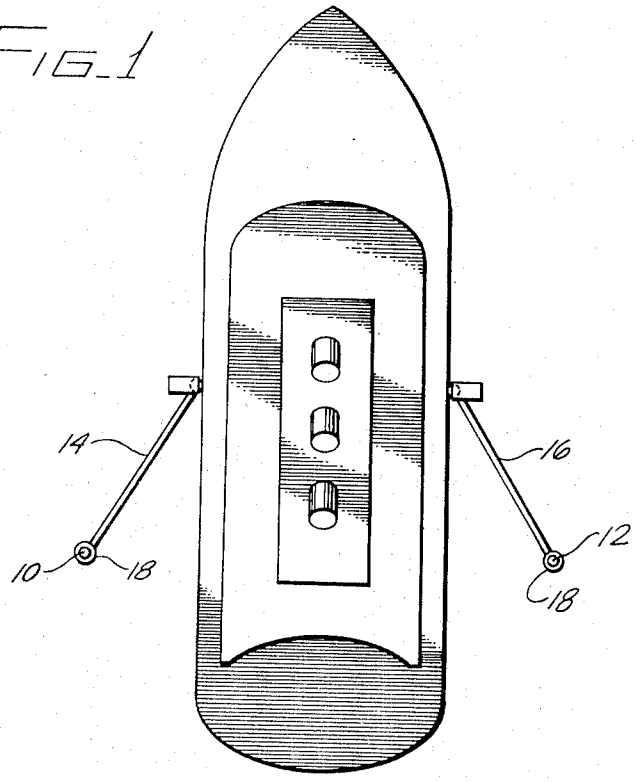


FIG. 5

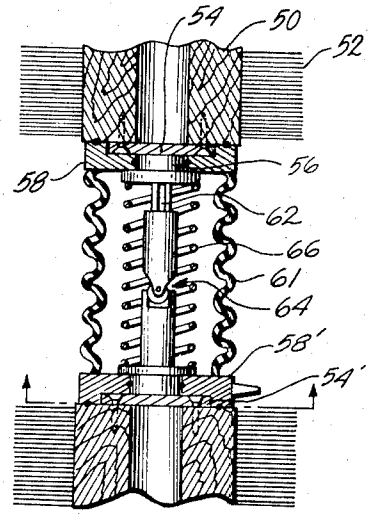


FIG. 2

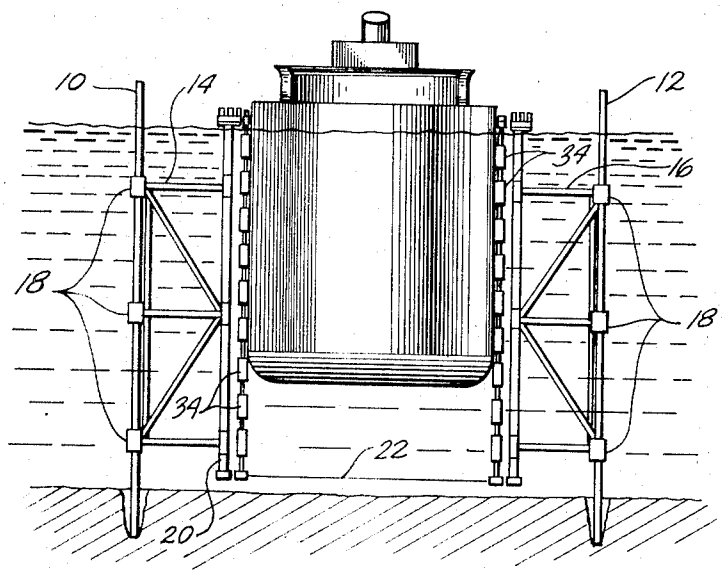
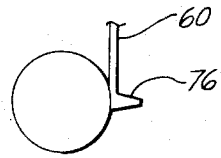


FIG. 6



INVENTOR.
RANDOLPH C.H. MICHAELSEN

BY

ATTORNEYS

FIG. 3

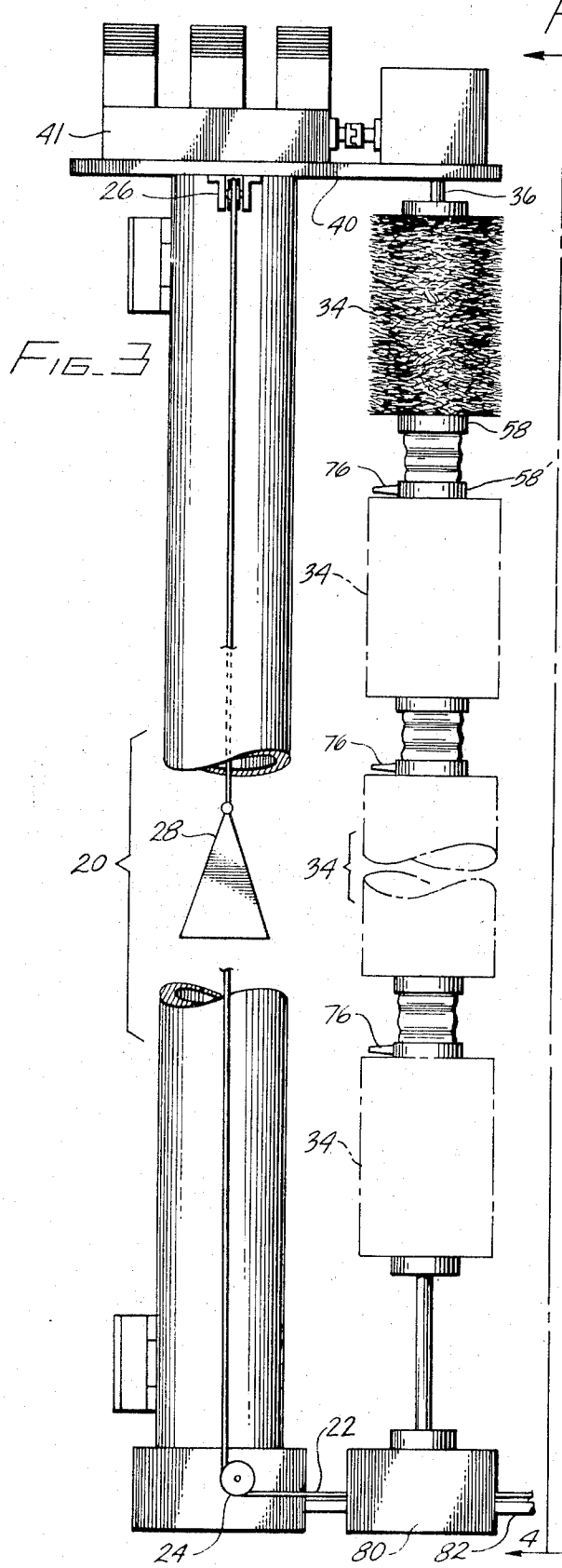
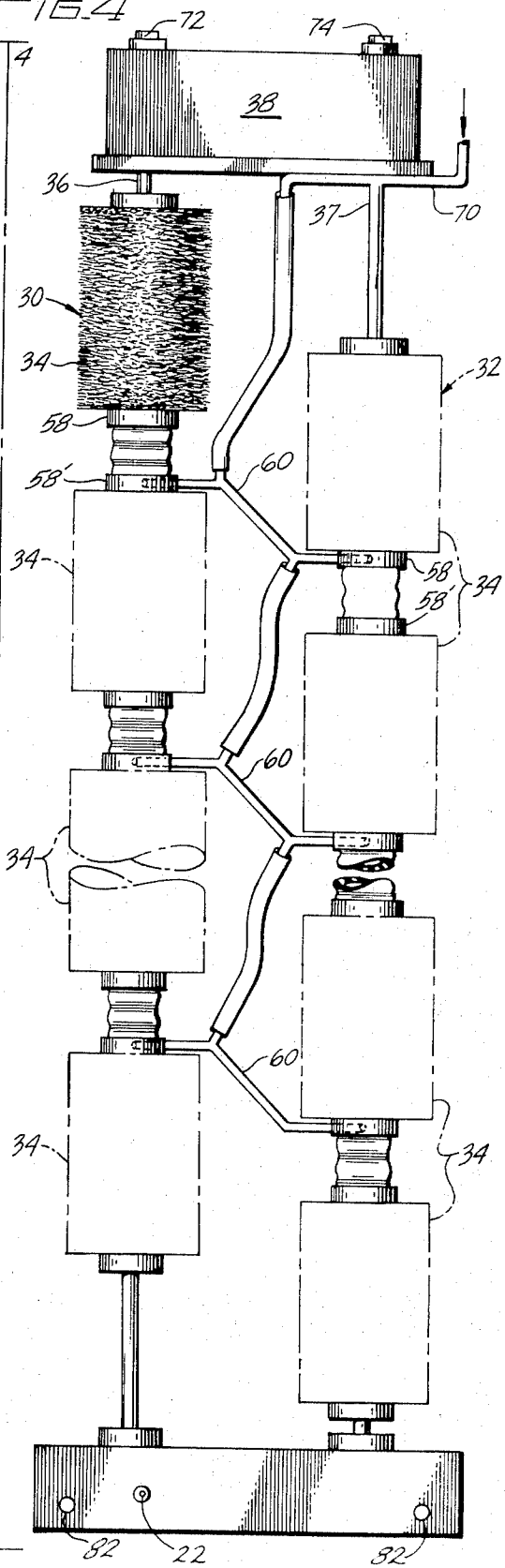

41
26
40
36
34
58
76
58
34
76
34
28
20
76
34
22
24
80
82
4

FIG. 4


4
72
74
38
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37
70
30
34
32
58
58'
60
34
58
58'
34
60
34
60
34
34
82
22
82

AUTOMATIC HULL CLEANING SYSTEM

FIELD OF THE INVENTION

This invention relates to apparatus for cleaning marine growth off of ships, and more particularly, is concerned with an automatic system for scrubbing both sides of a ship as the ship is moved through the apparatus.

BACKGROUND OF THE INVENTION

It is well recognized that accumulation of marine growth on the hull of a ship or vessel may seriously affect operating efficiency. The speed of the vessel begins to drop off and the fuel consumption increases substantially as a result of increased drag produced by such growth, requiring the vessel to be periodically taken into drydock and the hull scraped clean of all such marine growth. While various attempts have been made at providing equipment for removing marine growth without taking the ship into drydock, such systems in the past have either been too slow or too costly to warrant use on a routine maintenance basis. Attempts to automate the hull-cleaning process have failed because the equipment has not been able to clean large areas at a time, or has been too costly to manufacture, install and maintain.

BRIEF DESCRIPTION OF THE INVENTION

The present invention relates to an improved apparatus for automatically scrubbing the sides of a vessel to remove marine growth without removing the ship from the water. The apparatus provides means for scrubbing the sides of the ship as the ship is moved along in the water, the scrubbing brushes being arranged to adjust their positions to the changing contours and the different dimensions of each vessel which passes through the scrubbing equipment. In brief, this is accomplished by providing a pair of vertical piles spaced apart in the water sufficiently to permit a ship to pass readily between the piles. A pair of frames are hingedly supported by the piles and are arranged to swing toward each other under the urging of a weighted cable linking the two frames. Each frame at its outer movable portion supports a plurality of vertically aligned rotary brushes and drive means for rotating the brushes. The brushes are linked together in a vertical string with the brushes being joined by linkage which permits rotary motion to be transmitted to all the brushes in the string and at the same time permits both the spacing between the brushes and the angular relationship of adjacent brushes to adjust. The vertical string of brushes is driven from one end of the string through the drive means linking the brushes together. Between each pair of adjacent brushes in the string, jet reaction means is provided which urges the string in a direction toward the sides of the ship. The jet reaction means holds the vertical string of rotary brushes firmly against the sides of the vessel, the linkage between the brushes permitting the brushes to adjust to the contour of the ship's sides. Thus the vertical strings of brushes apply scrubbing action to the full vertical extent of the ship's hull as the ship is moved through the water past the scrubbing apparatus. The swinging frames permit the equipment to adjust to ships different widths.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention reference should be made to the accompanying drawings wherein:

FIG. 1 is a plan view of the equipment showing a ship passing through the scrubbing apparatus;

FIG. 2 is an elevational view showing a ship passing through the scrubbing equipment;

FIGS. 3 and 4 are detailed views of the drive mechanism for the scrubbing brushes;

FIG. 5 is a detailed sectional view showing the drive linkage between adjacent brushes in a string, and

FIG. 6 is a detailed sectional view taken on the line 6—6 of FIG. 5 showing the jet construction.

DETAILED DESCRIPTION

Referring to the drawings in detail, the numerals **10** and **12** indicate a pair of vertical piles which are firmly supported in the floor of the body of water in which the ship is floating. Each pile supports a frame, as indicated at **14** and **16**, respectively, the frame being supported from the piles by hinge members **18** that permit the frames to swing toward and away from each other in the manner of a double gate. The frames are of such a size that when they swing toward each other they substantially span the space between the piles **10** and **12**. The frames are made up of hollow tubular members which are sealed to provide buoyancy to neutralize the weight of the frames in the water. The outer swinging edge of each of the frames supports a hollow vertical tubular member **20**, which preferably is also permitted to rotate relative to the supporting frame. A cable **22** extends between the lower ends of the tubular members **20** of the respective frames, the cable passing around a sheave or pulley **24** rotatably secured to and adjacent the lower end of each of the members **20**. The cable passes upwardly along the length of the vertical frame member **20** to the upper end thereof. The cable then passes over a second pulley **26** and passes down through the center of the hollow tubular frame member **20** to a weight **28**. The weights **28** on either end of the cable produce a constant tension on the cable **22**, causing the frames **14** and **16** to swing toward each other and toward the sides of a ship as it passes between the piles **10** and **12**. Because of the constant tension on the cable **22**, the force urging the frames towards the sides of the ship is the same regardless of the width of the ship. At the same time, the cable holds the members **20** fixed angular relationship to each other and the sides of the ship.

Referring to FIGS. **3**, **4** and **5**, each frame supports two strings of rotary brushes indicated generally at **30** and **32**. Each string includes a plurality of cylindrical brushes **34** which are arranged with their axes of rotation substantially aligned. The top brush of each string is connected to a shaft, as indicated at **36** and **37**. A frame plate **40** mounted on top of the frame member **20** supports a transmission unit **38** from which the shafts **36** and **37** extend downwardly toward the top brushes of the two strings. A prime mover **41**, such as a diesel engine, is mounted on the plate **40** and coupled to the transmission **38**.

While the first two brushes in the string are rigidly coupled to the transmission **38**, all the brushes in the string below the top brush are linked together by flexible drive coupling means, the details of which are shown in FIG. **5**. Each rotary brush includes a hollow cylindrical core **50** to which the radially projecting bristles **52** of the brush are secured in conventional man-

ner. Secured to the lower end of the core **50** is a flanged hub **54** having a shaft portion **56** on which is journaled a jet member **58.** Normally as the brush rotates, the jet member **58** is constrained from rotating so that in effect the shaft **56** rotates within the jet member **58.**

Similarly the top of the next brush down in the string has a flanged hub **54'** secured thereto on which is journaled a second jet member **58'.** The jet member **58** and the jet member **58'** are joined by a cylindrical flexible boot or bellows **61** which provides an enclosed space between the two jet members and which prevents relative rotation between the two jet members. The flanged hubs **54** and **54'** are linked by a keyed shaft **62** and universal joint **64** through which angular torque is transferred from one brush to the next but which permits the distance between brushes to vary as well as the angle between the axes of rotation of the two brushes to vary. A coil spring **66** is joined at either end to the flanged hubs **54** and **54'.** The spring **66** is normally under tension so as to pull adjacent brushes toward each other and thereby tend to maintain the entire string of brushes in alignment and under tension.

The jet members **58** and **58'** are prevented from rotating by rigid tubing members **60** which connect a jet member **58'** of one string to adjacent jet member **58** in the parallel string of brushes, as best seen in FIG. **4.** The tubing **60,** as shown in FIG. **6,** terminates in radially projecting nozzle **76** at both jet members. Water under pressure is admitted to the interior of each of the tubing members **60** by means of a hydraulic connection through a conduit **70.** Thus fluid under pressure is exhausted through the jet nozzles **76** which, as shown in FIG. **3,** are pointed in a direction to urge the brushes in the string laterally toward the sides of the ship. The connecting tubing members **60** maintain the jet members **58** and **58'** in proper orientation so that the jet reaction acts in the proper direction at all times.

The lower end of each brush string is anchored in a block **80** mounted on a pair of guide rods **82** which permit the block **80** to shift under the action of the jets in a direction towards the sides of the ship.

In operation, it will be seen that the cable **22** urges the two frames toward each other, bringing the topmost brush in each of the strings into direct engagement with the side of the ship on either side thereof. Because the sides of the ship may not be vertical but contoured, either in a concave or convex fashion, the action of the nozzles **76** causes the brush string to be displaced laterally so as to bring all of the brushes into contact with the sides of the ship, the vertical strings of brushes thereby adjusting to fit the contour of the ship. The brushes in the two adjacent parallel strings are staggered, as best shown in FIG. **4,** so that the brushes scrub overlapping areas as they sweep along the side of the ship. The two strings of brushes are rotated in opposite direction so that the scrubbing action does not tend to displace the strings lengthwise of the ship.

In this manner it will be seen that ships of almost any size can utilize the facility because it automatically adjusts itself to whatever the width of the ship might be. At the same time, cleaning pressure of the brushes is maintained through the constant tensioning system of the cable, combined with the reaction force of the jets associated with the brushes. While normally most of the marine growth is closer to the waterline and the bottom stays relatively clean, an additional rotary string of brushes may be positioned below the ship on a frame hinged for rotation about a horizontal axis. Counterweights and/or positive buoyancy may be employed to hold the brushes against the bottom of the ship.

The above-described system for hull cleaning may be incorporated as part of a dry-dock operation. The swinging frames could be positioned adjacent the entrance to the dry dock so that much of the hull could be cleaned as the ship moved into the dry dock. This would simplify the cleaning operation and remove much of the marine life before it dried out and became hardened by the removal of the ship from the water.

Also, although the invention has been specifically described as utilizing cylindrical brushes, it will be understood that other types of cleaning elements may be used, such as barnacle scrapers and the like.

It will be appreciated that, although the preferred embodiment shows the ship moving relative to the cleaning equipment, the equipment could be mounted on movable platforms, such as barges, rails, or the like, which permit the ship to be stationary and the equipment to move along the length of the ship.

What is claimed is:

1. Apparatus for cleaning a ship's hull comprising a pair of vertical piles spaced apart in the water for permitting the ship to pass between the piles independently of any propelling force applied to the ship by the apparatus, a pair of frames hingedly supported by the piles, the frames being arranged to swing toward each other about the piles, a plurality of rotary brushes rotatable about substantially vertical axes, means for supporting the brushes from the frames, the brushes being moved by the frames toward each other as the frames swing together, means interconnected between the frames for urging the rotary brushes into contact with a ship disposed between the frames with a force which is substantially constant and equal between opposite sides of the ship and which is not dependent upon the beam of the ship or upon the alignment of the ship between the piles, the ship pivoting the frames and forcing the brushes apart as it passes between the piles against the force of said urging means, and means for rotating the brushes to produce a scrubbing action against the sides of the ship.

2. Apparatus as defined in claim **1** wherein the urging means includes a weight, and means including a cable connecting the weight and frames such that the pull of the weight by gravity forces the frames to swing together bringing the brushes into contact with the sides of the ship.

3. Apparatus as defined in claim **1** wherein the frames are neutrally buoyant in water.

4. Apparatus as defined in claim **1** wherein each frame has associated therewith a plurality of rotary brushes with the axes of the brushes substantially aligned with each other, and including drive means operable for imparting rotation to each of the brushes and linking the brushes together in a vertical string, the drive means being arranged to permit the space and angle between adjacent brushes in the string to vary while transmitting a rotary force to the brushes.

5. Apparatus as defined in claim **4** further including jets associated with the brushes in the string, means for exhausting fluid under pressure through the jets, and means for keeping the jets pointed away from the center of the ship such that the reaction of the jets forces the string of brushes toward the sides of the ship.

6. Apparatus as defined in claim 4 wherein each frame has associated therewith a parallel pair of said strings of brushes, the brushes in the two strings being staggered so as to clean overlapping areas along the side of the ship.

7. Apparatus as defined in claim 6 wherein the drive means rotates the brushes in the two parallel strings in opposite directions.

8. Apparatus for cleaning a ship's hull comprising a pair of vertical piles positioned in the water at spaced apart locations for permitting the ship to pass between the piles, a pair of frames hingedly supported by the piles, the frames being arranged to swing toward each other about the piles, the piles and the frames extending to a greater depth in the water than the draft of the ship being cleaned, a plurality of rotary brushes, means for supporting the brushes from the frames, the brushes being moved by the frames toward each other as the frames swing together, means urging the frames and associated rotary brushes together, the urging means including a weight and means including a cable extending between the lower ends of the frames beneath the path of the ship and connecting the weight and frames such that the pull of the weight by gravity forces the frames to swing together bringing the brushes into contact with the sides of the ship, the ship pivoting the frames and forcing the brushes apart as it passes between the piles against the force of said urging means, and means for rotating the brushes to produce a scrubbing action against the sides of the ship.

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