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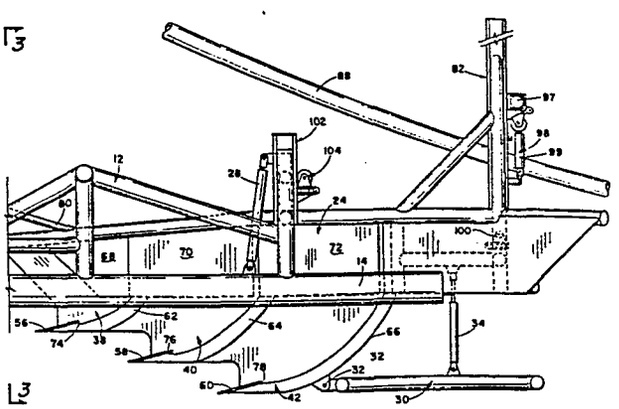
(54) Marine pipeline trenching plough.

(57) A combination trenching and pipe laying device (10) comprising a plow assembly (24) having at least two plows (38, 40, 42) thereof of progressively increasing depth wherein the leading plow initially opens the trench and the succeeding plow or plows increase the depth of the trench to a desired ultimate depth thereof, pipe laying apparatus (82) carried by the plow assembly (24) for laying of the pipe (88) in the trench substantially immediately behind the hindmost or trailing plow and load cells (98) or sensing devices provided on the pipe laying apparatus for detecting the physical orientation of the pipe on the apparatus in order that the optimum position of the pipe may be maintained during the pipe laying operation.



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This invention relates to improvements in pipeline laying apparatus and more particularly, but not by way of limitation, to a marine trenching plow for excavating a pipeline trench in an underwater location while simultaneously laying the pipe in the dredged trench.

It is common practice today to lay or bury marine pipelines on the floor of the ocean or other bodies of water to protect the pipeline from damage due to underwater currents, anchors, or other underwater hazards. The pipeline is normally carried on a lay barge and is wound onto and off of suitable reel means mounted on the barge whereby the pipeline is transferred to the ocean bottom. In addition, an underwater plow or trenching means is usually towed by the barge for dredging a pipeline receiving trench on the floor or bottom of the body of water. Conventional underwater trenching or marine dredging techniques frequently comprise the initial cutting of the trench on the floor of the ocean and subsequently laying the pipeline in the open trench. Another common method of installing a pipeline underwater comprises the laying of the pipeline on the ocean floor and subsequently excavating a trench beneath the pipe by using a high pressure water jet sled. Many attempts at solving the problems involved in the laying of marine pipelines have been devised, as shown in United States Patent Nos. 3,401,473, 3,333,432, 3,952,532, 4,011,727, 4,129,992, 3,898,852, 3,824,789, 3,788,085, 3,540,226, 3,347,054, 3,217,499, 2,142,136, 2,067,717, 4,112,695, 4,091,629, 4,037,422, 3,786,642, 3,372,461, 3,982,402 and 4,260,287. These devices have certain disadvantages, however, in that most of them require the laying of the pipe and the dredging of the trench therefor be accomplished in separate operations, which is both expensive and time consuming.

The present invention contemplates a novel combined pipe laying and trenching apparatus which has been particularly designed and constructed for overcoming the foregoing disadvantages. The novel device combines the laying of the pipeline and the dredging of a trench therefor in a single operation, thus providing for both economy and reduction of time required in a marine pipeline laying or construction operation. The novel device comprises a plurality of progressive depth cutting elements arranged in an in-line relation or sequence on a common plow, as opposed to the conventional single plow share. This construction reduces the towing force required by the barge for pulling the plow through the water. In addition, the structural requirement for the supporting of the plurality of cutting elements or blades is lessened with respect to the supporting requirements for a single plow arrangement, thus resulting in a construction which is both lightweight and efficient. As the multiple sequentially arranged cutting elements move through the earth at the bottom of the ocean, the water from an immediately preceding cutting element is injected into the cutting directly behind the cutting edge whereupon the water may be dispersed throughout the entire trench depth, or may be selectively directed to or applied to a particular cutting element or blade.

Each blade is provided with a trailing curved ramp means which elevates the cuttings upwardly from the bottom of the trench being dredged to the ground level or level of the floor of the body of water. The elevated cuttings are diverted or split by a V-shaped diverter means which directs the cuttings for discharge at a sufficiently great distance from the trench so as to substantially eliminate any of the cuttings or spoil falling back into the dredged trench. In addition, a step is provided at the juncture of the cutting element and the respective elevating ramp which permits the injection of the lubrication water between

the cuttings and the elevating ramp for reducing friction during the dredging or trenching operation, and for facilitating the elevation of the cuttings away from the bottom of the trench. The step means also fractures the cuttings, which enhances the co-mingling of the cuttings with the lubrication water, thus increasing the efficiency of the trenching operation. It is also preferable to provide water jet nozzles at the apex of the V-shaped diverter to further facilitate the delivery of the cuttings away from the trench.

The cutting elements or blades are pivotally secured to the support sled or skid means which slides over the surface of the ocean floor while being towed by the lay barge. Suitable actuators, such as hydraulic means, are provided for rotating the cutting module in the vertical direction, thus selectively elevating the cutting elements to a position above or out of engagement with the natural bottom of the ocean, thus allowing the entire apparatus to be towed through the ocean or body of water without cutting a trench. This is an important feature since there are many marine or underwater locations in offshore oil fields whereby many pre-existing pipeline have been buried to a depth of approximately three feet. The pivotal feature of the novel apparatus which permits the raising of the cutting elements allows the apparatus to be moved over or across an existing pipeline installation without damage thereto and without impediment of the operation of the novel combined trenching and pipe laying apparatus.

A depth regulating means is pivotally secured to the rear portion or trailing end of the rear or final cutting elements. The depth regulation means may be in the form of a pad which rides on the bottom of the dredged trench, and the angle of the regulating pad may be adjusted in relation to the bottom of the trench. The application of a downward force against the trench bottom by the regulating pad permits a control of the depth to which the trench

is cut. The soil encountered at the bottom of the trench is normally of a higher bearing resistance than the soil at the mud line, thus the use of the depth regulating means at the bottom of the trench permits a more precise control of the trench depth. Suitable retractable and extensible steering plate means is also provided on the skid or sled device for facilitating short radius turns during a trenching and pipe laying operation. A plurality of suitably cushioned roller means is provided, preferably at the rearward portion of the apparatus, for guiding the pipe being fed from the lay barge into the trench which has been dredged by the cutting elements disposed forwardly of the rollers. Load sensing means is operably connected between the roller means and suitable indicator gauges installed on the barge, thus providing a visual determination as to how hard the pipe is bearing on any specific portion of the roller means. This unique feature may be considered critical to the operation of the novel combination pipeline laying and trenching apparatus since it is highly desirable that the apparatus be positioned in a precise range relative to the catenary curve of the pipeline during the laying operation in order to prevent damage to the pipe. As is well known, the pipe catenary is a function of the water depth, the mechanical properties of the pipe, and the tension applied to the pipe. For a given water depth, the pipe catenary profile is a constant. The catenary of the tow wire for the apparatus is not a constant because the plowing force constantly changes as different types of soils are encountered during the trenching operation. The instrumented roller means give the operator of the equipment a substantially instantaneous indication of the plow position relative to the pipe, and thus facilitates immediate adjustment of the tow wire length, if required, in order to prevent pipe damage. The novel combined pipe laying and trenching apparatus is simple and efficient in operation and economical and durable in construction.

The invention will now be described further, by way of example with reference to the accompanying drawings, in which:-

FIGURE 1 is a side elevational view of a combined trenching and pipe laying apparatus embodying the invention, and illustrates the trenching apparatus in a raised position.

FIGURE 2 is a broken side elevational view of a combined trenching and pipe laying apparatus embodying the invention, and illustrates the trenching apparatus in a lowered position.

FIGURE 3 is a view taken on line 3-3 of FIGURE 2.

FIGURE 4 is a broken side elevational view of a combined trenching and pipe laying apparatus embodying the invention and particularly illustrates an instrumented cable shoot as used in the invention.

FIGURE 5 is a side elevational view of a modified plow structure embodying the invention.

FIGURE 6 is an end elevational view of the plow structure shown in FIGURE 5.

FIGURE 7 is a plan view of the plow structure shown in FIGURE 5.

Referring to the drawings in detail, reference character 10 generally indicates a combined trenching and pipe laying apparatus comprising a suitable skid means or assembly 12 having a pair of spaced substantially mutually parallel runners 14 and 16 adapted for disposition on the bottom of a body of water during a trenching and pipe laying operation. The runners 14 and 16 are preferably provided with beveled leading or forward ends as shown at 18 in FIGURE 1, to facilitate the movement of the skid assembly 12 over the bottom of the body of water, and suitable means 20 is provided on the forward or leading ends of each runner 14 and 16 for connection with a towing barge or vessel (not shown) by a usual tow rope 22, all as is well known in the art.

A plow assembly 24 has one end pivotally secured to the skid assembly 12 in any suitable manner, and as shown at 26 whereby the assembly 24 may be selectively moved between a raised position as shown in FIGURE 1 and a lowered position as shown in FIGURE 2. In the raised position of the plow assembly 24, the apparatus 10 may be towed along or over the bottom of the body of water without disturbing any previously laid pipe, or the like, which may be present in the area wherein the pipe laying and trenching operation is occuring. In the lowered position of the plow assembly 24, a trenching operation may be achieved, as will be hereinafter set forth. In order to raise and lower the plow assembly 24 or pivot the assembly 24 about the pivot connection means 26, it is preferable to operably secure suitable cylinder and rod means 28 between the skid assembly 12 and the plow assembly 24. It will be apparent that extension of the rod and cylinder means 28 as shown in FIGURE 1 will elevate the assembly 24 with respect to the bottom of the skid assembly 12 and contracting of the rod and cylinder means 28 will lower the plow assembly into the plowing position thereof.

It may be desirable to provide a depth regulating pad means 30 at the trailing end of the plow assembly 24, although many installations will not require such an element. The depth regulating pad means may have one end pivotally secured to the rear portion of the plow assembly in any suitable manner, such as shown at 32, and suitable cylinder and rod means 34 may be operably connected between plow assembly 24 and the depth regulating pad means 30 for pivoting of the pad means about the pivot connection 32.

The plow assembly means comprises a suitable support structure 36 having a plurality of plows 38, 40 and 42 mounted on the lower or under side thereof in spaced in-line relationship. Whereas three of the plows are shown herein, it is to be understood that there is no intention of limiting the invention to this particular number of plows since two or more plows have been found to provide efficient trenching results. The plows 38, 40 and 42 are of a generally similar construction with the exception of overall depth size. The leading plow 38 is of an overall depth or penetration size of a preselected dimension, the next succeeding plow 40 is of an overall depth or penetration size somewhat larger than the depth or penetration size of the plow 38, and the next succeeding plow 42 is of an overall depth or penetrating size somewhat larger or greater than the depth or penetration size of the plow 40. In this manner, during a plow or trenching operation, the trench is initially opened by the leading plow 38, and deepened or increased in depth by each of the succeeding plows 40 and 42 to achieve the desired end depth for the trench. It will be apparent that the initial penetration of the bottom of the body of water by a first relatively shallow plow, such as the plow 38, followed by succeeding trenching of the initially opened trench by the plows 40 and 42 creates considerably less drag on the apparatus 10 than the digging or opening of a trench at the desired end depth thereof by the penetration of the bottom of the body of water by a single plow.

The plows 38, 40 and 42 preferably each comprise a pair of substantially mutually parallel spaced side plates 44, 46 and 48, respectively (FIGURE 3). Each pair of plates 44, 46 and 48 is rigidly secured to an arcuate bottom plate 50, 52, and 54, respectively, whereby each plow 38, 40 and 42 is of a substantially scoop-shaped configuration, with the forward or leading ends thereof open to perform the plowing operation. The arcuate bottom plates 50, 52 and 54 function as elevating ramps for the respective plow. Of course, each plow 38, 40 and 42 is also provided with a sharp cutting edge means or elements 56, 58 and 60, respectively, (FIGURE 2) as is well known, for facilitating the penetration of the soil by the plows during a plowing or trenching operation, as will be hereinafter set forth. Centrally disposed longitudinally extending rib members 62, 64 and 66 are rigidly secured to the outer surface of the arcuate plate members 50, 52 and 54, respectively.

Each arcuate plate means or elevating ramp 50, 52 and 54 terminates at the upper end thereof in communication with a V-shaped diverter plate means 68, 70 and 72, respectively. In addition, step means 74, 76 and 78 is provided at the juncture of each cutting element 56, 58 and 60 with its respective elevating ramp 50, 52 and 54. The step members 74, 76 and 78 permit or provide for the injection of lubricating water between the cuttings and the elevating ramps during a trenching operation, thus minimizing the friction and aiding in the elevation of the cuttings away from the bottom and sides of the trench. The step members further fracture the cuttings which enhances the co-mingling of the cuttings and the lubrication water during the trenching operation, thus increasing the overall efficiency thereof. It may be desirable to provide lubrication water jet nozzle means (not shown) at the apex of each diverter plate means 68, 79 and 72, and a jet

water hose 80 may be secured to the plow assembly 24 in open communication with the jet nozzles for supplying the lubrication water thereto, as is well known. It may also be desirable to provide water jet means (not shown) at each step 74, 76 and 78 for directing lubrication water to the associated elevating ramp during a trenching operation.

The trailing end of the plow assembly 24 is provided with an upstanding frame assembly generally indicated at 82 having a pair of spaced outwardly diverging support arm members 84 and 86 forming a substantially V-shaped trough 87 therebetween for receiving a length of pipe 88 to be layed or deposited in the trench being excavated by the plows 38, 40 and 42. The V-shaped trough 87 is open to a hiatus 96 provided between a pair of spaced upright sensing roller means 92 and 94 and directs the pipe 88 into a position within the hiatus during the pipe laying operation, as will be hereinafter set forth. The sensing roller means 92 and 94 are suitably mounted on the upright support means 82 and are operably connected with suitable load cell means generally indicated at 98. At least one horizontally extending sensing roller means 100 is provided on the upright support apparatus 82 and disposed at the proximity of the bottom of the hiatus 96 for sensing the pipe thereagainst during a pipe laying operation.

A second upright support assembly 102 is secured on the plow assembly 24, and is provided with at least one horizontally extending sensing roller means 104 adapted to receive the pipe 88 thereagainst prior to the entry of the pipe into the hiatus 96. The load cells and/or sensing rollers are operably connected with suitable or well known gauging equipment or apparatus (not shown) provided on the towing vessel or barge (not shown), and are operable by the engagement of the pipe 88 therewith for transmitting information to the personnel on the barge

relating to the position of the pipe during the laying operation, as will be hereinafter set forth.

Referring now to FIGURE 4, an instrumented cable guide chute means is generally indicated at 106 and may be secured to the plow assembly 24 in any suitable manner to provide a chute for receiving the cable 89 therethrough or thereagainst during a pipe laying operation. The chute means 106 is preferably provided with suitable sensing rollers 108 and 110 at the opposite ends thereof which are "instrumented" in any well known manner for "telling" or transmitting load information to the surface of the body of water or to the gauging instrumentation provided on the lay barge. The load of the cable 89 on the chute means 106 may be transmitted for visual interpretation by the personnel on board the lay vessel in order to ascertain the progress of the cable laying operation.

In use, the apparatus 10 initially opens a trench on the floor or bottom of a body of water and lays the pipe in the opened trench simultaneously with the continued dredging of the trench ahead of the pipe being laid therein. The skid means 12 may be pulled over the bottom or floor of the body of water by the tow rope 22 secured between the lay barge or vessel and the skid means 12, as is well known. The cylinder and rod means 28 may be actuated in any suitable or well known manner for contracting of the rod whereby the plow assembly 24 is disposed in the lowermost position therefor, thus engaging the floor or bottom of the body of water. The progressive depth arrangement between the successively disposed or mounted plows 38, 40 and 42 greatly facilitates the opening of a trench, it being apparent that the initial opening of the trench is accomplished by the leading plow 38, and the depth of the opened trench is increased by the successive engagement thereof by the plows 40 and 42. The elevating ramps 50, 52 and 54 direct the cuttings upwardly from the

bottom and sides of the trench and into contact with the respective diverters 68, 70 and 72. The diverters direct the cuttings in a direction to the sides of or away from the open trench. In addition, the steps 74, 76 and 78 fracture the cuttings, thus facilitating the dispersing thereof by the diverter plates. Blade lubricating water is directed into the cutting substantially immediately or directly behind the cutting elements 56, 58 and 60, which reduces the friction between the cuttings and the elevating ramps. It will be apparent that this method and means for the dredging or opening of an under water trench greatly reduces the towing force required for moving the apparatus 10 through the water during the trenching operation.

The pipe 88 is carried by the plow assembly 24 and is directed above the sensing roller means 104 and through the hiatus 96 for engagement with the open trench substantially immediately behind the apparatus 10. As the apparatus 10 is moved over the floor of the body of water in a forward direction, the trench is opened by the plows 38, 40 and 42, and the pipe 88 is deposited within the open trench in the area thereof behind the forwardly moving apparatus 10.

It may be desirable to utilize the depth regulating pad means 30 during the trenching operation. If so, the pad means may be forced downwardly against the bottom of the trench, thus limiting or determining the position of the trailing plow 42 and controlling the ultimate depth of the trench. In many instances, however, it is found that this feature is not required.

In the event the apparatus 10 approaches an area of the floor of the body of water wherein previously laid pipe, cable, or the like is present, and it is not desirable to disturb same, the rod and cylinder means 28 may be actuated in the well known manner for pivoting the plow

assembly 24 about the pivot 26 for elevating the plows 28, 40 and 42 to a position above the bottom or floor of the body of water. The apparatus 10 may then be towed or moved through the water without engagement of the bottom by the plows, thus avoiding any damage to pre-existing buried (or unburied) equipment.

The sensing roller means utilized in the apparatus of the invention are preferably covered or coated with rubber, or the like, for precluding damage to the outer periphery of the pipe 88 in the event the pipe comes into engagement therewith. The upright sensing rollers 92 and 94 are activated when engaged by the pipe, thus providing a signal to the operating personnel aboard the lay vessel as to the position of the pipe, and permitting proper action to be taken for correction of the pipe position. Similarly, in the event the load on any of the sensing rollers or other load sensing cells exceeds a predetermined quantity, a signal is provided to the operating personnal which indicates an undesirable position or condition of the underwater portion of the pipe, and the condition may be promptly corrected in the usual or well known manner. The V-shaped configuration of the trough 87 facilitates the positioning of the pipe 88 within the hiatus 96, and since this is frequently accomplished when the pipe is under water and not readily visible, this feature becomes of value.

The signalling feature of the apparatus 10 wherein the under water orientation of the pipe may be detected from the surface of the water is important in the overall operation of the apparatus 10 since the catenary curve of the pipeline is critical to prevent damage to the pipe during the laying operation. The sensing of the load on the sensing cells readily determines whether or not the catenary curve of the pipeline is within the permissible limits, thus providing not only an efficient trenching

operation, but also an efficiently controlled pipe laying operation.

As will be seen in FIGURE 3, the sensing means 98 includes an upper sensing roller 97 which normally horizontally disposed across the upper end of the hiatus 96. The roller 97 is preferably pivotal about one end thereof whereby the roller may be moved toward a substantially vertical orientation for providing acess to the hiatus 96 when the pipe 88 is initially installed or admitted into the hiatus. The roller 97 may be pivoted about the one end thereof in any suitable manner, such as by a fluid cylinder means 99, and may be returned to the normal horizontal position therefor when the pipe 88 has been inserted into the hiatus 96. The sensing rollers 97 and 100 provide a signal at the surface or remote from the pipe laying apparatus when the orientation of the pipe is excessively high or low within the hiatus 96, thus permitting the operating personnel to adjust the position of the pipe to the optimum underwater position therefor, which is preferably substantially centrally disposed within the hiatus. The pipe 88 extending through the hiatus 96 in the natural catenary angle therefor is laid into the ditch or trench opened by the plow apparatus, and is essentially supported by the bottom of the ditch during the pipe laying operation.

In actual underwater ditching operations, it has been found that different types of marine soils responds to the plowing operation in different or unique ways and as a result it is not practical to consider that a single plow structure may be efficiently utilized in all soil environments. Some marine soils resist an "upright" standing position at the sides of a ditch opened therein, and may fall into the ditch or tend to reclose the ditch. In this case, the particular plow configuration show in FIGURES 5, 6 and 7 may be utilized in lieu of the plow

configuration shown in FIGURES 1 through 4. Reference character 130 generally indicates a modified plow structure comprising plow shares 132, 134 and 136 which are substantially identical to the plow shares 38, 40 and 42, respectively, as hereinbefore set forth and which function in substantially the same manner during a trenching or ditching operation.

The opposite sides of each plow share 132, 134 and 136, however, are enclosed by sidewalls which extend rearwardly from each plow substantially throughout the length of the skid 12 and ride along the sides of the trench or ditch as it is opened by the plows. As shown herein, a pair of spaced elongated plates 138 and 140 extend downwardly from the skid assembly 12 substantially throughout the length thereof and preferably are disposed at a downwardly diverging angle with respect to each other. The plates 138 and 140 form sidewalls for the leading plow share 132 and as the plow 132 initially opens the trench the walls 138 and 140 slide or glide along the opened trench for packing the soil behind the plow 134 for substantially precluding collapsing of the ditch as the trench is opened. A second pair of spaced elongated plates 142 and 144 may be suitably secured along the lower edge of the plates 138 and 140, respectively, and form sidewalls for the plow share means 134 and extend rearwardly therefrom to perform substantially the same function as the plates 138 and 140. It may also be preferable that the plates 142 and 144 be inwardly and downwardly diverging with respect to one another. Another pair of spaced elongated plates 146 and 148 may be suitable secured along the lower edge of the plates 142 and 144, respectively, and form sidewalls for the plow share means 136 and extend rearwardly therefrom for substantially the same purpose as the plates 138 and 140, and the plates 142 and 144. Here again, it may be preferable that the plates 146 and 148 be inwardly and

downwardly diverging with respect to one another.

In addition, in order to facilitate the stabilization of the upper surfaces of the sides of the trench during the ditching or trenching operation it may be desirable to provide oppositely disposed flange or shelf means 150 and 152 for the apparatus 130 adapted to glide or ride along the bottom of the body of water and at the sides of the opened trench. The flanges 150 and 152 may be in the form of elongated substantially horizontally disposed plates secured to the opposite sides of the walls 138 and 140 and at the upper edges thereof whereby the plates 150 and 152 will be disposed against the horizontal surfaces at the upper end or edge of the opened trench. It will be apparent that the apparatus 130 provides wall means adapted to slide along the downwardly extending substantially vertical sidewalls of a ditch during the trenching operation as well as shelf or flange means adapted to move or slide over the bottom surface of the water immediately adjacent the side edges of the opened trench, thus facilitating the opening of a trench in relatively unstable soil or the like which resists stabilization of the sides of the opened trench.

From the foregoing it will be apparent that the present invention provides a novel combined trenching and pipe laying apparatus wherein the trenching operation is achieved by a plurality of progressive depth plow members, and the pipe is laid in the opened trench substantially immediately behind the plows. Sensing means is provided for acertaining the orientation of the pipeline being laid in the trench whereby a control of the catenary curve of the pipe may be maintained during the pipe laying operation for substantially precluding accidental damage to the pipe during the laying thereof.

CLAIMS

1. A trenching and pipe laying apparatus (10, 130) comprising a plowing device (24) having a trailing and a leading end, characterized in that at least two plows (38, 40, 42 or 132, 134, 136) are provided on the plowing device (24) for the initial opening and subsequent deepening of a trench and pipe laying apparatus (82) carried on the plowing device adapted to deposit the pipe (88) in the opened trench substantially behind the hindmost plow (42 or 136) simultaneously with the continuation of the trenching operation.

2. A trenching and pipe laying apparatus according to claim 1, characterized in that two plows (38, 40, 42, or 132, 134, 136) comprise a leading plow (38 or 132) having cutting means for initially opening of the trench and at least one trailing plow (40, 42 or 134, 136) of a progressively greater depth than the leading plow (38 or 132) for deepening of the initially opened trench.

3. A trenching and pipe laying apparatus according to claim 1, characterized in that a sensing device (104) is carried by the plowing device (24) and responsive to the physical orientation of the pipe (88) during a pipe laying operation whereby a visual indication of the position of the pipe is provided for affording a control thereof to reduce damage to the pipe during the pipe laying operation.

4. A trenching and pipe laying apparatus according to claim 3, characterized in that the sensing device (104) includes sensing roller (100) responsive to engagement thereof by the pipe (88) during the pipe laying operation to provide the indication of the position of the pipe.

5. A trenching and pipe laying apparatus according to claim 1, characterized in that a skid assembly (12) supports the plowing device (24) and pipe laying apparatus (82) during travel thereof over a surface wherein the trench is to be dredged.

6. A trenching and pipe laying apparatus according to claim 5, characterized in that a pivot connection (26) secures the plowing device (24) to the skid assembly (12), a device co-operating between the skid assembly (12) and plowing device (24) pivots the plow about

the pivot to provide alternate lowered and raised positions for the plowing device.

7. A trenching and pipe laying apparatus according to claim 1, characterized in that each plow (38, 40, 42) comprises a pair of spaced mutually parallel side plates (44, 46, 48), an arcuate plate (50, 52, 54) secured between the side plates (44, 46, 48) providing an elevating ramp for each plow for facilitating elevation of cuttings from the bottom of the trench during the trenching operation.

8. A trenching and pipe laying apparatus according to claim 7, characterized in that each plow (38, 40, 42) is provided with a cutting element (56, 58, 60) at the leading edge (18) of the elevating ramp for cutting the trench and directing the cuttings on to the elevating ramp for elevation away from the bottom of the trench.

9. A trenching and pipe laying apparatus according to claim 8, characterized in that a step member (74, 76, 78) is provided at the juncture between each cutting means and its respective elevating ramp for fracturing of the cuttings to reduce friction during the trenching operation.

10. A trenching and pipe laying apparatus according to claim 8, characterized in that a diverter plate (68, 70, 72) in communication with the elevating ramp (50, 52, 54) of each plow (38, 40, 42) for diverting the cuttings away from the open upper end of the trench during the trenching operation.

11. A trenching and pipe laying apparatus according to claim 1, characterized in that a depth control pad (30) secured to the trailing end (32) of the plowing device (24) for controlling the ultimate depth of the trench.

12. A trenching and pipe laying apparatus according to claim 1, characterized in that the plowing device (24) comprises a first plow (38 or 132) of a selected depth for the initial opening of the trench and a second plow (40 or 134) disposed in substantial axial alignment with the first plow and of a progressively greater depth than the first plow for increasing the depth of the trench.

13. A trenching and pipe laying apparatus according to claim 1, characterized in that it includes a pipe receiving device (87) provided on the plowing device (24) for guiding of the pipe (88) into the optimum position in the apparatus for laying the pipe in opened trench behind the trailing end of the plow.

14. A trenching and pipe laying apparatus according to claim 13, characterized in that the pipe receiving device comprises V-shaped trough (87) in open communication with a pipe receiving hiatus (96) for facilitating the positioning of the pipe in the hiatus.

15. A trenching and pipe laying apparatus according to claim 14, characterized in that it includes sensing rollers (92, 94) provided at the sides of the hiatus (96) and responsive to the lateral position of the pipe for providing a visual, indication thereof in order that the position of the pipe may be maintained at the optimum orientation thereof during a pipe laying operation.

16. A trenching and pipe laying apparatus according to claim 14, characterized in that it includes a sensing roller (97, 100) provided at the upper and lower ends of the hiatus (96) and response to the vertical position of the pipe for providing a visual indication thereof in order that the position of the pipe may be maintained at the optimum orientation thereof during a pipe laying operation.

17. A trenching and pipe laying apparatus according to claim 1, characterized in that it includes sidewalls (44, 46, 48) provided on the opposite sides of each plow (38, 40, 42), the sidewalls extending along the side of the respective plow and rearwardly therefrom for sliding engagement with the sidewalls of the trench opened by the respective plow for facilitating the trenching operation.

18. A trenching and pipe laying apparatus according to claim 1, characterized in that it includes oppositely disposed substantially horizontally extending shelves (150, 152) provided on the pipe laying apparatus for sliding engagement with the upper surface immediately adjacent the upper edges of the opened trench during the trenching operation.

19. A trenching and pipe laying apparatus according to claim 1, characterized in that each plow comprises a pair of spaced mutually

parallel side plates (44, 46, 48), an arcuate plate (50,52, 54) secured between the side plates providing an elevating ramp for each plow for facilitating elevation of cuttings from the bottom of the trench during the trenching operation, each plow being provided with a cutting element (56, 58, 60) at the leading edge of the elevating ramp for cutting the trench and directing the cuttings on to the elevating ramp for elevation away from the bottom of the trench, step members (74, 76, 78) provided at the juncture between each cutting element and its respective elevating ramp for fracturing of the cuttings to reduce friction during the trenching operation, and a jet (80) provided in the proximity of each step member for facilitation the trenching operation.

20. A trenching and pipe laying apparatus according to claim 19, characterized in that each plow comprises diverter plates (68, 70, 72) in communication with the elevating ramp (50, 52, 54) of each plow for diverting the cuttings away from the open upper end of the trench during the trenching operation, the jet (80) being provided the proximity of the diverter plates for facilitating the trenching operation.

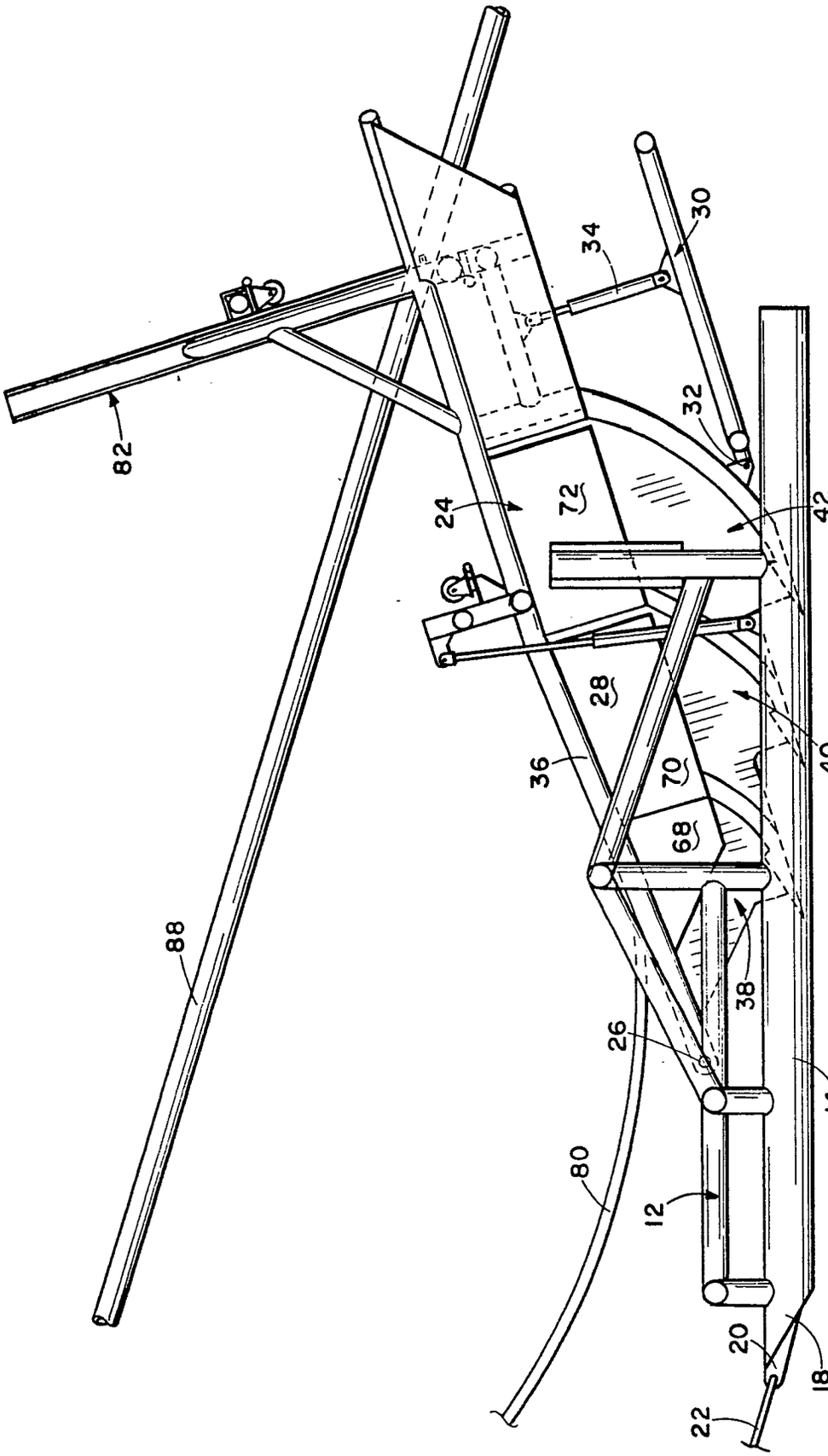

Fig. 1

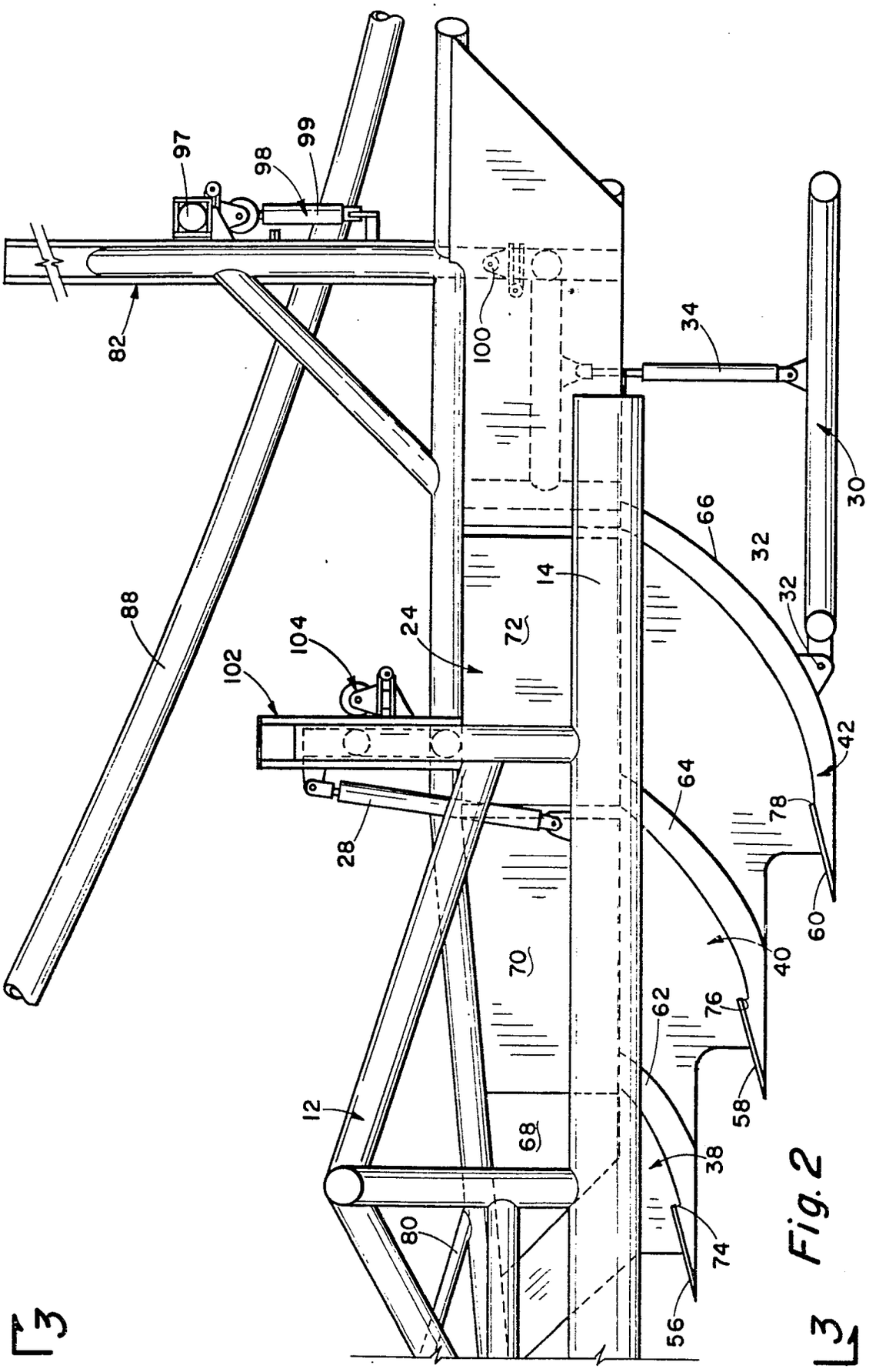
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Fig. 2

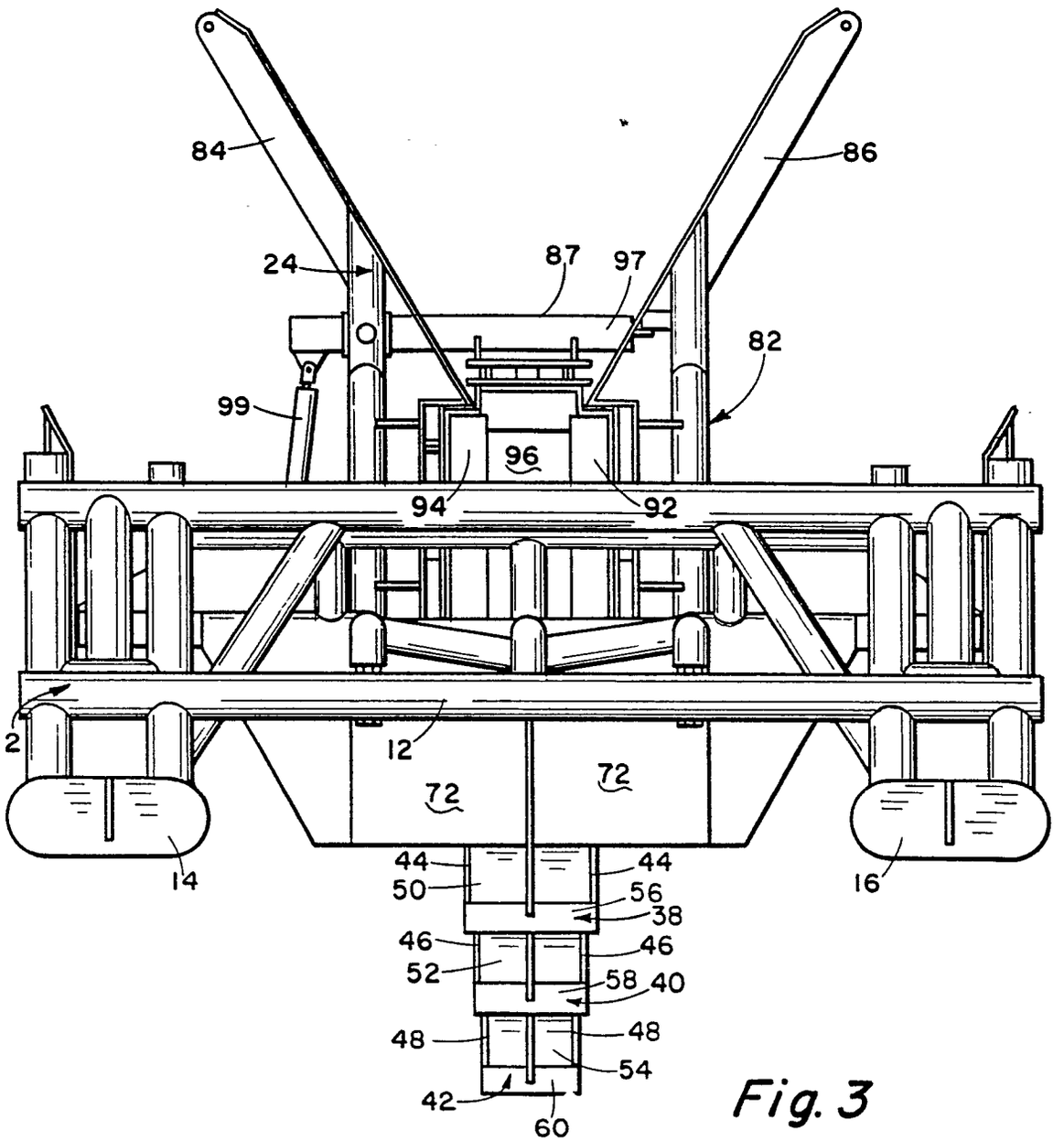
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Fig. 3

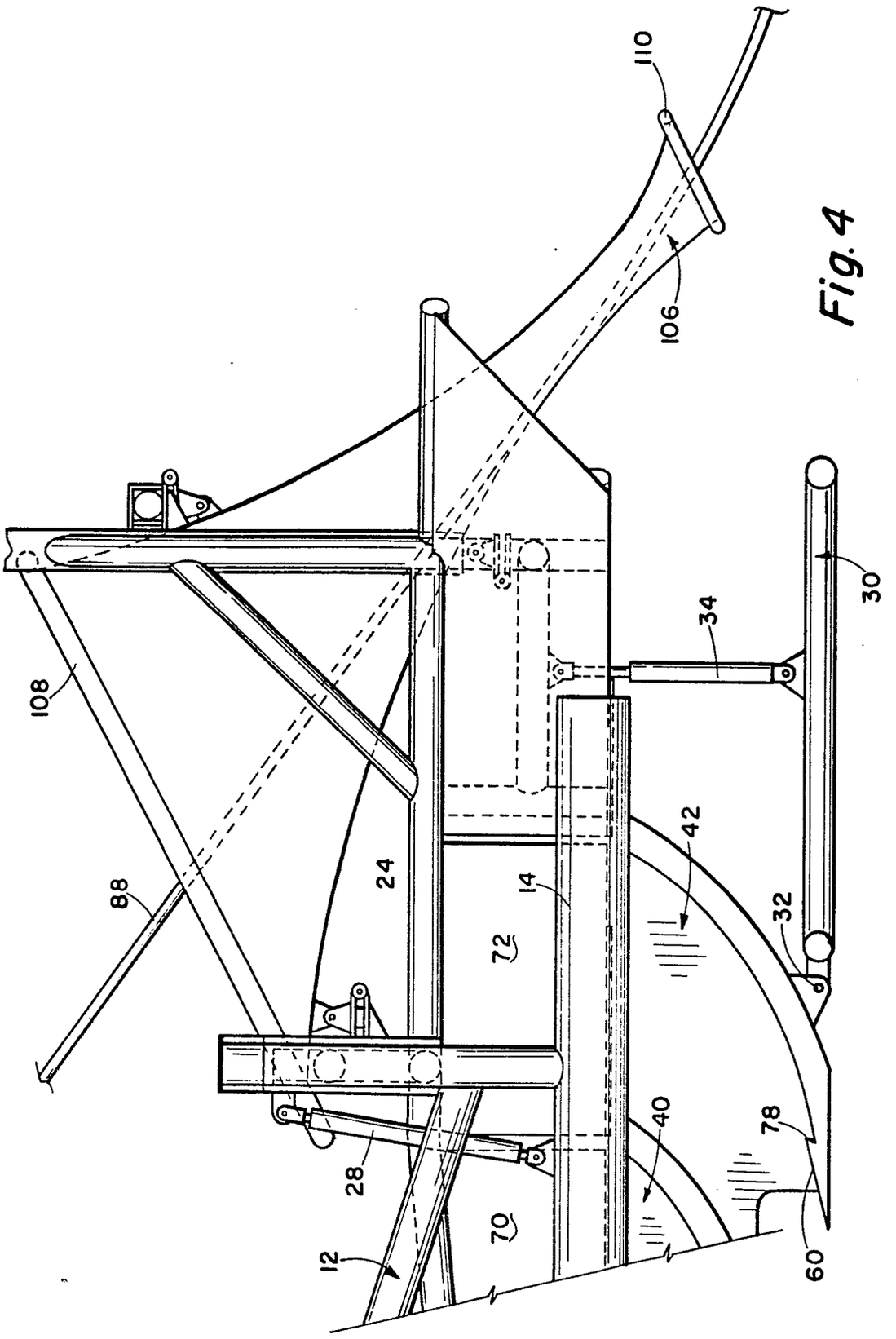

Fig. 4

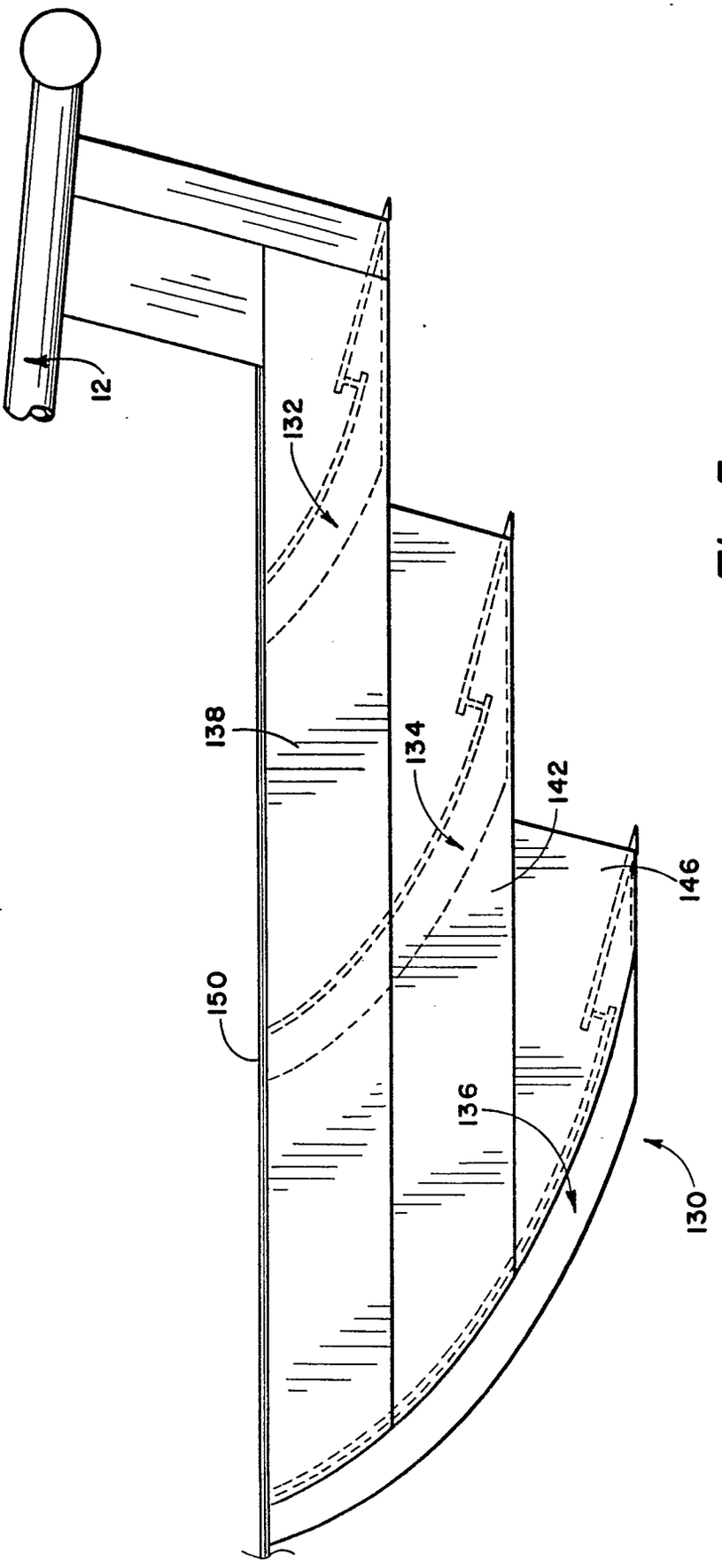

Fig. 5

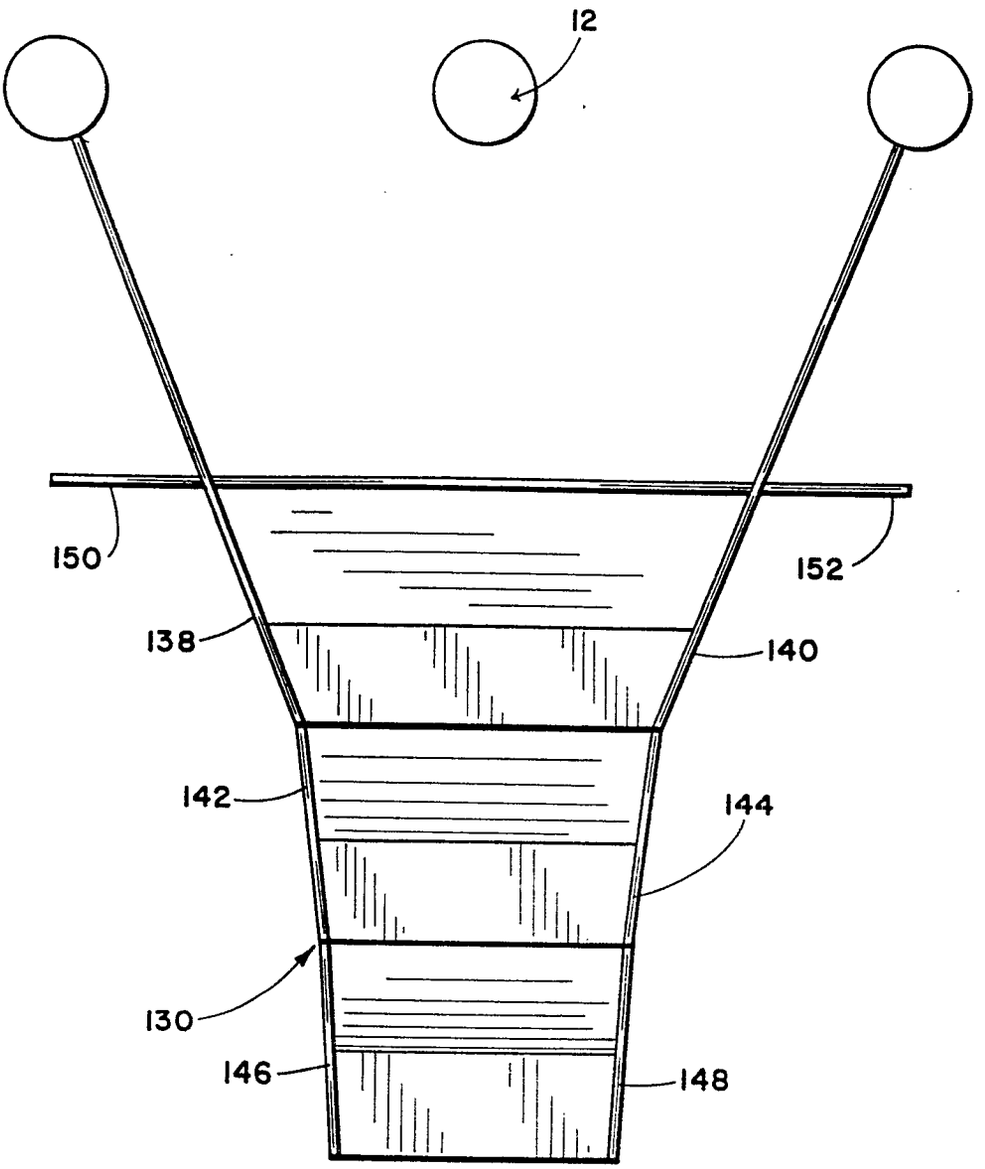

Fig. 6

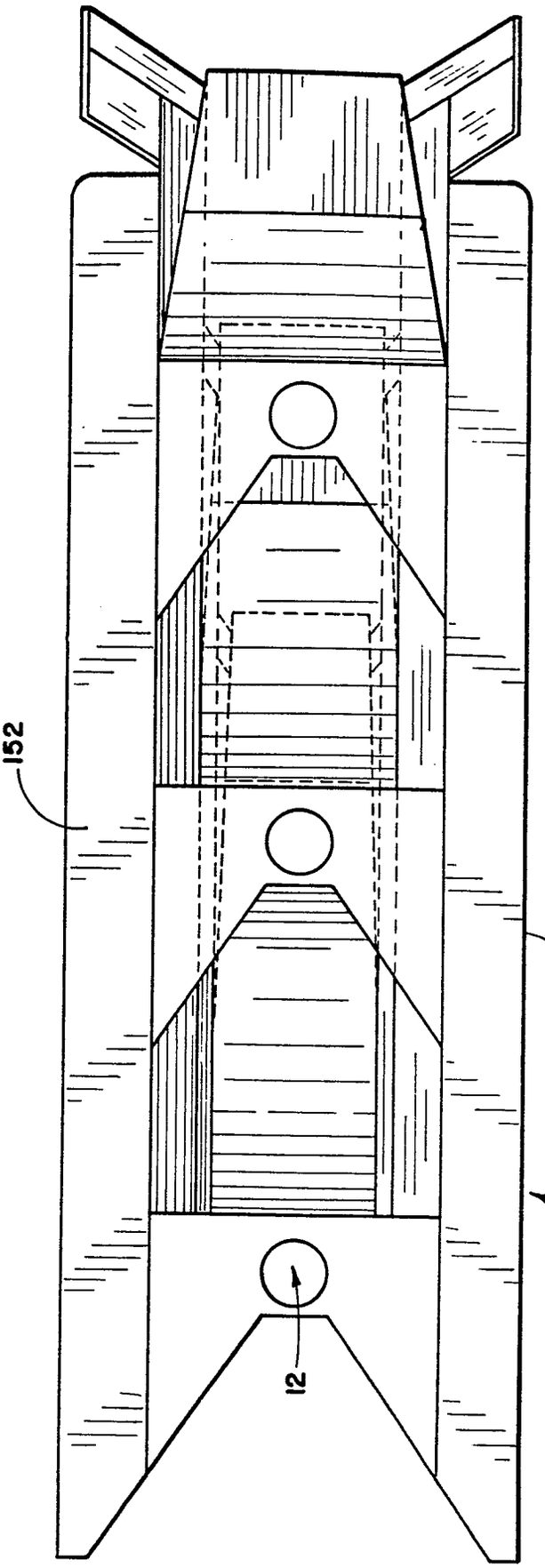

Fig. 7

0164202

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 85302860.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
D,A	DE - A1 - 2 815 673 (GIBSON INDUSTRIES INC.) * Totality *	1,5	F 16 L 1/04 E 02 F 5/02 B 63 B 35/04
A	FR - A1 - 2 475 681 (COFLEXIP) * Totality *	1,5	
A	FR - A1 - 2 455 235 (COFLEXIP) * Totality *	1,5	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

F 16 L 1/00
E 02 F 5/00
B 63 B 35/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-07-1985	SCHUGANICH

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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