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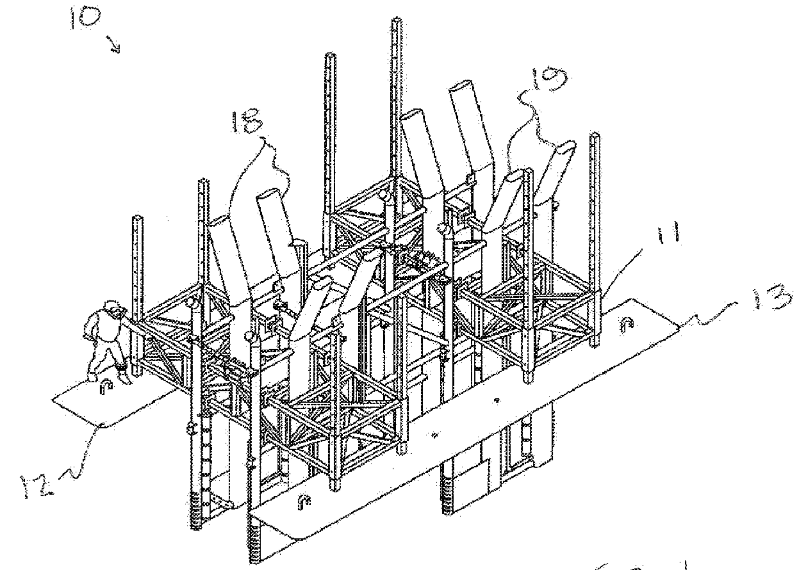

FIG 1

(57) Abstract: The present invention provides an improved pipeline burying apparatus that uses specially configured jetting nozzles that intake sea water surrounding the nozzle. The apparatus provides a frame supporting spaced apart left and right inclined pipe sections that are configured to be placed on opposing sides of the pipeline to be buried. Each inclined pipe section is fitted with a plurality of jetting nozzles that are positioned on one of the inclined pipe sections, in vertically spaced apart positions and in horizontally spaced apart positions. At least some of said jetting nozzles include a nozzle body having an outer surface and a main, central longitudinal fluid flow channel with a central channel axis. A fluid inlet end portion of the nozzle body has an externally threaded portion that enables connection to an internally threaded portion of a selected one of the inclined pipe sections. A discharge end portion of the nozzle body extends outwardly from an inclined pipe and the threaded portion. A plurality of lateral channels each intersect the main channel at an

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acute angle. In one embodiment, the main central longitudinal channel has an inlet section with an inlet section diameter, a discharge section having an outlet section diameter and a connecting section that is in between the inlet section and the outlet section.

PATENT APPLICATION

TITLE OF THE INVENTION

UNDERWATER PIPELINE BURYING APPARATUS AND METHOD

ASSIGNEE: BISSO MARINE, LLC, a Texas limited liability company, having an address of 11311 Neeshaw Drive, Houston, Texas 77065, US.

CROSS-REFERENCE TO RELATED APPLICATIONS

Priority to and/or the benefit of US Provisional Patent Application Serial No. 62/325,740, filed 21 April 2016, which is hereby incorporated herein by reference, is hereby claimed.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to underwater pipeline burying and more particularly to an improved underwater pipeline burying apparatus and method wherein jetting nozzles on a sled or frame mix a high velocity jetting stream with surrounding sea water that surrounds the outer surface of a nozzle body. The high velocity fluid stream flows in a central channel. Mixing uses one or more diagonally extending lateral channels that each connect the central channel to the nozzle body outer surface which is in communication with the surrounding sea water.

2. General Background of the Invention

Pipeline burying sleds typically use a frame that can be self-propelled or towed. The sled travels along the pipeline, usually straddling the pipeline. One or more (e.g., usually two or more) inclined pipes are each fitted with multiple jetting nozzles that can cut the seabed as the sled moves (or is moved). The nozzles preferably only cut the seabed. The sediment that has been cut must then be fluidized and slurried so that it can be removed from the trench or ditch area. Patents have issued that are directed to pipeline burying apparatus/methods. The following table lists examples, each of which is hereby incorporated herein by reference:

TABLE

Patent No.	Title	Issue Date
9,140,382	Gripper for Continuous Elongated Members, Vehicles Movable Along a Continuous Elongated Member, and Method of Advancing the Vehicle	09-22-2015
8,834,068	Group and Method for Laying and Burying Pipelines at the Seafloor	09-16-2014
8,066,450	Device and Method for the Towing of Underwater Pipelines	11-29-2011
7,637,696	Underwater Trenching Apparatus	12-29-2009
6,821,054	Method and System for Laying Pipe Through the Use of a Plow	11-23-2004
6,719,494	Cable and Pope Burial Apparatus and Method	04-13-2004
6,705,029	Trenching Machine	03-16-2004
6,681,711	System for Developing Cable	01-27-2004
6,449,883	Method and Device for Dredging Underwater Ground Layers	09-17-2002
6,273,642	Buoyant Propulsion Underwater Trenching Apparatus	08-14-2001
6,154,988	Machine for Digging Under Pipes and Caterpillar Traction Device	12-05-2000
6,022,173	Underwater Trenching System	02-08-2000
5,944,447	Underwater Pipeline Entrenching Apparatus and Method of Using the1 Same	08-31-1999
5,659,983	Device for Filling in a Trench Dug in the Sea Bed in Order to Cover a Pipe Laid Down in the Trench	08-26-1997
5,626,438	System for Excavating and Rehabilitating Underwater Pipelines	05-06-1997
4,986,697	Marine Pipeline Trenching Plow for Simultaneous Pipe Laying and Entrenchment	01-22-1991

Patent No.	Title	Issue Date
4,787,777	Method and Device for Progressively Producing an Underwater Laying-Out Channel	11-29-1988
4,721,409	Method and Device for Progressively Producing an Underwater Laying-Out Channel	01-26-1088
4,714,378	Apparatus and Method for Trenching Subsea Pipelines	12-22-1987
4,586,850	Underwater Trenching System	05-06-1986
4,537,530	Marine Cable Burying Method and Device Therefor	08-27-1985
4,516,880	Underwater Trenching Apparatus	05-14-1985
4,479,741	Device for Laying Underground or Digging up Subsea Conduits	10-30-1984
4,389,139	Oscillating Jet Head Underwater Trenching Apparatus	06-21-1983
4,280,289	Underwater Trenching Machine for Burying Pipeline and the Like	07-28-1981
4,274,760	Self-Propelled Underwater Trenching Apparatus and Method	06-23-1981
4,165,571	Sea Sled with Jet Pump for Underwater Trenching and Slurry Removal	08-28-1979
4,114,390	Burying a Conduit in the Bottom of a Body of Water	09-19-1978
4,112,695	Sea Sled for Entrenching Pipe	09-12-1978
4,091,629	Marine Pipeline Installation System	05-30-1978
4,044,566	Machine for Forming Trenches for Pipelines or the Like in the Sea Bed	08-30-1977
3,982,403	Laying Cables and the Like Under Water	09-28-1976
3,877,237	Underwater Trenching Apparatus Guidance System	08-15-1975
3,338,059	Methods and Apparatus for Entrenching Submerged Elongate Structures	08-29-1967

BRIEF SUMMARY OF THE INVENTION

A preferred embodiment of the apparatus of the present invention provides an improved pipeline burying apparatus using a specially configured jetting nozzle arrangement that includes an intake of sea water surrounding the nozzle.

The apparatus provides a frame that can support spaced apart left and right inclined pipe sections that can be configured to be placed on opposing sides of the pipeline to be buried.

Each inclined pipe section is preferably fitted with a plurality of jetting nozzles that can be positioned on the inclined pipe sections, in vertically spaced apart positions and in horizontally spaced apart positions.

At least some of said jetting nozzles preferably include a nozzle body having an outer surface and a main, central longitudinal fluid flow channel with a central channel axis.

A fluid inlet end portion of the nozzle body has an externally threaded portion that enables connection to an internally threaded portion of a selected one of the inclined pipe sections.

A discharge end portion of the nozzle body extends outwardly from an inclined pipe and a threaded portion.

A plurality of lateral channels each intersect the main channel at an acute angle.

In one embodiment, the main central longitudinal channel has an inlet section with an inlet section diameter, a discharge section having an outlet section diameter and a connecting section that is in between the inlet section and the outlet section.

In one embodiment, the connecting section is generally cylindrically shaped.

In one embodiment, the connecting section has a diameter that is smaller than the diameter of the discharge section.

In one embodiment, at least one lateral channel intersects with the discharge section.

In one embodiment, multiple lateral channels intersect with the discharge section.

In one embodiment, each lateral channel has a lateral channel inlet and a lateral channel outlet that is in fluid communication with the discharge section, and wherein the lateral channel outlet is closer than the lateral channel inlet to the discharge end portion.

In one embodiment, there are at least three of the lateral channels.

In one embodiment, there are at least four of said lateral channels.

In one embodiment, at least a part of said central longitudinal axis is conically shaped.

In one embodiment, at least a part of said longitudinal axis is frustoconically shaped.

In one embodiment, the angle is between about ten and eighty degrees.

In one embodiment, the angle is between about twenty and seventy degrees.

In one embodiment, the angle is between about thirty and sixty degrees.

In one embodiment, the angle is between about forty and fifty degrees.

In one embodiment, the angle is about forty-five degrees.

The present invention also provides an improved method of burying an underwater pipeline.

The method includes providing a frame that is adapted to travel along the pipeline to be buried, the frame having one or more vertical members fitted with multiple jetting nozzles, each jetting nozzle having a central fluid flow channel having an inlet that communicates with the interior of an inclined pipe and an outlet that discharges pressurized fluid externally of an inclined pipe.

Water and air are pumped under pressure to the central channel of the jetting nozzles via the vertical members.

Sea water surrounding at least part of the outer surface of the nozzle is water that is at a hydrostatic pressure based upon the water depth at the nozzle. Sea water mixes with water in the central channel by intaking the sea water via one or more lateral flow lines that each communicate with the nozzle outer surface and the nozzle central channel.

In one embodiment, the pressure of air and water flowing in the central channel is between about three hundred and three thousand p.s.i. (between about 2,068 and 20,684 kilopascal).

In one embodiment, the central channel has an inlet section with an inlet section diameter, a discharge section with a discharge section diameter and a connecting channel section in between the inlet section and discharge section.

In one embodiment, the connecting channel has a diameter that is smaller than the discharge section diameter.

In one embodiment, air flows into one or more air lifts that lift cuttings away from the trench or ditch.

In one or more embodiments, an underwater pipeline burying apparatus, comprises:

(a) a frame;

(b) spaced apart left and right inclined pipe sections of the frame that are configured to be placed on opposing sides of the pipeline to be buried;

(c) each said inclined pipe section fitted with a plurality of jetting nozzles that are positioned on a said pipe section in substantially vertically spaced apart positions and in substantially horizontally spaced apart positions; and

(d) at least some of said plurality of jetting nozzles including:

- a nozzle body having an outer surface and a main, central longitudinal channel with a central channel axis;

- a fluid inlet end portion of said body having an externally threaded portion;

- a discharge end portion of said body extending outwardly from a said inclined pipe section and said threaded portion; and

- a plurality of lateral channels that intersect said main channel at an acute angle.

In one or more embodiments, said main central longitudinal channel having an inlet section with an inlet section diameter, a discharge section having an outlet section diameter and a connecting section that is in between the inlet section and the discharge section.

In one or more embodiments, the connecting section is generally cylindrically shaped.

In one or more embodiments, the connecting section has a diameter that is smaller than the diameter of the discharge section.

In one or more embodiments, at least one said lateral channel intersects with said discharge section.

In one or more embodiments, multiple said lateral channels intersect with said discharge section.

In one or more embodiments, each lateral channel has a lateral channel inlet and a lateral channel outlet that is in fluid communication with said discharge section, and wherein the lateral channel outlet is closer than the lateral channel inlet to the discharge end portion.

In one or more embodiments, there are at least three of said lateral channels.

In one or more embodiments, there are at least four of said lateral channels.

In one or more embodiments, at least a part of said central longitudinal axis is conically shaped.

In one or more embodiments, at least a part of said central longitudinal axis is frustoconically shaped.

In one or more embodiments, said angle is between about ten and eighty degrees.

In one or more embodiments, said angle is between about twenty and seventy degrees.

In one or more embodiments, said angle is between about thirty and sixty degrees.

In one or more embodiments, said angle is between about forty and fifty degrees.

In one or more embodiments, said angle is about forty-five degrees.

In one or more embodiments, the fluid inlet includes a supply of pressurized air.

In one or more embodiments, the pressurized air has a flow rate of between about 400 cubic feet per minute (c.p.m) and 10,000 cubic feet per minute (c.p.m.) (between about 11 to 283 cubic meters per minute).

In one or more embodiments, the pressurized air has a pressure of between about 100 and 300 p.s.i. (between about 689 and 2,068 kilopascals (kpa)).

In one or more embodiments, the fluid inlet connects to a source of fluid of between 400 cubic feet per minute (c.f.m.) (11 cubic meters per minute) at 100 p.s.i. (689 kpa) and 10,000 c.f.m. (283 cubic meters per minute) at 300 p.s.i. (2,068 kpa).

In one or more embodiments, a method of burying an underwater pipeline, comprises the steps of:

(a) providing a frame that is adapted to travel along the pipeline to be buried, the frame having one or more vertical members fitted with multiple jetting nozzles, each jetting nozzle having an outer surface and a central flow channel having an inlet that communicates with an interior of an inclined pipe and an outlet that discharges pressurized fluid externally of an inclined pipe to cut soil or sediment at a seabed;

(b) pumping fluid under pressure to the central flow channel of the jetting nozzles via the vertical members; and

(c) mixing sea water that is at a hydrostatic pressure based upon water depth at the jetting nozzles with the fluid under pressure of step "b" by intaking the sea water via one or more lateral flow lines that each communicate with the nozzle outer surface and the nozzle central flow channel.

In one or more embodiments, the pressure in step "b" is between about three hundred and three thousand p.s.i (between about 2,068 and 20,684 kilopascal).

In one or more embodiments, the central channel has an inlet section with an inlet section diameter, a discharge section with a discharge section diameter and a connecting channel section in between the inlet section and discharge section.

In one or more embodiments, the connecting channel has a diameter that is smaller than the discharge section diameter.

In one or more embodiments, the apparatus is powered by 100 to 20,000 total horsepower (74.56 to 14,914 total kilowatts).

In one or more embodiments, in step "b" the fluid includes air.

In one or more embodiments, the air flows at between 400 and 10,000 cubic feet per minute (c.f.m.) (between about 11 to 283 cubic meters per minute) .

In one or more embodiments, the frame weighs between 5 and 250 tons (between 4.5 to 227 metric tons).

In one or more embodiments, the frame operates at a seabed soil pressure of between about 200 pounds per square foot (976 kilograms per square meter) and 6,265 pounds per square foot (30,588 kilograms per square meter) .

In one or more embodiments, the soil or sediment density is between about 68 pounds per cubic foot (1089 kilograms per cubic meter) and 187 pounds per cubic foot (2,995 kilograms per cubic meter).

In one or more embodiments, the pipeline is between about 2 inches (5.08 centimeters) and 84 inches (213 centimeters) in diameter.

In one or more embodiments, the pipeline is rigid steel, flexible steel, an umbilical, HDPE (high density polyethylene), or a cable.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

Figure 1 is a perspective view of a preferred embodiment of the apparatus of the present invention;

Figure 2 is a side elevation view of a preferred embodiment of the apparatus of the present invention;

Figure 3 is a side elevation of a preferred embodiment of the apparatus of the present invention;

Figure 4 is a front elevation view of a preferred embodiment of the apparatus of the present invention;

Figure 5 is a plan view of a preferred embodiment of the apparatus of the present invention;

Figure 6 is a plan view of a preferred embodiment of the apparatus of the present invention;

Figure 7 is a bottom view of a preferred embodiment of the apparatus of the present invention;

Figure 8 is a front elevation view of a preferred embodiment of the apparatus of the present invention;

Figure 9 is a side elevation view of a preferred embodiment of the apparatus of the present invention;

Figure 10 is a rear view of a preferred embodiment of the apparatus of the present invention;

Figure 11 is a rear view of a preferred embodiment of the apparatus of the present invention;

Figure 12 is a perspective view of a preferred embodiment of the apparatus of the present invention;

Figure 13 is a perspective view of a preferred embodiment of the apparatus of the present invention;

Figure 14 is an fragmentary end view of a preferred embodiment of the apparatus showing the jetting nozzle;

Figure 15 is a fragmentary side view of a preferred embodiment of the apparatus showing the jetting nozzle;

Figure 16 is a fragmentary view of a preferred embodiment of the apparatus showing the jetting nozzle;

Figure 17 is a fragmentary view of a preferred embodiment of the apparatus showing the jetting nozzle;

Figure 18 is a fragmentary view of a preferred embodiment of the apparatus showing the jetting nozzle;

Figure 19 is a fragmentary view of a preferred embodiment of the apparatus showing the jetting nozzle; and

Figure 20 is a fragmentary view of a preferred embodiment of the apparatus showing the jetting nozzle.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1-20 show a preferred embodiment of the apparatus of the present invention, designated generally by the numeral 10. Pipe burying apparatus 10 and the method of the present invention provides a frame or sled 11 (e.g., of welded steel construction). In one embodiment of the present invention, pipe burying apparatus 10 is preferably about 25-50 feet (7.62 to 15.24 meters) in length, more preferably about 30-40 feet (9.14 and 12.19 meters) in length, and most preferably, about 31 feet (9.45 meters), 6 inches (15.24 centimeters) in length. In one embodiment of the present invention, pipe burying apparatus 10 is preferably about 10-60 feet (3.05 to 18.29 meters) wide, more preferably about 15-45 feet (4.6 to 13.7 meters) wide, and most preferably about 20-30 feet (6.1 to 9.14 meters) wide.

In one embodiment of the present invention, pipe burying apparatus 10 is preferably about 15-45 feet (4.6 to 13.7 meters) in height, more preferably about 20-40 feet (6.1 to 12.19 meters) in height, and most preferably about 26 feet, 15 5/16 inches (7.9 meters and 38.89 centimeters) in height. In one embodiment of the present invention, frame or sled 11 is preferably about 20-50 feet (6.1 to 15.24 meters) long, more preferably about 30-40 feet (9.14 and 12.19 meters) long, and most preferably about 35 feet (10.67 meters) long. In one embodiment of the present invention, frame or sled 11 is preferably about 10-55 feet (3.05 to 16.76 meters) wide, more preferably about 12-40 feet (3.6 to 12.19 meters) wide, and most preferably about 16-26 feet (4.87 to 7.9 meters) wide. In one embodiment of the present invention, frame or sled 11 is preferably about 10-30 feet (3.05 to 9.14 meters) in height, more preferably about 12-25 feet (3.7 to 7.6 meters) in height, and most preferably about 15 feet (4.6 meters), 10 5/16 inches (26.12 centimeters) in height.

Frame 11 has a pair of spaced apart pontoons or skids 12, 13 that track the seabed 44 as the frame 11 is moved or moves along the seabed 44 while burying a pipeline 40 (as seen as in Figure 12 and indicated by direction of travel arrow 21). In one embodiment of the present invention, skids 12, 13 are preferably made out of steel, stainless steel or aluminum. In one embodiment of the present invention, each skid 12, 13 is preferably about 1-24 inches (2.54 to 60.96 centimeters) in height, more preferably, about 2-18 inches (5.08 to 45.72 centimeters) in height, and most preferably, about 8 5/8 inches (21.9 centimeters) in height. In one embodiment of the present invention, each skid 12, 13 is preferably about 2-10 feet (.61 to 3.05 meters) wide, more preferably, about 3-8 feet (.91 to 2.43 meters) wide, and most preferably, about 4 feet (1.22

meters) wide.

In one embodiment of the present invention, each skid 12, 13 is preferably about 25-60 feet (7.62 to 18.29 meters) long, more preferably about 30-45 feet (9.1 to 13.71 meters) long, and most preferably about 31 feet (9.45 meters), 6 inches (15.24 centimeters) long. The frame 11 can be made to straddle the pipeline 40, with one pontoon or skid 12 being a port side pontoon or skid, the other pontoon or skid 13 being a starboard pontoon or skid (see Figure 13).

In order to excavate a trench or ditch 41 and thus bury the pipeline 40, multiple jetting nozzles 20 are provided. These nozzles 20 are mounted to inclined or vertical pipe sections 14-17 on frame 11. The vertical pipe sections 14-17 preferably define the width of the trench or ditch 41. The position of each inclined or vertical pipe 14-17 can be adjusted relative to the frame 11. In one embodiment of the present invention, the nozzles 20 can be made out of stainless steel with inserts (e.g., metal that is harder than steel).

Pipe sections or pipes 14, 15, 16 and 17 on frame 11 can be inclined or generally vertically oriented. In one embodiment of the present invention, pipe sections 14, 15, 16, and 17 can be made out of steel, stainless steel or aluminum. There can be forward pipe sections 14, 15 at the front of frame 11 and rear pipe sections 16, 17 at the rear of frame 11.

Each vertical or inclined pipe or pipe section 14, 15, 16, 17 can be fitted with multiple or several spaced apart jetting nozzles 20 (see Figures 1-2, 12). Jetting nozzles 20 can be vertically spaced apart and laterally spaced apart. The jetting nozzles 20 can point in different directions such as forward, sideways, angled up, or angled down to provide jetting in as many directions as possible and thus maximize digging and mechanical breakup of the seabed 44 when forming a trench or ditch 41 to hold pipe or pipeline 40. As an example, a single one of the pipes or pipe section could have 25-250 or more nozzles 20.

In one embodiment of the present invention, each pipe section 14, 15, 16 and 17 can be preferably about 10-40 feet (3.05 to 12.19 meters) in height and more preferably, about 15-30 feet (14.57 to 9.14 meters) in height. In various embodiments, the pipe sections 14, 15, 16, 17 have different lengths. In various embodiments the pipe sections 14, 15 have different lengths from pipe sections 16, 17. In one embodiment of the present invention, each pipe section 14, 15, 16 and 17 can be preferably about 3-10 inches (7.62 to 25.4 centimeters) in diameter, more preferably about 4-8 inches (10.16 to 20.32 centimeters) in diameter, and most preferably about 6 inches (15.24 centimeters) in diameter.

As the frame 11 or sled moves forward, such as being pulled by a barge or a vessel or a winch on a barge or vessel, the trench or ditch 41 is formed by the cutting jetting nozzles 20. Seabed sediment or seabed material is mechanically broken up and fluidized or slurried, or becomes an emulsification and thereby is removed to prevent its settling back into the trench or ditch 41. Air lifts 18, 19 are provided to remove this mechanically broken up or slurried seabed material and transport it laterally away from the ditch or trench 41 (see Figures 1, 13).

In one embodiment of the present invention, air lifts 18, 19 can be made out of steel, stainless steel, aluminum or PVC. In one embodiment of the present invention, each air lift 18, 19 can preferably be about 10-40 feet (3.048 to 12.192 meters) in height and more preferably, about 15-30 feet (4.572 to 9.144 meters) in height. In various embodiments, the air lifts 18 and 19 have different lengths. In various embodiments, the air lifts 18, 19 have lengths that are not equal. In one embodiment of the present invention, each air lift 18, 19 can preferably be about 12-36 inches (30.48 - 91.44 centimeters) wide, more preferably about 18-30 inches (45.72 - 76.2 centimeters) wide, and most preferably about 24 inches (60.96 centimeters) wide.

Each vertical or inclined pipe section 14, 15, 16, 17 preferably has multiple internally threaded openings 42 thus providing a place for attachment of the jetting nozzles 20. Each jetting nozzle can have nozzle body 23 with external threads or externally threaded portion 22 (see Figures 16-17). Nozzle body 23 can have outer end portion 45 and inner end portion 46. External threads or externally threaded portion 22 preferably extends between inner end portion 46 and channels 30, 31, 32, 33. Each jetting nozzle 20 preferably is installed on or attaches to a vertical or inclined pipe section 14, 15, 16, 17 by engaging external threads 22 of nozzle body 23 with an internally threaded opening 42 on a selected pipe section 14, 15, 16, 17. Hexagonal portion 24 on nozzle body 23 enables a tool (e.g., wrench) to connect with and rotate nozzle body 23 during such installation.

During use, large pumps are used to transmit pressurized water flow to the bore or interior of each vertical or inclined pipe section 14, 15, 16, 17 and to the jetting nozzles 20. In one embodiment of the present invention, one or more large pumps, such as a Union, 4 Stage or 9 Stage, or Patterson, 10x10, can be used. As an example, this pressure can be between about three hundred and three thousand (300-3,000) p.s.i. (2068 - 20,684 kpa).

As seen in Figures 14-20, jetting nozzle 20 can have a nozzle body 23 with a central longitudinal channel 25 having conically shaped or conical sections 26, 27. The conical sections

26, 27 can have a maximum internal diameter that can be greater than the internal diameter 39 of cylindrical section 28 of central longitudinal channel 25. An insert, such as insert 35, can be included for "wear" resistance, and can typically be made out of tungsten or ceramic. Insert 35 can have a cylindrically shaped channel 37 and a conically shaped channel 36 (see Figure 17). Insert 35 can be held in place with an interference fit, threaded connection, or weld, for example.

Conically shaped channel 36 can have a maximum internal diameter that can be greater than the internal diameter of the cylindrically shaped channel 37. In one embodiment of the present invention, conical sections 26, 27 have an internal diameter of preferably about 0.3-1.2 inches (0.762-3.048 centimeters), more preferably about 0.5-1 inches (1.27 - 2.54 centimeters), and most preferably about 0.788 inches (2.00 centimeters) in diameter. Central longitudinal channel 25 has a discharge section 29 with a maximum internal diameter 38 that is larger than the internal diameter of cylindrical section 28. Cylindrical section 28 is in between conically shaped sections 26, 27 and discharge section 29. During use, channel 25 receives fluid flow from the bore or interior of a vertical or inclined pipe or pipe section 14, 15, 16 or 17. Fluid in channel 25 discharges via discharge section 29 to the surrounding lake, ocean or sea where pressure is hydrostatic and based upon the water depth. The pressure of the fluid stream in channel 25 cylindrical section 28 is much higher than the outside surrounding hydrostatic pressure.

In one embodiment of the present invention, jetting nozzle 20 can have a nozzle body 23 with a diameter of preferably about 0.750-3.00 inches (1.905 to 7.62 centimeters), more preferably about 1.00-2.50 inches (2.54 to 6.35 centimeters), and most preferably about 1.315 inches (3.340 centimeters). In one embodiment of the present invention, internal diameter 39 of cylindrical section 28 is preferably about 0.0625-0.500 inches (0.1589 - 1.27 centimeters), more preferably about 0.125-0.375 inches (0.318-0.9523 centimeters), and most preferably about 0.250 inches (0.635 centimeters). Jet nozzle 20 can have a body length of preferably 1.00-5.00 inches (2.54 - 12.7 centimeters). More preferably about 1.50-4.00 inches (3.81 - 10.16 centimeters), and most preferably 2.905 inches (7.379 centimeters).

Downstream of cylindrical section 28, water flows via a plurality of lateral channels 30, 31, 32, 33 from the outer surface of nozzle body 23 to discharge section 29 because of venturi effect (see Figures 14-15). The result is a higher volume but lower pressure discharge from nozzle 20 discharge section 29. Nozzle 20 thus performs some cutting, but high volume of water flow helps fluidize cut material and remove it from its original location. Angle 34 is the angle formed by a said lateral channel 30, 31, 32, 33 and the central longitudinal axis 43 of central longitudinal channel 25. Thus, angle 34 can be between about ten and eighty degrees, more preferably about twenty and seventy degrees, even more preferably between about forty and sixty degrees.

The following is a list of parts and materials suitable for use in the present invention:

PARTS LIST:

PART NUMBER	DESCRIPTION
10	pipe burying apparatus
11	frame/sled
12	pontoon/skid
13	pontoon/skid
14	front vertical or inclined pipe
15	front vertical or inclined pipe
16	rear vertical or inclined pipe
17	rear vertical or inclined pipe
18	port airlift
19	starboard airlift
20	jetting nozzle/nozzle
21	arrow
22	external threads/externally threaded portion
23	nozzle body
24	hexagonal portion
25	central longitudinal channel
26	conically shaped section
27	conically shaped section
28	cylindrical section
29	discharge section
30	lateral channel
31	lateral channel
32	lateral channel

33	lateral channel
34	angle
35	insert
36	conically shaped channel
37	cylindrically shaped channel
38	internal diameter
39	internal diameter
40	pipeline
41	ditch/trench
42	internally threaded opening
43	central longitudinal axis
44	sea bed
45	outer end portion
46	inner end portion

All measurements disclosed herein are at standard temperature and pressure, at sea level on Earth, unless indicated otherwise. All materials used or intended to be used in a human being are biocompatible, unless indicated otherwise.

The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

CLAIMS

1. An underwater pipeline burying apparatus, comprising:

(a) a frame;

(b) spaced apart left and right inclined pipe sections of the frame that are configured to be placed on opposing sides of the pipeline to be buried;

(c) each said inclined pipe section fitted with a plurality of jetting nozzles that are positioned on a said pipe section in substantially vertically spaced apart positions and in substantially horizontally spaced apart positions; and

(d) at least some of said plurality of jetting nozzles including:

- a nozzle body having an outer surface and a main, central longitudinal channel with a central channel axis;
- a fluid inlet end portion of said body having an externally threaded portion;
- a discharge end portion of said body extending outwardly from a said inclined pipe section and said threaded portion; and
- a plurality of lateral channels that intersect said main channel at an acute angle.

2. The pipeline burying apparatus of claim 1 wherein said main central longitudinal channel having an inlet section with an inlet section diameter, a discharge section having an outlet section diameter and a connecting section that is in between the inlet section and the discharge section.

3. The pipeline burying apparatus of claim 2 wherein the connecting section is generally cylindrically shaped.

4. The pipeline burying apparatus of claim 2 wherein the connecting section has a diameter that is smaller than the diameter of the discharge section.

5. The pipeline burying apparatus of claim 2 wherein at least one said lateral channel intersects with said discharge section.

6. The pipeline burying apparatus of claim 2 wherein multiple said lateral channels intersect with said discharge section.

7. The pipeline burying apparatus of claim 2 wherein each lateral channel has a lateral channel inlet and a lateral channel outlet that is in fluid communication with said discharge section, and wherein the lateral channel outlet is closer than the lateral channel inlet to the discharge end portion.

8. The pipeline burying apparatus of claim 1 wherein there are at least three of said

lateral channels.

9. The pipeline burying apparatus of claim 1 wherein there are at least four of said lateral channels.

10. The pipeline burying apparatus of claim 1 wherein at least a part of said central longitudinal axis is conically shaped.

11. The pipeline burying apparatus of claim 1 wherein at least a part of said central longitudinal axis is frustoconically shaped.

12. The pipeline burying apparatus of claim 1 wherein said angle is between about ten and eighty degrees.

13. The pipeline burying apparatus of claim 1 wherein said angle is between about twenty and seventy degrees.

14. The pipeline burying apparatus of claim 1 wherein said angle is between about thirty and sixty degrees.

15. The pipeline burying apparatus of claim 1 wherein said angle is between about forty and fifty degrees.

16. The pipeline burying apparatus of claim 1 wherein said angle is about forty-five degrees.

17. The pipeline burying apparatus of claim 1wherein the fluid inlet includes a supply of pressurized air.

18. The pipeline burying apparatus of claim 17 wherein the pressurized air has a flow rate of between about 400 cubic feet per minute (c.p.m) (11 cubic meters per minute) and 10,000 cubic feet per minute (c.p.m.) (283 cubic meters per minute) .

19. The pipeline burying apparatus of claim 17 wherein the pressurized air has a pressure of between about 100 and 300 p.s.i. (689 and 2,068 kpa).

20. The pipeline burying apparatus of claim 1 wherein the fluid inlet connects to a source of fluid of between 400 c.f.m. (11 cubic meters per minute) at 100 p.s.i. (689 kpa) and 10,000 c.f.m. (283 cubic meters per minute) at 300 p.s.i. (2,068 kpa).

21. A method of burying an underwater pipeline, comprising the steps of:

(a) providing a frame that is adapted to travel along the pipeline to be buried, the frame having one or more substantially vertical members fitted with multiple jetting nozzles, each jetting nozzle having an outer surface and a central flow channel having an inlet that communicates with an interior of an inclined pipe and an outlet that discharges pressurized fluid externally of an inclined pipe to cut soil or sediment at a seabed;

(b) pumping fluid under pressure to the central flow channel of the jetting nozzles via the vertical members; and

(c) mixing sea water that is at a hydrostatic pressure based upon water depth at the jetting nozzles with the fluid under pressure of step "b" by intaking the sea water via one or more lateral flow lines that each communicate with the nozzle outer surface and the nozzle central flow channel.

22. The method of claim 21 wherein the pressure in step "b" is between about three hundred p.s.i (2,068 kpa) and three thousand p.s.i. (20,684 kpa).

23. The method of claim 21 wherein the central channel has an inlet section with an inlet section diameter, a discharge section with a discharge section diameter and a connecting channel section in between the inlet section and discharge section.

24. The method of claim 23 wherein the connecting channel has a diameter that is smaller than the discharge section diameter.

25. The pipeline burying apparatus of claim 1 wherein the apparatus is powered by 100 to 20,000 total horsepower (74.57 to 14,913 kilowatts).

26. The method of claim 21 wherein in step "b" the fluid includes air.

27. The method of claim 26 wherein the air flows at between 400 and 10,000 cubic feet per minute (c.f.m.) (11 to 283 cubic meters per minute).

28. The apparatus of claim 1 wherein the frame weighs between 5 tons (4.5 metric tons) and 250 tons (227 metric tons).

29. The method of claim 21 wherein the frame operates at a seabed soil pressure of between about 200 pounds per square foot (9.58 kilopascals) and 6,265 pounds per square foot (299.97 kilopascals).

30. The method of claim 21 wherein the soil or sediment density is between about 68 pounds per cubic foot (1,089 kilograms per cubic meter) and 187 pounds per cubic foot (2,995 kilograms per cubic meter).

31. The method of claim 21 wherein the pipeline is between about 2 inches (5.08 centimeters) and 84 inches (213 centimeters) in diameter.

32. The method of claim 31 wherein the pipeline is rigid steel, flexible steel, an umbilical, HDPE, or a cable.

33. The invention(s) substantially as shown and/or described herein.

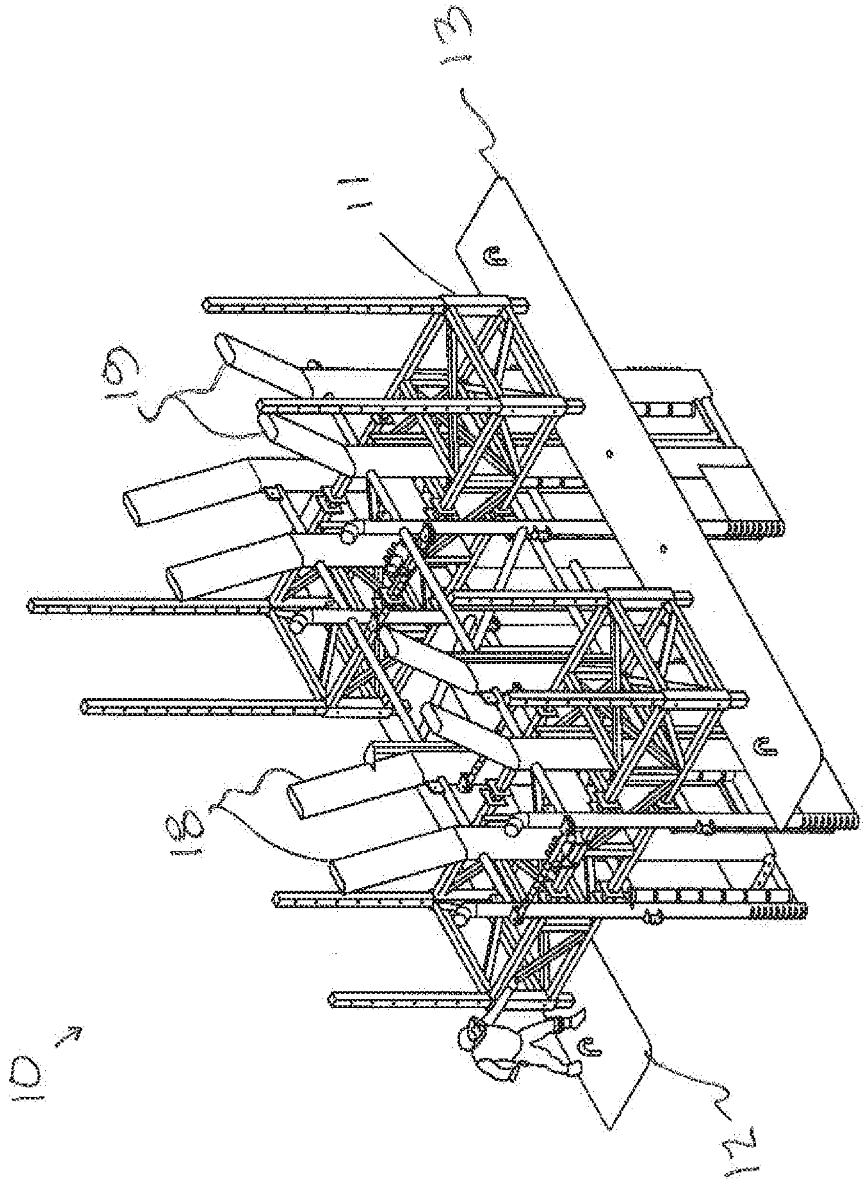


Fig 1

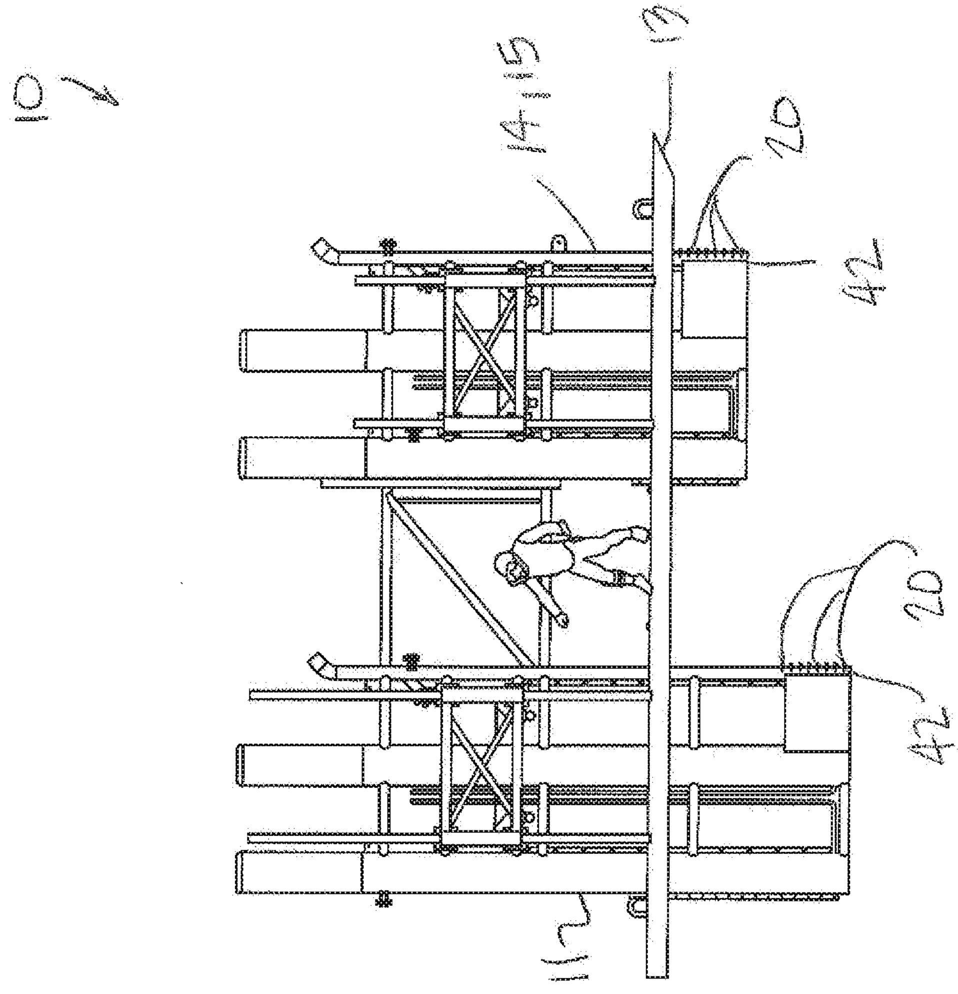


FIG 2

FIG 3

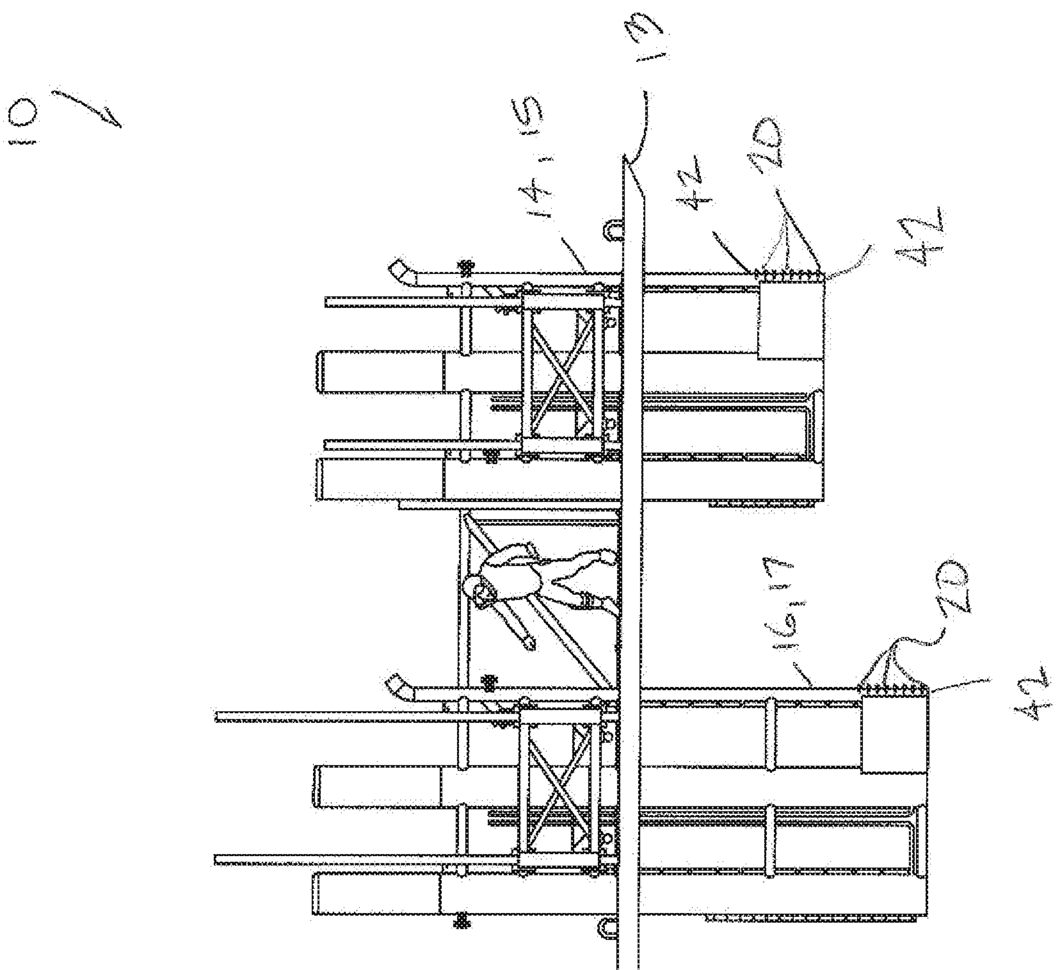
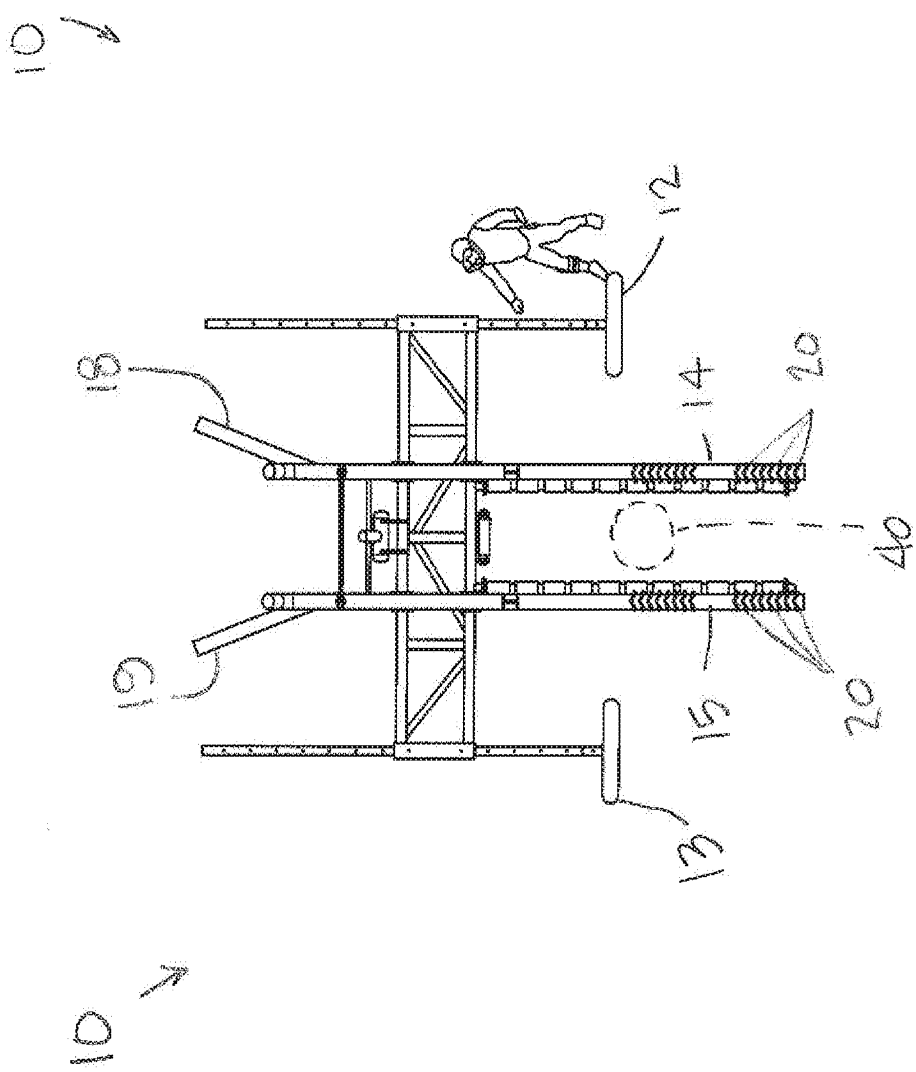


FIG 4



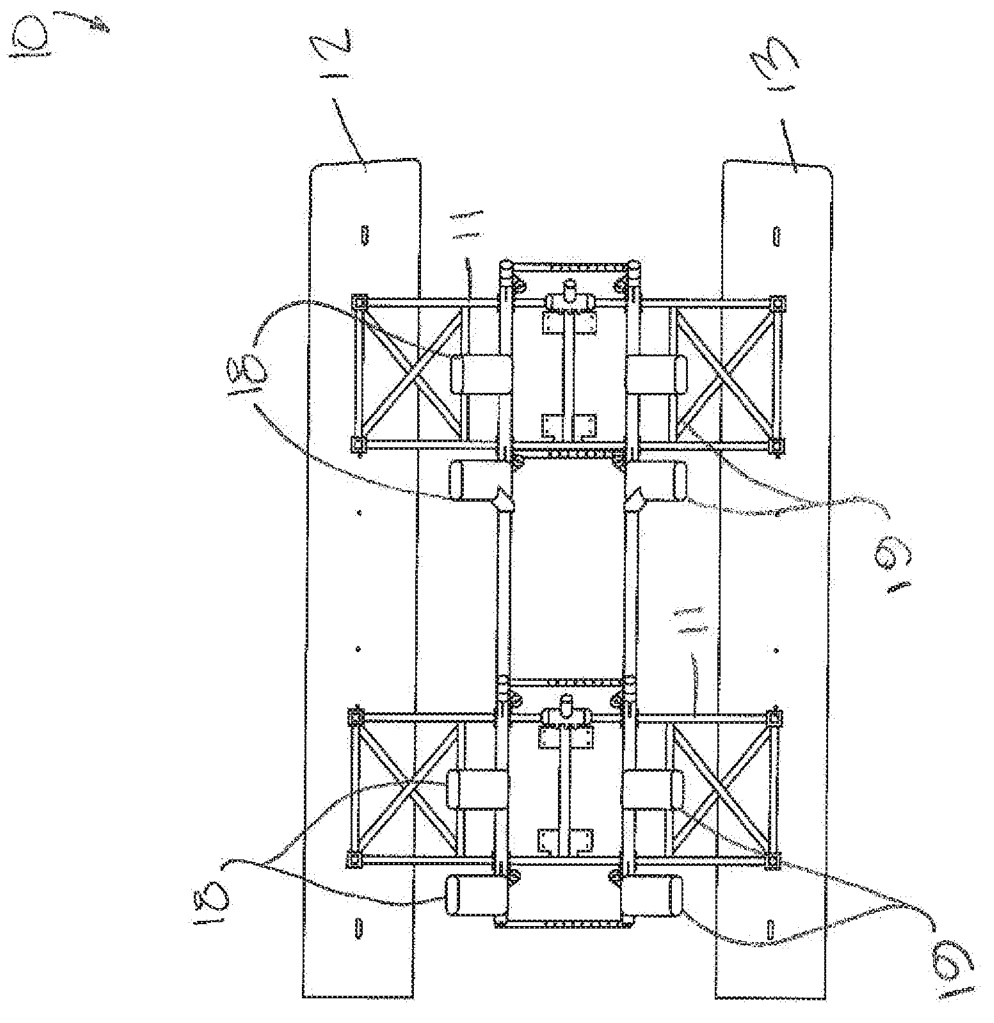
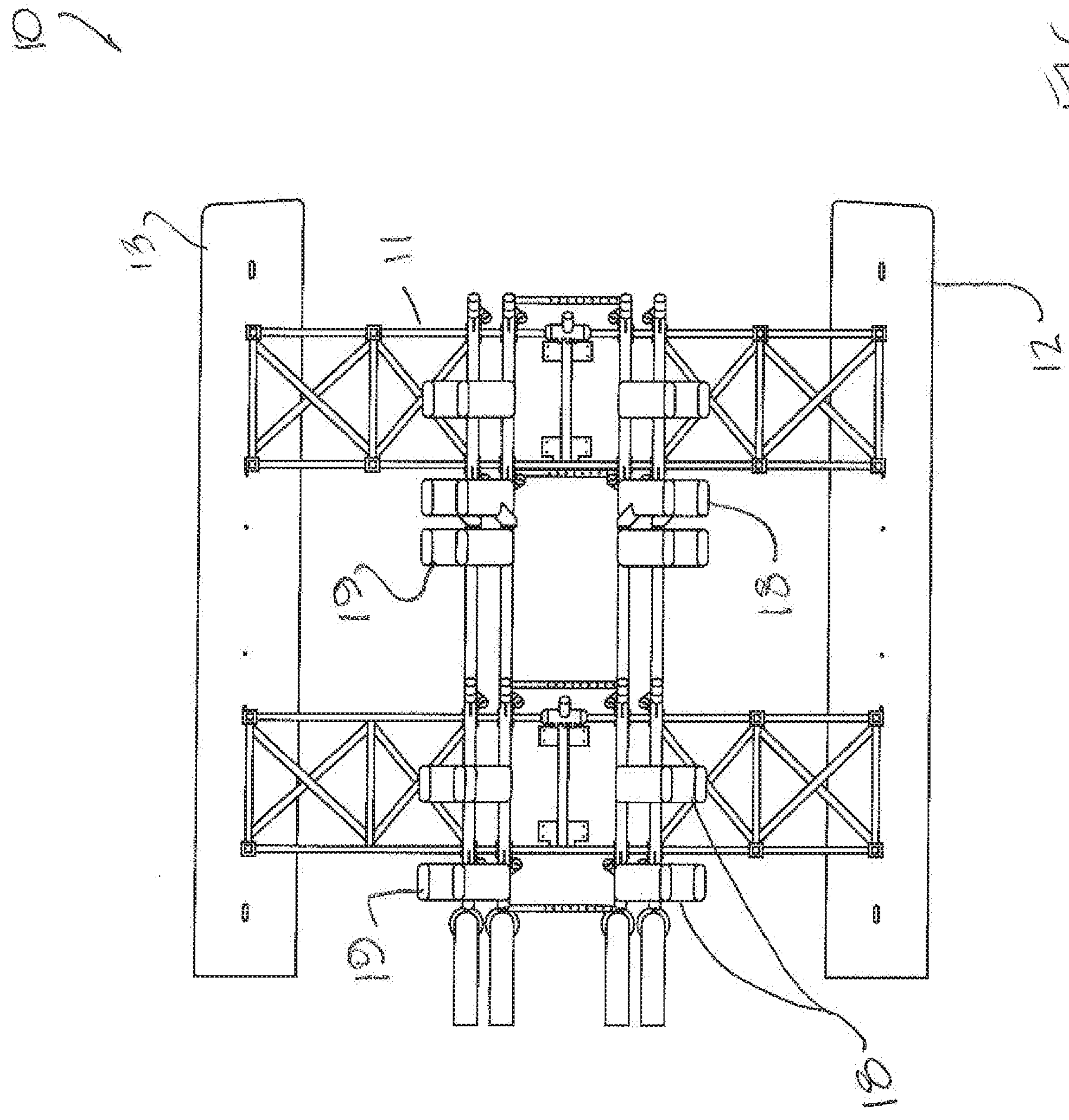


FIG 5

FIG 6



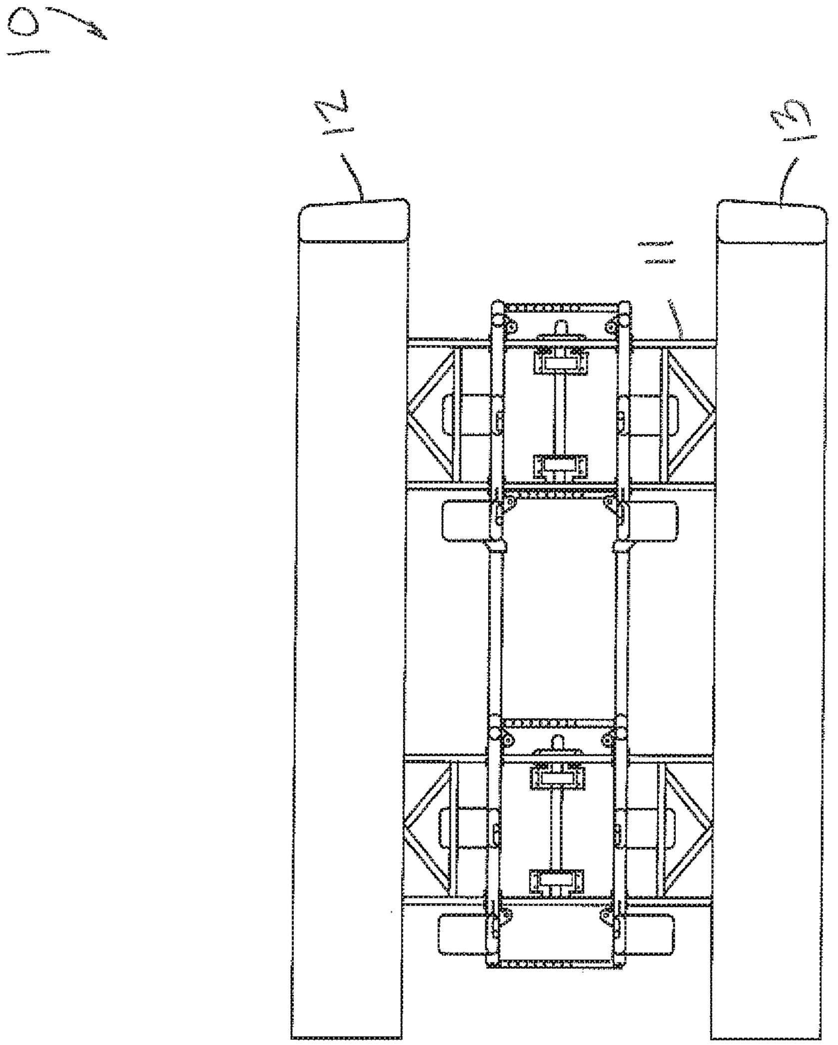


FIG 7

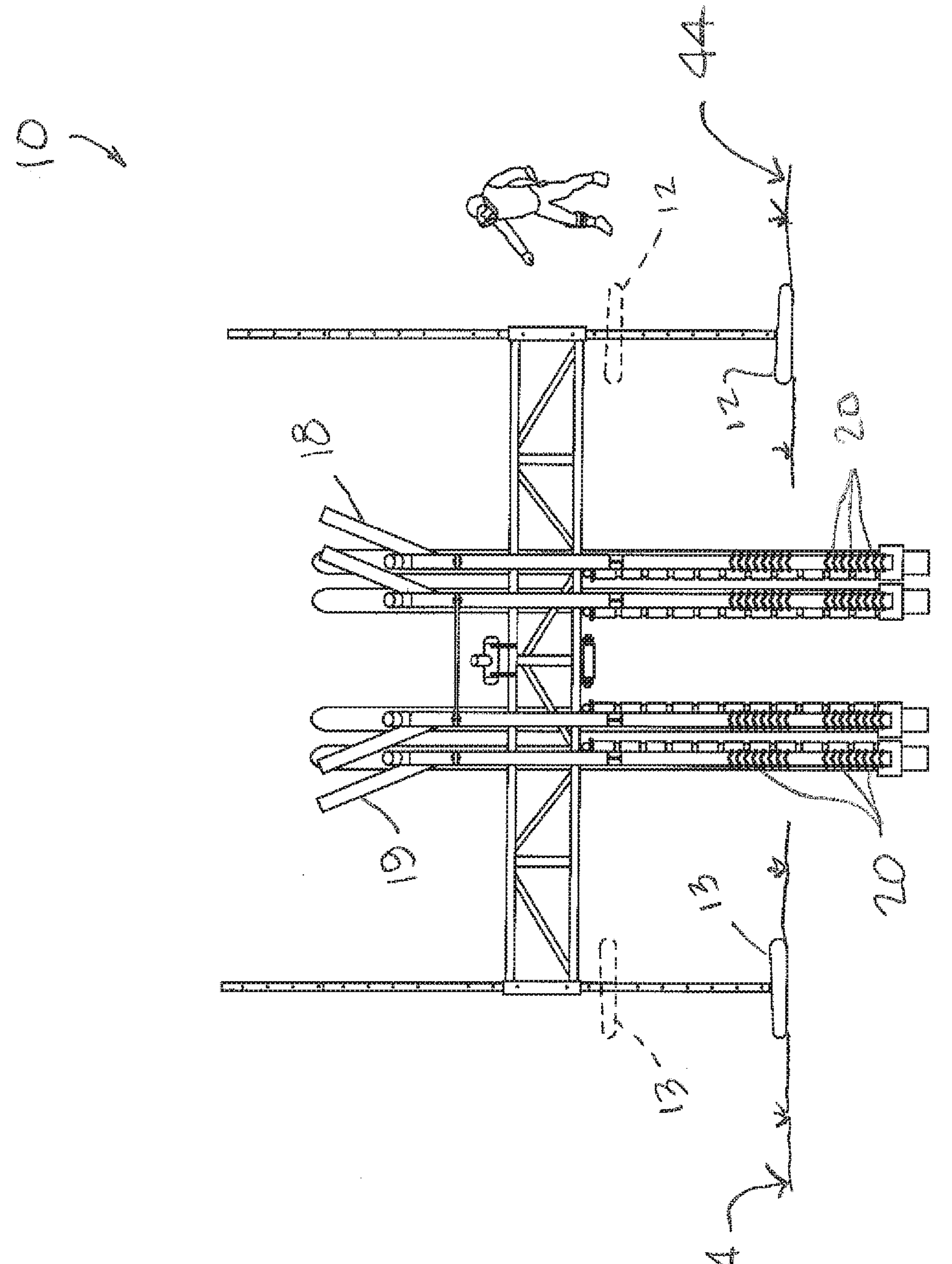


FIG 8

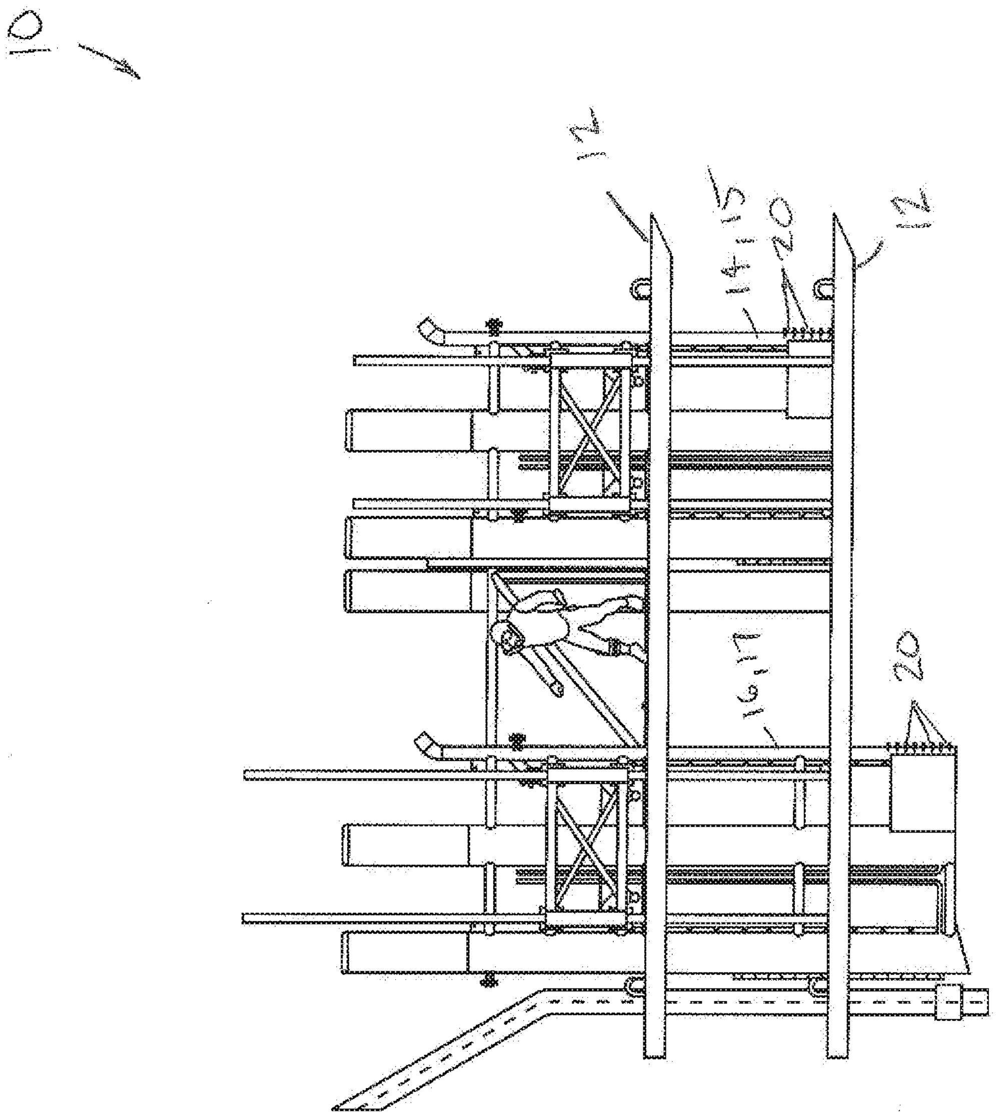


FIG 9

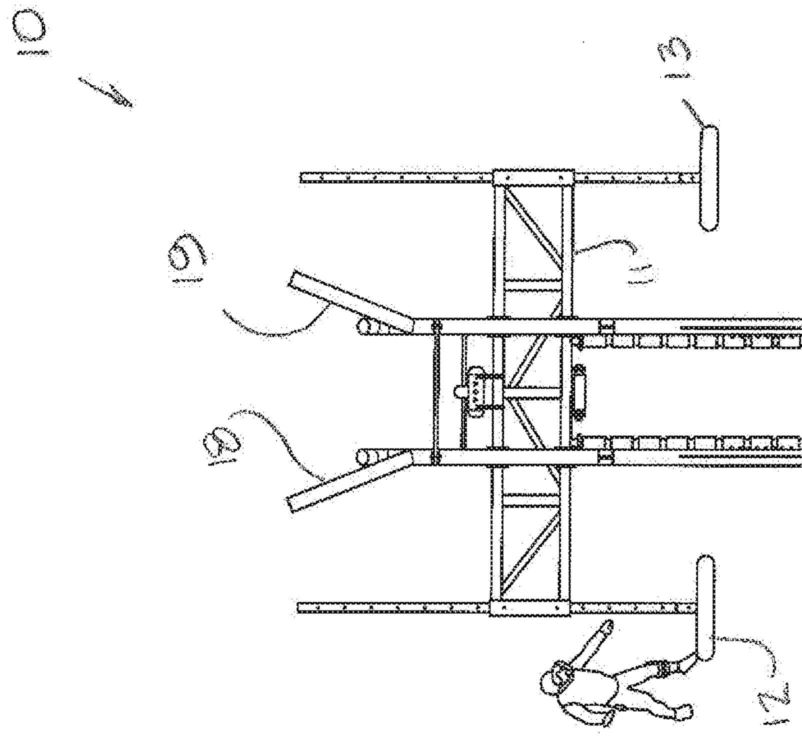


FIG 11

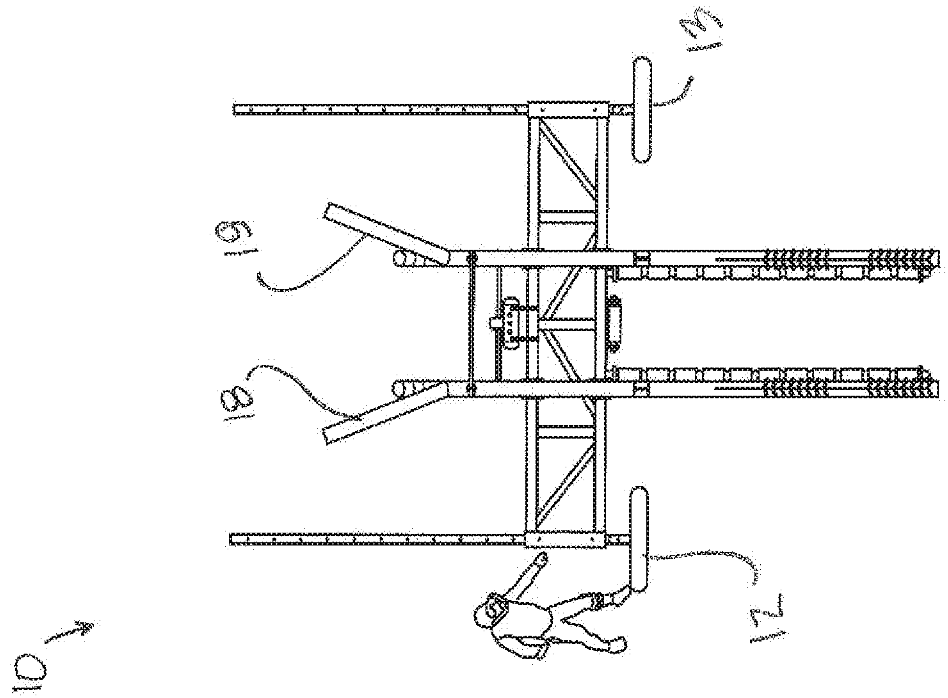


FIG 10

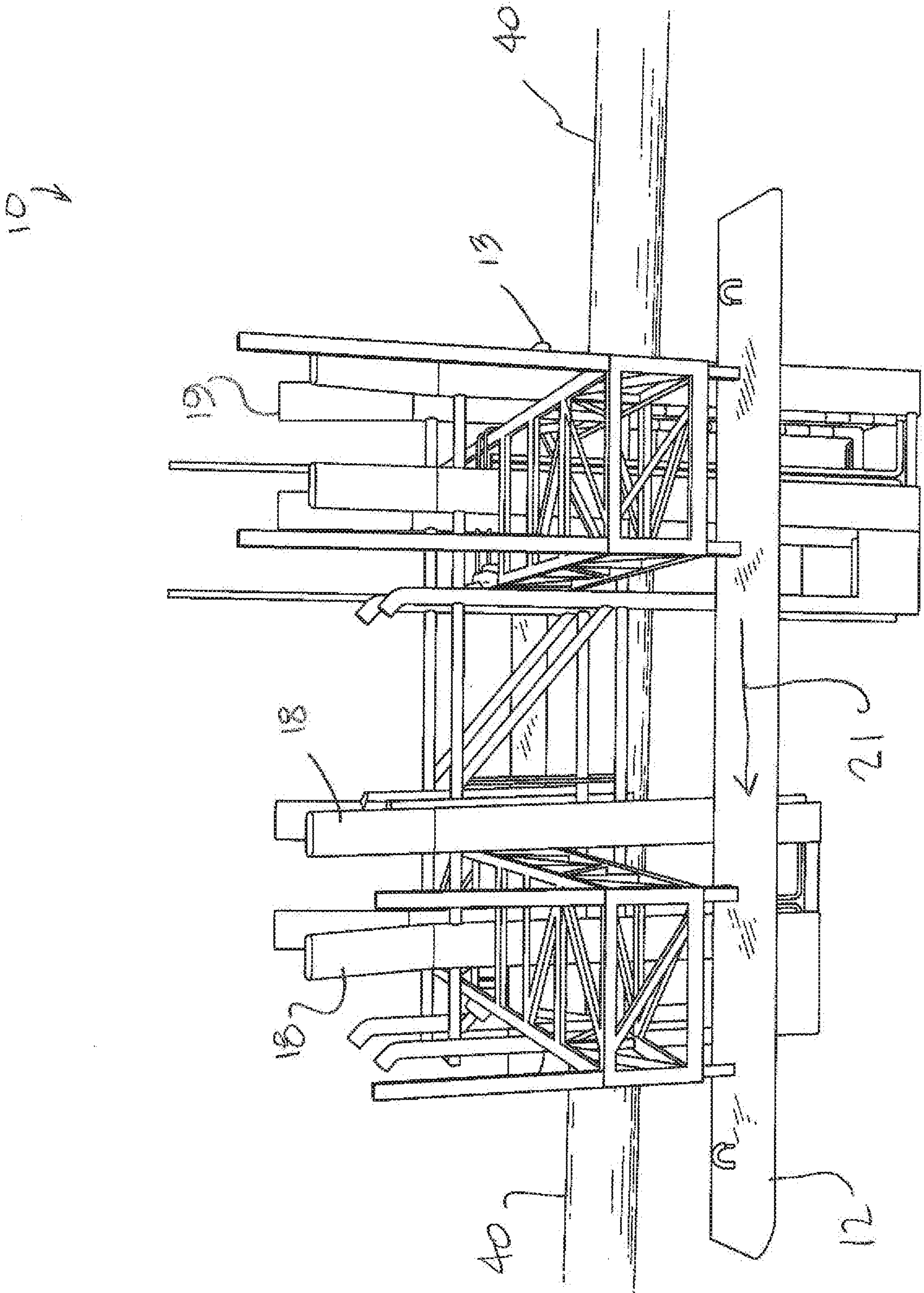


FIG 12

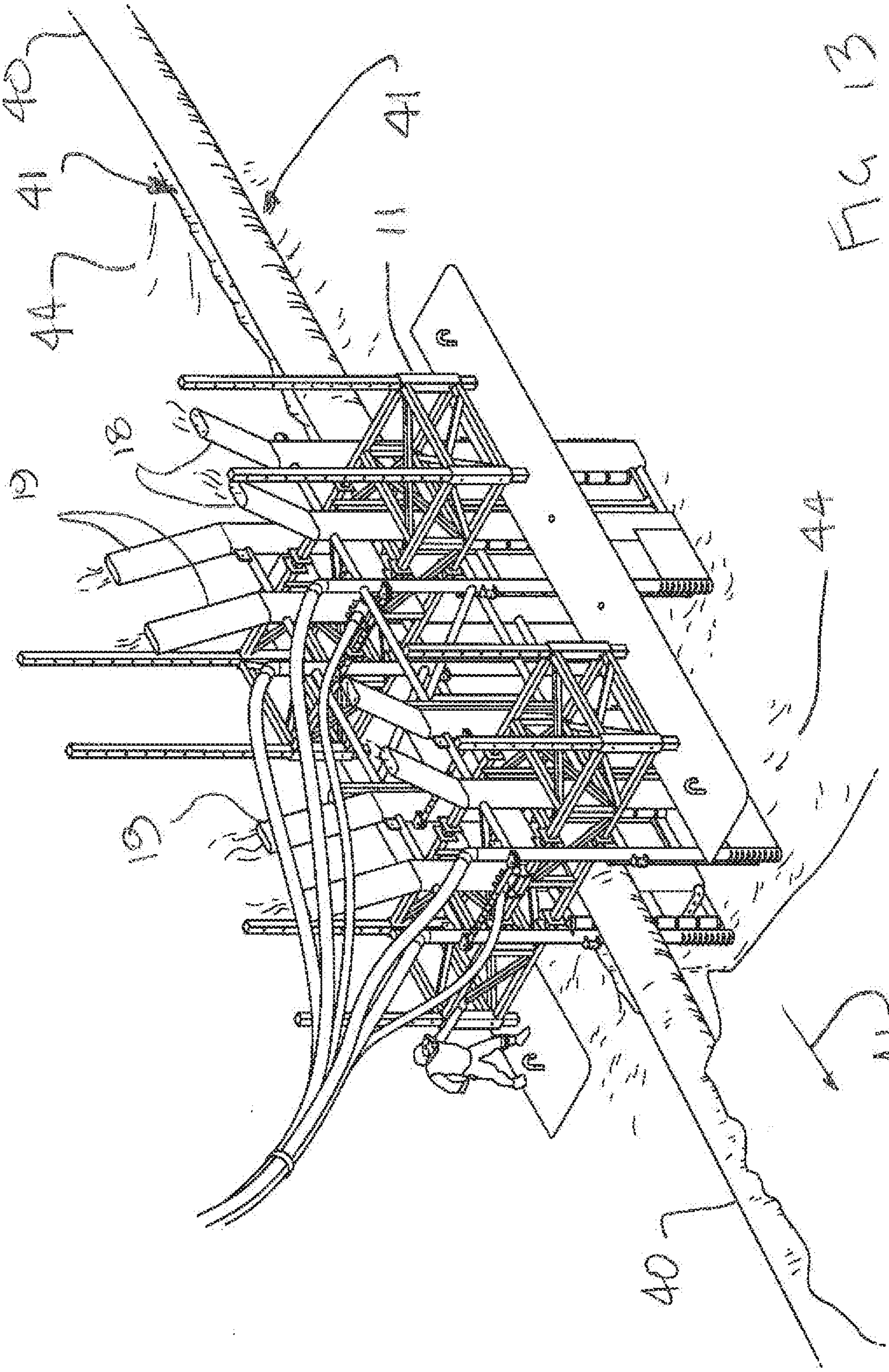


Fig 13

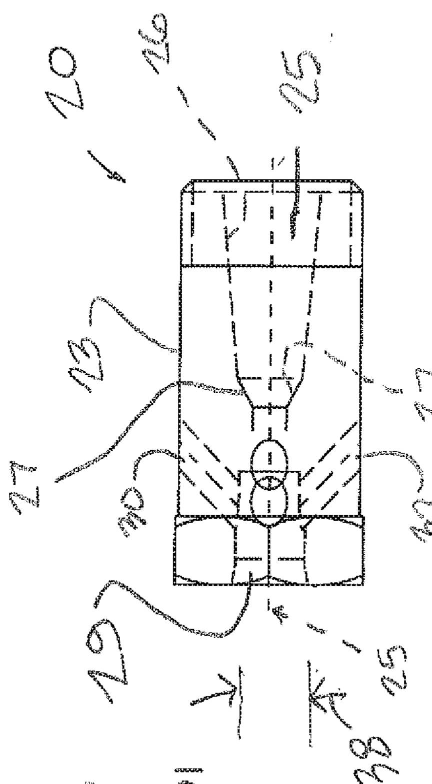


FIG 15

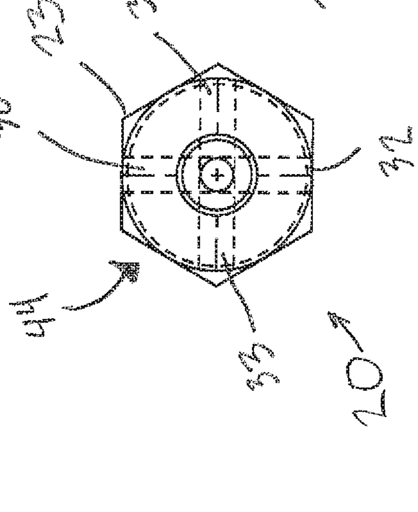


FIG 14

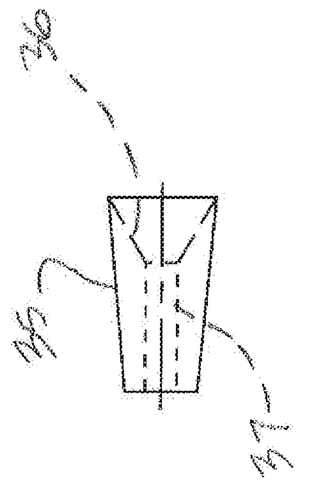


FIG 17

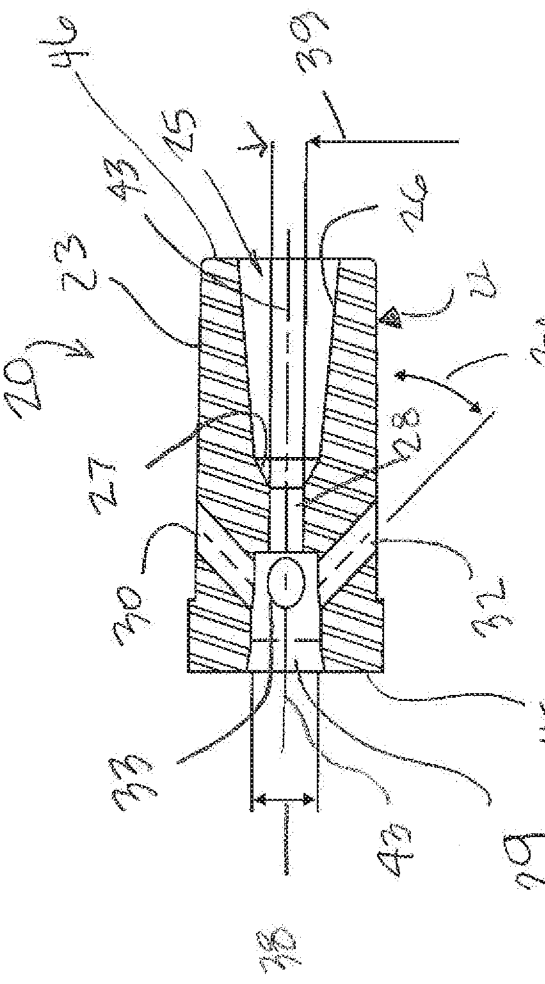


FIG 16

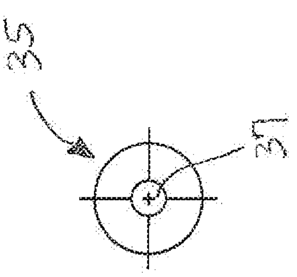


FIG 20

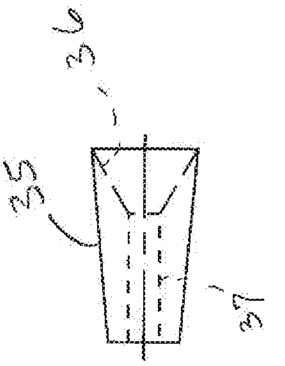


FIG 19

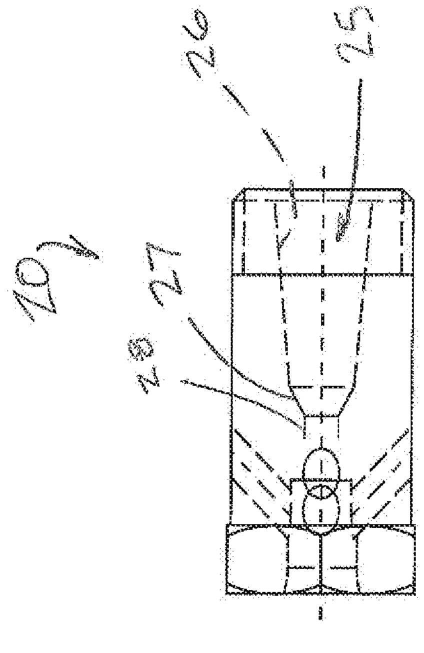


FIG 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/028929

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2017.01) E02F 5/10, B05B 1/02, E21B 7/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (2017.01) E02F 5/10, B05B 1/02, E21B 7/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Databases consulted: Esp@cenet, Google Patents, FamPat database, PatBase, Derwent Innovation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010129158 A1 ANTILL SR MARVIN J 27 May 2010 (2010/05/27)	1-32
A	US 2003177670 A1 ANDERSON RICHARD A 25 Sep 2003 (2003/09/25)	1-32
A	US 4274760 A NORMAN ROBERT M 23 Jun 1981 (1981/06/23)	1-32

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 Aug 2017	22 Aug 2017

Name and mailing address of the ISA:	Authorized officer
Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	COHEN Galit Telephone No. 972-2-5651806

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 33
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 33 does not meet the requirements of PCT Rule 6.2, which required that claims shall not relay on reference to the description or drawings for defining the technical features of the invention.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2017/028929

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
US 2010129158 A1	27 May 2010	US 2010129158 A1	27 May 2010
		US 8083437 B2	27 Dec 2011
		US 2009274520 A1	05 Nov 2009
		US 7637696 B2	29 Dec 2009
US 2003177670 A1	25 Sep 2003	US 2003177670 A1	25 Sep 2003
		US 6705029 B2	16 Mar 2004
		AU 2003218257 A1	08 Oct 2003
		AU 2003218257 A8	08 Oct 2003
		WO 03080940 A2	02 Oct 2003
		WO 03080940 A3	15 Jul 2004
US 4274760 A	23 Jun 1981	US 4274760 A	23 Jun 1981