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(54) **HYDROPOWER BARGE**

(57) The invention provides a portable hydroelectric system comprising a housing configured to float in a body of water, a hydroelectric generation means attached to the housing and comprising a hydroelectric element, wherein the hydroelectric generation means is configured to generate electricity when a flow of water causes movement of the hydroelectric element, and a deployment means configured to orient the hydroelectric generation means relative to the housing between a navigation state and a generation state.

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Description

Field of the Invention

[0001] This patent application relates to a barge/boat or floating platform with a hydropower turbine such as an Archimedes screw generator or Kaplan turbine built onto or into the barge.

Background of the Invention

[0002] It is known to use water turbines to generate electrical power from flowing water. Examples of such turbines are the Archimedes screw and Kaplan turbine, both of which require a head of water (i.e. a difference in water level between inlet and outlet of the turbine) to function.

[0003] These water turbines usually take the form of permanent installations at river locations having appropriate water flow to generate electricity.

[0004] However, it can be problematic installing such water turbines at certain locations. For instance, a desired site may be inaccessible due to the natural terrain or manmade structures such as houses or buildings and therefore difficult or impossible to deploy the turbine and machinery needed for installation of the hydropower system. Similarly, legal access to the site may not be permitted, or the flood-risk associated with the site may prevent the permanent installation of such a water turbine.

[0005] Beyond this, permanently installed water turbines may only generate sufficient electrical power at certain times of day or year in view of the natural transience of river or waterway cycles.

[0006] Accordingly, there is a need to provide a water turbine that can more easily be deployed and/or more suitable for use with highly variable water flow.

Summary of the Invention

[0007] The invention provides a portable hydroelectric system comprising a housing configured to float in a body of water, hydroelectric generation means attached to the housing and comprising a hydroelectric element, wherein the hydroelectric generation means is configured to generate electricity when a flow of water causes movement of the hydroelectric element, and deployment means configured to orient the hydroelectric generation means relative to the housing between a navigation state and a generation state.

[0008] The hydroelectric generation means may define an inlet and an outlet, wherein water flows from the inlet to the outlet via the hydroelectric element.

[0009] The navigation state may refer to a state wherein the hydroelectric generation means is generally raised (i.e. with respect to a water level) relative to the generation state. This may enhance the ability of the system to navigate or be navigated.

[0010] The generation state may refer to a state wherein the hydroelectric generation means is generally lowered (i.e. with respect to a water level) relative to the navigation state. This may enhance the ability of, or allow, the hydroelectric generation means to generate electricity from flowing water.

[0011] In an embodiment of the invention, the hydroelectric generation means comprises a generator unit and, optionally a gearbox, in a sealed waterproof compartment.

[0012] The sealed waterproof compartment may be positioned at the inlet or the outlet of the hydroelectric generation means, and may also comprise an aperture for allowing the flow of water through the sealed waterproof compartment. Alternatively, or in addition, water may be configured to flow over, under, or around the compartment.

[0013] In an embodiment of the invention, the hydroelectric element comprises a Kaplan turbine or an Archimedes screw.

[0014] In an embodiment of the invention, the deployment means comprises articulating arms configured to allow rotation of the hydroelectric generation means relative to the housing.

[0015] In an embodiment of the invention, the deployment means comprises ballast tanks connected to the hydroelectric generation means, wherein the ballast tanks are configured to be reversibly filled with water to thereby cause the hydroelectric generation means to be at a lower level in the water when the ballast tanks are filled than when the ballast tanks are empty.

[0016] In an embodiment of the invention, the deployment means comprises a volume defined at least by a trough which surrounds at least the underside and sides of the hydroelectric element when in use and a sluice gate positioned at an opening of the trough, wherein the sluice gate is movable between an open position and a closed position, wherein when the sluice gate is in the open position, water contained in the volume causes the hydroelectric generation means to be at a lower level in the water relative to when the sluice gate is in the closed position, and water is removed from the volume.

[0017] The sluice gate can also be used to prevent, or alter, the flow of water through the hydroelectric generation means. This can be advantageous if a head pressure or flow rate of the water exceeds an operating capacity of the hydroelectric generation means.

[0018] The deployment means may comprise one such sluice gate or a plurality of sluice gates.

[0019] The deployment means may comprise a pump and/or air compressor, or any other device for expelling fluid from the ballast tanks and/or the volume of the trough.

[0020] In an embodiment of the invention, the system comprises at least one battery for storage of the generated electricity, and optionally wherein the housing comprises the battery.

[0021] In an embodiment of the invention, the hydroelectric generation means comprises at least one sealing

panel configured to contact the walls of a water flow channel to thereby focus the flow of water through the hydroelectric generation means.

[0022] The panels may be formed of rubber. A plurality of panels may be used. The sealing panels may be hinged.

[0023] In an embodiment of the invention, the housing comprises an inboard motor, an outboard motor, or a tow point for attachment to a separate propulsion means.

[0024] In an embodiment of the invention, the housing comprises a control system configured to control the hydroelectric generation means and/or the deployment means.

[0025] The control system may provide for fixed and/or variable speed control of the hydroelectric generation means.

[0026] The control system may control operation of the pump, air compressor, articulating arms, and sluice gates, if present.

[0027] In an embodiment of the invention, the housing comprises navigation means for navigating the system.

[0028] In an embodiment of the invention, the system is configured such that the housing can be positioned downstream of the flow of water, wherein the hydroelectric generation means can be oriented upwardly into the flow of water, and/or the housing can be positioned upstream of the flow of water, wherein the hydroelectric generation means can be oriented downwardly into the flow of water.

Detailed Description of the Invention

[0029] As shown, the invention provides a portable water turbine comprising a barge (e.g. housing) and an installed Archimedes screw. The Screw sits inside a trough on the barge and the trough is braced with a Truss Bridge. Plating is placed under the screw and over the truss to allowing a large volume of displacement to be made available. Depending on the size of the screw, this can create a number of cubic meters of air space. The buoyancy created in this space is needed to float and navigate using a propulsion unit. When this airspace is flooded, the turbine section of the barge lowers to a power generating level and is attached to the control room/propulsion unit (i.e. housing) with articulating arms. This configuration enables the turbine section (e.g. the hydroelectric generation means) to sink to generation production levels whilst the control/navigation section remains afloat. This is henceforth called a "hydropower barge".

[0030] The hydropower barge may be (i) equipped with outboard or inboard motors, steering system and other navigation systems: A bespoke barge is built with articulating arms attached. The barge will be made to navigate and float. The ballast tanks will sink the hydroelectric section while the articulating arms will allow the barge/housing to float. (ii) towed/pushed by a separate boat, and/or (iii) permanently or semi permanently attached to a propulsion unit or boat.

[0031] The hydropower barge can be navigated on rivers, lakes or streams (700) to take advantage of potential hydropower sites that before this invention, were too difficult to develop for one or more reasons. Examples of some of those reasons which the hydropower barge overcomes are:

1. The site is inaccessible due to the natural terrain or manmade structures such as houses or buildings and therefore difficult or impossible to deploy the turbine and machinery needed for installation of the hydropower system.

2. The site requires full flow of water without the restriction of a conventionally installed hydropower system during times of high river flows so as not to risk flooding.

3. Where land access rights are not available.

[0032] Furthermore, the hydropower barge can be moved and, if necessary, easily adapted to other usable head sites when needed. For example, the hydropower barge may be moved from a site during low flow or low head occurrences to another site where appropriate flow and usable head are available. Uniquely the barge can be made adaptable to different locations. The screw will have panels, sealed with a with rubber sealing, that will flap out and press against an existing concrete weir to seal. No screw has been built which can be converted for different shapes and sizes.

[0033] Once dropped into place hinged panels with rubber seals can flap out and seal at various different sized weirs. That enables us to take advantage of the mobile system as the barge can be navigated to and moored at other weirs.

[0034] The hydropower barge may also be equipped with energy storage technology such as a battery bank where energy could be stored during generation on a head of water, then the barge moved to another location to supply the stored energy to the grid or end user. This enables the invention to supply hydroelectric generated energy to customers where there is no usable head and/or flow of water.

Where it will be used

[0035] The hydropower barge system requires a head differential between the upper and lower water levels and can be moored behind or in front of a head of water created by a weir, dam or other civil construction, in a waterway that creates a usable difference in head or water level between the upstream and downstream sides. The hydropower barge design is not a run-of-river generation system, other words only requiring a fast-moving stream with no head differential where the turbine uses only kinetic energy from a running river to extract energy. This invention requires both a minimum flow and head differ-

ential, just as conventional Archimedes or Kaplan turbines do.

How it will can be deployed

[0036] Once the hydropower barge system has been navigated to a usable head of water the hydropower barge will be moored or anchored behind or in front of a head of water. The hydropower barge or attached ballast tank(s) can then be either flooded or the turbine lowered from the hydropower barge to the most optimum and appropriate angle and depth in the water for generating power. When the system used to achieve the optimum angle is hydraulically driven, the hydraulic system will force the turbine down to the necessary angle.

How the barge can be moved from the weir

[0037] The hydropower barge own system can automatically pump air into the ballast tanks or pump water from them to make the entire hydropower barge buoyant enough for navigation. Where the hydropower barge remains buoyant and the turbine is oriented into the water, the control system will also automatically retract the turbine from the water. Once the moorings are removed and/or anchor lifted the hydropower barge can then be towed or moved under its own power away from the weir.

Unique modifications to allow the hydropower barge to become buoyant and navigable

[0038] To enable the hydropower turbine to be built into or onto a floating boat/barge, unique adaptations had to be made to the hydropower system. The upper housing of the turbine containing the generator and gearbox are sealed and made waterproof. This has never been used in this way before. The upper housing has always been permanently bolted to the ground. It is now being used as part of the buoyancy system to enable navigation. Sluice gates are used to seal off the center section of the turbine allowing water to be pumped out, making the system buoyant and ready for navigation. The way the sluice gates are being used is unique in that a system will be built onto the turbine to seal the entrance to the screw for navigation and opened to lower the turbine to an operating level when generating electricity.

[0039] The hydropower barge consists of two sections: (i) the turbine housing and a sealed watertight motor housing with gear box, generator and associated equipment attached with articulating arms, and (ii) a control room and navigation system. The motor housing has a watertight access hatch for machinery maintenance.

Reference Numerals

101. Air and Water Buoyancy Pumps

[0040] Nobody has floated nor navigated an Archimedes screw like this. An embodiment of the invention uses air and a water buoyancy pump so we can stop and sink for electricity generation or navigate to a new location. No Archimedes screw has used air and water buoyancy pumps for navigation before.

102. Hydropower Gearbox

[0041] This helps increase the rotational speed of a generator shaft relative to the turbine (element) rotational speed.

103. Hydropower Turbine

[0042] This can be any type of medium to low head turbine, i.e, Archimedes screw, Kaplin, propeller, etc.

104. Hydropower Electric Generator

201. Hydropower Control Cabinets

[0043] All systems use industrial computers taking measurements from a hydropower site. But this feature is enabling writing a code into the industrial computer whereby the system can change from generation mode to navigation mode. This will allow a controlled shutdown, blowing the ballast tanks full of air and also controlling stability during navigation. These controls will enable the system to either generate electricity at variable speeds, fixed speed or, remove water from the turbine area for navigation/transportation.

202. Propulsion Engines

[0044] There has never been an Archimedes screw that has marine style propulsion engine to be navigated.

203. Hydropower Energy Battery Storage

[0045] Energy storage is becoming more common in standard renewable generation, however; transportable energy storage is unique to this invention.

301. Articulated Hydraulic Control Angle and Level Control Arms

[0046] This feature helps enable the hydropower system to be configured for either navigation/transportation on a body of water or reconfigured for the correct angles and depths for energy generation.

400. Hydropower Barge Front View

401. Turbine

402. Gearbox. Generator Room

403. Turbine Buoyancy Control Sluice Gate

[0047] Sluice gates control water flowing into the screw. A system is built onto the turbine to seal the entrance to the screw, dewater the trough for buoyancy and navigate the system to other locations.. The way the sluice gates are being used is unique.

404. Navigation. Energy Storage and Hydropower Control Room

[0048] These have never been combined in any energy device before. Combining them allows for movement of the turbine, storage of the energy and transportation of the energy. One can generate stored energy and move to another location for use or move away from a weir during flood time or move to a another location for generation.

405. Navigation Water Level

500. Existing Weir

[0049] Standard.

501. Two Hydropower Barges Moored and Operational

600. Two Barges on Weir Operational Angle and Moored to Weir

601. Existing Weir

[0050] Standard.

602. Articulated Hydraulic Control Angle and Level Control Arms

[0051] This is unique because it allows for moving to and from navigation to generation. This has not been done before. A Propulsion unit hasn't been connected to an Archimedes screw before. This not only connects it but because they articulate it enables us to have a solid method of mooring onto a weir and remaining stable. The screw section needs to sink for generation but not the control/navigation section (i.e. the housing): the arms allow screw generation section to sink but control/navigation section to remain above water level.

603. Hydropower Turbine, Gearbox and Generator Room

604. Navigation. Energy Storage and Hydropower Control Room

[0052] Unique to this invention. This section of the hydro system is unique in that no other hydropower system exists which can be navigated under its own power or external boat/barge to and from a weir or other source of head.

700. Hydropower Barge in Navigation Mode

Claims

1. A portable hydroelectric system comprising:

a housing configured to float in a body of water, hydroelectric generation means attached to the housing and comprising a hydroelectric element, wherein the hydroelectric generation means is configured to generate electricity when a flow of water causes movement of the hydroelectric element, and
deployment means configured to orient the hydroelectric generation means relative to the housing between a navigation state and a generation state.

2. The system of claim 1, wherein the hydroelectric generation means comprises a generator unit and, optionally a gearbox, in a sealed waterproof compartment.

3. The system of claims 1 or 2, wherein the hydroelectric element comprises a Kaplan turbine or an Archimedes screw.

4. The system of claims 1 to 3, wherein the deployment means comprises articulating arms configured to allow rotation of the hydroelectric generation means relative to the housing.

5. The system of claims 1 to 4, wherein the deployment means comprises ballast tanks connected to the hydroelectric generation means, wherein the ballast tanks are configured to be reversibly filled with water to thereby cause the hydroelectric generation means to be at a lower level in the water when the ballast tanks are filled than when the ballast tanks are empty.

6. The system of claims 1 to 5, wherein the deployment means comprises a volume defined at least by a trough which surrounds at least the underside and sides of the hydroelectric element when in use and

a sluice gate positioned at an opening of the trough, wherein the sluice gate is movable between an open position and a closed position, wherein when the sluice gate is in the open position, water contained in the volume causes the hydroelectric generation means to be at a lower level in the water relative to when the sluice gate is in the closed position, and water is removed from the volume.

7. The system of claims 1 to 6, wherein the system comprises at least one battery for storage of the generated electricity, and optionally wherein the housing comprises the battery.

8. The system of claims 1 to 7, wherein the hydroelectric generation means comprises at least one sealing panel configured to contact the walls of a water flow channel to thereby focus the flow of water through the hydroelectric generation means.

9. The system of claims 1 to 8, wherein the housing comprises an inboard motor, an outboard motor, or a tow point for attachment to a separate propulsion means.

10. The system of claims 1 to 9, wherein the housing comprises a control system configured to control the hydroelectric generation means and/or the deployment means.

11. The system of claims 1 to 10, wherein the housing comprises navigation means for navigating the system.

12. The system of claims 1 to 11, wherein the system is configured such that the housing can be positioned downstream of the flow of water, wherein the hydroelectric generation means can be oriented upwardly into the flow of water, and/or the housing can be positioned upstream of the flow of water, wherein the hydroelectric generation means can be oriented downwardly into the flow of water.

Amended claims in accordance with Rule 137(2) EPC.

1. A portable hydroelectric system comprising:

a housing configured to float in a body of water, hydroelectric generation means attached to the housing and comprising a hydroelectric element, wherein the hydroelectric generation means is configured to generate electricity when a flow of water causes movement of the hydroelectric element, and
deployment means configured to orient the hydroelectric generation means relative to the housing between a navigation state and a generation state,
wherein the hydroelectric element comprises a Kaplan turbine or an Archimedes screw,
wherein the deployment means comprises a volume defined at least by a trough which surrounds at least the underside and sides of the hydroelectric element when in use and a sluice gate positioned at an opening of the trough, wherein the sluice gate is movable between an open position and a closed position, wherein when the sluice gate is in the open position, water contained in the volume causes the hydroelectric generation means to be at a lower level in the water relative to when the sluice gate is in the closed position, and water is removed from the volume,
wherein the housing comprises an inboard motor, an outboard motor, or a tow point for attachment to a separate propulsion means, and
wherein the housing comprises navigation means for navigating the system.

2. The system of claim 1, wherein the hydroelectric generation means comprises a generator unit and, optionally a gearbox, in a sealed waterproof compartment.

3. The system of claims 1 or 2, wherein the deployment means comprises articulating arms configured to allow rotation of the hydroelectric generation means relative to the housing.

4. The system of claims 1 to 3, wherein the deployment means comprises ballast tanks connected to the hydroelectric generation means, wherein the ballast tanks are configured to be reversibly filled with water to thereby cause the hydroelectric generation means to be at a lower level in the water when the ballast tanks are filled than when the ballast tanks are empty.

5. The system of claims 1 to 4, wherein the system comprises at least one battery for storage of the generated electricity, and optionally wherein the housing comprises the battery.

6. The system of claims 1 to 5, wherein the hydroelectric generation means comprises at least one sealing panel configured to contact the walls of a water flow channel to thereby focus the flow of water through the hydroelectric generation means.

7. The system of claims 1 to 6, wherein the housing comprises a control system configured to control the hydroelectric generation means and/or the deployment means.

8. The system of claims 1 to 7, wherein the system is configured such that the housing can be positioned downstream of the flow of water, wherein the hydroelectric generation means can be oriented upwardly into the flow of water, and/or the housing can be positioned upstream of the flow of water, wherein the hydroelectric generation means can be oriented downwardly into the flow of water.

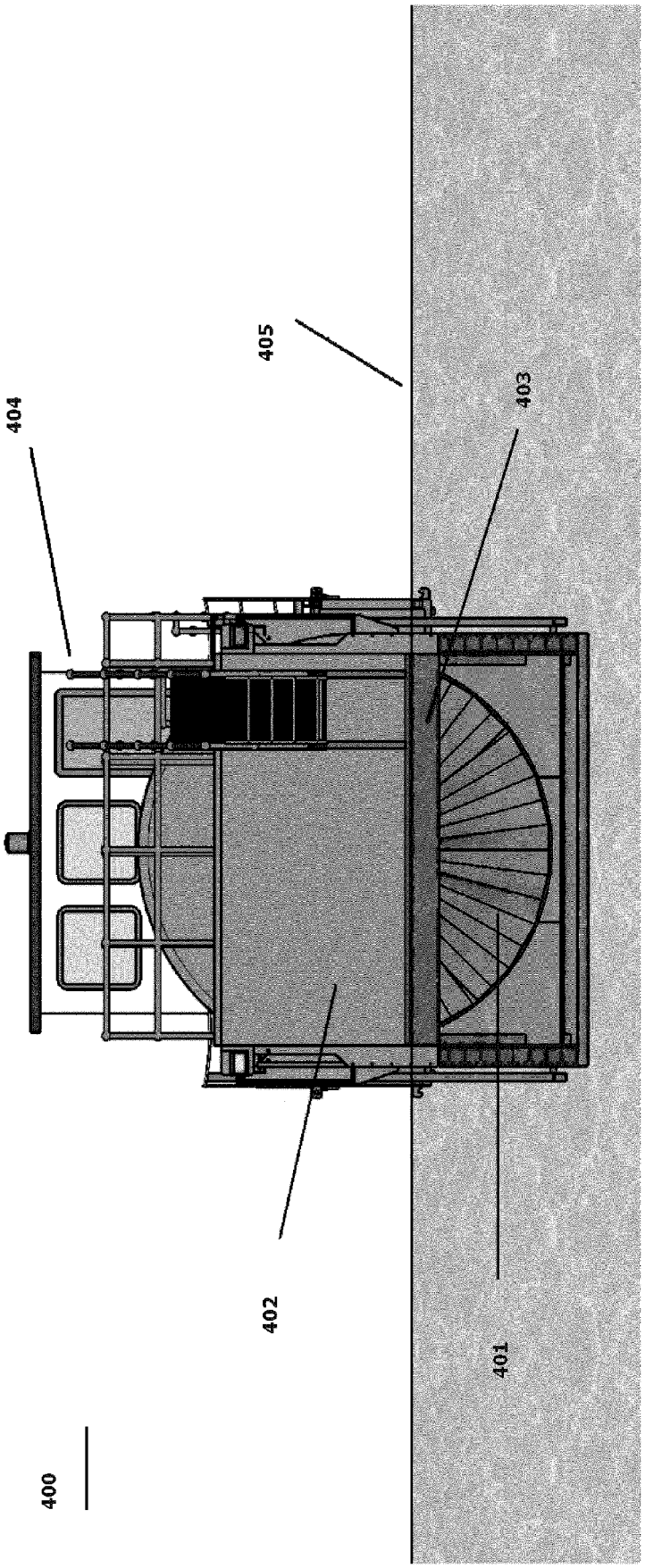

Fig. 1

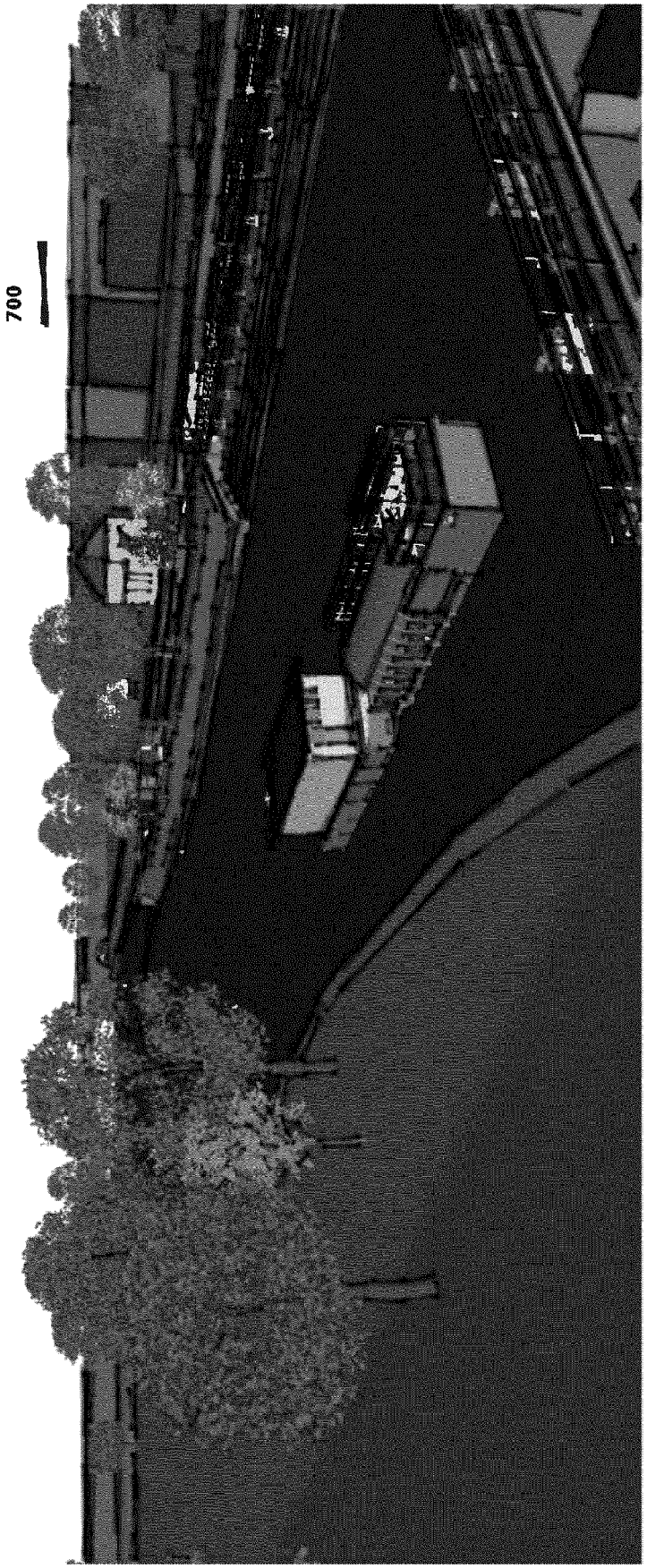

Fig. 2

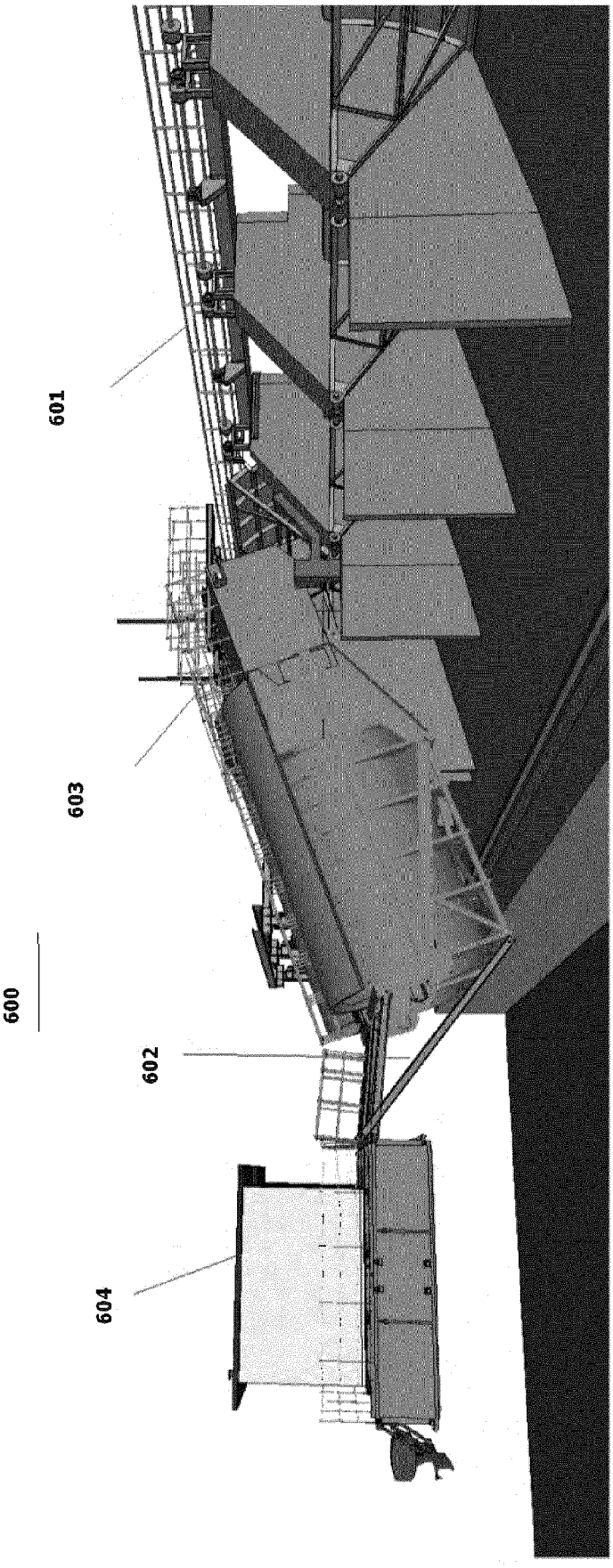

Fig. 3

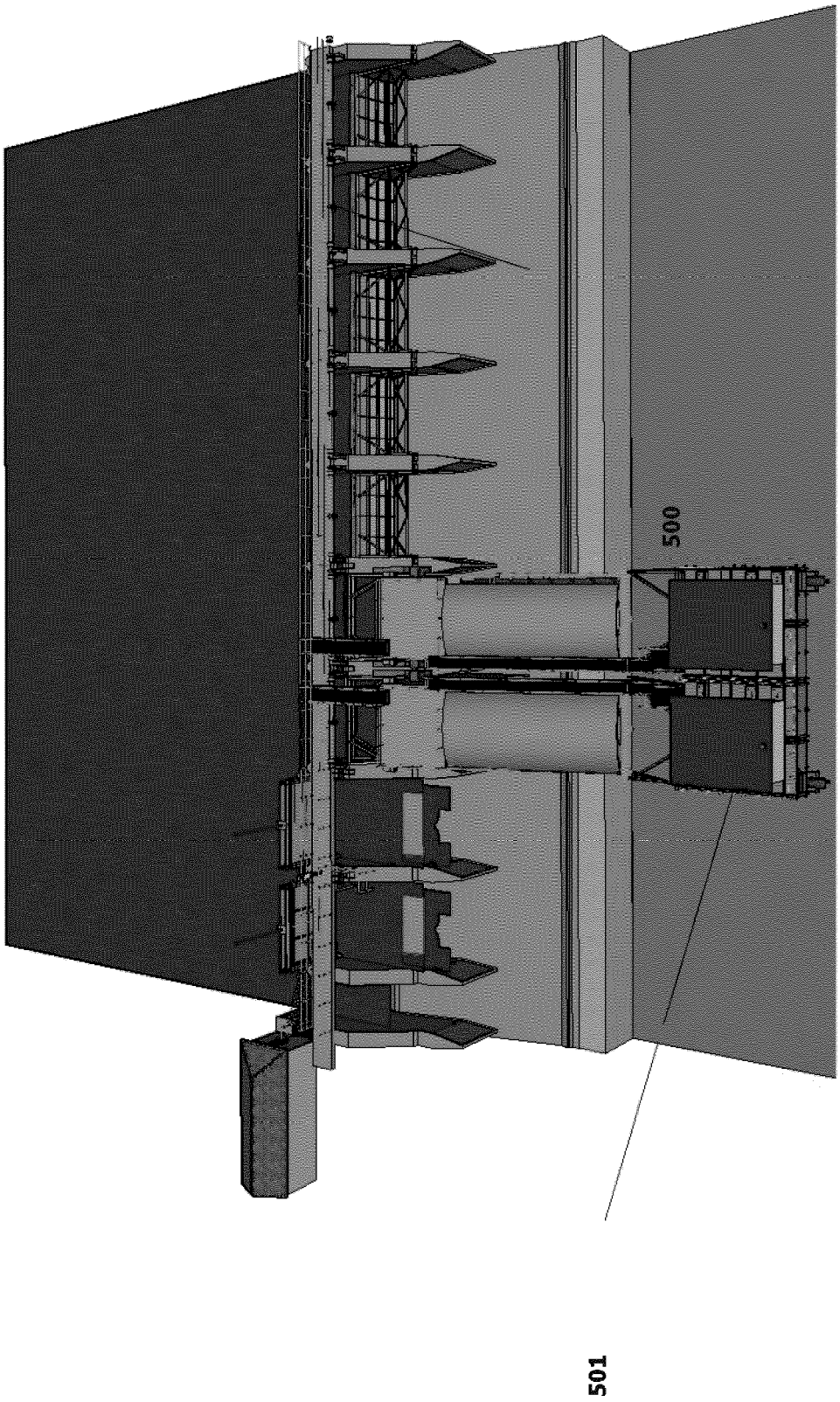

Fig. 4

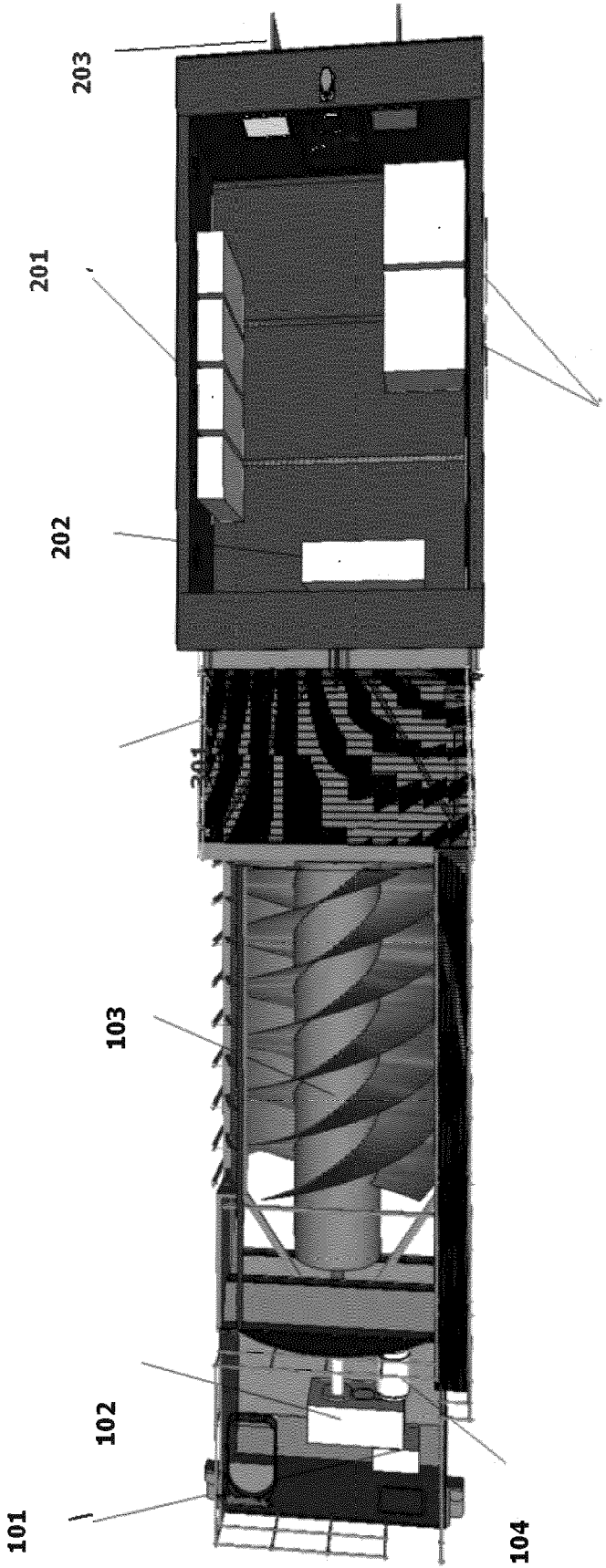

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 8752

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 May 2022	Lux, Ralph

CATEGORY OF CITED DOCUMENTS

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