(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 165 911**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **85830133.6**

(51) Int. Cl.⁴: **B 63 B 59/06**

(22) Date of filing: **04.06.85**

(30) Priority: **22.06.84 IT 8337384**

(43) Date of publication of application:
27.12.85 Bulletin 85/52

(84) Designated Contracting States:
AT BE CH DE FR GB LI LU NL SE

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(54) Method and robot platform for washing, sandblasting and painting in shipbuilding dry dock.

(57) A robot platform for washing, sandblasting and painting in shipbuiding dry dock, comprising three operative units respectively: washing unit with washing nozzles (13), sandblasting unit with sandblasting guns (8) provided with dust recovery means (10), and painting unit on trolley means which moves backwards and forwards at one side of the platform (11) provided with respective spray guns (12);

at least one robot computerized control and programming unit and detecting means of the surface to be treated (15) in order to remote-control and move automatically or by operator the above-described assembly for performing the washing, sandblasting, and painting operations on the correspondent broadside surface of the vessel concerned (S).

Said structure is particularly useful for the automation of the plant thereby dispensing with the need for labor on the platform with all the attendant economical, ecologic, and safety advantages.

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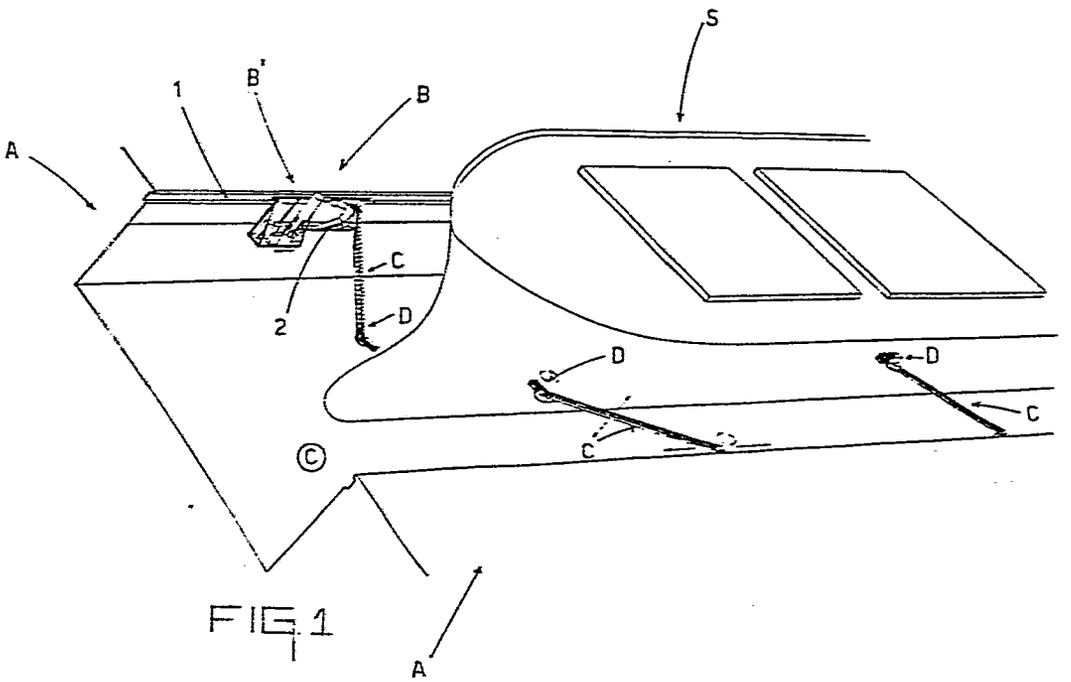

FIG 1

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Method and robot platform for washing, sandblasting and painting in shipbuilding dry dock

The present invention relates to a robot platform for washing, sandblasting, and painting in shipbuilding dry dock and related method of actuation.

The invention is particularly suitable for use in the washing, sandblasting, and painting of vessels in dry docks.

At the present state of the art, platforms are well known on articulated arm mounted on trolley sliding lengthwise along the sides of the dry dock or shipbuilding dock provided with manual movement control at the platform side and with operators on the platform using known manual equipments, such as washing nozzles, sandblasting nozzles and spray guns.

The drawbacks of the currently-used known embodiments and of the above-mentioned prior art consist essentially in that the presence of operators on the platform is always needed, thereby involving danger of accidents, exacting work, greater necessity of labor, and quality level not always satisfactory, as well as considerable ecology and environment problems.

The invention as claimed is intended to provide a remedy to the above-mentioned disadvantages. It solves the problem providing an automatized revolving platform mounted on swinging shortenable and extensible articulated arm further mounted on a trolley structure sliding horizontally along the sides of the shipbuilding dock or dry dock, and in which on said platform at least three operative units for washing, sandblasting and painting are further mounted provided

with extracting and recovery means of waste and/or pollutants (sandblasting dusts, painting steam, etc.) and in which at least one painting unit is placed on one longer side of the platform with spraying means movable along same, the whole being controlled by program control unit or robot remote-control either on said trolley structure or in fixed position on said dry or shipbuilding dock.

In another preferred embodiment of the invention said trolley structure is operatively connected to a "tender" trolley suitable for transporting all the equipments and materials necessary to the robots located on the platform. A convenient embodiment of the invention provides essentially a support arm structure supporting said platform, said support arm being connected articulated to a trolley structure consisting of two upper trolleys and one lower trolley.

The assembly is suitable for accomplishing the functions corresponding to the various washing, sandblasting, and painting phases as well as for providing, by means of an extracting plant, to the recovery of dusts, the whole being automated.

This is obtained associating the structural design of the platforms on articulated arm and trolley with programming and control means and with the assembling on the platform of said operative washing, sandablasting, and painting units, automatically controlled during management and working thereof. This can be accomplished also by adapting the extant autoshifters, making same suitable for housing the equipments and permitting automatic movement thereof, as follows:

- replacing the slide valves by suitable servovalves,
- locating convenient position transducers on the rotation axes.

All equipments (washing nozzles, sandblasting head, painting trolley, the features of which are well known in the art and are also described, particularly with respect to the painting unit, in the Italian patent application in the name of the same applicant, filed November 27, 1981 with filing number 83501A/81 and the robot sandblasting system described in the Italian patent application filed May 19, 1982 with filing number 83391A/82) must be conveniently housed on the revolving platform so as to make it possible to perform each operation according to the type of treatment to be carried out.

The advantages offered by this invention are obvious and result mainly from the automation (robots) of the equipments and related plant, thereby solving important ecology and accident prevention problems with attendant labor and management cost saving.

Operations and characteristics thereof are as follows:

Washing unit

In the preferred embodiment the washing unit is designed to operate in fully automatic way on the vessel broadsides. The use of water at a pressure of about 250 - 300 bars allows to reach about 700 sq m/h productivity. The moto pump unit, conveniently sized, is placed at a distance of about 60 m from the nozzles.

The supply includes all the equipment such as hoses, nozzles, pipe fittings, etc.

Sandblasting unit

In the preferred embodiment the sandblasting unit is conveniently designed to operate in fully automatic way on the vessel broadsides, with a productivity equal to about 70 sq m/h. The sandblasting nozzles are mounted on a special support integral with the revolving platform. The automatic control ensures continuous working system

and uniformity of jets. The support frame of the sandblasting nozzles, made of strong rolled steel sections, is constructed in such a way as to be able to tilt the nozzles by simple two fixed position movement of a pneumatic cylinder. The nozzles are Ventury-type nozzles, with tungsten carbide exits. The diameter may vary from 6 to 8 mm and length from 100 to 150 mm. The distance and arrangement of the nozzles from the vessel broadside is constant and convenient. The facilities machines, including sand silos, are placed at a distance of about 60 m from the operative head. The plant comprises sand silo, sandblasting machines complete with valves, pipes and pipe fittings, all mechanical equipment and carpentry for support and automatic positioning of the sandblasting unit, movement pneumatic cylinders, fuel mixture feed pipes, flow control valves, etc.. A high head dust extracting plant is further provided also placed at a distance of about 60 m and is connected direct to the metal covering case within which the sandblasting head is situated. Constant suction pressure allows removal of dusts produced during working as well as partial recovery of the sand used. The dust extracting plant obviously includes also a cyclone separator, filters, and pipe fittings.

Painting Unit

In the preferred embodiment the painting unit is designed to operate in fully automatic way on the vessel broadsides, with a productivity equal to about 700 sq m/h based on 50 micron thickness. All equipments, except spray guns, are placed at a distance of about 60 m from the revolving platform. The nozzles are mounted on a suitable trolley which moves backwards and forwards and is capable of two-way painting. The automatic control ensures economical spraying system and uniform paint application, thus reducing waste to a minimum. The nozzles, two in number, with relative supports, are placed on a painting trolley suspended from four points by means of ball

bushings running on cylindrical hardened and tempered steel rails. The full extent of such rails is covered so as to protect same against paint. Covering is easily removable. The painting trolley is operated by fluid-dynamic motor. All supports for cables and tubes are provided. The distance of the nozzles from the vessel broadside is constant and about 300 mm measured along the paint spray. During painting, the movement of the platform supporting arm and relative support trolley structure is integrated by the translation of the trolley carrying the spray guns which is placed on the platform and which will be rotated for this purpose with the respective side against the vessel surface to be painted. Such trolley must have conveniently flexible movements so as to adapt to the various painting requirements. The equipment will be obviously known to those skilled in the art and will work preferably by airless spraying in order to operate with all types of paints available on the market. The plant is operated by high pressure pump and is provided with paint recirculating system, thus obtaining a considerable advantage with respect to everyday cleaning. The equipment comprises a high pressure air-lift pump, compressed air treatment unit, pneumatic hoister, plenum chamber, filters, etc. and is provided with all the necessary pressure gauges, valves, and unions, and the plant will obviously be completed with all pipes and necessary pipe fittings for connecting pump with nozzles, as well as with air-operated agitator, with bladed propellers provided with speed regulator in accordance with well known prior art.

Automation

Autoshifter motion and operation of washing, sandblasting, and painting plants can be fully automatized. Such automation is ensured by four-axis hardware medium managed by dedicated microcomputer executing and controlling all operations as shown in tables 1 and 2 as set forth below.

TABLE 1

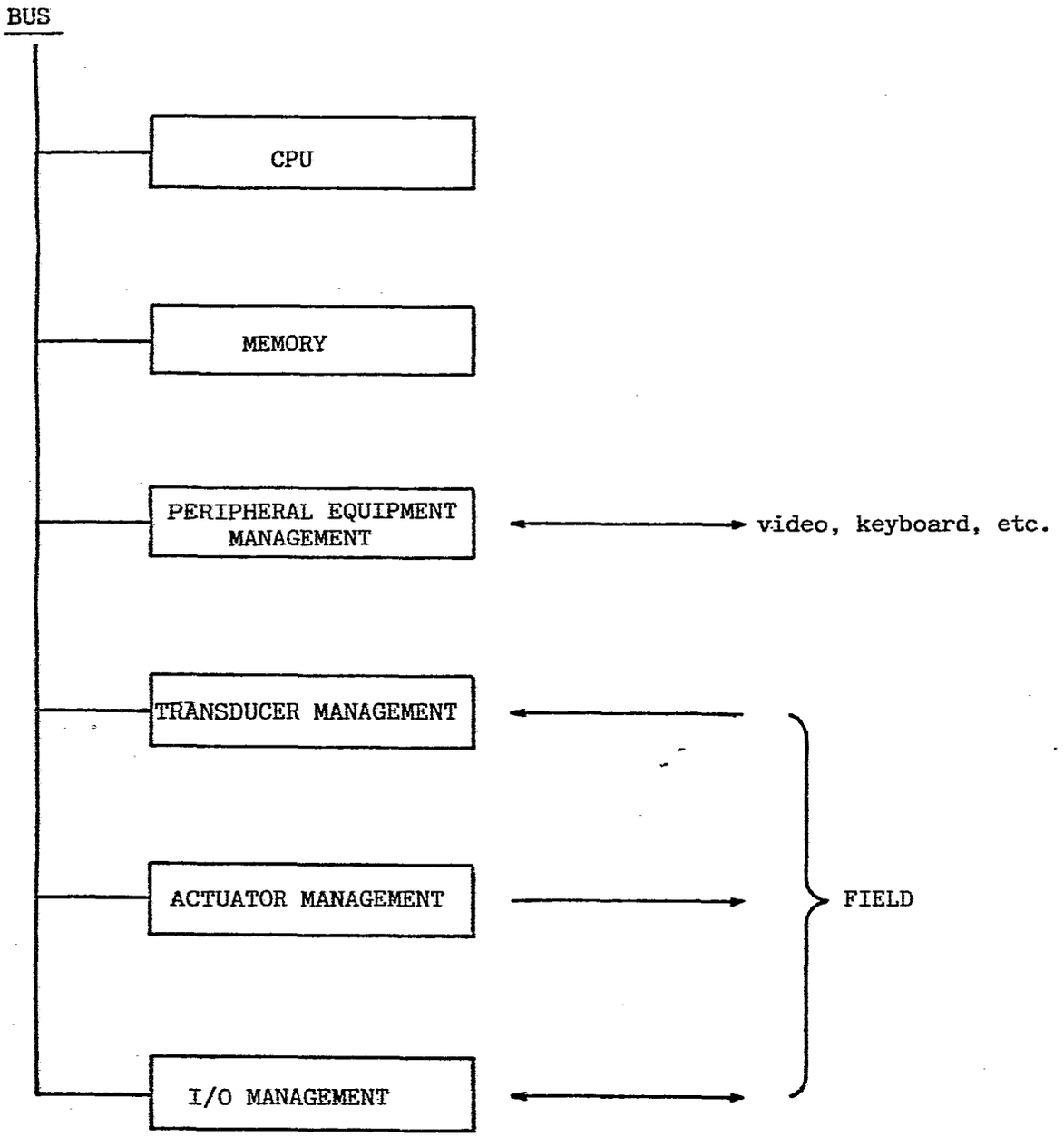
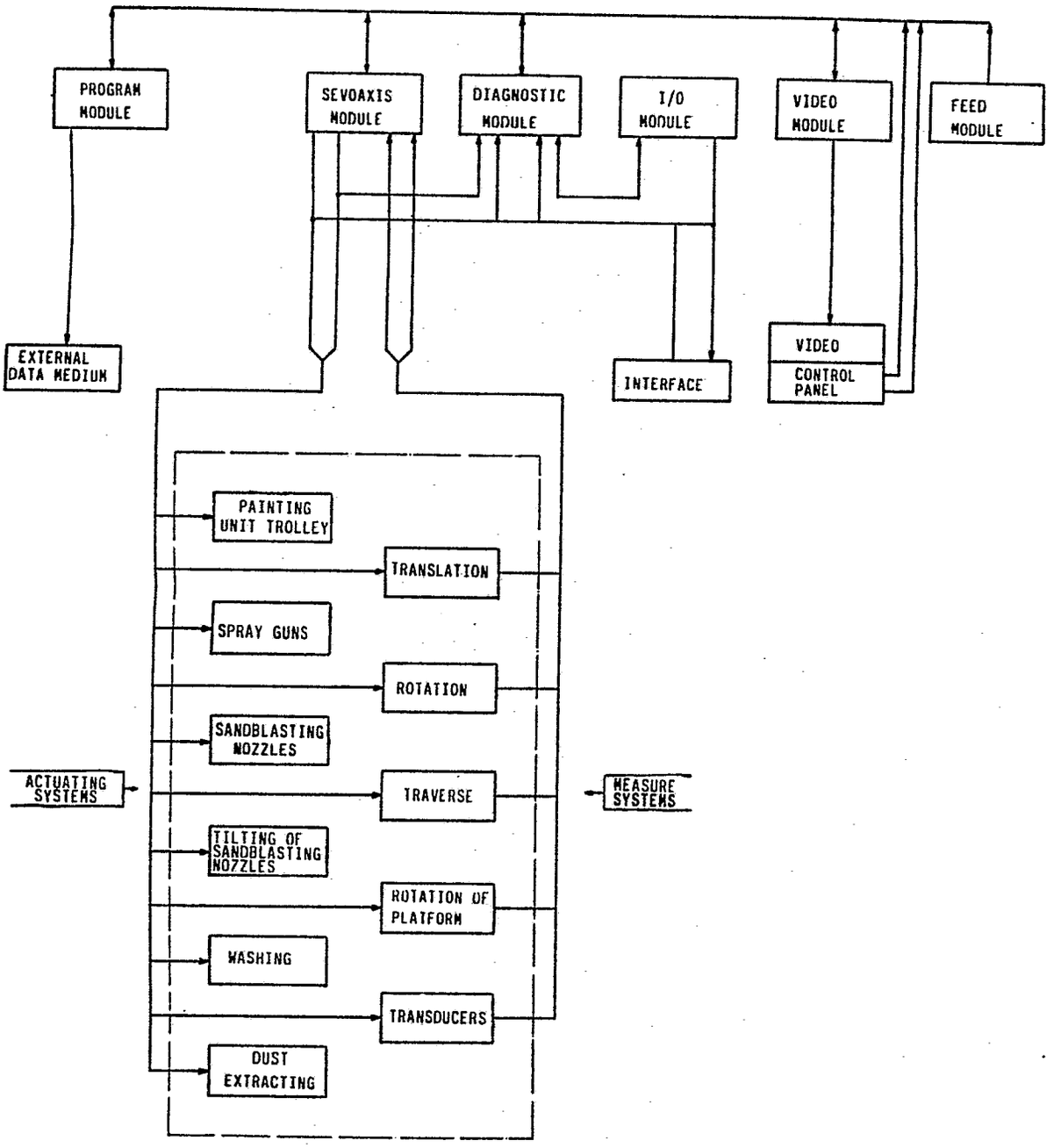

BUS
CPU
MEMORY
PERIPHERAL EQUIPMENT MANAGEMENT
video, keyboard, etc.
TRANSDUCER MANAGEMENT
ACTUATOR MANAGEMENT
I/O MANAGEMENT
FIELD

TABLE 2


PROGRAM MODULE
SEVOAXIS MODULE
DIAGNOSTIC MODULE
I/O MODULE
VIDEO MODULE
FEED MODULE
EXTERNAL DATA MEDIUM
INTERFACE
VIDEO
CONTROL PANEL
PAINTING UNIT TROLLEY
TRANSLATION
SPRAY GUNS
ROTATION
SANDBLASTING NOZZLES
ACTUATING SYSTEMS
TRAVERSE
MEASURE SYSTEMS
TILTING OF SANDBLASTING NOZZLES
ROTATION OF PLATFORM
WASHING
TRANSDUCERS
DUST EXTRACTING

The hardware medium is suitable for the simultaneous control of four independent movements and management of all the tasks of the separate plants. Hardware is used by suitable software in order to ensure all process of motion, operating and control so as to make the operative machines fully autonomic. Executive software contains special parameters related to the machine and control operating. These data are stored and assisted by battery should a blackout occur. Address information received from the input data selects the axis to be positioned and provides command for motion thereof. Information received from input data provides command for the execution of movements. The trajectory along which the unit moves is controlled by function generators with linear or circular interpolation depending on the selection executed by the preparatory functions. The generators supply simultaneous positioning commands to the axes concerned. Movements are kept under constant control by servomotors for maintaining the actuated positions. The feedback unit indicates the error between the machine position and the controlled position. Any difference between the two values, representing the position error delivers to the servomotor a signal which moves said servomotor so as to correct such position error. The control has on-line self-checking system which clearly indicates errors or malfunction.

Equipped platform or tender trolley

On a platform about 7 x 2 m in size, all the necessary equipments are placed in convenient and rational manner in order to facilate approach thereto and maintenance thereof. The platform includes the following devices and elements:

No. 1 silo for storing sand, having a capacity of 8 - 10 cu m, a sufficient amount for one work shift to operate.

No. 6 sandblasting machines, of the air-grit mixture type, having a capacity of 200 l, and maximum running pressure of 12 bar,

complete with dose-measuring valves, fittings and quick-fit unions for rapid connections and disconnections to the various plants.

No. 1 painting pump installed on the paint container, with all the accessories for the use thereof, provided with fittings and quick-fit unions for rapid insertion into production.

No. 1 high head dust extracting plant, as described above, complete with all equipment, including cyclone separator.

No. 1 timed plant for quick discharge of waste sand and dusts into containers placed on the bottom of the dock.

No. 1 air-lift motor pump for the washing plant.

The platform is carried out by using strong section bars and plates and is provided with the necessary eyebolts for easy transport by means of crane to the operating site.

The advantages offered by this invention, in addition to what already set forth above, consist essentially in that the absence of operators aboard the platform ensures a considerable reduction in work accidents; the automated control ensures an economical spraying system and uniform paint application, thus reducing waste to a minimum, and since the plant is operated by high pressure air-lift pump and is provided with recirculating system, a considerable advantage is obtained with respect to everyday cleaning.

One way of carrying out the invention is described in detail below with reference to drawings which illustrate some preferred embodiments, in which:

Figure 1 is a perspective view of the automatized platform during working on a vessel hull; Figure 2 is a front view (from the dock

side) of the trolley associated with the translation truck; Figure 3 is a side view of the arm connected to said trolley structure, showing at the end the relative "platform" swinging in three different positions: upwards (shortened), horizontal, and downwards (partial representation) respectively; Figure 4 is a plan view of the trolley structure with arm and platform and relative tender near the trolley structure; Figure 5 is an enlarged view of the platform mounted on the end of the arm showing the washing nozzles in operative condition; Figure 6 is an enlarged plan view of the end of the arm with relative platform of Figure 5; Figure 7 is a further enlarged side view of the platform showing details regarding sandblasting (in the operative phase at the head to the supporting arm) and painting (inoperative at the side, i.e. frontally in the drawing); Figures 8 and 8/1 show further enlarged details relating to the spray guns and painting trolley; Figure 9 shows an enlarged detail of the nozzles of the sandblasting unit.

According to the above figures the invention consist of a support structure for use in a dry dock A, within which a vessel hull S is situated. The structure A, internally and sideways externally opposite to the hull S, is provided with two sliding rocking trolley means connected between them B,B' supporting arm C and platform D and tender/go-devil respectively .

The support structure A consists of a steel framing which supports the whole machine. On the top thereof the trolley means B,B' hang sliding from guides 1 and on the bottom slide on guides 2. The washing motor pump 4, painting unit 5, sandblasting unit provided with silos 6, sandblasting machines 7, and dust extracting plant 8 are placed on the tender trolley means B'.

On the top of the translation trolley structure B the rotation unit of the arm C is housed with relative motor and rocking unit of said

arm with articulated supports of the hoisting cylinders. All the motion motors, electric and hydraulic systems, and fluid-dynamic power gearcase with the main motor which may be electric/diesel or diesel/electric motor are also housed on said structure.

The upper structures relative to the trolley means B and B' are made of steel structural work, mechanically worked. All the vertical stresses of the machine, all the horizontal stresses in traverse direction, and part of the transversal stresses resulting from eccentric loads when the machine is working discharge on said upper structures. Each trolley means is secured to the structure by means of special non-stiff bearing, the function of which is to make the system statically determined. Each trolley means is provided with: horizontal axis wheels, vertical axis wheels 3, an effective antiderailment mechanical lock system for safety purpose, fluid-dynamic operated motor reducers for the sliding of the whole machine.

The lower structures of the trolley means B and B' are made of strong steel structural work, mechanically worked. All the horizontal stresses in direction opposite to traverse, and part of the torsional stresses resulting from eccentric loads when the machine is working discharge on said lower structures. Also this portion of trolley means is secured to the structure by means of special non-stiff bearing, the function of which is to make the system statically determined. Said portion of trolley means is provided with vertical axis wheels 3 and another effective mechanical lock system for safety purpose.

The swinging arm C is made of a strong steel structural work, mechanically worked. On the top thereof the unit for rotating the

work platform D is housed. On the bottom there are: the vertical axis system for rotating said arm, a vertical axis thrust bearing system, the motion motor reducer. The arm is provided with linkage arranged so as to keep the work platform D horizontal, whatever the inclination of the arm. On the top of the arm, steps to reach the platform are placed, protected by a double row of grab rods. At the interior and at the bottom of the arm all the tubes and electric cables necessary to the treatment plants are housed.

The work platform D is made of a strong steel structural work. At the bottom thereof the rotation unit and operating motor reducer are housed with all the safety locks. At the sides of the platform, on suitable structures acting also as grab rods there are: the sandblasting nozzles 8, orientable and movable by motor means 9, sand collector 10, trolley 11 supporting spray guns 12 and provided with motion system therefor by fluid-dynamic motor and rack, including limit switches, solenoid valves, sensors, etc.. At the side supporting the sandblasting nozzles 8, the hood is placed for extracting the sandblasting residual dusts 10.

Alongside of this unit on the same shorter side of the platform the washing unit 13 is situated as well, provided with suction sump 14, operating alternately (either one or the other).

On the platform head the respective feeding and positioning sensors 15 are obviously installed, controlling the position of the platform and operative units according to the vessel hull being treated.

The machine working is performed essentially in four phases:

- Washing phase

At the start of the operating cycle, the machine is positioned in any point of the vessel broadside. Correct positioning is ensured by suitable tracer points placed on the mobile platform. Upon go message the motor pump unit begins to operate and the plant begins the washing operation by pressure water, moving lengthwise at predetermined speed. Such longitudinal movement continues to cover the whole predetermined distance. At this moment the mobile platform lowers automatically by a convenient length so as to ensure by the successive travel in opposite direction complete superimposition with the portion already washed. Such operations repeat cyclically to the complete vertical covering of the determined length. The first cycle being completed, the machine translates and positions at the successive cycle.

- Sandblasting phase

The washing cycle being completed, the machine is positioned for starting the sandblasting phase. The sandblasting head 8 is placed at the same side of the mobile platform where the washing nozzles 13 are mounted. Upon go message the solenoid valves controlling the inlet of air-grit mixture open and the plant starts the sandblasting operation with all the nozzles working in accordance with the same operating cycle as described for the washing phase. The nozzle holder head is housed within a metal covering case 10; the interior of said case is constantly vacuum in order to avoid outlet of dusts and recover partially the sand used.

- Painting phase

The sandblasting cycle being completed, the whole mobile platform D rotates by 90° thus presenting the longer side parallel to the vessel broadside. On this portion of the platform a frame is placed complete with rails on which a trolley 11 runs supporting two spray

guns for airless spraying 12. At the start of the working cycle the machine is positioned on an edge of the vessel broadside. Upon go message the trolley translates, spraying lengthwise the vessel broadside for a portion equal to the working stroke of said trolley (about 3 meters). The coat being completed, the whole machine lowers along the same path for a portion equal to the length sprayed in one coat. At this moment, the trolley translates, still spraying, in opposite direction. The cycle repeats as far as the end of the vertical path along the vessel broadside; the same cycle is then repeated on a path adjacent the preceding one. Working on rounded portions in longitudinal direction is corrected by rotating the mobile platform controlled by convenient transducers.

- Working on rounded surfaces

With respect to rounded portions in vertical direction, the sandblasting nozzles are positioned by predetermined inclination upward whenever the lower sensor of the sandblasting head signals that the surface to be painted is too remote from the working distance.

TECHNICAL PARTICULARS

1. Washing plant by pressure water

No. 2 nozzles

No. 1 pump

capacity: 100 liters/min.

working pressure: 300 bars

max pressure: 350 bars

installed horsepower: 90 HP

r.p.m.: 1800

productivity/h: approx. 700 sq m

2. Sanblasting plant

No. 6 sandblastign nozzles

Nozzle diameter: 8 mm

Minimum width of sandblasted path: 400 mm

Sandblasting speed variable up to 3 m/min.

Plant productivity at a speed of 2,5 m/min.: 70 sq m/h

Silos capacity: 10 cu m

No. 6 Sandblasting machines including accessories

capacity: 200 liters each

max working pressure: 12 bars

air consumption for each sandblasting machine: about 4,5 cu m/min.

Quick-fit union pipes and pipe fittings

3. Dust extracting and recovery plant

Capacity: about 3000 cu m/h

Total head: 2500 mm a.c.

Installed power: 30 Kw

Cyclone separator and filter of suitable size

4. Painting plant

No. 2 spray guns

Width of painted path for coat: approx. 600 mm

Painting speed variable up to 1,5 m/sec

Average productivity: 700 sq m/h

Painting pump suitable for any types of paint, complete with trap, pressure regulator, automatic lubricators, valves, etc.

ratio: 60:1

max capacity: 12 liters/min.

Automatic hoister for lifting the pumping unit

Double propeller pneumatic agitator

horsepower: 1 HP

Obviously changes and modifications can be made without departing

from the spirit or scope of the invention as defined in the appended claims.

Udine, June 28, 1985

p. VIANOVA S.p.A.

The Representative

Dr. Giovanni D'Agostini

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Claims:

1. Robot platform for washing, sandblasting and painting in shipbulding dry dock, of the type insertable into the side structures provided with guide rails (1) of a shipbuilding dock or dry dock (A) preferably for middle and large size vessels (S), comprising at least one support translation structure provided with sliding trolley (B) horizontally controlled on said guide rails (1) on the dock sides (A), said trolley structure supporting a swinging and/or variable in length arm (C), at the end thereof a platform being mounted articulated so as to stay always oriented in a predetermined direction independently of the movements thereof (D), characterised in that:

- on said platform (D) at least three operative units are located, respectively washing unit with washing nozzles (13), sandblasting unit with sandblasting guns (8) provided with dust recovery means (10), and painting unit on trolley means which moves backwards and forwards at one side of the platform (11) provided with respective spray guns (12);
- at least one robot computerized control and programming unit and detecting means of the surface to be treated (15) in order to remote-control and move automatically or by operator the above-described assembly for performing the washing, sandblasting and painting operations on the correspondent broadside surface of the vessel concerned (S).

2. A platform as claimed in claim 1, characterised in that said platform supports operating means in polygonal structure placed (D), being said painting unit (11,12) at one side placed.

3. A platform as claimed in the preceding claims, characterised in

that the platform side on which the painting unit is installed is the longer side, said platform having operating means in rectangular adjacent position placed, and wherein at the adjacent side of the painting unit at least one of the other operative washing and/or sandblasting unit is placed, said platform being rotatable in order to present in operating condition either one side or the other respectively.

4. A platform as claimed in the preceding claims, characterised in that the units for storage and respective conveyance of the treatment materials (4,5,6,7) are placed near said translation trolley structure (B).

5. A platform as claimed in the preceding claims, characterised in that the units for storage and respective conveyance of the treatment materials (4,5,6,7) are placed on a tender connected unhookable (B') to said translation trolley structure (B).

6. A platform as claimed in the preceding claims, characterised in that the movement control means of the assembly are placed on said translation trolley structure (B).

7. Plant for washing, sandblasting and painting in shipbuilding or dry dock (A) for middle and large size vessels (S), characterised in that said plant comprises at least one robot platform structure according to the features as claimed in preceding claims said robot platform structure being placeable on horizontal guides (1) of the sides of said dock (A) .

8. Method and plant for washing, sandblasting and paiting using at least one robot platform according to the features of preceding

claims, characterised in that said method and plant comprise the following phases without the presence of labor on the platform for the treatment of the vessel surface:

- Washing phase

At the start of the working cycle, each robot platform can be positioned in any point of the vessel broadside. Correct positioning is ensured by suitable tracer points placed on the mobile platform. Upon go message the motor pump unit begins to operate and the plant begins the washing operation by pressure water, moving lengthwise at predetermined speed. Such longitudinal movement continues to cover the whole predetermined distance. At this moment the mobile platform lowers automatically by a convenient length so as to ensure by the successive travel in opposite direction complete superimposition with the portion already washed. Such operations repeat cyclically to the complete vertical covering of the determined length. The first cycle being completed, the machine translates and positions at the successive cycle.

- Sandblasting phase

The washing cycle being completed, the machine is positioned for starting the sandblasting phase. The sandblasting head (8) is placed at the same side of the mobile platform where the washing nozzles (13) are mounted. Upon go message the solenoid valves controlling the inlet of air-grit mixture open and the plant starts the sandblasting operation with all the nozzles working in accordance with the same operating cycle as described for the washing phase. The nozzle holder head is housed within a metal covering case (10); the interior of said case is constantly vacuum in order to avoid outlet of dusts and recover partially the sand used.

- Painting phase

The sandblasting cycle being completed, the whole platform (D) rotates by 90° thus presenting the longer side parallel to the

vessel broadside. On this portion of the platform a frame is placed complete with rails on which a trolley (11) runs supporting two spray guns for airless spraying (12). At the start of the working cycle the machine is positioned on one edge of the vessel broadside. Upon go message the trolley translates, spraying lengthwise the vessel broadside for a portion equal to the working stroke of said trolley (about 3 meters). The coat being completed, the whole machine lowers along the same path for a portion equal to the length sprayed in one coat. At this moment, the trolley translates, still spraying, in opposite direction. The cycle repeats as far as the end of the vertical path along the vessel broadside; the same cycle is then repeated on a path adjacent the preceding one. Working on rounded portions in longitudinal direction is corrected by rotating the mobile platform controlled by transducers.

- Working on rounded surfaces

With respect to rounded portions in vertical direction, the sandblasting nozzles are positioned by predetermined inclination upward, whenever the lower sensor of the sandblasting head signals that the surface to be painted is too remote from the working distance.

Udine, June 28, 1985

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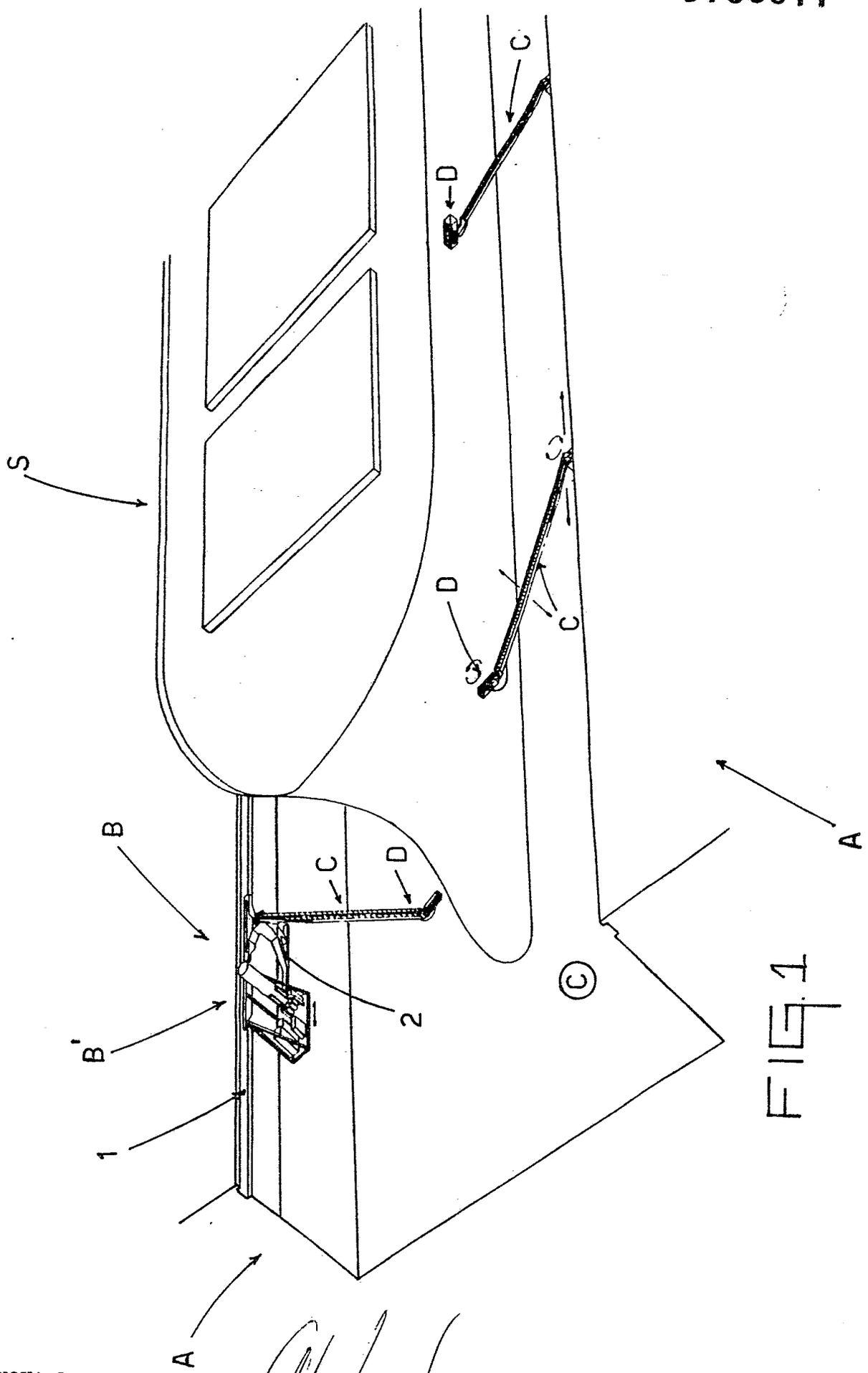

FIG 1

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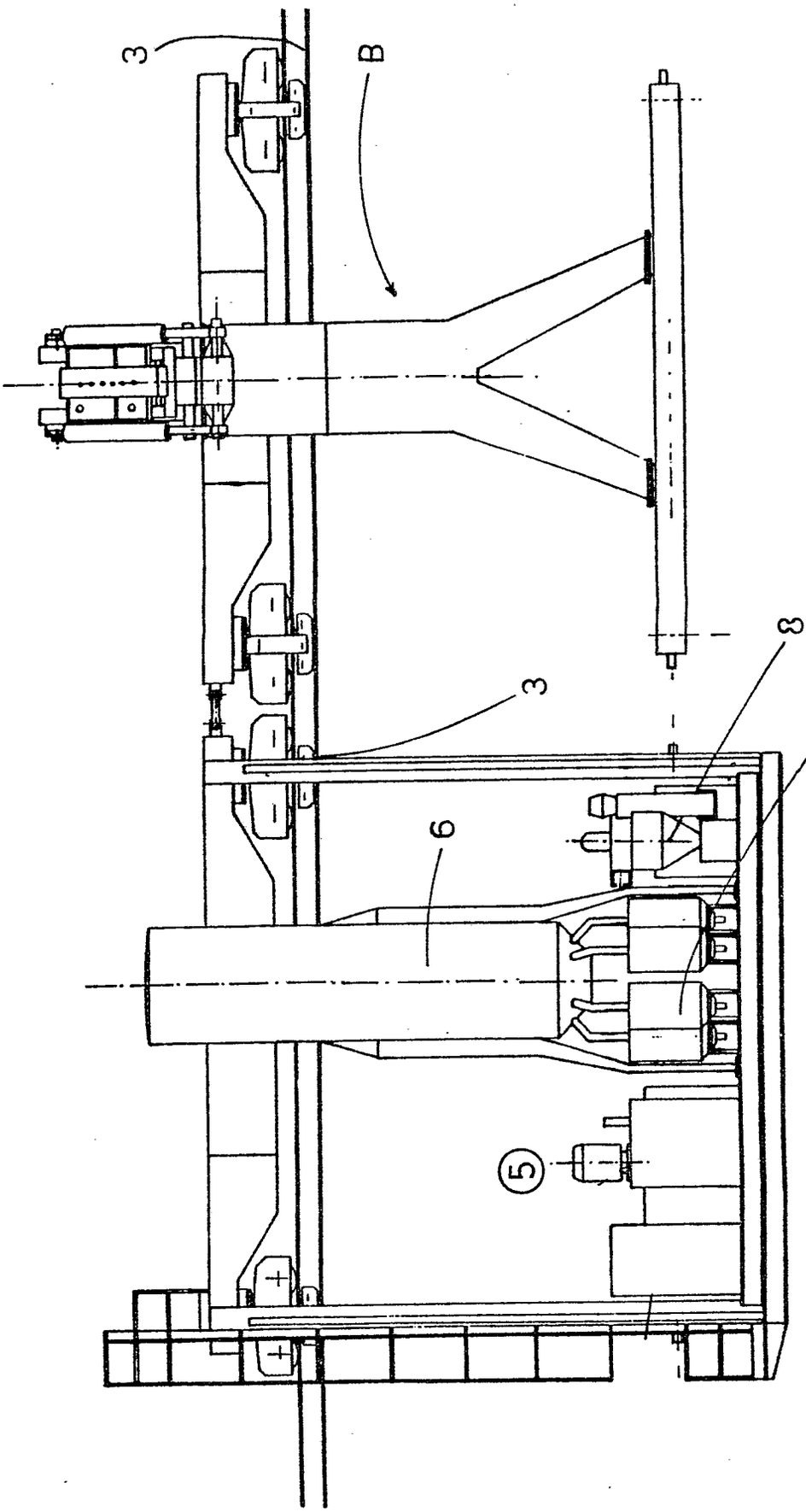

FIG 2

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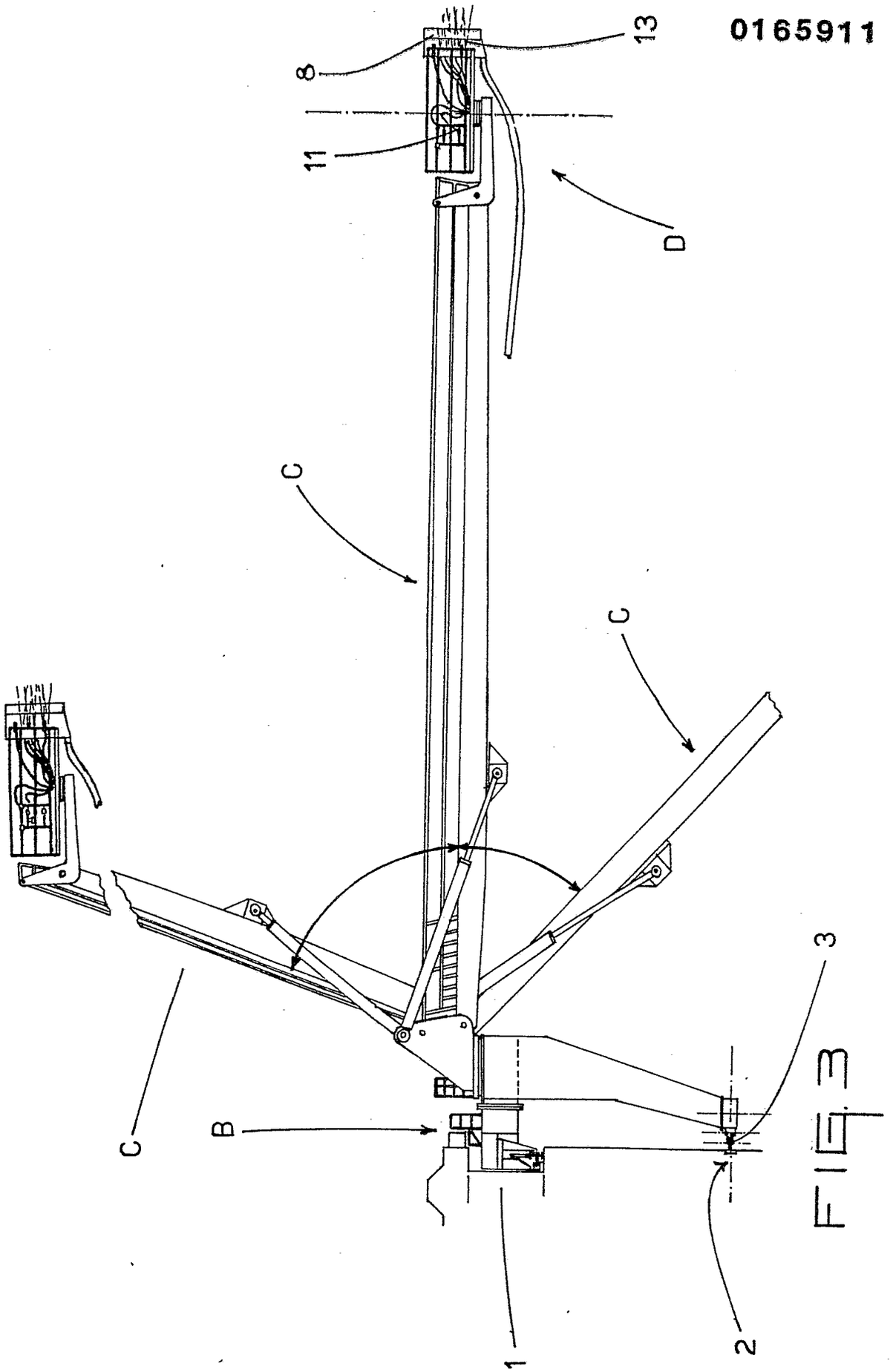

FIG 3

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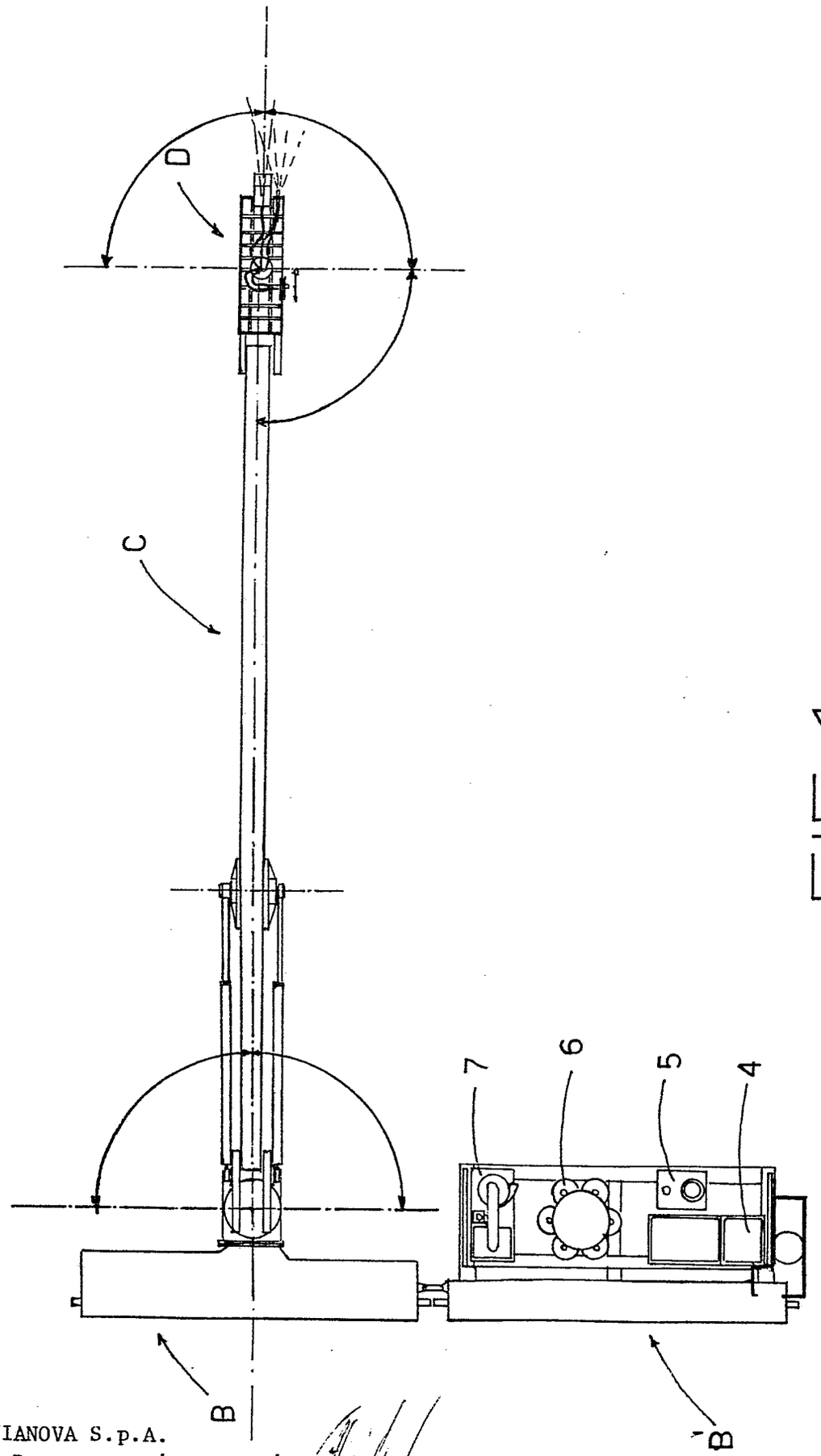

FIG 4

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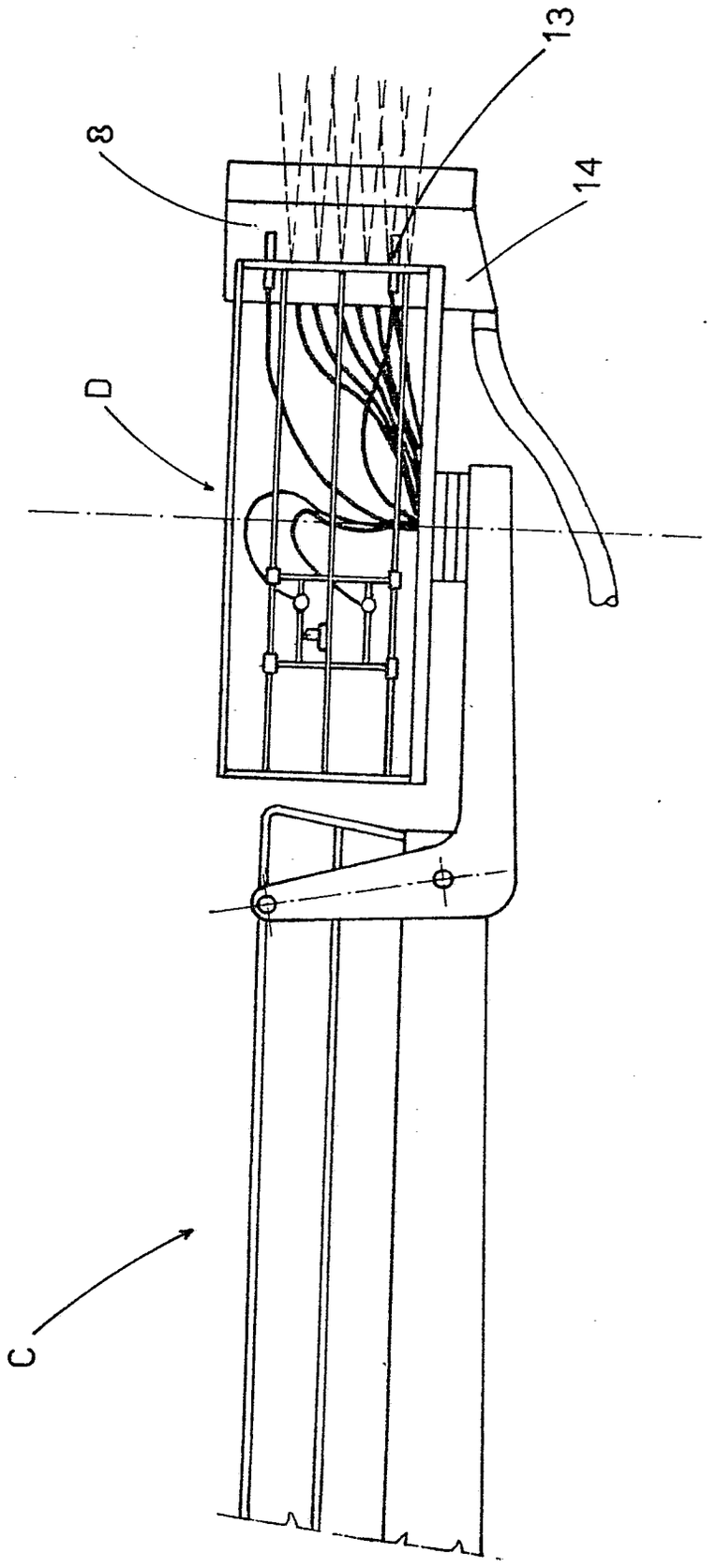

FIG 5

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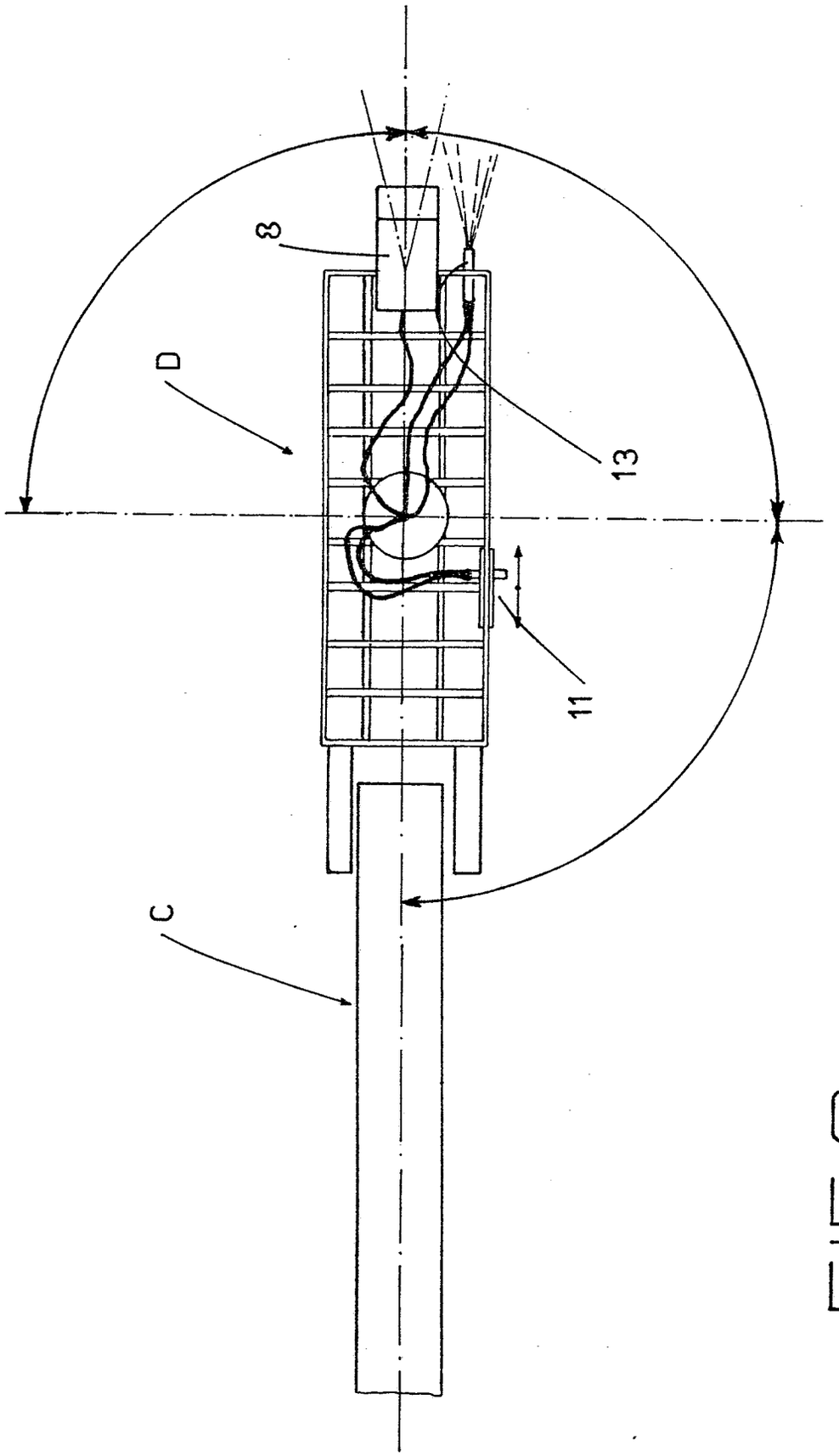

FIG 6

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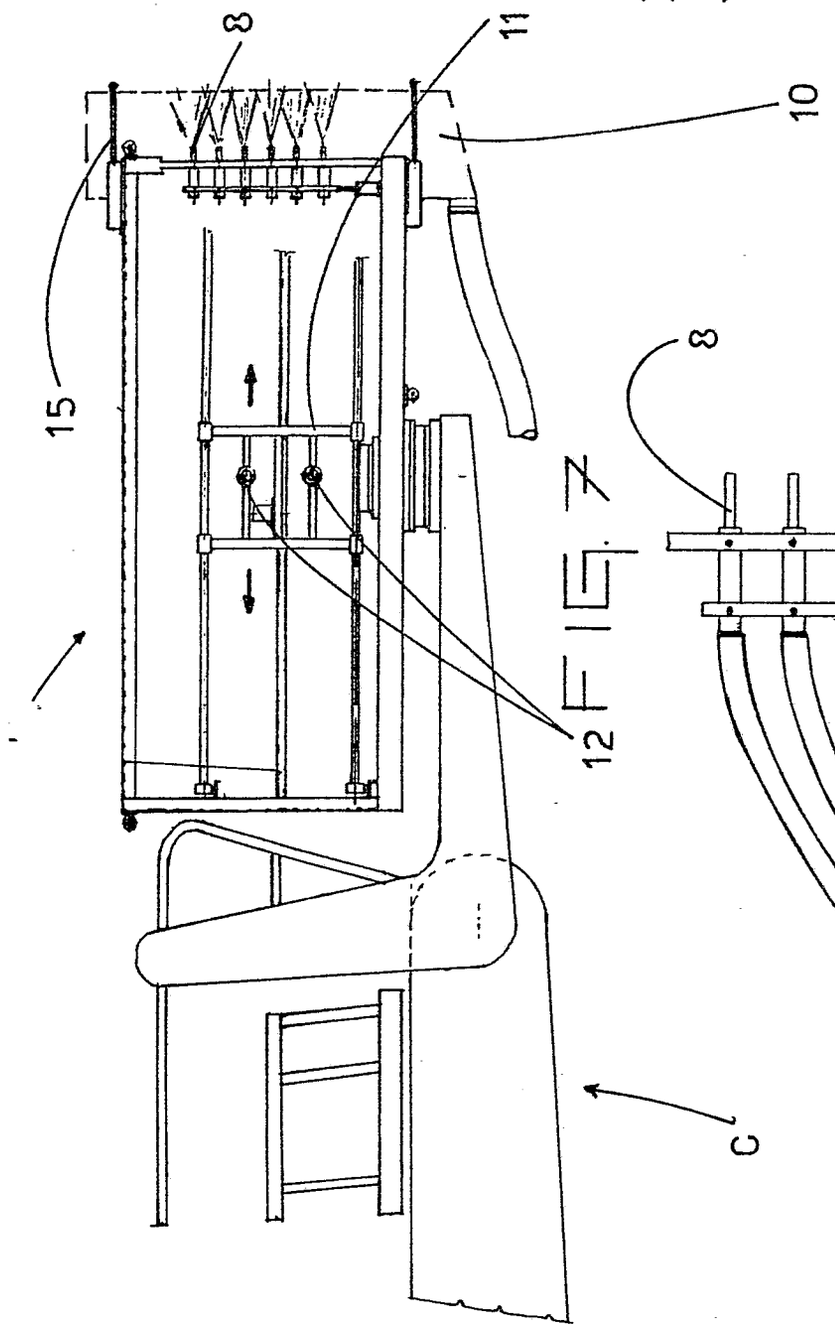

FIG. 7

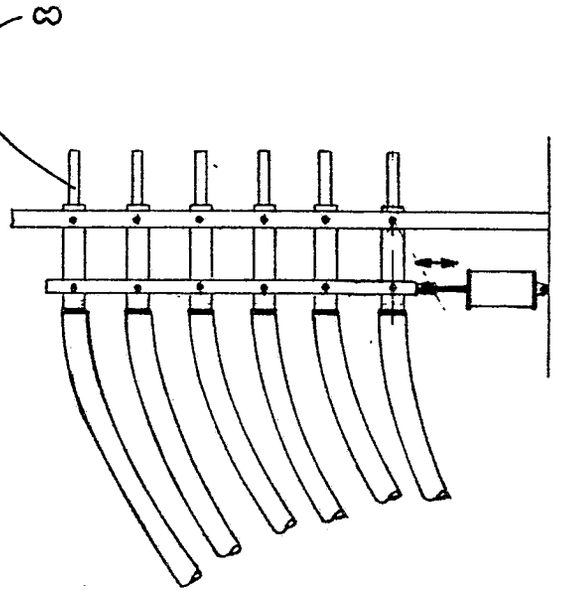

FIG. 9

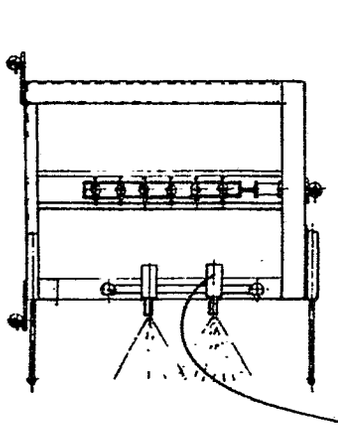

FIG. 8

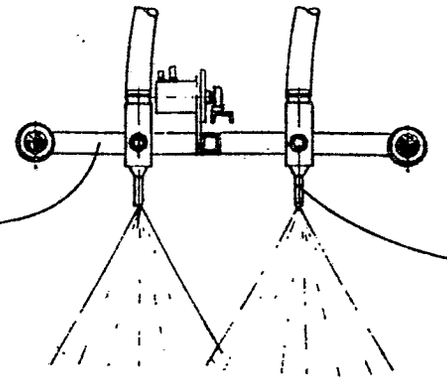

FIG. 8/1

p.VIANOVA S.p.A.

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