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(54) Marine vessel based system and method of managing municipal solid waste

(57) A marine vessel provided with the appropriate layout and equipment for the reception, segregation and treatment of municipal solid waste so as to deliver discrete quantities of various recyclable materials, along with a mainstream product of dried, biologically stabilised, waste. The vessel is provided with an upper deck whereupon containers (1) which can be of any type (C1-C5) are parked along a plurality of rows and columns. Whilst containers (C3,C4,C5) loaded with used oils, batteries and medical hazardous waste and containers (C2) loaded with used appliances remain onto the upper deck, containers (C1,C2) loaded with MMSW, SMSW, green waste, sewage sludge, bulky waste and tyres are selectively rearwardly led at a plurality of waste treatment decks (D1-D3) underlying the upper deck and/or into a biotreatment area (43). Following segregation, shredding, baling operations, packaged recyclable paper, plastic and aluminium is loaded back into containers (C1), whilst collected recyclable glass and shredded tyres and bulky waste is loaded into containers (C2) and the dried, biologically stabilised, product extracted from the biotreatment area (43) is loaded into containers (C1), all these containers being transferred and parked onto the upper deck. ready for delivery at a final destination.

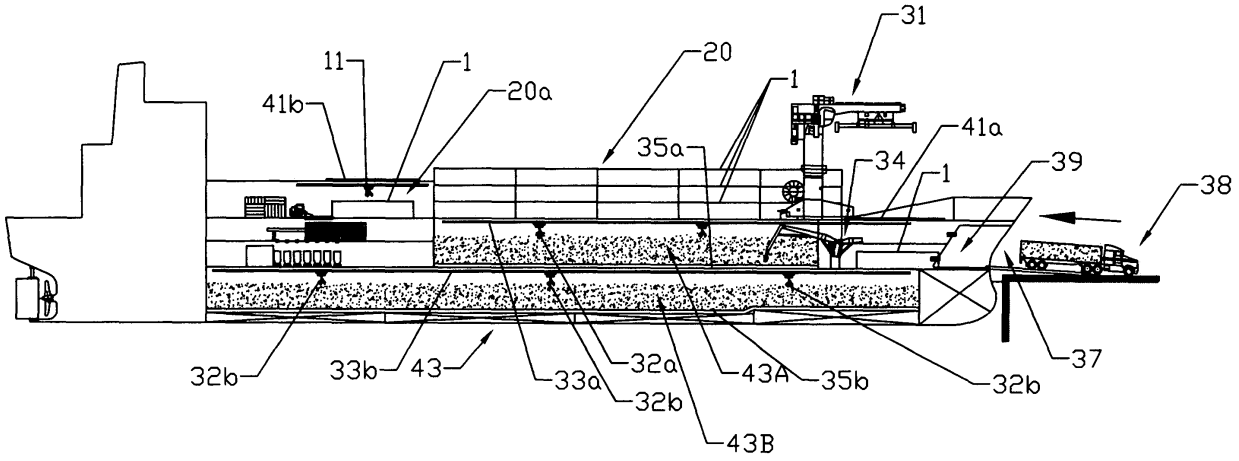

Fig. 1

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Description

[0001] The invention relates to a marine vessel provided with the appropriate layout and equipment for the reception, segregation and treatment of municipal solid waste so as to deliver discrete quantities of various recyclable materials, said marine vessel including a biotreatment site and providing dried, biologically stabilised, waste material delivery. Accordingly the invention relates to a method of on board managing municipal solid waste.

[0002] Waste disposal is known to represent one major problem of modem cities. The problem is further aggravated in isolated, periodically heavily populated sites, such as islands with massive tourist attraction. Landfill sites are difficult to provide, whilst they are apt to lead to contamination of water ways and aquifers. On the other hand waste incineration gives rise to hazardous emissions of combustion gases and toxic ashes. Both methods are therefore environmentally non acceptable, especially for sites such as touristically attractive islands, wherein the investment required would be economically unacceptable, given the excessive difference in required waste processing capacity between the relatively sort tourist period where waste production is peak and the long quiet period where waste production is minimal.

[0003] Scarcity of landfill sites and hazardous incineration emissions have led to offshore waste disposal having been practiced with floating barges converted into septic tanks wherein waste is passively allowed to decompose under anaerobic conditions. Such processing however is rendered inefficient and even ineffective in decomposing organic waste, whilst, if collected waste is merely dumped into barges without prior opening of plastic bags and segregation, these closed plastic bags constitute potentially dangerous spots for initiating explosions. DE-4113993 alternatively proposes a procedure of composting waste material within a covered barge or similar craft-vessel, however including means of aeration.

[0004] US-5,148,758 proposes a floating recycling and transfer station working in association with a plurality of waste recipient barges, wherein first stage operations of solid waste separation into recyclable and non-recyclable fractions are implemented within this floating station, the non-recyclable fractions being subsequently transferred into floating refuse barges. JP-2003251314 also proposes a stationary structure of a pontoon or artificial island as a garbage disposal site. In the same logic of providing stationary floatable structures for waste disposal, WO 2007/004905 discloses a method treating municipal solid waste offshore, alternative to incineration and landfill, comprising segregation of municipal solid waste into biodegradable, recyclable and non recyclable fractions, sealing non recyclable fractions within a plurality of anchored flat top floating vessels and treating the biodegradable fraction on top of the above mentioned plurality of floating vessels by composting or vermi-composting, wherein such plurality of anchored floating vessels progressively forms an ever expanding stationary offshore complex of interconnected flat top floating vessels by the continuous arrival of vessels containing the non-recyclable waste materials.

[0005] Alternatively, US-5,063,862 discloses a method of treating solid waste, wherein waste loaded onto a first vessel is separated into recyclable and non-recyclable fractions, where the non-recyclable waste is transferred onto a second vessel and incinerated. JP-11005589 provides another example of incinerator ship where incineration is carried out on board following a sorting step.

[0006] On the other hand, WO-03049995 discloses a self contained incinerator ship for domestic and hospital waste with ash drying and turbine power generation.

[0007] Other prior art documents, such as US-5842652, are limited into a transportable unit adapted to sort and process recyclable materials with a scope of substantially reducing the volume thereof through compacting.

[0008] JP-11171676 discloses a container-type composting apparatus for the treatment of organic waste, transportable by ship or track to a port near a demand site.

[0009] JP-2004268710 proposes a floating vessel equipped for the intermediate treatment of industrial waste, e.g. disposable motor cars, incorporating separation by raw material and transferring such separated raw material bulks at a port close to the final disposal sites.

[0010] From the hereinabove discussion of the prior art, it follows that whilst marine vessel based managing systems for municipal solid waste have developed as a means of overcoming municipal restrictions associated with land based waste processing systems, they still are deficient in managing the overall bulk of the excessive variety of municipal solid waste and, in relation to waste disposal legislation, in ensuring optimum recyclable quantities whilst effecting an economically viable treatment of biodegradable waste with a scope of mass and volume diminishing and biological stabilisation thereof prior to delivery at a final processing station or at a disposal facility.

[0011] It is therefore an object of the present invention to disclose a marine vessel appropriately configured and equipped for effecting segregation and treatment of municipal solid waste, wherein waste intake is realized with a plurality of containers, said containers, excluding those importing batteries, oils, appliances and hazardous medical waste, being unloaded to provide the waste material that is subject to segregation and conducting shredding and baling operations of the recyclables, and diminishing of mass and volume and biostabilisation of the biodegradable fraction, prior to refilling the same containers with discrete quantities of recyclables and of dried, biologically stabilised, waste for delivery at a final destination.

[0012] A further object of the invention is to provide

within the aforementioned marine vessel a container management system with the containers being imported within a reception area of the bow thereof, being lifted upwardly and lined horizontally and vertically onto the upper deck of the marine vessel wherein containers specifically assigned for carrying special waste categories, i.e. batteries, used frying and engine oils, electrical appliances and possibly medical hazardous waste, remain ready for delivery at a final destination, whilst containers carrying the mainstream general waste categories of either mixed or separated municipal solid waste, together with those carrying green waste, sewage sludge and bulky waste or tyres, are being led at the rear of the vessel, onto a deck underneath the upper deck, wherein waste is emptied and undergoes appropriate waste management operations either at the same deck (shredding of bulky waste and tyres) or after having moved within a number of further decks underlying the aforementioned deck underneath the upper deck at the rear of the vessel, whereby packaged paper, plastic, aluminium recyclables and collected glass return onto this same deck and are loaded into containers and the shredded product of bulky waste and tyres is also loaded into containers, all these containers being thereafter led back onto the upper deck ready for delivery at a final destination, whilst the biodegradable waste fraction after having moved through the aforementioned number of further decks and having undergone appropriate waste management operations is being led and selectively processed with a scope of mass and volume diminishing and biostabilisation, within specified compartments of decks underlying the upper deck, prior to being containerised again and returned to the upper deck ready for delivery at a final destination.

[0013] It is a further object of the invention to disclose an optimally designed and economically viable method of municipal solid waste management on board an appropriately configured marine vessel with a scope of waste segregation and performance of shredding including selective crushing and cutting thereof and baling (compacting) operations to the resultant recyclable materials and of diminishing mass and volume and stabilising of the biodegradable waste fraction prior to containerising the same for delivery at a final destination.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The invention will be made apparent to those skilled in the art by reference to the appended drawings, in which:

Fig. 1 shows a general side view of the marine vessel of the invention adapted for performance of municipal solid waste management during a container intake operation.

Fig. 1a shows a detail of the side view of the marine vessel depicted in Fig. 1 during a container loading output operation.

Fig. 2 shows a general top plan view of the upper deck of the marine vessel of Fig. 1.

Fig. 3 shows a detailed side view of the rear of the vessel of Fig. 1 wherein municipal solid waste is selectively led for further processing.

Fig. 4 shows a plan view of the layout of the third deck level at the rear of the marine vessel depicted in Fig. 1, including a container handling area, a shredding and a bobcat device, as well as an elevator platform and a series of openings leading to underlying deck levels.

Fig. 5 shows a plan view of the layout of bag-opening, hand-picking and shredding arrangements provided on a second deck level underlying the abovementioned third deck at the rear of the marine vessel depicted in Fig. 1.

Fig. 6 shows a general plan view of the second deck of the marine vessel depicted in Fig. 1.

Fig. 7 shows a plan view of the layout of shredding and baling arrangements provided on a first deck level underlying the abovementioned second deck at the rear of the marine vessel depicted in Fig. 1.

Fig. 8 shows a general plan view of the first deck level of the marine vessel depicted in Fig. 1.

Figs. 9 and 9a respectively show a detailed block diagram of mixed municipal solid waste (MMSW) and separated municipal solid waste (SMSW) treatment process performed on board the marine vessel depicted in Fig. 1.

Fig. 10 shows a block diagram of the process for the treatment of green waste on board the marine vessel depicted in Fig. 1.

Fig. 11 shows a block diagram of the process for the treatment of sewage sludge on board the marine vessel depicted in Fig. 1.

Fig. 12 shows a block diagram of the process for the treatment of bulky and elastic waste performed on board the marine vessel depicted in Fig. 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] The marine vessel of the invention is capable of managing the general bulk of municipal solid waste that is expected to comprise the following categories:

- Mixed municipal solid waste (MMSW) that is expected to contain organic materials at a weight percentage exceeding 50%. This is due to the fact that packaging recyclable materials (glass, paper, plastic and metal) are source separated in accordance with recycling protocols and is also due to the touristic character of the regions of municipal solid waste collection that leads to prevalent dwelling activities.
- Separated municipal solid waste (SMSW) containing a mix of the above mentioned packaging recyclable materials; however, it is to be expected that SMSW will most probably be contaminated with ordinary organic waste, such organic waste thereby necessi-

tating segregation and appropriate processing equivalent to that of the above MMSW category.

- Green waste comprising source separated food waste and horticulture resides.
- Sewage sludge.
- Bulky waste (e.g. furniture, panels, mattresses, etc.).
- Tyres of motor cars.
- Electrical and electronic appliances, such as refrigerators, washing machines, cookers, television sets, etc.
- Used frying oils and engine oils:
- Batteries of all kinds.
- Medical hazardous waste.

[0016] The method of managing the abovementioned waste categories of the invention aims at further separation of the waste intake on board the marine vessel, so as to provide maximum quantities of recyclable materials at the maximum possible purity and at a minimal volume for subsequent delivery of the same for further processing at suitable recycling plants, whilst at the same time effecting mass and volume diminishing and biological stabilisation of the biodegradable waste fraction thereby optimising shipment and final disposal (landfill or incineration) costs.

[0017] Various categories of containers are employed in the managing process of the aforementioned categories of waste.

[0018] Container type C1 is a closed unit employed in the initial waste intake step for loading of MMSW, SMSW and of green waste on board the marine vessel and in the final waste delivery step for the discharge of the dry, biologically stabilised, waste and/or compost, as well as of recyclables, such as paper, plastic and aluminium packaging material. Container type C1 is provided with a rear gate and a compression piston assembly adapted to perform unloading of the content thereof.

[0019] Container type C2 is an open container type covered by a sliding textile covering and provided with a rear gate, employed for the importing on board the marine vessel of bulky waste, tyres, electrical/electronic appliances and sewage sludge. Container type C2 is also employed for the discharge of the shredded product of bulky waste and tyres and for recyclable glass. Electrical/electronic appliances are not treated and remain within the same container type C2 until discharge to final recycling station destination.

[0020] Container type C3 is an appropriately configured closed container, divided in compartments, for the transport of used frying and engine oils. Container type C4 is also a closed unit, divided in a plurality of compartments for transporting various types of batteries. Finally, C5 is a special purpose refrigerator container for the transport of medical hazardous waste.

[0021] By way of example, a typical embodiment of the marine vessel based system of the invention for processing municipal solid waste is configured so as to handle a total of ninety-five containers, sixty of which are containers of the type C1, thirty containers of the type C2, one container of the type C3, one container of the type C4 and three containers of the type C5. Containers are lined horizontally and vertically along a plurality of discrete parallel rows and columns at a frontal part of the upper deck of the marine vessel of the invention, such rows and columns defining a container transit area that is denoted by numeral 20. Whilst at full capacity of the abovementioned illustrative marine vessel embodiment, ninety of the abovementioned containers are provided onto the transit area 20 of the upper deck, a further number of five containers are appropriately lined along five discrete container handling positions P1-P5 at the third deck at the rear of the marine vessel in a container handling area denoted by numeral 20a. As derived from the combination of Fig. 1 and Fig. 2 in the illustratively depicted embodiment of the marine vessel of the invention, the container transit area 20 comprises six parallel rows, each row with a length equivalent to the length of five containers, thereby providing a total of thirty container parking positions, whilst each one of the equivalent thirty columns comprises three sequentially stacked containers.

[0022] As shown in the general side view of Fig. 1, the marine vessel of the invention adapted to perform management of municipal solid waste is provided with a bow gate 37 that opens to allow entrance of container carrying track 38 within a reception area 39 of the ship. A gantry crane 31 is provided onto the upper deck at the bow end of the ship employed to pick the container 1 that can be of any type C1-C5 from track 38 and raise it upwardly onto the upper deck and, depending on the waste category and time schedule, either line it along the array of containers lined horizontally and vertically in the transit area 20 onto the aforementioned upper deck or directly transfer the same at the third deck D3 at the rear of the vessel, past container transit area 20, within container handling area 20a to start processing.

[0023] A hatch opening 41 a is provided at the frontal bow area of the ship to allow transfer through lifting of imported container 1 that can be of any type C1-C5 from the reception area 39 onto the upper deck and another hatch opening 41b is provided at the rear of the ship, past container transit area 20, to allow bringing the container onto one of the five container handling positions provided in the container handling area 20a at the third deck D3.

[0024] As shown in the block diagrams of Figs. 9 and 9a, the municipal solid waste, mixed or separated, enters the vessel within the general purpose closed containers C1, which are raised through the hatch opening 41 a by means of a gantry crane 31 (Fig. 1) that slides along rails 40 (Fig. 2), provided on either side of the container transit area 20, and are either directly or at a later scheduled stage led at the rear of the vessel, through hatch opening 41b, into either position P1 for MMSW or position P5 for SMSW in the container handling area 20a located at the third deck D3 of the marine vessel. Thereafter the waste, MMSW or SMSW, after being unloaded from containers

C1 through their rear gate with operation of the compression piston incorporated therein, is led via hole 6 for MMSW and via hole 7 for SMSW (Fig. 4) at a second waste treatment deck D2 (Figs. 5, 6) underlying deck D3 of the marine vessel. Therein MMSW and SMSW are respectively guided through bag opening apparatuses 15 and 16 and thereafter through respective conveyor belts to corresponding hand-picking vibrating platform lines 17 and 18. At the discharge end of the vibrating platform lines 17 and 18, waste is led through corresponding holes 22, 23 into shredding devices 24 and 28 located at a first deck D 1 (Figs. 7, 8), underlying D2. Prior to that, recyclables have been removed through the hand-picking process. Following their removal, recyclables (paper, plastic, aluminium, glass) are led through holes 25a into collectors 25 for MMSW and through holes 26a into collectors 26 for SMSW, such collectors 25, 26 being provided at the first waste treatment deck D1 (Figs. 7, 8) underlying aforementioned second deck D2.

[0025] Recyclables are divided in two broad categories of packaging materials, i.e. paper and plastic on the one hand, which whilst within collectors 25, 26 being rolled by workers are led to a baler device 27a and aluminium cans on the other hand, which are accordingly led to a baler device 27b.

[0026] Baler devices 27a, 27b are located onto the aforementioned first waste treatment deck D1 of the marine vessel of the invention and operate so as to eventually provide appropriately packaged compact units of discrete recyclable materials (paper, plastic and aluminium). Packaged recyclables are henceforth loaded by workers onto elevator platform 19 and led upwardly onto the second deck D2, thereafter being loaded onto elevator platform 9 and lifted upwardly onto the aforementioned third deck D3, wherein bobcat device 42 and bridge crane 11 that slides along rails 11a (Fig. 4) are used to load them into containers C1 through the rear gate thereof within any of the three available positions from the successive handling positions P2-P4 in the container handling area 20a, loaded containers thereafter being led by means of gantry crane 31, through hatch opening 41 b, in the container transit area 20, where they are parked ready for delivery at a final recycling station destination.

[0027] Glass is not subject to baling and whilst within collectors 25, 26 rolled by workers is being led sequentially through elevator platforms 19, 9 onto deck D3 in the same manner as aforementioned, wherein bobcat device 42 and bridge crane 11 are employed to empty collectors 25, 26 and load recyclable glass into a container type C2 appropriately lined along any of the three available positions from the successive handling positions P2-P4 within container handling area 20a. Henceforth such container C2 loaded with recyclable glass can be transferred, through hatch opening 41 b, by means of gantry crane 31 to be parked at an available position in the container transit area 20, ready for delivery at a final recycling station destination.

[0028] Following removal of abovementioned recyclable materials, MMSW and MMSW respectively discharged from shredder devices 24 and 28 are sequentially guided via conveyor belt means through corresponding magnetic metal separators 29a, 29b and through non-ferrous screens 30a, 30b, whereby workers manually collect ferrous and non-ferrous metals and whilst the segregated organic waste fraction is thereafter led via opening 21 into the biotreatment area 43, collected recyclable content is being supplied to baler device 27b wherein it is appropriately packaged, thereafter being lifted upwardly sequentially through elevator platform 19 leading at deck D2 and henceforth through elevator platform 9 leading at the aforementioned third deck D3. At this level, bobcat device 42 and bridge crane 11 are employed to load packaged recyclables into a container type C 1 through the rear gate thereof, such container C 1 being provided within any of the three available positions from the successive handling positions P2-P4 in the container handling area 20a, this container being subsequently transferred, through hatch opening 41b, by means of gantry crane 31 to be parked at an available position in the container transit area 20, ready for delivery at a final recycling station destination.

[0029] The biotreatment area 43 comprises an upper compartment 43A that is located underneath the upper deck container transit area 20, where containers of the various types C1-C5 are lined horizontally and vertically along the aforementioned plurality of rows and columns. Compartment 43A occupies the overall height corresponding to rear marine vessel first and second waste treatment decks D1 and D2. A further lower compartment 43B of the biotreatment area extends all the way along the hold of the marine vessel underlying the abovementioned upper compartment 43A of the biotreatment area and the abovementioned first deck D1 of waste treatment. The upper compartment 43A communicates with the lower compartment 43B through an opening 36 appropriately provided on the bottom of compartment 43A and the ceiling of compartment 43B. A pair of bridge cranes 32a-32b, slidable along corresponding rail infrastructures 33a-33b are located on the top of the abovementioned upper and lower compartments 43A and 43B of the biotreatment area 43 and air ducts 35a-35b are provided longitudinally along the bottom of upper compartment 43A and the bottom of lower compartment 43B, respectively.

[0030] The organic biodegradable waste is led following abovementioned separation and shredding processes within the biotreatment area 43, firstly within the lower compartment 43B and thereafter, by means of the aforementioned successively operating bridge cranes 32b, 32a, through the opening 36, within the upper compartment 43A. The waste is, in accordance with a preferred embodiment of the invention, expected to remain for a period typically of the order of twenty-one days within the biotreatment area. Whilst within the biotreatment area, organic waste is being continuously mixed by means of

bridge cranes 32a, 32b and supplied with air through air ducts 35a and 35b, the air being preferentially heated so as to maximise drying effectiveness. The abovementioned estimated period of organic waste treatment within the biotreatment area 43A-43B is expected to effect biodrying and stabilisation of the waste, in which removal of moisture through physical drying as well as through degradation of organic matter leads to a substantial reduction in both mass and volume of the resultant product, thereby providing delivery of dried, biologically stabilised, waste that is subsequently loaded back into containers C1 through pneumatic loader pipe 34, such containers C1 being appropriately provided at the reception area 39 (Fig. 1a) wherefrom they are henceforth being raised upwardly by means of gantry crane 31, through hatch opening 41a, onto the container transit area 20 wherein they are being parked appropriately along the provided plurality of rows and columns, ready to be delivered at a final destination.

[0031] Further, as shown in the block diagram of Fig. 10, green waste, i.e. the pure organic fraction of municipal solid waste comprising source separated food and horticulture residues, received within containers type C1, following raising thereof by means of gantry crane 31 onto the transit area 20, is either directly or at a later scheduled stage led at the rear of the vessel, through hatch opening 41b, onto one of the three positions P2-P4 available in the container handling area 20a located at the third deck D3 of the marine vessel, whereby it is being unloaded through the rear gate thereof with operation of the compression piston inbuilt therein and, by means of bobcat device 42, the contents thereof are led, since no bag opening and/or segregation operations are needed, through anyone available of the pair of holes 12 and 13, directly into whichever one of shredder devices 24 or 28 for MMSW or SMSW is available at waste treatment deck D1 (Figs. 7, 8). After exit from shredder devices 24 and/or 28, shredded green waste is led through conveyor belt means directly into the opening 21 leading into the biotreatment area 43, firstly within the lower compartment 43B and thereafter, by means of successively operating bridge cranes 32b, 32a, through the opening 36, within the upper compartment 43A. Following biodrying and stabilisation, the product of treatment thereof is eventually loaded by means of pneumatic loader pipe device 34 (Fig. 1a) into containers type C1 appropriately provided within reception area 39, whereby following loading thereof such containers C1 are lifted upwardly by means of gantry crane 31, through hatch opening 41a, and appropriately parked in the transit area 20, ready for delivery at a final destination.

[0032] As shown in the block diagram of Fig. 11, sewage sludge is received on board the marine vessel within open containers type C2, which are preferentially directly being led by means of gantry crane 31, successively through hatch openings 41a, 41b at the rear of the marine vessel, onto deck D3 being lined within any available position among container handling positions P2-P4 in the container handling area 20a, and henceforth, when treatment begins, being unloaded through the rear gate of the container, by means of bobcat device 42 is led through either hole 12 or hole 13 into either one of shredder devices 24, 28 respectively located at the first deck D1. If however sewage sludge is deemed to be sufficiently shredded at a pellet size that is not expected to substantially alter through shredding, the shredding step in shredder devices 24, 28 is ommitted and sewage sludge is instead being led, by means of bobcat device 42, through hole 10, directly into the opening 21 for subsequent treatment within the biotreatment area 43, firstly within the lower compartment 43B and thereafter, by means of successively operating bridge cranes 32b, 32a, through the opening 36, within the upper compartment 43A. On the other hand if the shredding step is deemed necessary, sewage sludge is also led, following exit thereof from shredder devices 24 and/or 28, through conveyor belt means into the opening 21 leading into the same process within the biotreatment area. Transfer of the resulting dried biostabilised material from the biotreatment area, through reception area 39, up onto the transit area is effected in the same manner as aforementioned.

[0033] It is to be understood that biotreatment of both the green waste and of the sewage sludge is expected to be carried out in mix with the main biodegradable waste fraction volume, that of MMSW and SMSW.

[0034] As shown in the block diagram of Fig. 12, treatment of bulky waste including elastic waste (tyres) being imported within containers type C2, is carried out onto the abovementioned third waste treatment deck D3 at the rear of the marine vessel (Fig. 3 and Fig. 4). Upon receipt of the open container type C2 with the abovementioned waste, gantry crane 31 is employed to either temporarily park these containers at the transit area 20 or transfer the same at the rear of the marine vessel, onto deck D3, wherein they can be accomodated onto one available position P2-P4 in the container handling area 20a. When treatment operations begin, bulky waste is being unloaded using bridge crane 11 and then by means of bobcat device 42 is fed into a shredder device 8 located at the same deck D3 and the shredded product discharged from the shredder device 8 is again appropriately reloaded by means of bobcat device 42 within the same container type C2, in the container handling area 20a, wherefrom the loaded container C2 is being lifted upwardly by means of gantry crane 31, through hatch opening 41b, and appropriately parked in the transit area 20, ready for delivery at a final destination.

[0035] As previously mentioned there are some municipal solid waste categories that are not subject to any treatment whatsoever on board (batteries, oils and appliances), whereby the special duty containers carrying such waste are merely transferred from reception area 39, by means of gantry crane 31, through hatch opening 41a, onto the upper deck, appropriately parked and permanently staying along the array of containers of the container transit area 20, ready for delivery at a final desti-

nation. This is the case with used frying oils and engine oils carried within appropriately configured containers type C3 and with batteries carried in containers type C4, as well as with electrical appliances being maintained within specially allocated containers type C2. Containers type C5 carrying medical hazardous waste that is also not treated are also transferred from reception area 39, by means of gantry crane 31, through hatch opening 41 a, onto the upper deck and appropriately parked along the array of containers in the container transit area 20. However these containers type C5 are connected to power supply means of the marine vessel of the invention to allow operation of their inbuilt refrigerator equipment. A medical waste steriliser means 14 is further preferentially provided onto the rear third deck D3 (Fig. 4) where container C5 might be transferred for carrying out a sterilisation process of such medical hazardous waste.

[0036] As stated in the introductory part, an object of the invention is to provide, along with the minicipal solid waste management on board the marine vessel, a container management system comprising sequential movement of each container with a scope of effecting efficient waste management on board the marine vessel. This container management system comprises importing a container carried by a track means 38 entering within the reception area 39 located at the bow of the vessel (Fig. 1), employing gantry crane 31 for picking and moving containers and permanently parking, horizontally and vertically onto the aforementioned transit area 20, those containers specifically assigned for carrying special waste categories, i.e. batteries, used frying and engine oils, electrical appliances and possibly medical hazardous waste, ready for delivery at a final destination, whilst, in accordance with waste processing schedule, either temporarily parking containers carrying the mainstream general waste categories of either mixed or separated municipal solid waste, together with those carrying green waste, bulky waste and tyres, or leading the same onto a deck D3, underneath the upper deck, at the rear of the vessel, in the container handling area 20a, where sewage sludge loaded containers are preferentially directly being led, said handling area 20a comprising a plurality of container accomodating positions P1-P5, and specifically along position P1 or P5 for containers type C1 loaded with MMSW or SMSW and along any available position P2-P4 for containers C1 containing green waste and for containers C2 containing sewage sludge or bulky waste or tyres, whereby following waste emptying, containers type C1 lined along positions P1 or P5 are lifted upwardly and led back onto the transit area 20, so as to provide positions P1 and P5 ready for receiving further waste loaded containers, whilst containers lined along positions P2-P4 stand by until they are again loaded with the shredded product of bulky waste and tyres as well as with recyclables provide in the form of discrete packaged units of paper, plastic, aluminium, ferrous and non-ferrous metals and with glass derived from waste management operations taking place at underlying decks D2, D1, and it is then that they are lifted upwardly and parked onto transit area 20 wherefrom they will move downwardly within reception area 39 to be exported from the vessel carried by track means 38 at the port destination thereof. Meanwhile, emptied containers C1 are downwardly led from transit area 20 back onto reception area 39 where, following completion of the biotreatment period, they are being loaded by means of pneumatic loader pipe 34 (Fig. 1a) with the dried, biostabilised waste product being extracted from the biotreatment compartment 43A and again upwardly led within the transit area 20 wherein they are parked at a final position wherefrom they will move downwardly within reception area 39 to be exported onto track means 38 from the vessel at the port destination thereof.

Claims

1. Marine vessel adapted for managing municipal solid waste that is being imported into the marine vessel loaded in containers (C1-C5) carried by track means (38) entering through a bow gate (37) within a reception area (39) of the marine vessel, **characterised in that** the marine vessel comprises an upper deck with a frontal hatch opening (41a) at a bow end thereof and a rear hatch opening (41 b) at a rear end thereof, a container transit area (20) being provided in between said frontal hatch opening (41a) and said rear hatch opening (41b), said containers (C1-C5) being lined horizontally and vertically along a plurality of parallel rows and columns onto said container transit area (20), a first pair of parallel rails (40) running longitudinally along the two lateral sides of the upper deck, a gantry crane (31) slidably movable along said first pair of rails (40) arranged to transfer containers (C1-C5) along the upper deck and vertically move the same through said frontal hatch opening (41a) upwardly from or downwardly onto said reception area (39) or through said rear hatch opening (41b) upwardly from or downwardly onto a container handling area (20a) at the rear of the vessel, a plurality of sequential deck levels being provided at the rear of the vessel, past said container transit area (20), said plurality of sequential deck levels comprising a third deck (D3) with said container handling area (20a), said third deck (D3) appropriately configured and equipped for conducting unloading of containers and initial handling of waste upon arrival of containers onto said container handling area (20a) and loading of recyclables onto containers prior to the departure and transfer thereof back onto said container transit area (20), said container handling area (20a) including five discrete container handling positions (P1-P5), a second pair of parallel rails (11a) running transversally along said container handling area (20a), a bridge crane (11) slidably movable along said rails (11a) arranged to perform, in asso-

ciation with a bobcat device (42), unloading and loading of containers brought within handling positions (P2-P4) in said container handling area (20a), a second deck (D2) appropriately configured and equipped for receiving waste from said third deck (D3) and conducting bag-opening and hand-picking operations thereupon and a first deck (D1) appropriately configured and equipped for receiving waste from either said second deck (D2) or directly from said third deck (D3) and conducting shredding, further segregation and baling of recyclables, a biotreatment area (43) wherein the biodegradable waste is being led, said biotreatment area (43) comprising an upper compartment (43A) and a lower compartment (43B), said compartments (43A, 43B) being provided underneath said container transit area (20) of the upper deck and communicating through an opening (36), said opening (36) appropriately provided on the bottom of compartment (43A) and the ceiling of compartment (43B), a third pair of parallel rails (33a) running longitudinally along the two lateral sides on the top of compartment (43A) to allow movement of a bridge crane (32a) and a fourth pair of parallel rails (33b) running longitudinally along the two lateral sides on the top of compartment (43B) to allow movement of a bridge crane (32b), said bridge cranes (32a, 32b) arranged to perform continous thorough mixing of the biodegradable waste fraction and transfer of the same from said lower compartment (43B) onto said upper compartment (43A) wherefrom dried, biologically stabilised, product is being extracted by means of a pneumatic loader pipe (34) located onto said reception area (39) and loaded into containers (C1), said containers subsequently being lifted upwardly and parked, ready for delivery at a port destination, onto said container transit area (20) wherefrom they will move downwardly within said reception area (39) to be exported from the vessel carried by track means (38) at the port destination thereof

2. Marine vessel adapted for managing municipal solid waste as in above claim 1, **characterised in that** said upper compartment (43A) of the biotreatment area (43) occupies the overall height corresponding to rear marine vessel said first and second decks (D1, D2) and extends all along underneath said transit area (20), whilst said lower compartment (43B) of the biotreatment area (43) extends all the way along the hold of the marine vessel underlying said upper compartment (43A) and said first deck (D1), air ducts (35a, 35b) being provided longitudinally along the bottom of upper compartment (43A) and the bottom of lower compartment (43B), respectively.

3. Marine vessel adapted for managing municipal solid waste as in above claim 1. **characterised in that** a shredder device (8) adapted to perform shredding of bulky waste and tyres and a steriliser device (14) adapted to perform a sterilisation process of medical hazardous waste are being provided onto said third deck (D3) that further comprises a pair of holes (6, 7) being provided adjacently handling positions (P1, P5) respectively for leading mixed municipal solid waste and seperated municipal solid waste unloaded from corresponding containers (C1) downwardly onto said second deck (D2) correspondingly into bag opening apparatuses (15, 16), a pair of holes (12, 13) correspondingly leading directly into shredder devices (24, 28) located at said first deck (D1), a hole (10) leading directly into an opening (21) onto said first deck (D1) through which biodegradable waste enters said biotreatment area (43) and an elevator platform (9) arranged to receive an elevator cabin departing from said second deck (D2).

4. Marine vessel adapted for managing municipal solid waste as in above claim 1, **characterised in that** a pair of bag opening apparatuses (15, 16) and corresponding hand-picking vibrating platform lines (17, 18), each with a plurality of corresponding holes (25a, 26a), are being provided onto said second deck (D2) adapted to perform segregation of recyclables from mixed municipal solid waste and separated municipal solid waste respectively, said recyclables being thereafter correspondingly led through said holes (25a, 26a) into collectors (25, 26) located onto the first deck (D1), said second deck (D2) further comprising a pair of holes (22, 23) being provided at the output of said hand-picking vibrating platform lines (17, 18) respectively for leading waste discharged from hand-picking vibrating platform lines (17, 18) downwardly onto said first deck (D1) correspondingly into shredding devices (24, 28), an elevator platform (9) arranged to receive an elevator cabin moving upwardly from said second deck (D2) onto said third deck (D3) and an elevator platform (19) arranged to receive an elevator cabin departing from said first deck (D1).

5. Marine vessel adapted for managing municipal solid waste as in above claim 1, **characterised in that** a pair of shredding devices (24, 28) followed by a pair of corresponding magnetic metal separators (29a, 29b) and a pair of corresponding non-ferrous screens (30a, 30b) are being provided onto said first deck (D1) adapted to perform waste crushing and cutting and removal of ferrous and non ferrous metals therefrom respectively thereby yielding an organic biodegradable waste fraction, a pair of baler devices (27a, 27b) being provided for effecting discrete compacted packaging of recyclables contained within said collectors (25, 26), said first deck (D1) further comprising an opening (21) through which biodegradable waste, being supplied directly through said

hole (10) of said third deck (D3), together with said organic biodegradable waste fraction discharged either directly from said pair of shredding devices (24, 28) or from said pair of non-ferrous screens (30a, 30b), enters said biotreatment area (43), and an elevator platform (19) arranged to receive an elevator cabin moving upwardly from said first deck (D1) onto said second deck (D2).

6. Method of municipal solid waste management on board an appropriately configured marine vessel with a scope of waste segragation so as to provide maximum quantities of recyclable materials at the maximum possible purity and at a minimal volume for subsequent delivery at suitable recycling plants, whilst at the same time effecting mass and volume diminishing and biological stabilisation of the biodegradable waste fraction, said method comprising the steps of:

receiving waste carrying containers (C1-C5), wherein containers (C1) are loaded with mixed municipal solid waste or separated municipal solid waste or green waste, containers (C2) are loaded with bulky waste or tyres or sewage sludge or electrical appliances, containers (C3) are loaded with used frying and engine oils, containers (C4) are loaded with waste batteries and containers (C5) are loaded with medical hazardous waste, through a bow gate (37) within a bow reception area (39);

lifting said waste carrying containers (C1-C5) through a frontal hatch opening (41a) by means of a gantry crane (31) and, with the exception of sewage sludge carrying containers (C2), parking them along a plurality of rows and columns onto a container transit area (20) of the upper main deck of the vessel, directly transferring sewage sludge carrying containers (C2) and selectively transferring mixed municipal solid waste, separated municipal solid waste and green waste carrying containers (C1) and bulky waste or tyres carrying containers (C2) rearwardly and through a rear hatch opening (41b) downwardly onto a container handling area (20a) including a plurality of discrete hanging positions (P1-P5) located at a third deck (D3) of the vessel, said mixed municipal solid waste and separated municipal solid waste carrying containers (C1) being accomodated onto handling positions (P1) and (P5) respectively and said green waste carrying containers (C1), said sewage sludge carrying containers (C2) and said bulky waste or tyres carrying containers (C2) being accomodated onto any available handling position (P2-P4);

unloading said green waste carrying containers (C1) and said sewage sludge and said bulky waste or tyres carrying containers (C2) and employing a shredder device (8) to diminish the volume of bulky waste or tyres through crushing and cutting, thereafter reloading the shredded product onto containers (C2) and leading said containers (C2) upwardly, through said rear hatch opening (41b), onto said container transit area (20) ready for delivery at a recycling plant destination, whilst leading green waste through one of a pair of holes (12, 13) provided onto said deck (D3) and subsequently through one of a pair of shredder devices (24, 28) located onto a first deck (D1), as well as leading sewage sludge, depending on the pellet size thereof, either directly through a hole (10) provided onto said deck (D3) or through one of said pair of holes (12, 13) and subsequently through one of said pair of shredder devices (24, 28), into an opening (21) at deck (D1) for entering a biotreatment area (43);

unloading said mixed municipal solid waste and separated municipal solid waste carrying containers (C1) being accomodated onto handling positions (P1) and (P5) respectively, through a rear gate thereof with operation of a compression piston assembly incorporated therein, and leading the mixed municipal solid waste or separated municipal solid waste contained therein directly through a corresponding pair of holes (6, 7) being provided adjacently said handling positions (P1) and (P5) respectively for leading mixed municipal solid waste and seperated municipal solid waste unloaded from corresponding containers (C1) downwardly onto a second deck (D2), correspondingly into a pair of bag opening apparatuses (15, 16) followed by a corresponding pair of hand-picking lines (17, 18);

following removal of recyclables, leading the waste fraction emanating from said hand-picking lines (17, 18) respectively through holes (22, 23) into shredder devices (24, 28) and passing the shredded output thereof correspondingly through magnetic metal separators (29a, 29b) and through non-ferrous screens (30a, 30b), thereafter leading the resulting organic biodegradable waste fraction through said opening (21) within a first lower compartment (43B) of said biotreatment area (43) located at the hold of the vessel underneath said container transit area (20) and said decks (D1-D3);

employing bridge cranes (32b, 32a) for transporting matter from said first lower compartment (43B), through an opening (36), onto a second upper compartment (43A) whilst providing air supply through duct means (35a, 35b) respectively within compartments (43A, 43B) and effecting a continuous, thorough mixing of the biodegradable waste fraction content of both said

first lower compartment (43B) and said second upper compartment (43A);
leading plastic, paper, glass and aluminium recyclables collected along said hand-picking lines (17, 18) through a plurality of holes (25a, 26a) at deck (D2) into collectors (25, 26) at deck (D1), emptying said collectors (25, 26) containing paper or plastic recyclables into a baler device (27a) and collectors (25, 26) containing aluminium recyclables or metals collected through said magnetic metal separators (29a, 29b) and through non-ferrous screens (30a, 30b), into a baler device (27b) to obtain appropriately packaged compact units of discrete paper, plastic, aluminium, ferrous and non-ferrous metal recyclables;
transferring said packaged compact units of discrete paper, plastic, aluminium and metal recyclables, as well as glass containing collectors (25, 26) upwardly through elevator platform (19) from deck (D1) to deck (D2) and then through elevator platform (9) from deck (D2) onto deck (D3), wherein bobcat device (42) and bridge crane (11) are employed for loading containers (C1) accomodated within handling positions (P2-P4) in said container handling area (20a) with said packaged compact units of discrete paper, plastic, aluminium and metal recyclables and containers (C2) with said glass recyclables, thereafter lifting said recyclables carrying containers (Cl, C2) upwardly by means of gantry crane (31), through hatch opening (41 b), and parking them along assigned positions within said container transit area (20) at the upper deck of the vessel, ready for delivery at a recycling plant destination;
employing said gantry crane (31) to transfer emptied containers (C1), moved from said container handling area (20a) onto said container transit area (20), downwardly through said frontal hatch opening (41a) within reception area (39) and extracting dried, biologically stabilised, waste product from said second upper compartment (43A) by means of a pneumatic loader pipe (34) for loading said containers (C1), thereafter appropriately lifting said containers (C1) loaded with dried, biologically stabilised, waste product by means of gantry crane (31), upwardly through said frontal hatch opening (41a), and parking them along assigned positions within said transit area (20) at the upper deck of the vessel, ready for delivery at final destination.

7. Method of municipal solid waste management on board an appropriately configured marine vessel as claimed in claim 6, further including the step of transferring medical hazardous waste carrying containers (C5) onto deck (D3), wherein a medical waste steriliser means (14) is employed for carrying out a sterilisation process of such hazardous medical waste.

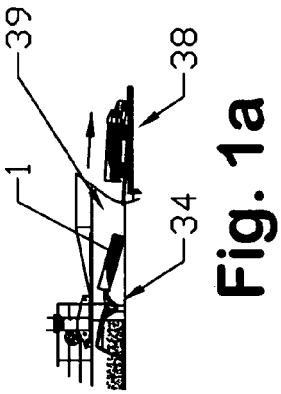
39
38
1
34

Fig. 1a

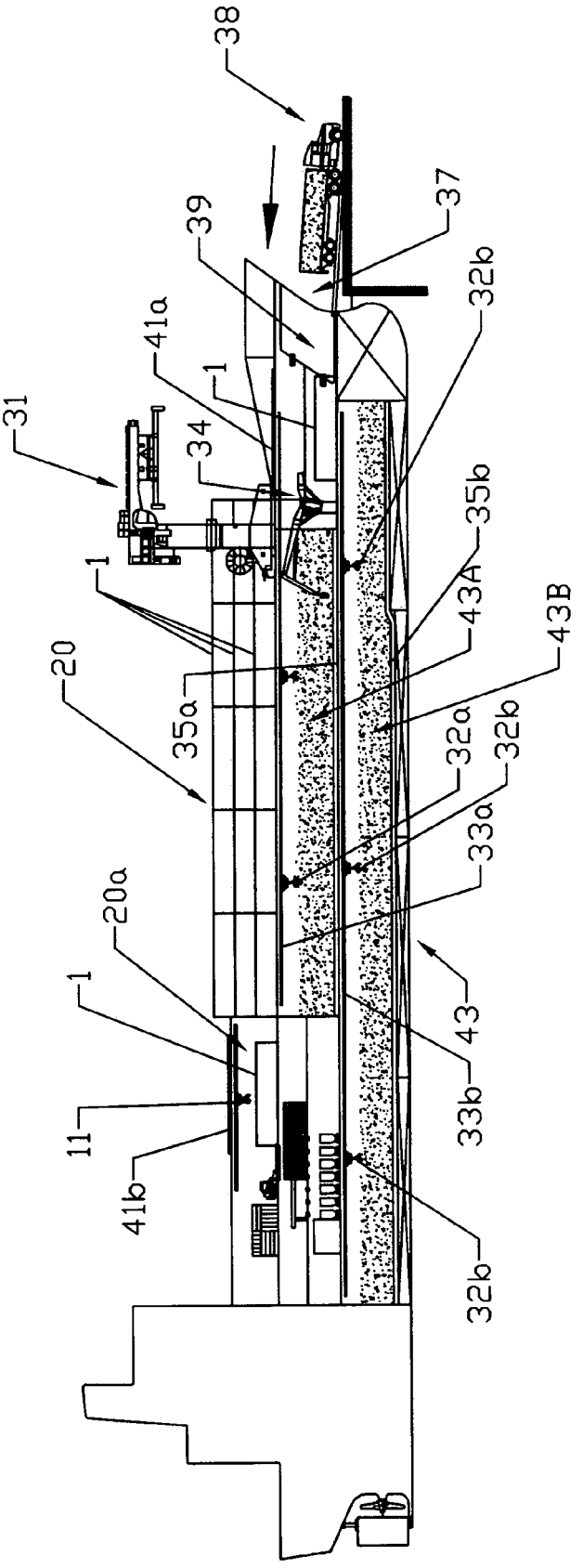
38
39
37
32b
41a
1
31
34
35b
43A
43B
20
35a
32a
32b
33a
20a
1
43
33b
11
41b
32b

Fig. 1

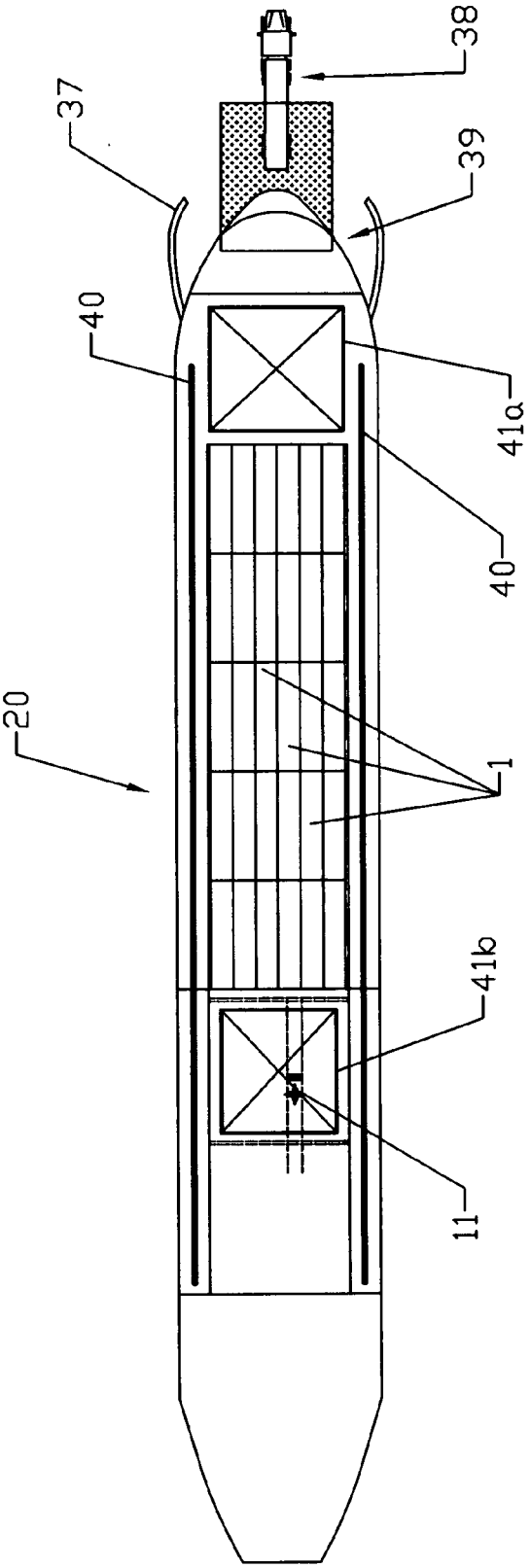

Fig. 2

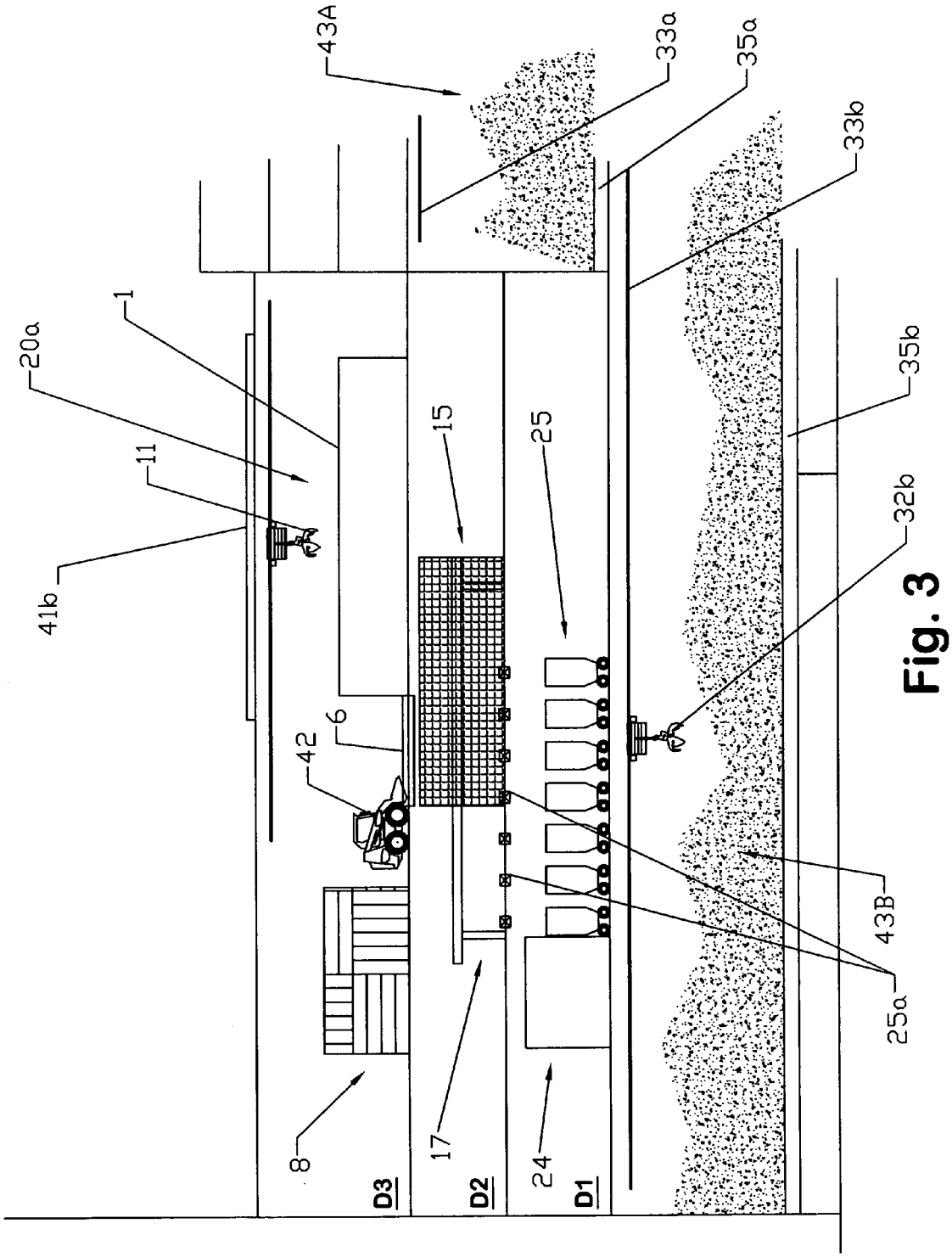
43A
33a
35a
33b
1
20a
35b
11
15
25
41b
32b
6
42
43B
25a
8
17
24
D3
D2
D1

Fig. 3

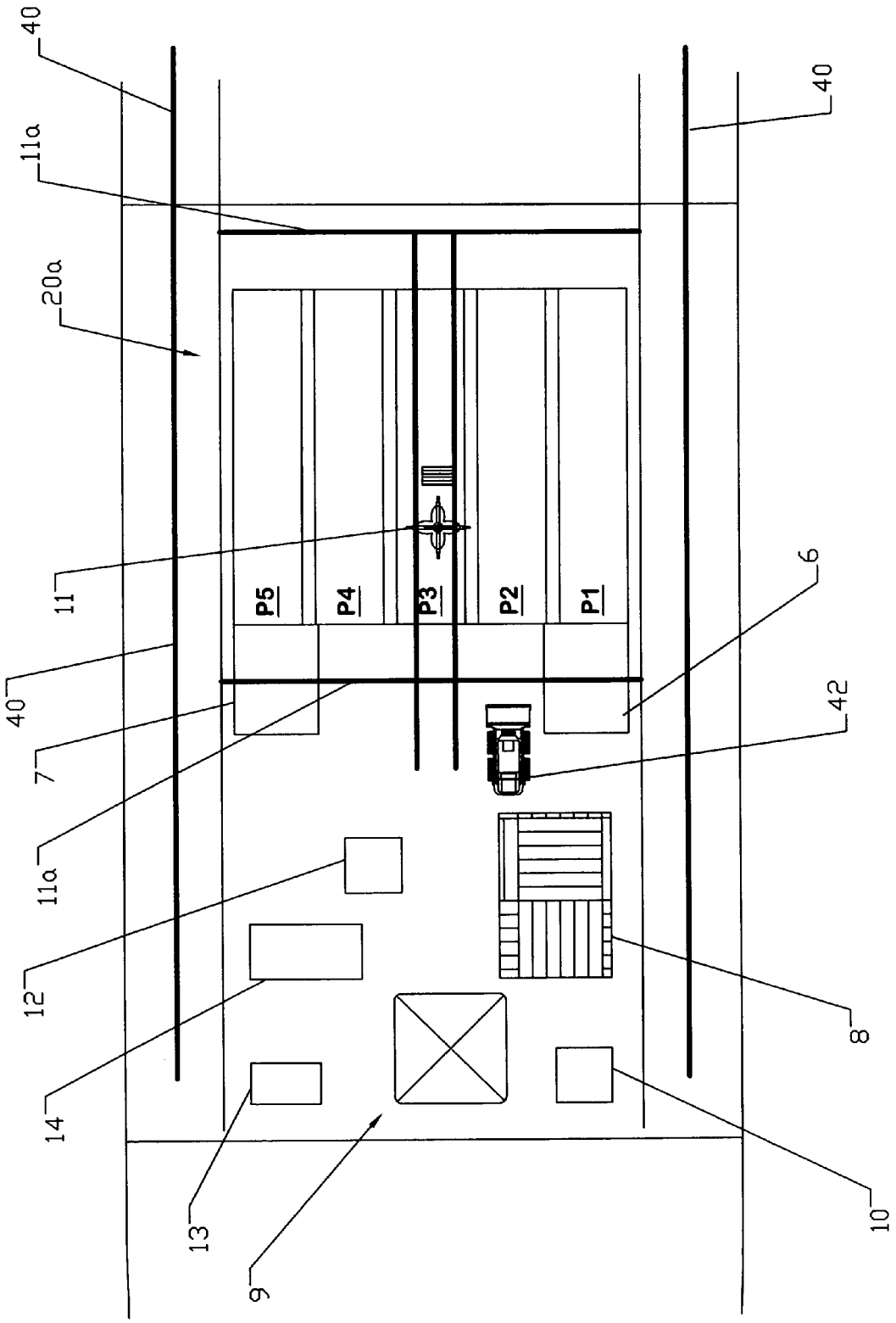

Fig. 4

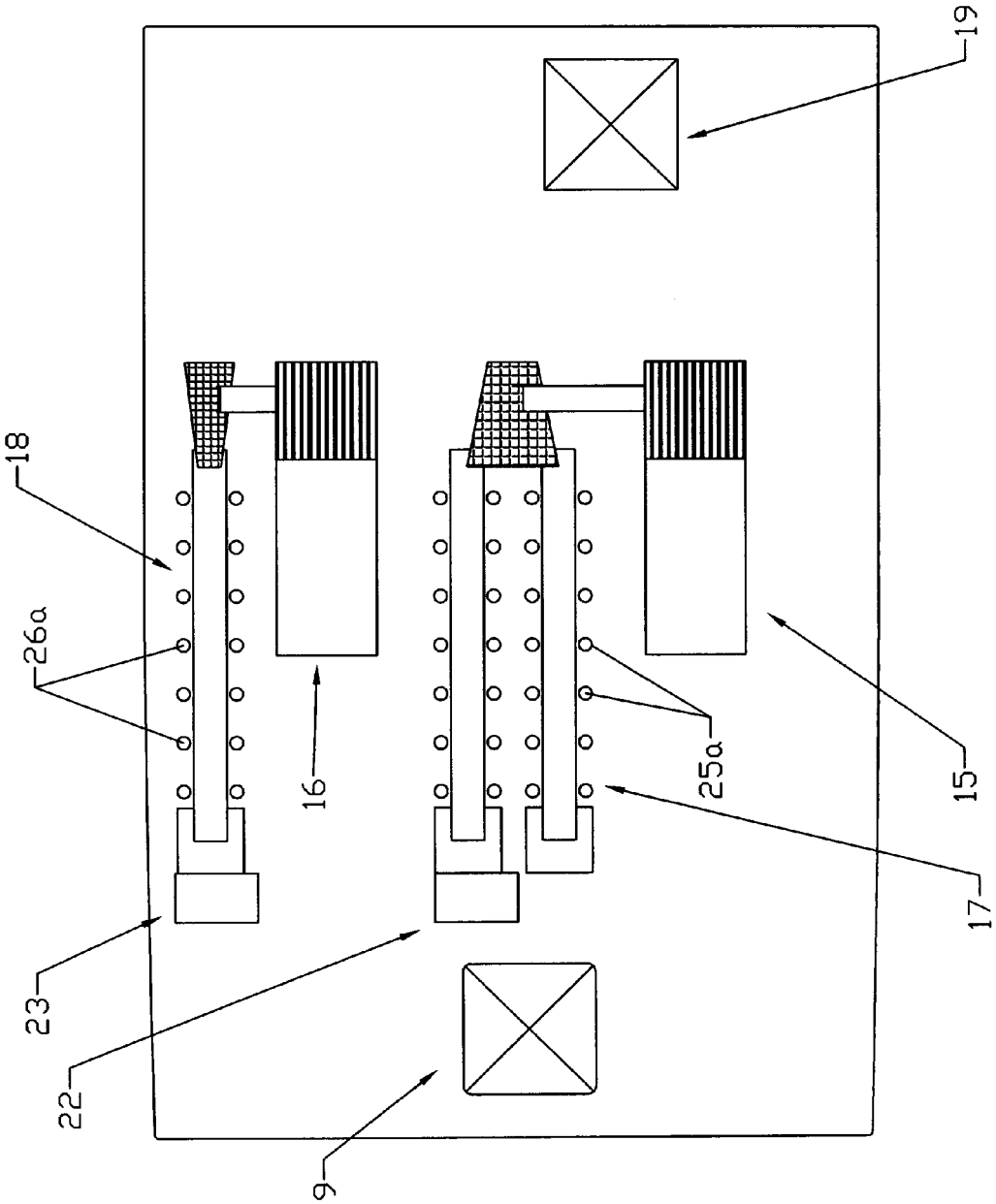

Fig. 5

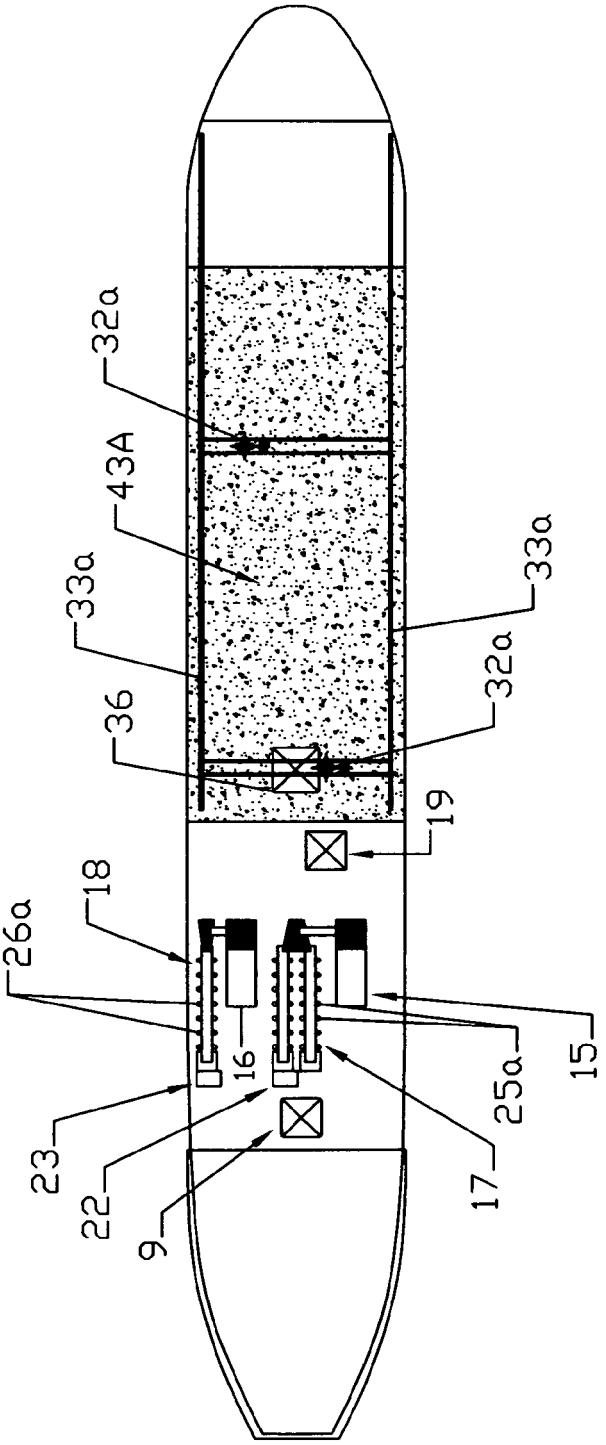

Fig. 6

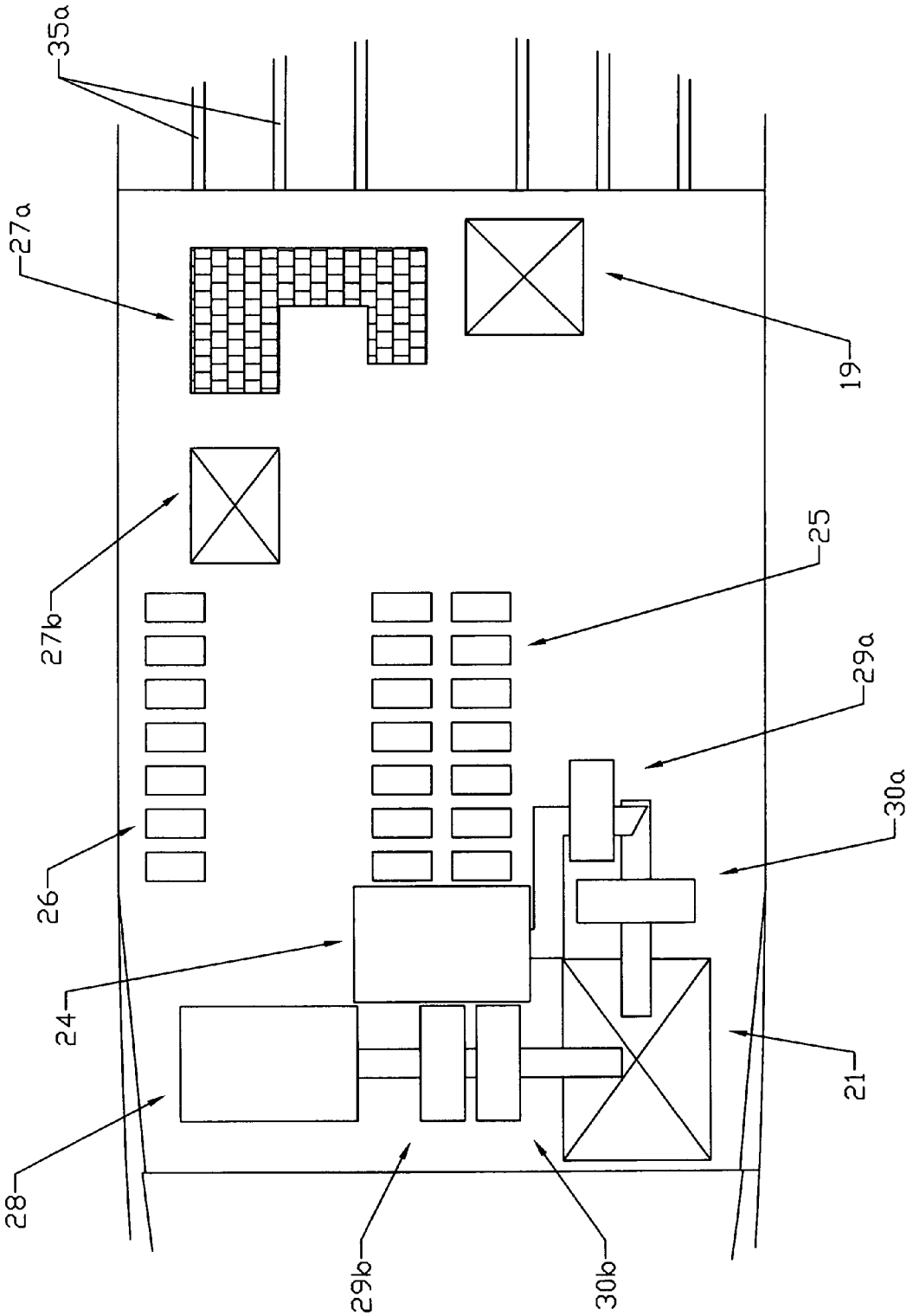

Fig. 7

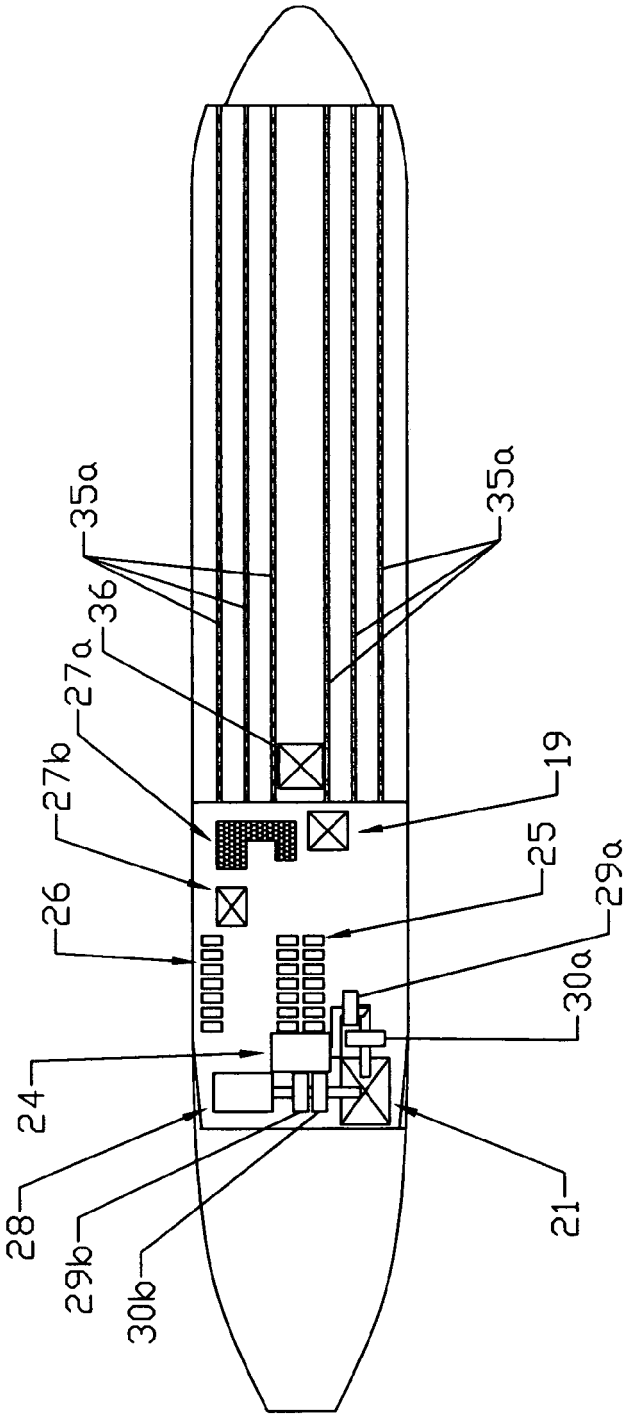

Fig. 8

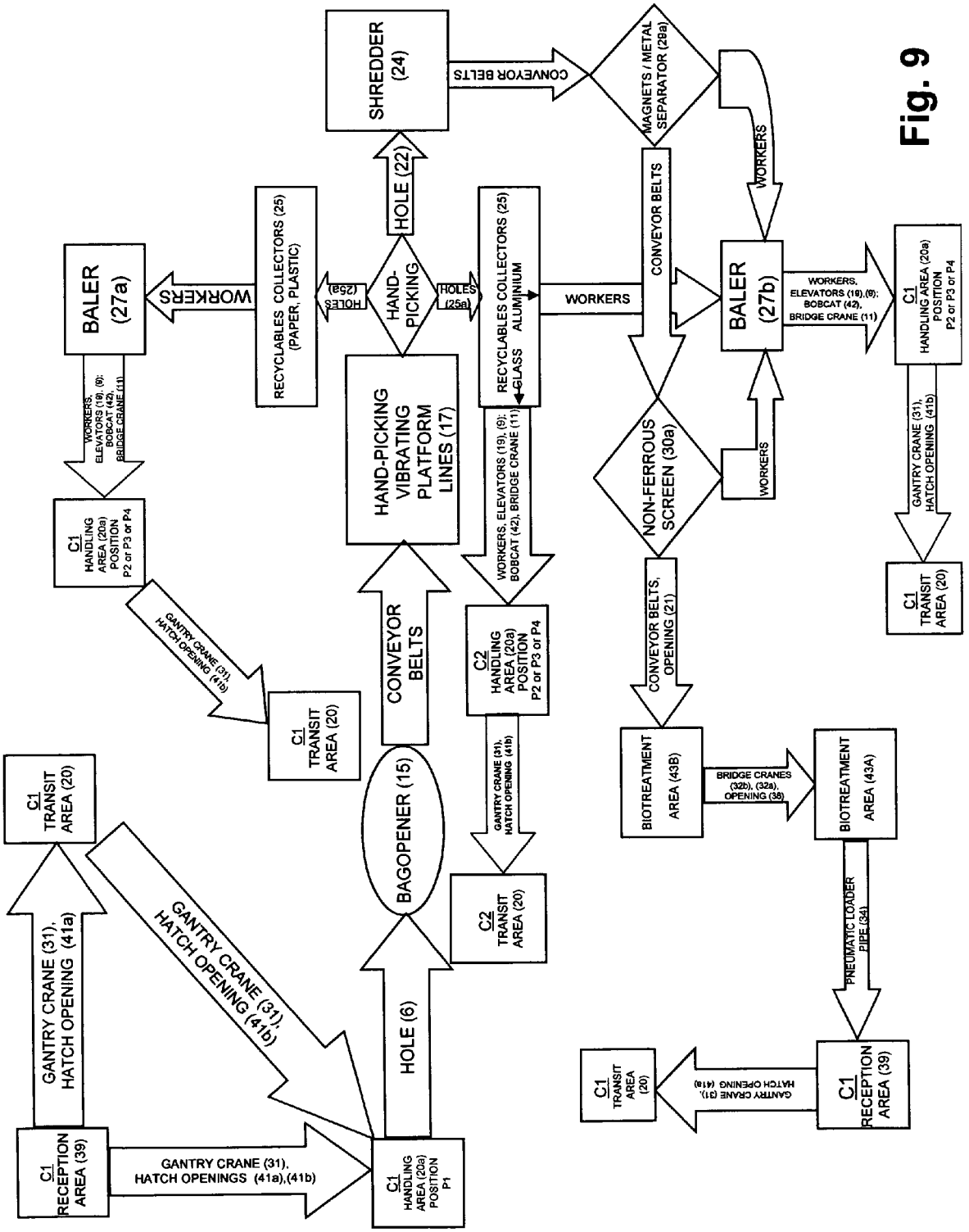
SHREDDER (24)
CONVEYOR BELTS
MAGNETS / METAL SEPARATOR (28a)
WORKERS
HOLE (22)
BALER (27a)
WORKERS
RECYCLABLES COLLECTORS (25) (PAPER, PLASTIC)
HOLES (25a)
HAND-PICKING
HOLES (25a)
RECYCLABLES COLLECTORS (25) ALUMINIUM GLASS
WORKERS
CONVEYOR BELTS
BALER (27b)
WORKERS, ELEVATORS (19),(9); BOBCAT (42), BRIDGE CRANE (11)
C1 HANDLING AREA (20a) POSITION P2 or P3 or P4
WORKERS, ELEVATORS (19), (9); BOBCAT (42), BRIDGE CRANE (11)
HAND-PICKING VIBRATING PLATFORM LINES (17)
WORKERS, ELEVATORS (19), (9); BOBCAT (42), BRIDGE CRANE (11)
NON-FERROUS SCREEN (30a)
WORKERS
GANTRY CRANE (31), HATCH OPENING (41b)
C1 HANDLING AREA (20a) POSITION P2 or P3 or P4
GANTRY CRANE (31), HATCH OPENING (41b)
C1 TRANSIT AREA (20)
C1 TRANSIT AREA (20)
CONVEYOR BELTS
C2 HANDLING AREA (20a) POSITION P2 or P3 or P4
CONVEYOR BELTS, OPENING (21)
C1 TRANSIT AREA (20)
C1 TRANSIT AREA (20)
BAGOPENER (15)
GANTRY CRANE (31), HATCH OPENING (41b)
BIOTREATMENT AREA (43B)
BRIDGE CRANES (32b), (32a), OPENING (35)
BIOTREATMENT AREA (43A)
C2 TRANSIT AREA (20)
GANTRY CRANE (31), HATCH OPENING (41a)
GANTRY CRANE (31), HATCH OPENING (41b)
HOLE (6)
PNEUMATIC LOADER PIPE (34)
C1 RECEPTION AREA (39)
GANTRY CRANE (31), HATCH OPENINGS (41a),(41b)
C1 HANDLING AREA (20a) POSITION P1
C1 TRANSIT AREA (20)
GANTRY CRANE (31), HATCH OPENING (41a)
C1 RECEPTION AREA (39)

Fig. 9

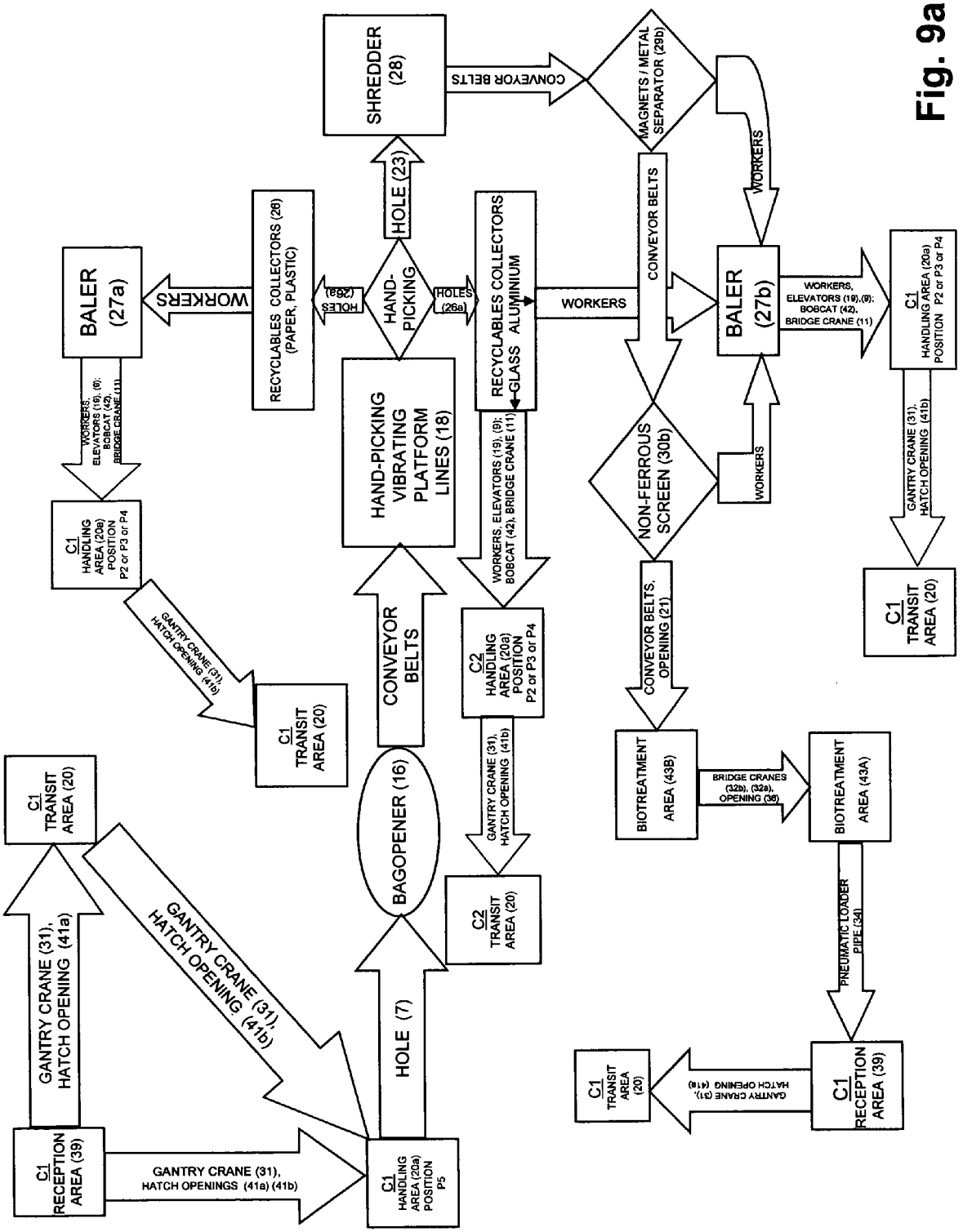
SHREDDER (28)
CONVEYOR BELTS
MAGNETS / METAL SEPARATOR (29b)
WORKERS
HOLE (23)
BALER (27a)
WORKERS
RECYCLABLES COLLECTORS (26) (PAPER, PLASTIC)
HOLES (28a)
HAND-PICKING
HOLES (26a)
RECYCLABLES COLLECTORS GLASS ALUMINIUM
WORKERS
CONVEYOR BELTS
BALER (27b)
WORKERS, ELEVATORS (19),(9); BOBCAT (42), BRIDGE CRANE (11)
C1 HANDLING AREA (20a) POSITION P2 or P3 or P4
WORKERS, ELEVATORS (19), (9); BOBCAT (42), BRIDGE CRANE (11)
C1 HANDLING AREA (20a) POSITION P2 or P4
HAND-PICKING VIBRATING PLATFORM LINES (18)
WORKERS, ELEVATORS (19), (9); BOBCAT (42), BRIDGE CRANE (11)
NON-FERROUS SCREEN (30b)
WORKERS
GANTRY CRANE (31), HATCH OPENING (41b)
C1 TRANSIT AREA (20)
CONVEYOR BELTS
C2 HANDLING AREA (20a) POSITION P2 or P3 or P4
GANTRY CRANE (31), HATCH OPENING (41b)
C1 TRANSIT AREA (20)
CONVEYOR BELTS, OPENING (21)
C1 TRANSIT AREA (20)
C1 TRANSIT AREA (20)
BAGOPENER (16)
C2 TRANSIT AREA (20)
BIOTREATMENT AREA (43B)
BRIDGE CRANES (32b), (32a), OPENING (36)
BIOTREATMENT AREA (43A)
GANTRY CRANE (31), HATCH OPENING (41a)
GANTRY CRANE (31), HATCH OPENING (41b)
HOLE (7)
PNEUMATIC LOADER PIPE (34)
C1 RECEPTION AREA (39)
GANTRY CRANE (31), HATCH OPENINGS (41a) (41b)
C1 HANDLING AREA (20a) POSITION P5
C1 TRANSIT AREA (20)
GANTRY CRANE (31), HATCH OPENING (41b)
C1 RECEPTION AREA (39)

Fig. 9a

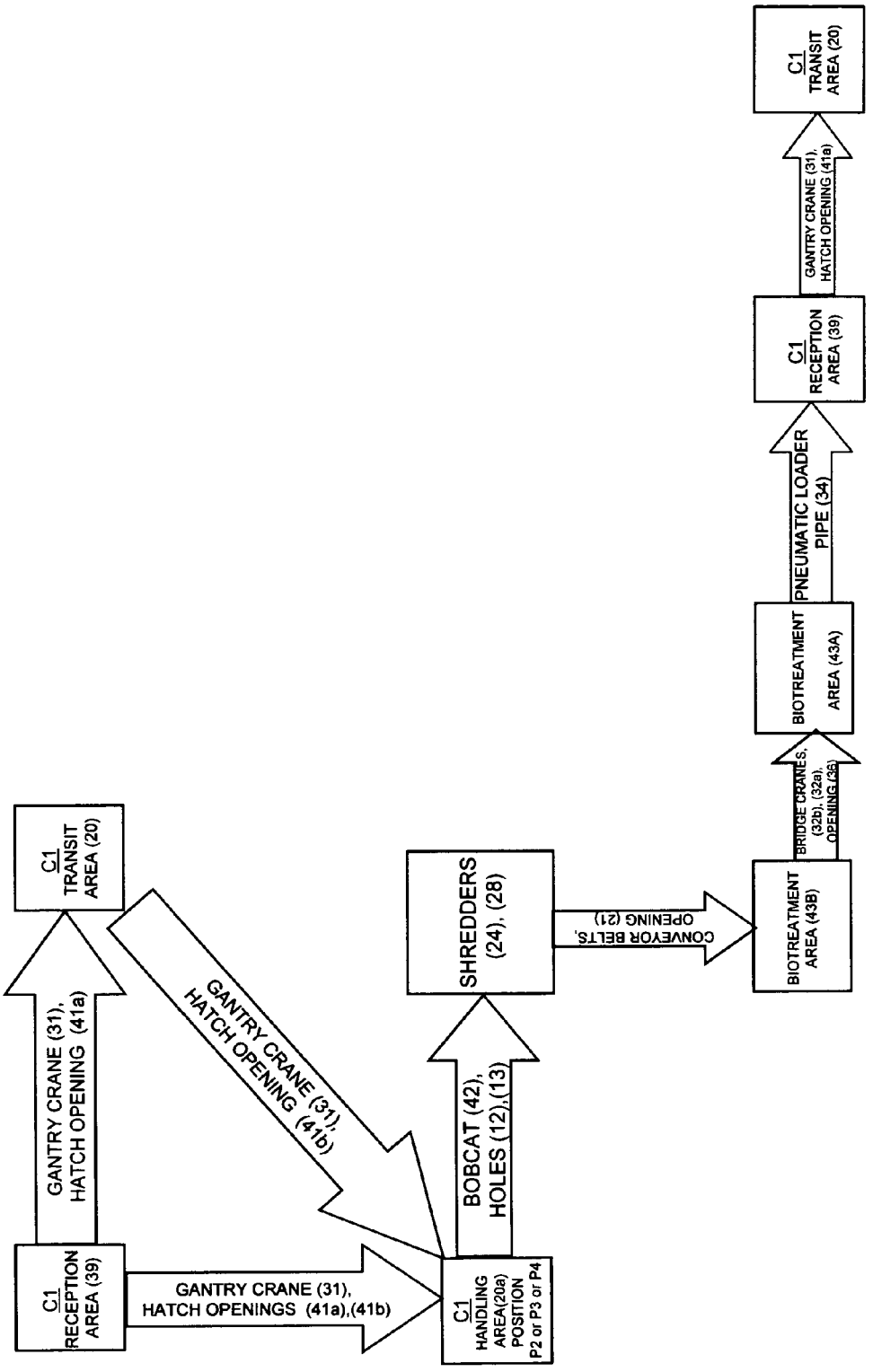
C1 TRANSIT AREA (20)
GANTRY CRANE (31), HATCH OPENING (41a)
C1 RECEPTION AREA (39)
GANTRY CRANE (31), HATCH OPENINGS (41a),(41b)
C1 HANDLING AREA(20a) POSITION P2 or P3 or P4
GANTRY CRANE (31), HATCH OPENING (41b)
BOBCAT (42), HOLES (12),(13)
SHREDDERS (24), (28)
CONVEYOR BELTS, OPENING (21)
BIOTREATMENT AREA (43B)
BRIDGE CRANES, (32b), (32a), OPENING (36)
BIOTREATMENT AREA (43A)
PNEUMATIC LOADER PIPE (34)
C1 RECEPTION AREA (39)
GANTRY CRANE (31), HATCH OPENING (41a)
C1 TRANSIT AREA (20)

Fig. 10

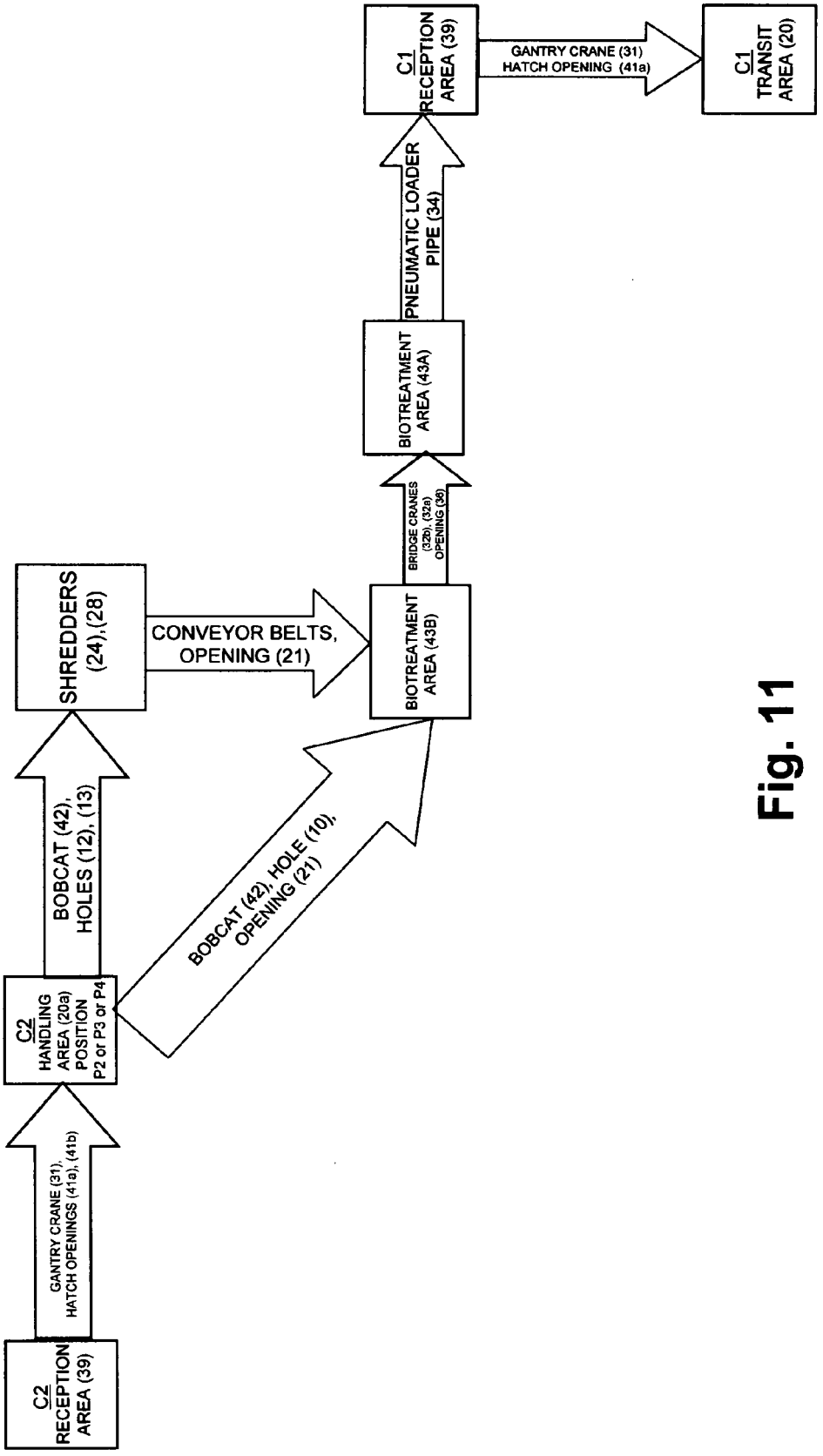
C2
RECEPTION
AREA (39)
GANTRY CRANE (31),
HATCH OPENINGS (41a), (41b)
C2
HANDLING
AREA (20a)
POSITION
P2 or P3 or P4
BOBCAT (42),
HOLES (12), (13)
BOBCAT (42), HOLE (10),
OPENING (21)
SHREDDERS
(24),(28)
CONVEYOR BELTS,
OPENING (21)
BIOTREATMENT
AREA (43B)
BRIDGE CRANES
(32b), (32a)
OPENING (30)
BIOTREATMENT
AREA (43A)
PNEUMATIC LOADER
PIPE (34)
C1
RECEPTION
AREA (39)
GANTRY CRANE (31)
HATCH OPENING (41a)
C1
TRANSIT
AREA (20)

Fig. 11

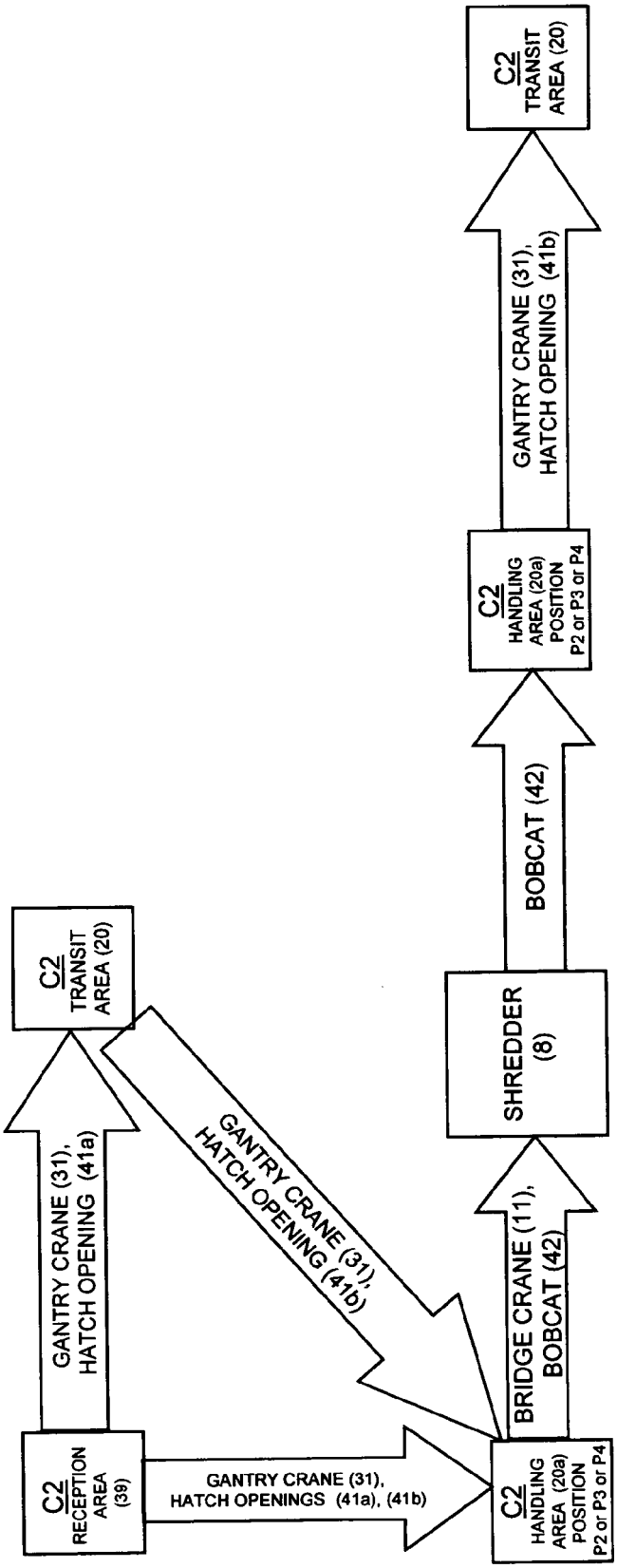
C2 RECEPTION AREA (39)
GANTRY CRANE (31), HATCH OPENINGS (41a), (41b)
C2 HANDLING AREA (20a) POSITION P2 or P3 or P4
BRIDGE CRANE (11), BOBCAT (42)
SHREDDER (8)
BOBCAT (42)
C2 HANDLING AREA (20a) POSITION P2 or P3 or P4
GANTRY CRANE (31), HATCH OPENING (41b)
C2 TRANSIT AREA (20)
GANTRY CRANE (31), HATCH OPENING (41b)
C2 TRANSIT AREA (20)

Fig. 12

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 38 6011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	WO 03/049995 A (ECOLSEA S R L [IT]; PARODI NICOLO [IT]) 19 June 2003 (2003-06-19) * page 5, line 4 - page 18, line 6; figure 1 *	1,6	INV. B63B35/44 B63B25/00
A	US 2006/060119 A1 (SKRYPEK THEODORE G [US] ET AL) 23 March 2006 (2006-03-23) * page 2, right-hand column, line 29 - page 5, left-hand column, line 53; figures 1-5 *	1,6	
A	GB 2 259 510 A (FLEXIBLE ENVIRONMENTAL SYST [US]) 17 March 1993 (1993-03-17) * page 4, line 28 - page 16, line 9; figures 1-3 *	1,6	
A	GB 2 280 888 A (FLEXIBLE ENVIRONMENTAL SYST [US]) 15 February 1995 (1995-02-15) * page 5, line 4 - page 8, line 4; figures 1-5 *	1,6	
A	DE 44 19 795 A1 (MERK HERMANN [DE]) 22 June 1995 (1995-06-22) * the whole document *	1,6	TECHNICAL FIELDS SEARCHED (IPC) B63B B03B
D,A	WO 2007/004905 A (CORPUS VICTOR N [PH]) 11 January 2007 (2007-01-11) * the whole document *	1,6	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 October 2009	Hofmann, Udo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 38 6011

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